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Review

Addressing Multidimensional Energy Poverty Implications on Achieving Sustainable Development

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Abstract: This study examines whether shifts in the stance of policymaking can account for the observed predictability in excess energy poverty (EP) or fuel poverty (FP) levels. Energy-related poverty is a subcategory of global poverty and can be categorized into accessibility problems related to EP and affordability issues associated with FP, which have a similar but not identical meaning. Furthermore, developed and developing countries have different energy issues, as the former deal with FP and the latter with EP. However, there are discrepancies in EP not only between countries but within counties as well; for instance, there are differences in urban and rural areas too. Difficulties in energy access can be devastating for people living at risk of poverty. Social welfare, although at stake due to the energy crisis sparked at the same time as the warfare in eastern Europe. Renewables and green fossil fuels have price fluctuations, and inflation is also a stress factor in EP. Generally, solutions to EP and FP could be, inter alia, the adoption of renewables, governmental regulation, and supranational support through the green deals and sustainable development goals (SDGs). In short, the inflationary trend disequilibrium and raging war have put Agenda 2030 at stake due to the provocation of sustainability via energy-related vulnerability, insecurity, and poverty phenomena.

Keywords: energy poverty; fuel poverty; multidimensional poverty; energy vulnerability; energy security; inflation; wartime

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1. Introduction

Energy is a pivotal element for a decent modern life, but the current energy, inflation, and war crises have augmented another problem as well—the multidimensional energy poverty. Primarily, energy-related poverty has been studied thoroughly in the UK in the 1990s and 2000s [1,2]. In the literature, the poverty associated with energy issues is called "*energy poverty*" (EP) and "*fuel poverty*" (FP) [3] (hereafter, EP will include the FP for brevity needs). However, there is a pivotal difference between the two terms, as EP is related to accessibility and FP to affordability problems [3–5].

According to the World Health Organization [6], the key findings on SDG 7 show that there are people without access to electricity and clean cooking that reached 789 million and 2.8 billion in 2018, respectively. Furthermore, almost 20% of the total final energy consumption of renewables was in 2017. However, what is of great importance is that from 2010 to 2017, the international financial flows towards developing countries have been doubled (from USD $10.1 billion to USD $21.4 billion), providing a helping hand to many developing countries in order to combat EP.

EP is being measured in a plethora of ways, mainly based on surveys or even the creation of expenditure-based indicators [7–14]. The reason why is going to be explained in the following section that sheds light on the approaches to EP and FP.

In order to capture the importance of energy in the modern lifestyle, several indicators have been proposed to cover this rising and alerting academic literature. Firstly, the UNDP, the UNDESA, and the WEC inaugurated in 2000 the *sustainable energy development* (SED) framework that takes into consideration, inter alia, affordability, economic competitiveness, and energy price issues [15]. Next in order came the energy indicators for sustainable development (EISD) [16–18]. On this basis, Iddrisu and Bhattacharyya introduced the sustainable energy development index (SEDI), which promoted a multidimensional perspective on SED. In the same manner, OLADE, ECLAC, and GTZ [19] included eight indicators to measure energy sustainability, whereas a more novel index was the energy development index (EDI) by the IEA [20].

Having these in mind, SED is intertwined with the stability of energy prices, but if there is instability and mainly inflationary trends in energy prices, what happens to energy poverty? Furthermore, the interconnections of EP with energy security and vulnerability are going to be clarified.

Two important issues on SED are EP and energy security [21–25], both of which have plenty of dimensions but different levels of monitoring: energy poverty is measured on a household level, whereas energy security has broader—regional and national—economic aspects. Accordingly, the multidimensional energy poverty index (MEPI) has been coined by Nussbaumer, Bazilian, and Modi [26] and Nussbaumer et al. [27], who enabled the monitoring of EP under a more complex theoretical and analytical background than solely uni-dimensional indicators. After these publications, an increasing trend of MEPI indices has sparked in the academic literature [28–31].

The common ground for these publications is the significance of access to clean energy sources for cooking and heating, mainly electricity, instead of rudimentary harmful sources. On this matter, a question that may come to mind is: what is the percentage of people with access to electricity?

A way of observing EP is through the monitoring of access to electricity based on people's income. In Figure 1, it is undoubtedly shown that people with low incomes have only 4% access to electricity; on the other hand, people with high incomes attain almost five times higher access.

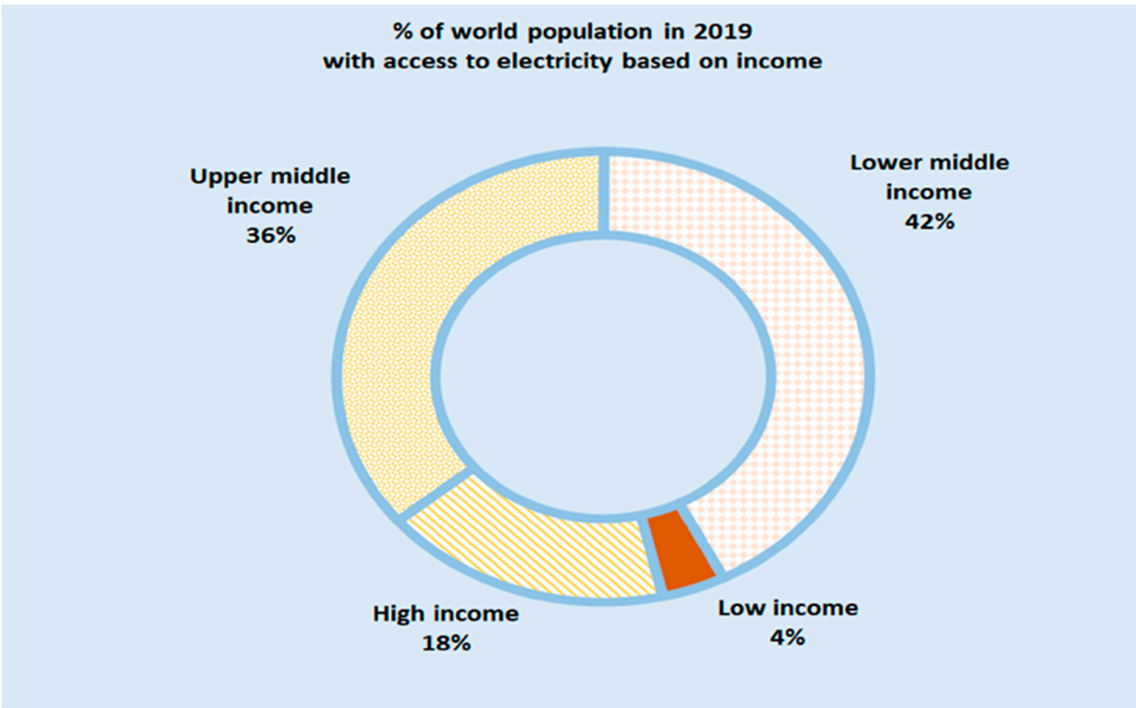

Figure 1. Percentage of the world's population with access to electricity based on income, 2019. Source: Figure produced by the authors, relying on data from OWID [32].

Energy and fuel poverties have been extensively studied in all corners of the world; however, the present study focuses mainly on countries of the Organization of Economic

Cooperation and Development (OECD) and BRICS, which is the cooperation of Brazil, the Russian Federation, India, the People's Republic of China, and South Africa. More specifically, there is a proliferation of *green deals* and white papers that create a framework for how to deal with EP. In the USA and in the EU, the green deals have opened a debate over the just transition towards carbon neutrality and sustainable development by adopting an approach that is either growth-centered or degrowth-oriented [33,34].

The tackling of EP has been a central theme in the European Commission (EC), as the EC develops a framework of close cooperation between all levels of administration [35]. The main target of the EC is to create a cohesive and integrated plan to cope with EP through the harmonization of data in cooperation with EUROSTAT and the European Energy Poverty Observatory (EPOV).

The EC also aims to achieve carbon neutrality by 2030 [36]. More specifically, the EC has put forward the "fit for 55" target, which aims to halve greenhouse gases (GHGs) compared to 1990 levels and attain climate neutrality by 2050 [37]. A way of observing EP is through the monitoring of access to electricity based on people's income. All these ought to be implemented under the umbrella of the REPowerEU plan, which tries to build *energy autarky* [38–41] against the turbulence on energy prices due to the Russo-Ukranian conflict.

In parallel, the "*30/60 goal*", or alternatively, the "*dual carbon goals*", is President Xi Jinping's commitment that China will peak carbon dioxide emissions before 2030 and reach carbon neutrality before 2060 [42]. This announcement is linked to the white paper "Energy in China's New Era", which tries to cope with poverty through the adoption of renewable energy sources and the creation of new green jobs [43].

From a global perspective, there are studies that have centered on affordability issues in developed countries and accessibility problems in developing countries [3,5]. The OECD studies are plentiful; hence, the categorization of the studies is going to be according to their continent.

Firstly, in North America, the main energy-related issues are mainly affordability in Canada [44,45], the USA [46,47], and Mexico [48]. Nevertheless, in South America, accessibility issues are assessed in some studies, such as in Colombia [49], Argentina [50], Latin America in general [19], and Chile [51–53].

In Europe, one of the earliest FP publications focused on the UK [1,54,55]. More recently, there have been significant EP studies in the UK [56–60], and in the EU specifically [4,12,14,61–67], which have monitored EP from different points of view. In more detail, in the EU, mainly affordability-focused studies took place in Ireland [68], in Germany [11], in different European countries [64], in Italy [9,10], in Portugal [69], in Lithuania and Greece [70], or in Greece exclusively [70–74].

Moreover, in the OECD countries in Asia, EP studies are centered on general EP issues, as with the people who live in deserts in Israel [75,76], vulnerable people in Türkiye [77,78], or even in Japan [79–81]. Whereas, in Oceania, FP studies are conducted in New Zealand [82] and Australia [83,84] as well.

Last but not least, the BRICS economies have a very important share of the global economy. BRICS have plenty of studies that give prominence to energy-related poverty, generally in BRICS as a comparison [85], or more specifically in Brazil [31,86,87], in China [88–90], in India [24,91–93], and in South Africa [94,95].

The central aim of the present study is to delve into the interconnections of EP and FP with other great dilemmas such as energy security and energy vulnerabilities. There is also monitoring of the multidimensionality of EP and FP under the scope of just transition and sustainable development. The following sections focus thoroughly on social exclusion, environmental pressures, and aporophobia. The research hypothesis of the review is that there is no difference between the OECD and BRICS on the matter of EP. Furthermore, the gap in the literature is the absence of a comparison of the multidimensionality of EP between international organizations such as the World Bank and the United Nations. This gap will be analyzed in Section 5, which covers the main advancements on the issue of global poverty, focusing mainly on the EP elements of global poverty and their connection with the SDGs.

The structure of the study begins with the focus on the causes and drivers of poverty (Section 3.1) and the impacts on health, psychology, and well-being (Section 3.2). Additionally, Section 4 discusses the two primary approaches to energy-related poverty: the consensual and the expenditure-based. Section 5 reviews the state-of-the-art questions over the multidimensionality of poverty, more specifically on its social (Section 5.1), technical (Section 5.2), economic (Section 5.3), institutional (Section 5.4), and environmental (Section 5.5) dimensions. Section 6 discusses three green deals and one white paper regarding the presence—or not—of energy poverty in them. Section 7 is centered on the discussion of the aforementioned conundrums and some future directions. Section 8 concludes the paper and mentions some policy implications—valuable for policymakers and academicians—with respect to the SDGs and the adverse effects of inflation, COVID-19, and war.

2. Materials and Methods

The present review tries to distinguish why EP is a problem through its historical identification. However, is there a difference between the OECD and BRICS economies on EP? This might be the research hypothesis of the present study. Accordingly, understanding EP as a conundrum might enable policymakers to cope with it more thoroughly. Hence, the present study provides Figure 2, which illustrates the structure of the present study. The conduct of the review has evaluated several publications on the matters of the direct and indirect causes or drivers of the phenomena, as well as the impacts of EP on public health, psychology, and well-being. The data for the review can be found in the following references: World Bank Group (WBG), Our World in Data (OWID), and Eurostat [32,96,97].

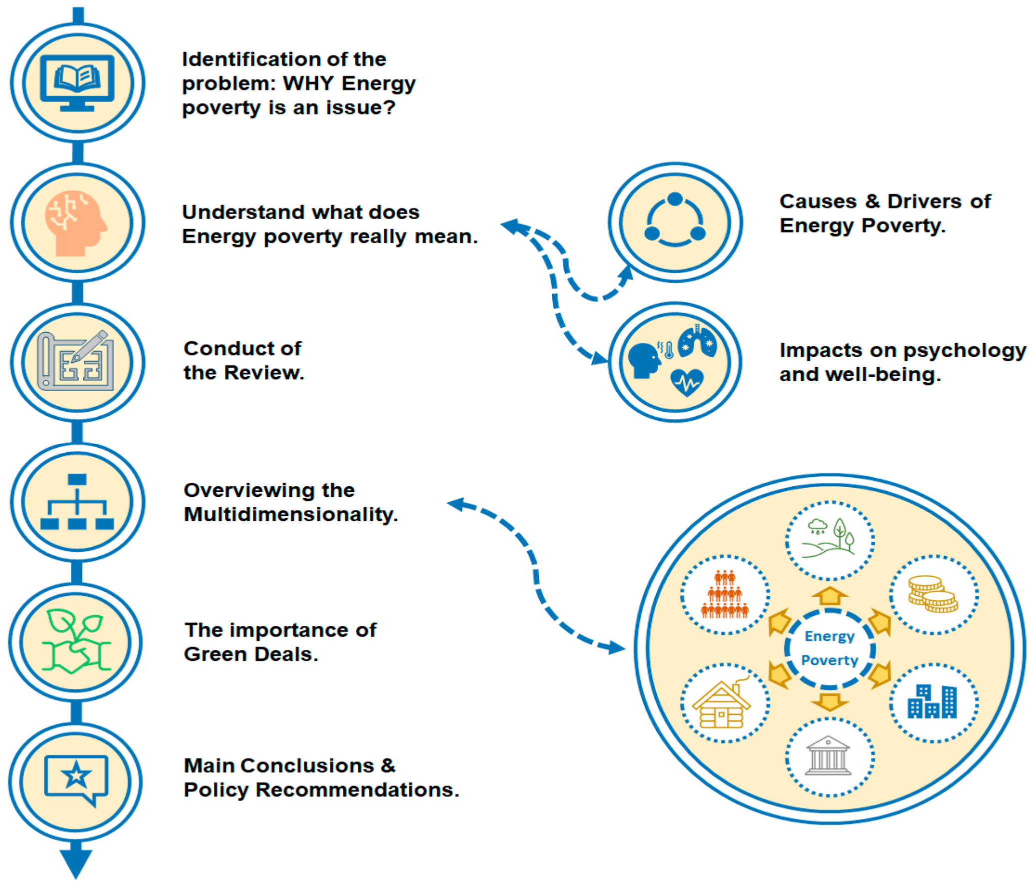

Figure 2. The methodology plan of the present study.

Furthermore, the analysis of the above issues has been put under the scope of the multidimensionality of EP. EP is multidimensional, with main social, economic, technical (urban or rural), institutional, and environmental dimensions. An understanding of multidimensionality would pave the way for policymakers to deal with it through strategies. Such strategies are the green deals that can provide a robust framework for eradicating EP.

3. Energy Poverty and Fuel Poverty

It is proper to make a distinction between what *fuel poverty* and *energy poverty* really mean: the developed countries are burdened by *fuel poverty* as a matter of affordability of energy/fuel utilization, while the developing countries deal with *energy poverty* issues as a matter of accessibility to clean energy sources [3,71,98]. The causes, drivers, and impacts of EP on human psychology and well-being are going to be clarified in the following sections.

3.1. Causes and Drivers of Poverty, Inequalities, and Vulnerability

EP has some common interlinkages with the broader notion of poverty. For instance, international organizations such as the World Bank and the United Nations have promoted multidimensional poverty indices based on energy-related, sanitation-related, and health-related issues as well. Meaning that energy deprivation has deeper roots than only addressing affordability and accessibility issues. In essence, it is the stigma of being energy/fuel poor that demoralizes a person to honestly state their living conditions and need for assistance [99,100]. Hence, a psychological aspect of energy/fuel poverty ought to be called for.

Poverty and inequalities push more people into destitution, more commonly referred to as social exclusion [39]. Typically, social exclusion in the context of EP is determined by how a person is able to attain thermal comfort and access to utilities that usher in a decent life. Poverty, inequalities, and social exclusion have been a central focus for Adam Smith, Amartya Sen, and René Lenoir [101–104], who have talked about the feeling of being ashamed and the social stigma of being poor and vulnerable, especially if you are aged, disabled, or a child. Just transition is based on the Rawlsian theory of social equity, making it a prominent debate on policymaking. Policy frameworks nowadays shed light on inter- and intra-generational equity as well as the idea of "leaving no one behind" (LNOB) [105–107]. The notion of EP is totally unnatural to justice, as EP makes people less happy, less free, and less likely to participate in social events due to stigma and a feeling of being marginalized [48,108].

This inspection of how poverty, inequalities, vulnerability, and social exclusion can be lessened [3,4,39,62,65] is in tandem with the matter of how the notion of just transition is attainable, which has been in the spotlight of modern scientific studies in EP [109]. In parallel, when dealing with EP, the goal is not only to reduce these phenomena, but to develop an energy-*secure*, *safe*, *self-sufficient*, and *sustainable* future [22,108].

Vulnerability to EP has also been addressed in several publications, focusing mainly on the negative externalities of climate change, first on urban agglomeration and planning issues, and second on households' materials. Briefly, Streimikiene et al. [110] distinguished important drivers of EP in the EU as: (i) accessibility and affordability issues; (ii) low energy efficiency and high energy losses; (iii) divergence between needs due to different individual factors; and (iv) lack of information about energy-related awareness and knowledge. In more detail, there is a plethora of drivers that aggravate the energy poor/rich status of a citizen; however, three core parameters that can be addressed are: (i) income, (ii) energy efficiency, and (iii) fuel prices [3,58,111]. Other drivers of EP could be the indoor or outdoor technical aspects of households or even climatic factors [112].

It would be insufficient to measure only access to electricity when observing energy development, as it covers only the dimension of energy consumption. In Figure 3, it is clear that in OECD and BRICS countries there are differences in average per capita electricity generation, as for example in Central and Latin America, South Africa, and India, where there are even five times lower values.

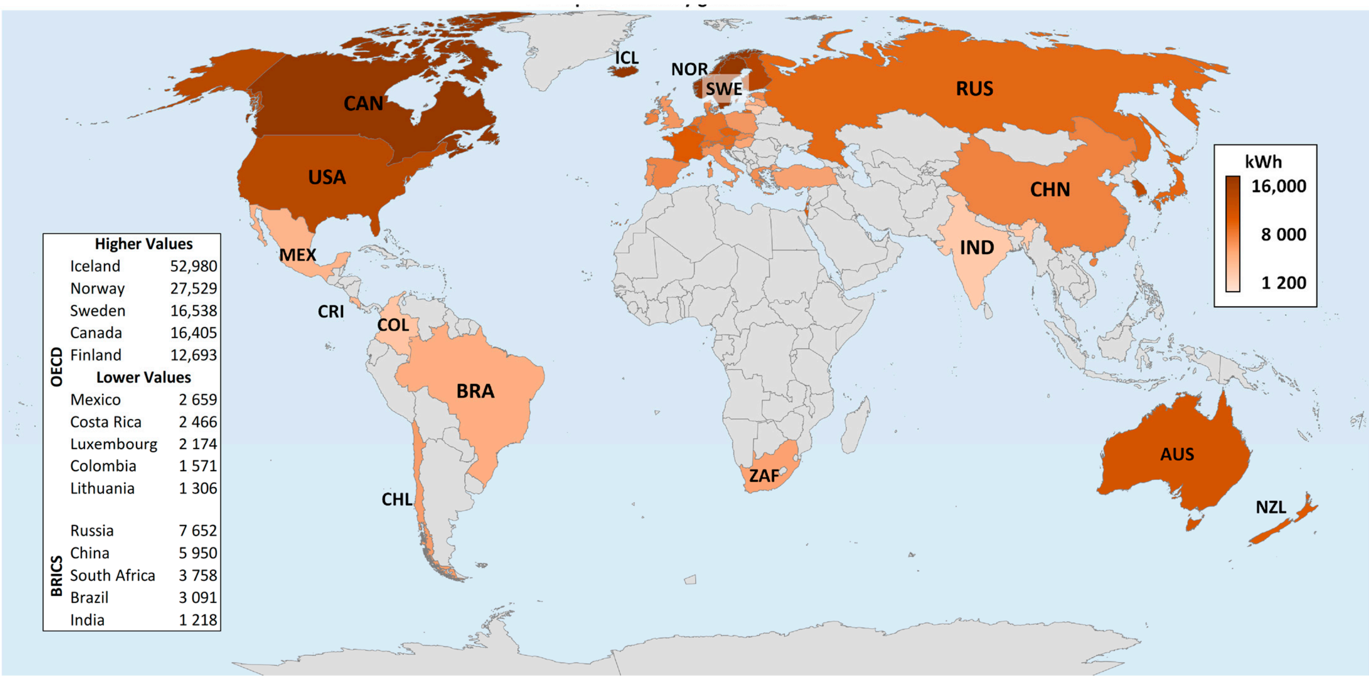

Figure 3. Per capita electricity generation in the OECD and BRICS, 2021. Source: Figure produced by the authors, relying on data from OWID [32].

Indoor technical aspects of households that can aggravate the EP status of a household are, for instance: (i) the burning of rudimentary fuels; (ii) the existence of leakages or damp on walls; and (iii) the inadequate warming (during winter months) or cooling (during summer) of households [113,114]. These issues are interlinked with EP according to people's basic carbon needs (BCN) and their basic energy needs (BEN) based on their economic and geographic conditions [28,115].

In parallel, there are the outdoor parameters that affect households' inner temperature and humidity. Firstly, there is the technical urban aspect of how households are being constructed, in essence: do the materials promote resilience to climate change? The EU-SILC takes into account the existence of leakages, dampness on walls, and mold as important indicators of EP [61,71,98].

Secondly, there are the environmental and purely climate change implications, which can contribute positively or negatively to EP. Climate change might aggravate the urban heat island (UHI) effect, which is the phenomenon that high temperatures sustain during the night [116]. In more detail, the UHI effect can be monitored in urban agglomerations during the summer, when the high morning temperatures are not diminishing in the night hours (when typically the temperatures are falling). Hence, there is a difference between the high temperatures in cities and the lower temperatures in rural areas, making climate change a probable aggravating parameter that augments the vulnerabilities of households in greater cities [74,117].

Thus, the territorial dimension ought to be monitored in order to alleviate the indoor (e.g., leakages) and outdoor (e.g., UHI) effects on human health. These phenomena are going to be discussed in Section 3.2 regarding the impacts and in Sections 5.2 and 5.5 regarding the technical and environmental dimensions of these phenomena.

3.2. Impacts on Health, Psychology, and Well-Being

There is great focus on the implications of EP on public health, on an individual's psychology, or even on their well-being. The health issues are being provoked either by indoor or outdoor parameters. For instance, the utilization of rudimentary cooking stoves or the impact of UHI might aggravate human-made infrastructure. In parallel, being unable to keep a house warm during the winter or cool during the summer might have negative impacts not only on health but on a person's well-being in general. The problems mentioned are going to be thoroughly examined in this section.

Hence, the categorization of indoor means of cooling or heating is necessary. A way to illustrate the transition from energy-poverty-stricken countries to a more clean and sustainable future is the *energy ladder* [118–121]. Countries climb the energy ladder as they develop; however, there lies the conundrum for fossil fuel-rich countries, which do not adopt renewable energy methods due to their access to fossil sources [118]. The energy ladder in Figure 4 briefly illustrates several means of heating, cooling, or communication in a transitional concept from rudimentary technology (e.g., abacha ("Abacha" stove is used to burn every possible fuel and is a very rudimentary form of cooking as it was used during kerosene shortages [122]), firewood, animal waste) to middle-transitional level (e.g., charcoal, coal, kerosene) and to more eco-friendly advanced technology (e.g., liquified petroleum gas (LPG), biofuels, and electric cookers).

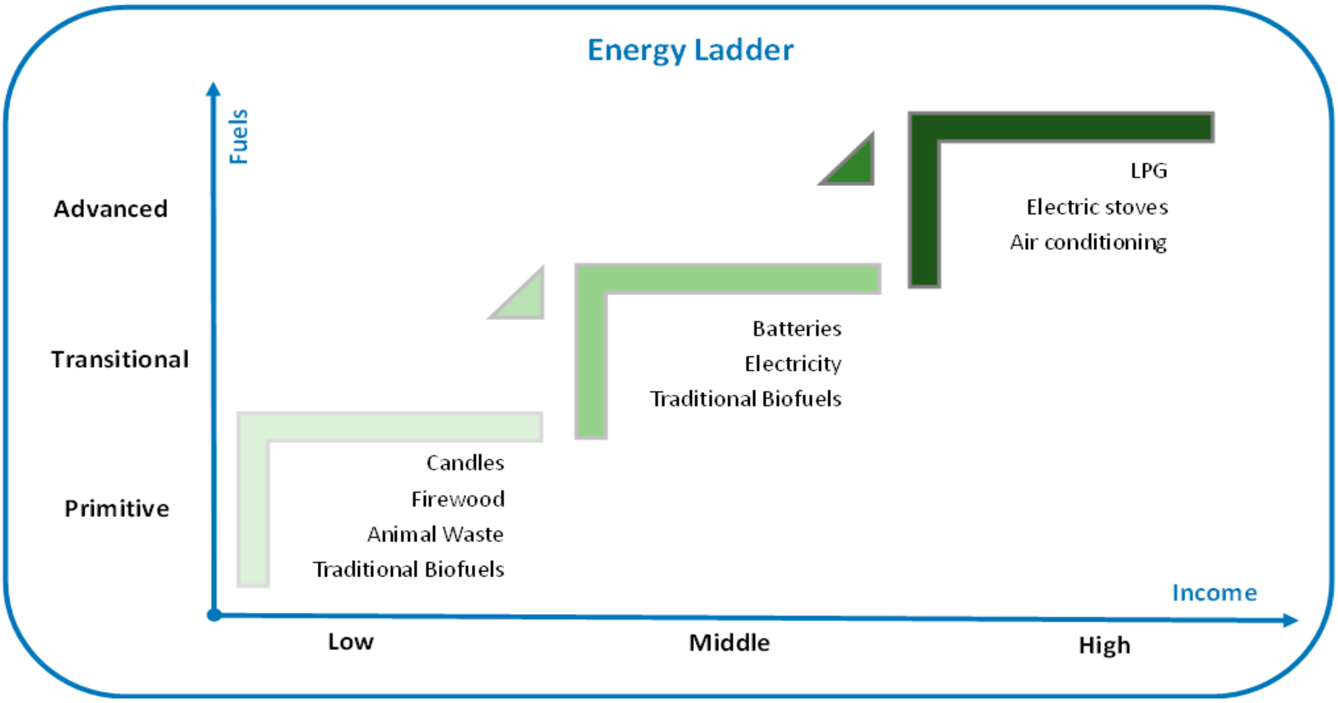

Figure 4. Energy ladder. Source: The figure was based on Kowsari and Zerriffi [119] and Bisaga and Parikh [121].

What really matters are the implications of EP on human health, either in developed or developing countries. A necessary theoretical background is an integral part of policymaking due to the complexity of deciding which strategy is more appropriate to deal with EP. Hence, it is important for policymakers to have choices on which eco-friendly and energy-efficient recipes are provided either for developed or developing countries.

In Figure 5, it is apparent that access to clean cooking was in an unfavorable condition, especially in rural areas. Even some OECD countries (Costa Rica and Türkiye) had almost 80% access in rural areas in 2000, or, even worse, had low access to clean cooking. For example, the rural population in Mexico with access to clean cooking has risen from about 50% in 2000 to about 60% in 2020. Similarly, the rural population in Columbia with access to clean cooking has grown from about 35% in 2000 to almost 65% in 2020. In comparison with the BRICS, there is a better performance in the OECD, as, for example, India had the least access with about 5–10% in rural areas in 2000 and reached only a bit above 50% in 2020.

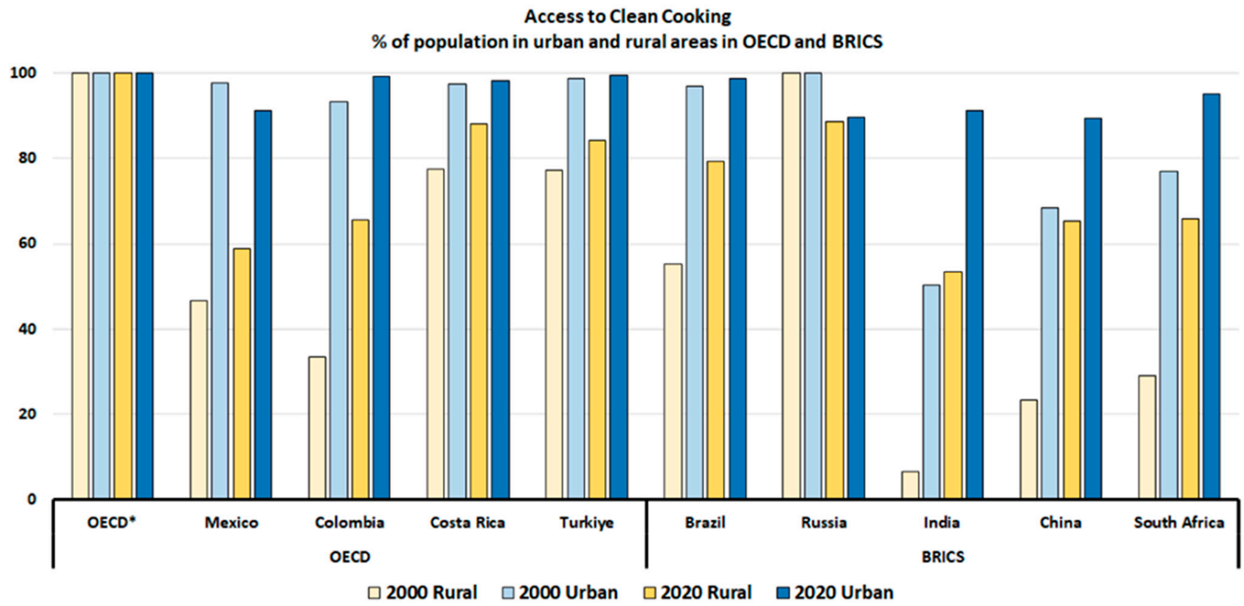

Figure 5. Percentage of the population with access to clean cooking. Note: OECD* contains all the OECD countries that have (sometimes almost) 100% access. Source: Figure produced by the authors, relying on data from WBG [96].

The percentage of access to basic sanitation is depicted in Figure 6 and shows that there is again a discrepancy between the OECD and the BRICS. Only a few OECD countries have not reached 100% access, mainly in rural areas. Regarding the BRICS economies, Russia and Brazil will have the highest values in 2020, followed by China, South Africa, and India on average scales. The BRICS attain high levels of access to basic sanitation in urban areas, with almost 80% or more in comparison to rural areas that reach lower sanitation levels, though the rural population seems to have ameliorated its standards looking back to 2000.

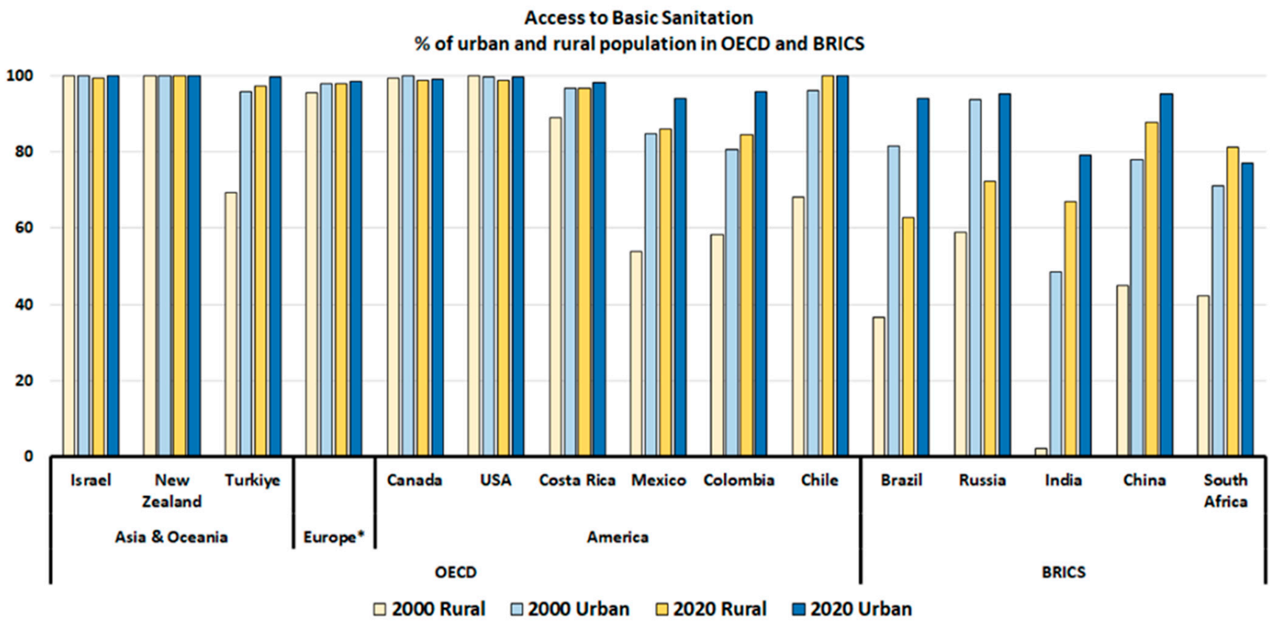

Figure 6. Percentage of the population with access to basic sanitation. Note: Europe* depicts the average value of the European-OECD countries. Source: Figure produced by the authors, relying on data from WBG [96].

EP can be detrimental, especially to rural populations, primarily due to non-modern ways of cooking food. Several studies have shown that in advanced countries, rudimentary cooking and heating methods utilize energy-inefficient coal-burning stoves [30,123–125]. The utilization of primitive or even transitional fuels is accompanied by the emission of harmful air pollution particles such as PM 2.5, carbon oxide (CO), and carbon dioxide (CO_2) that can augment morbidity and mortality levels [23,114,126]. Whereas, people who live in cold homes might have asthma, heart diseases, or even strokes, based on the literature [62]. All these health issues have appeared due to worsening indoor air quality (IAQ).

Another issue of EP is access to basic drinking water services, which are of utmost importance not only for sustainable development but primarily for survival reasons. Hopefully, in Figure 7, both the OECD and BRICS seem to have above 95% access to basic drinking water services in 2020, making it possible to attain universal access to clean water in the upcoming years. The lower values can be spotted in India, China, and South Africa in the BRICS and in Latin America in OECD countries.

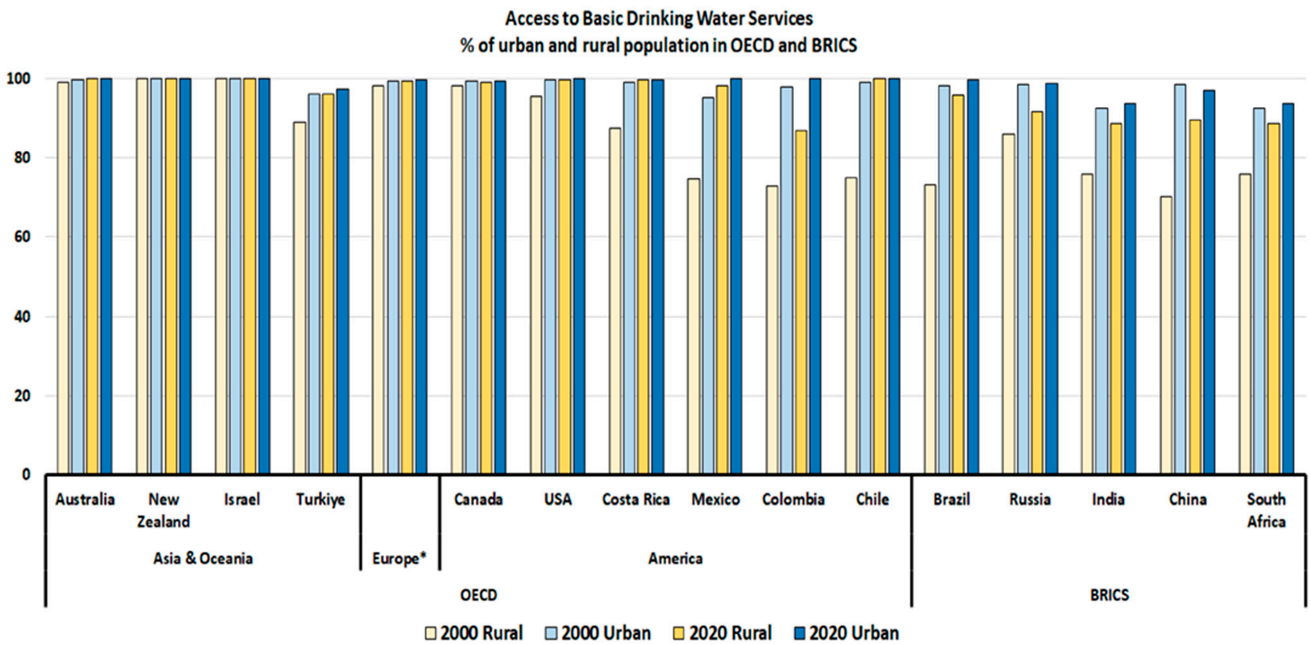

Figure 7. Percentage of the population with access to basic drinking water services. Note: Europe* depicts the average value of the European-OECD countries. Source: Figure produced by the authors, relying on data from WBG [96].

In parallel, high fuel prices make ends meet in developed countries; in addition, when a household cannot be kept cool or warm, there might be mold on the ceilings or walls. The Environmental Protection Agency (EPA) in the USA [127] noted that mold is able to produce allergens, irritants, and potentially toxic substances, which are called mycotoxins. Mold is typically derived from high humidity [73,110] and can lead to temperature-related health problems such as irritation, allergies, dermatitis, or asthma [58,59,127]. According to the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE), it is also possible that building water systems or improperly maintained air conditioning in coexistence with mold might be an indication of legionella in very rare situations and that of legionellosis (in Standard 188, it is stated that Legionellosis can provoke two different illnesses: the less severe influenza-like illness (i.e., "Pontiac fever") and the pneumonia by the bacterium Legionella called "Legionnaires' disease" (LD) and can cause lung diseases [128]), as in Standards 12-2020 and 188-2021 [128].

More specifically, Figure 8 depicts some health problems related to low indoor temperatures. To exemplify, lower temperatures than the safe temperature range (18–24 °C) might provoke respiratory problems (<16 °C), circulatory problems (<12 °C), or even hypothermia (5–6 °C) [58,129]. Furthermore, rising outdoor air pollution might aggravate premature mortality on a global scale [112,113], as it creates a vicious circle with poor indoor conditions.

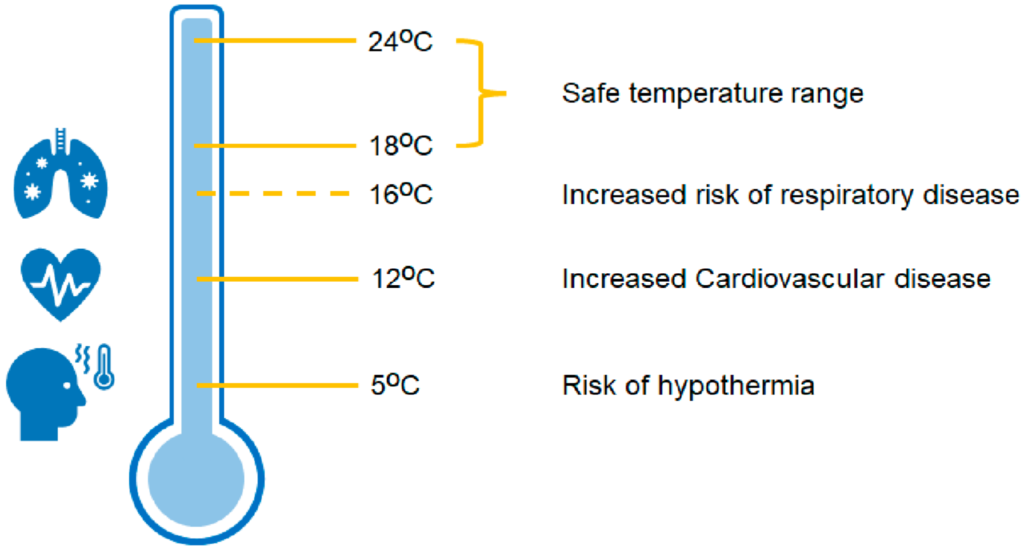

Figure 8. Suggested temperatures at which detrimental impacts occur. Note: The primary source denotes that the graph is based on various sources. Source: Author's edit from Figure 3.12 from Hills [58]. Crown copyright 2011.

Bearing in mind the above energy-related health issues, EP can also provoke problems in individuals' psychology and well-being. Next in order, what happens in psychology and well-being? As mentioned before, stigma and social exclusion are some of the adverse effects of EP. Harrington [100], Boardman [99], and Hills [58] illustrated some examples of psychological and well-being problems due to EP as follows:

- A person might express denial to accept its fuel-poor status due to its pride;
- People *conceal information* during interviews;
- People go to bed earlier (for example, at 7 o'clock) in order to not feel cold and become socially *isolated*;
- People become more *socially excluded* as they do not welcome others to their houses and cannot keep their houses warm;
- EP might cause *asthma* in children;
- Children might not go to school for some covert reason(s) linked to EP; hence, poor educational attainment and *truancy* are also important matters for a kid's educational pathway;
- Children and retired people feel more stress, less comfort, and more depression.
- Retired people become *withdrawn* and limit their expenses solely to keeping their house warm;
- People feel that they are being "trapped in a *vicious circle*".

In total, keeping a house warm adequately during the winter or cool during the summer is a matter of social acceptability. The above psychological and well-being problems aggravate physical health and mental conditions too. Hence, it is important that such conundrums be answered in order to ameliorate, firstly, the indoor conditions of house and secondly, and most importantly, the well-being of citizens.

4. Approaches on Measuring Energy and Fuel Poverty

Academic and institutional literature uses mainly two approaches when dealing with the matter of EP. More specifically, the two main approaches are the *consensual* and the *expenditure-based* approaches. These approaches establish the main methodology on which a survey, a study, an indicator, or even a framework is going to be based. Hence, it is of utmost importance that the core advantages and disadvantages of these approaches be clarified.

On the one hand, the *consensual approach* utilizes the results of surveys that include the self-reported responses of citizens. Then, the collected surveys are decoded and interpreted, so one can distinguish if the household is fuel- or energy-poor or not. However, what is the main reason for creating a consensual approach?

In the 1980s and 1990s, there was a debate over "*who is poor?*" and "*how poor is too poor?*". These two questions were the central idea of a 1983 questionnaire (the Breadline Britain) that tried to create a framework for dealing with such conundrums. One of the most relevant publications that adopted a conceptual approach is the book "Poor Britain" by Mack and Lansley [130], who mentioned Professor A.H. Halsey's quote:

"let's vote all together on what we think constitutes poverty. If you get some kind of social *consensus* about that definition, then that actually fits the reality of what people experience" Mack and Lansley (pp. 47–48) [130].

In total, having the capability to gather all people and have them answer one well-structured questionnaire, it might be probable to have a universal democratically-created and socially acceptable answer to what really constitutes poverty, or, on the present study's idea, what does energy and fuel poverty really mean? Of course, this might be impossible due to economic and time restrictions, but it is our age that could find an answer. Nevertheless, some of the disadvantages of the consensual approach, as illustrated in Table 1, are based on these assumptions.

Academic literature finds disadvantages in the subjectivity of people's answers, which create problems with the accuracy and reliability of the results [14,54,61,98]. In addition, the binary nature of the utilized indices might not capture the *depth* of EP [14].

In contrast, the consensual approach focuses on "socially perceived necessities" [130], evaluates energy deprivation [131], and can delve into social exclusion and material deprivation as well [61,132]. Furthermore, the consensual approach is characterized by a simpler methodology compared to the expenditure-based approach [61] and can take into account the multidimensionality of EP [63]. In essence, while there are some unfavorable elements in the consensual approach, there are potential ideas that can make this approach go further on the measuring of EP, principally due to the inclusion of the multidimensionality of poverty.

On the other hand, the *expenditure-based approach* is based on the book *Fuel Poverty: From Cold Homes to Affordable Warmth* by Boardman [2], in which if a household's energy-related expenses exceed 10% of its income, it is deemed as fuel poor. The utilization of a threshold is proper when using this approach; however, some dangers loom, such as the arbitrariness of the selected threshold or the selection of an arbitrary cut-off point that might have misleading results [54].

This index has been replaced by the "Low Income High Cost" (LIHC) index [59], but nowadays the "Low Income Low Energy Efficiency" (LILEE) proposed by BEIS/bre [133] has taken the place of the previous two indices in the UK. The LILEE indicates that a fuel-poor household (i) has been rated as energy inefficient and (ii) if all energy-related costs "disappear" the disposable income and render it below the poverty line.

Table 1. Comparison of the consensual and expenditure-based approaches.

Consensual Approach		Expenditure-Based Approach	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Proper for measuring poverty intensity, if the survey uses pre-set responses to close-ended questions [14]	Subjectivity creates reliability and accuracy issues [14,54,61,98,99,109]	The threshold is chosen based on externally investigated levels of material and social deprivation [54]	Misleading results due to arbitrary threshold and cut-off points [54,131]
Can retrieve information about social exclusion and material deprivation too [61,132]	The binary nature of consensual indicators [14]	Comparability if there is standardized data [54,131]	Single indicators should be avoided due to multidimensionality [14,98]
Incorporates socially perceived necessities [130]		Simple and quantifiable [54,61,98]	Confusion if the index is purely poverty-focused or inequality-based [54,134]
Simple methodology on how to collect data [61]		Availability of detailed data on housing conditions [131]	Subsidies for covering disability-related needs are being expended on energy-related needs [60]
Evaluation of energy deprivation [131]		Utilization of absolute or relative thresholds [61]	(The 10% approach has) Complex methodology [61]
It considers multidimensionality [98]		Objectivity [61]	Tyranny of numbers' might mislead from the real EP households' needs. [61,100]
Evaluation of energy deprivation [131]		Takes into account monetary aspects [98]	

There are several reasons for measuring EP based on expenditures. Some of the disadvantages are that there is confusion among some indices about whether they are truly poverty indices or if they belong to inequality indices [54,134]. There is also a risk that the selected expenditure-based index might rate some relatively wealthy households as fuel poor [131]. Naturally, the uni-dimensional indicators are not widely preferred [14], as they omit important aspects of EP [98].

In essence, it is the objectivity of expenditure-based indices that overcomes many problems that can appear with a consensual approach [61]. Moreover, these indices take into account monetary aspects of EP [98], making a study comparable to other studies with the same index [54,131]. The bottom line of the expenditure-based approach is its comparability to other studies due to the monetary aspects that offer a practical element to this approach.

There are also some other approaches, such as the temperature-based and the outcome-based [12,98]. In addition, there is also the direct approach, which has the advantages of transparency [54] and compatibility [14], but it is very labor-intensive [54], and households with central heating systems might appear to have distortions in the EP measurement [109]. The above approaches are significant during the construction of indices that measure the impacts and effects of EP. Bearing in mind the five aforementioned approaches, it is now possible to continue with the dimensions of EP.

5. Overviewing the Multidimensionality

The wide notion of uni-dimensional poverty has been studied in the 20th century, even though the advent of the 21st century has brought about the necessity of measuring poverty in a multidimensional way. Multidimensional poverty has been thoroughly examined by Bourguignon and Chakravarty [135], who took into account monetary and non-monetary elements of essential living standards for a decent life.

Furthermore, Alkire and Foster [136] incorporated various socioeconomic factors because the omission of the non-monetary nature of poverty leads to misleading results. For example, the non-monetary elements of poverty were more difficult to monitor during the COVID-19 pandemic due to the complexity of the issue compared to the monetary dimension [137]. Hence, it is important that the *extent* (how many people EP affects?) and the *depth* (what is the degree to which people are affected by EP?) of the problem be measured [58,59].

The United Nations Development Programme (UNDP), in coalition with the Oxford Poverty and Human Development Initiative (OPHI) at the University of Oxford, initiated the first global multidimensional poverty index (MPI) in 2010 and the moderate multi-dimensional poverty index (MMPI) in 2022 [138,139]. Both MPI and MMPI consider the necessity of measuring educational, health, and sanitation issues based on ten broad deprivations [139–142]. In parallel, the World Bank created in 2018 the multidimensional poverty measure (MPM), which incorporated monetary and nonmonetary elements [137,143,144]. In Table 2, there is a comparison between the MMPI and MPM on the specific dimensions for the energy-related poverty and connections to the SDGs. SDGs 1, 6, 7, and 11 are important as they have built a framework that promotes the LNOB idea by "prioritizing interventions for the poorest of the poor" [106,141].

Table 2. The energy poverty-related dimensions of global poverty adopted by the World Bank, UNDP, and OPHI.

SDG	Multidimensional Poverty Measure (MPM)		Moderate Multidimensional Poverty Index (MMPI)		
	Dim.	**Parameters**	**Dim.**	**Indicator**	**A Household Is Deprived If:**
6 CLEAN WATER AND SANITATION	Access to basic Infrastructure	The household lacks access to limited-standard drinking water.	Living standards	Drinking water	A household does not have access to safe piped water on the premises.
6 CLEAN WATER AND SANITATION		The household lacks access to limited-standard sanitation.		Sanitation	A household does not have flush toilet that is not shared with any other household.
7 AFFORDABLE AND CLEAN ENERGY		The household has no access to electricity.		Electricity	A household does not have electricity or does not have access to the internet or a smartphone.
7 AFFORDABLE AND CLEAN ENERGY				Cooking fuel	A household cooks with dung, agricultural crops, shrubs, wood, charcoal, or coal.
11 SUSTAINABLE CITIES AND COMMUNITIES				Housing	A household has inadequate housing: the floor or roof or walls are made of natural or rudimentary materials or there are more than three people per sleeping room.
1 NO POVERTY				Assets	A household does not own more than two assets (radio, TV, telephone, computer, animal cart, bicycle, motorbike, refrigerator, washing machine, bank account) and does not own a car or truck.

Note: Dim. indicates the dimension of poverty. Sources: [39,137,138,140,143,144].

The multidimensionality of EP has been a central idea in recent academic literature as well as in policymaking institutions and governments [131,145,146]. Nonetheless, there is a plethora of barriers that aggravate the multidimensional nature of EP [21,23]:

- corruption;
- local opposition;
- failure to include externalities;
- political and institutional instability;
- underinvestment in electricity infrastructure;
- the lack of high-quality standards and certification.

With these barriers to the measurement of multidimensionality in mind, the following sections are going to reveal the inner, covert aspects of multidimensional EP. The affairs of energy security, vulnerability, and fuel or energy poverty can be depicted in Table 3. Energy security is a very debatable theme nowadays due to COVID-19, the inflation in energy prices, and war; however, the ESI [22,147,148] and AESPI [149,150] indices might provide useful information about proper and robust policies. Furthermore, the GVI [151], the GEVI [152], and the EPVI [69] indices could be very insightful for policymakers, when they deal with energy vulnerabilities in local, regional, and national study areas.

Table 3. Selected publications on energy-related poverty, vulnerability, and security.

	Index	Abbr.	Explanation	Source
Energy Security	Energy security index	ESI	ESI is a multidisciplinary index that focuses on availability and affordability issues, as well as the impacts of technological advancements, sustainable development, and governance.	[22,147,148]
	Aggregated energy security Performance indicator	AESPI	AESPI is an important tool for observing and measuring the impacts of energy policies on the pathway towards sustainability. Typically, a low carbon society is associated with greater AESPI levels.	[149,150]
Energy Vulnerability	Composite Vulnerability Index	CVI	CVI appears to be a composite index that measures the multifaceted tiers of energy vulnerability.	[151]
	Global Energy Vulnerability Index	GEVI	GEVI measures a system's exposure to negative externalities and risks. It can be a useful policy tool for copying with socioeconomic and environmental "traps".	[152]
	Energy Poverty Vulnerability Index	EPVI	EPVI combines gaps between socioeconomic aspects and buildings energy performance, can provide a local, regional, and national information about heating and cooling levels as well.	[69]
Fuel Poverty	10% share of Income or expenditure	10%	Was utilized as the official indicator in the UK on measuring energy affordability and denotes a fuel household that consumes more of the 10% income (or expenditure) on trying to primarily achieve a comfortable level of warmth, and lately to maintain a minimum acceptable level on cooking and heating.	[2,44,68,73,153]
	Low Income High Cost	LIHC	The rising fuel prices in combination with the low incomes in households renders many households as fuel poor. The LIHC replaced the 10% indicator, as the latter utilizes the arbitrary 10% level without a specific reason.	[59]
	After Housing Cost	AHC	There are many alterations of the AHC relatively to which level ought to attain regarding the national median AHC income. Many researchers select the 60% of AHC income as a central indicator.	[13,58]
	Minimum Income Standard	MIS	The MIS budgets considers a basket of products for food, clothing, and even the capability of participating in cultural events.	[13,55]
	Fuel Poverty Index	FPI	It is the geometric mean of a standard of living indicator, it measures house energy inefficiency and potential heating restriction.	[154]
	Fuel Poverty Potential Risk Index	FPPRI	This index provides a robust framework on copying with the risk of fuel poverty.	[53]
	(Modified) Foster–Greer–Thorbecke	FGT	Assesses the incidence, gap and severity of poverty based on the poverty index developed by Foster–Greer–Thorbecke [155].	[94,156]
	Basic Energy Needs and Basic Carbon Needs	BEN and BCN	The index measures the basic carbon needs, which are defined as the amount of carbon emissions needed to achieve (socially and materially) adequate levels of domestic energy services.	[115]
	Multitier Framework for measuring energy access	MTF	The index categorized different energy services across household, productive and community needs, in parallel with issues on electricity, cooking, and heating services categorization.	[146,157]

Table 3. *Cont.*

	Index	Abbr.	Explanation	Source
Energy Poverty	Multidimensional Energy Poverty Index	MEPI	The index incorporates basic household energy services such as ways of cooking, lighting, and services provided by appliances for universal communication and pleasant entertainment.	[26–31,131]
	Household Energy Poverty Index	HEPI	This index can categorize households into four categories: (i) "least energy poor", (ii) "less energy poor", (iii) "more energy poor", and (iv) "most energy poor".	[158]
	Energy Poverty Barometer	EPB	This index complements three issues: (i) measured energy poverty, (ii) perceived energy poverty, and (iii) hidden energy poverty.	[159]
	Hidden Energy Poverty	hEP	hEP exists if: (i) energy expenditure is below a fixed threshold, (ii) total expenditure is below the relative poverty threshold, (iii) households are absolutely poor, not well insulated, and energy inefficient.	[160]
	Compound Energy Poverty Indicator	CEPI	It takes into account the inadequate living conditions (such as not warm or not cool, or even dark household), arrears on utility bills, and the existence of leaks by weighting them composing an index.	[161]
	EU Statistics on Income and Living Conditions	EU-SICL	Three main indicators: (i) inability to keep home adequately warm; (ii) arrears on utility bills; and (iii) population living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor.	[62,71,98]

In addition, common FP indices are the 10% share of income or expenditure [2,44,68,73,153], the LIHC [59], and the LILLE [133]. In addition, the AHC [13,58] and the MIS [13,55] are very useful in providing a framework for the aforementioned three indices. Other fuel poverty indices that have provided similar but distinctive features of this phenomenon are the FPI [154], FPPRI [53], the FGT and the modified-FGT [94,156], and the MFT [146,157]. Whereas, the EP is being critically assessed by uni-dimensional, composite, or integrated indices such as the MEPI [26–31,131], HEPI [158], EPB [159], and EU-SILC indicators [62,71,98].

The arrears on utility bills and the inadequacy of keeping homes warm during the winter season are indications of FP based on EU-SILC surveys. In Figure 9, the greatest rise in homes that are inadequately kept warm is in the Western EU, where it reached 26%. On the other hand, there are decreases in this standard; more specifically, a better image of dealing with FP can be seen in the Southern, Northern, and Central and Eastern EU regions, respectively. Moreover, the arrears on utility bills between 2011 and 2021 have been cut in every EU-28 region. However, where does FP reach its greatest values? The answer is that in absolute terms, Spain, Greece, Portugal, Cyprus, Lithuania, and Bulgaria had from 21% to 32% inability to keep homes warm in 2021, next in order, regarding the utility bills. Cyprus, Spain, Hungary, Croatia, Bulgaria, and Greece had arrears that ranged from 22.8% to 49.8% in 2021.

Bearing in mind the barriers to multidimensionality and having also noted several publications with uni-dimensional or multidimensional aspects of EP, it is necessary for academic reasons to state the specific components of multidimensionality. The succeeding sections focus on the social (Section 5.1), technical (Section 5.2), economic (Section 5.3), institutional (Section 5.4), and environmental (Section 5.5) dimensions of EP.

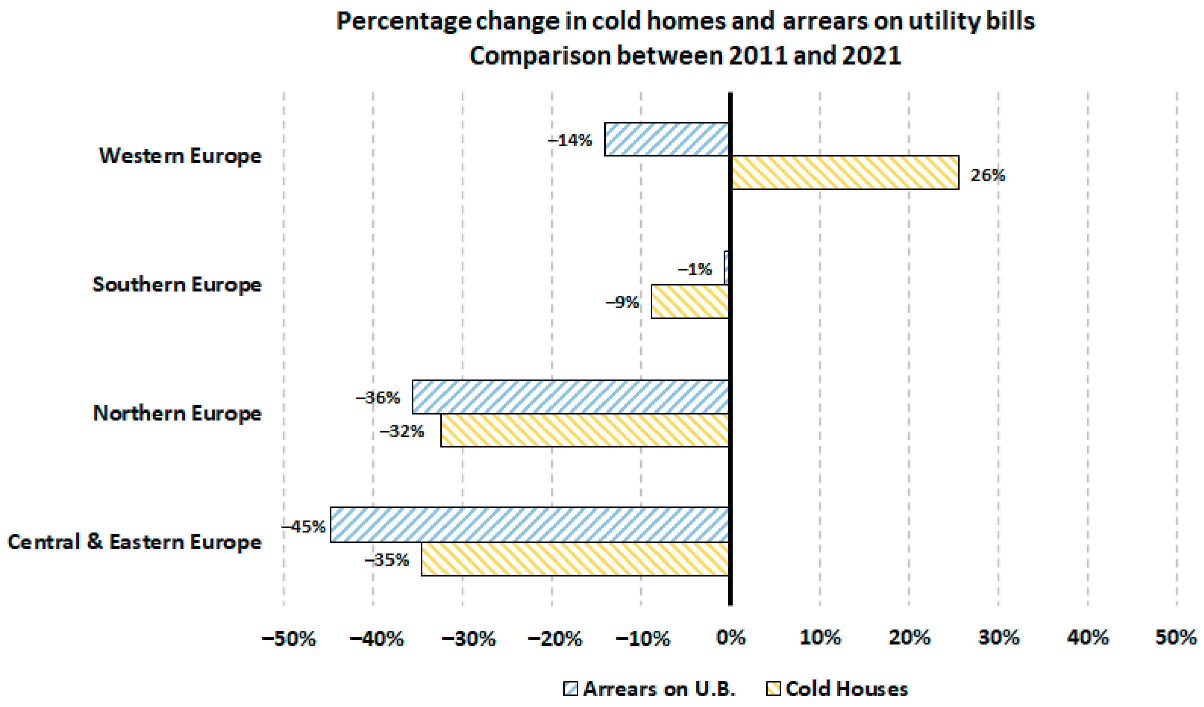

Figure 9. Percentage change in the inability to keep homes warm and arrears on utility bills in EU-28 between 2011 and 2021. Note: The values of 2021 in the graph for Slovakia and the UK are 2020 and 2018, respectively. Source: Figure produced by the authors, relying on data from Eurostat [97].

5.1. Social Dimension

It is common in EP publications to mention phenomena such as social exclusion, which is an individual-focused approach, as EP can aggravate disabled people's living conditions [60]. Moreover, EP might provoke social withdrawal in older people [100,162] and absenteeism in children who avoid going to school [99,162].

Social exclusion can ignite phenomena such as "*aporophobia*", as described by Cortina [163]. Aporophobia derives from the Greek words "*aporos*" (poor) and "*phobia*" (fear). This term encompasses the aversion to poverty, especially when having to deal with impoverished and vulnerable people (e.g., migrants and Roma people) [164,165]. It is now time to reflect on whether this nomenclature can be specified for the energy poor too, making energy aporophobia the result of COVID-19, inflation in energy prices, and war in Eastern Europe [39].

Additionally, EP can be linked to national-focused approaches. A phenomenon that might incite greater levels of EP is energy security. Energy security destabilizes energy prices and can precipitate regional supply shortfalls, according to Bielecki [166]. Gasser [167] mentioned a wide range of typically different conflicts, such as the terrorist attacks in the USA, environmental phenomena, and the Russo-Ukraine gas dispute at the beginning of the 21st century, but all these phenomena are linked to global energy insecurity. Nowadays, the REPowerEU is trying to alleviate the Russia-Ukraine warfare impact in order to stabilize the inflationary price phenomenon and the disentanglement of EU energy security policy from Russian oil and natural gas [38–41]. Making contribution to building resilience towards EP should the conflict continue.

Hence, the social importance of energy is undoubtedly a central theme for every government, especially during an era of inflation, pandemics, and war. Policymakers ought to focus more on the safeguarding of basic human needs, the protection of infrastructure possible via subsidies, and securing energy-related sources under the scope of the SDGs in order to build resilience and cope with energy vulnerability and exposure to exogenous pressures such as the aforementioned phenomena.

5.2. Technical Dimension: Urban and Rural Aspects

Environmentally sustainable design concepts also include aspects related to the commercial and residential heating, ventilation, and air conditioning (HVAC) factors. Among several considerations, a significant topic is the monitoring of air quality throughout the design and construction stages of a building's life. The technical dimension in this section consists of the framework provided by an international organization, the EU, and the UHI effect due to building materials and climate change.

Building resilient and sustainable cities is based on properly constructed and maintained buildings, and especially households should follow some guiding principles in order to have clean and safe HVAC conditions. A solution might be through energy audits on existing buildings through energy efficiency measures (EEMs) and energy conservation measures (ECMs) [168]. Moreover, energy audits could offer practical ways to attain climate change mitigation, specifically when provisioning cost savings for energy-vulnerable households [70,74,169].

Furthermore, the ASHRAE has focused on framing the building environment through standards and guidelines with the aim of ameliorating the IAQ. More specifically, ASHRAE [128] has standards related to building infrastructure that are related to EP as: (i) the ventilation and acceptable IAQ in residential buildings (standard 62.2-2022), (ii) energy-efficient design of low-rise residential buildings (standard 90.2-2018), and (iii) energy efficiency in existing buildings (standard 100-2018).

What happens to the energy efficiency and energy performance of buildings in the EU as part of the circular economy? The EU has also created a robust institutional framework of guidelines, regulations, and directives that formulate energy resilience based on general economic factors, but they can be directly or indirectly linked to EP. Firstly, the security of energy supply is protected by the objectives of the Energy Union, particularly the targets for 2030 [170].

Secondly, the directive 2019/944 (in articles 28 and 29) necessitates the protection of vulnerable consumers from disconnection of electricity if there are issues on: (i) the share of energy expenditure of disposable income; (ii) household's energy efficiency; and (iii) critical dependence on electrical equipment due to a wide range of reasons (age, disability, or even if the household is in a remote area). Thirdly, the EU strategy on heating and cooling centered on the quote "big savings can be made through simple renovations", such as the implementation of better insulation in attics or walls and the installation of double or triple glazing [129,171]. Another useful way for further upgrading a modern house might be a solution such as green roofs or well-rounded vegetation on public spaces [172], which can usher in direct or indirect positive contributions to urban sustainability.

Fourthly, the directive on energy efficiency (EED) [173] laid down principles on removing barriers in the energy market and reaching a 27–30% target of energy efficiency for 2030. Last but not least, the directive on energy performance of buildings (EPBD) [174] is linked to the circular economy and endeavors to alleviate EP and GHGs by at least 40% by 2030 in comparison with 1990 levels via green solutions such as the incorporation of renewable energy sources (some useful information is on the directive on the promotion of the use of energy from renewable sources [175]).

Comparing the OECD and BRICS on the matter of access to electricity, the BRICS had lower values (especially India and South Africa) at the beginning of the 21st century (Figure 10), whereas the OECD had almost 100% access in urban areas. It could also be noted that rural areas, even in OECD countries, had lower access to electricity; nevertheless, in 2020, all countries had ameliorated their levels on this parameter.

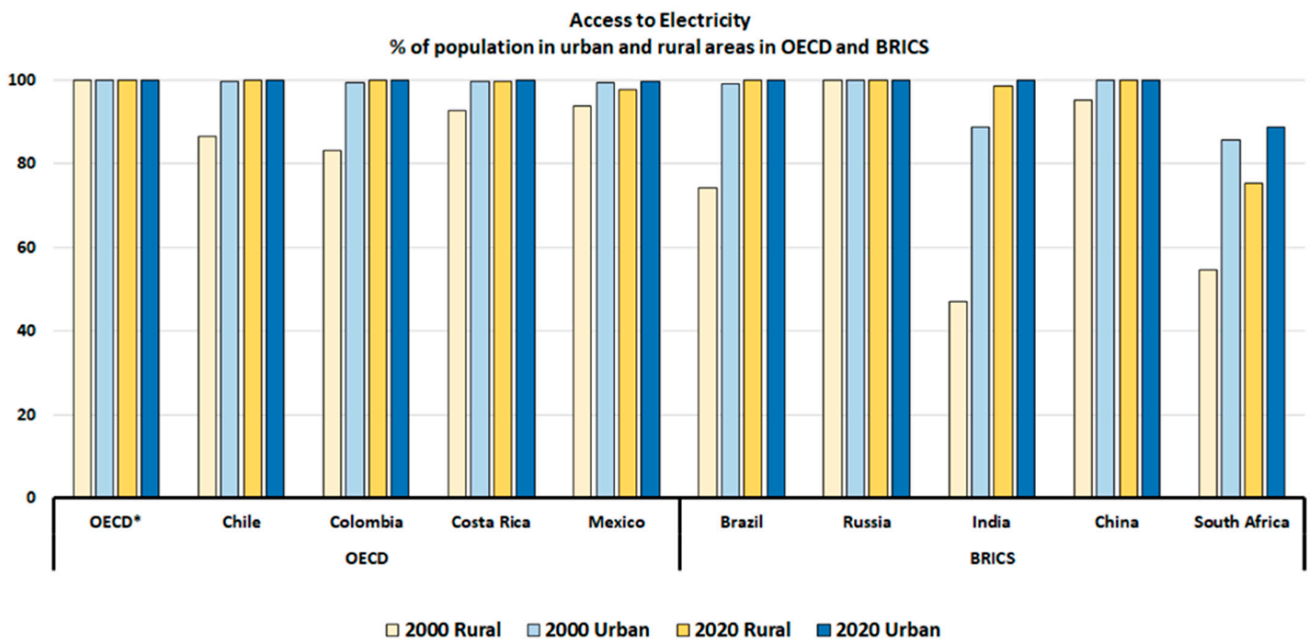

Figure 10. Percentage of the population with access to electricity. Note: OECD* contains all the OECD countries that have 100% access. Source: Figure produced by the authors, relying on data from WBG [96].

Another important aspect of the technical dimension is the vulnerability of buildings to climate change under the scope of UHI effect. Especially in the Mediterranean, there are three factors that create complexity that can destabilize the "urban energy balance" due to the UHI effect on urban agglomeration: (i) the morphological characteristics; (ii) how compact the households are; and (iii) how dense can the buildings be [116,117]. As stated before, the UHI is a phenomenon that describes the inability of buildings to reject the high morning temperatures during the nighttime, resulting in a non-decreasing temperature in urban environments in comparison to rural areas. Rural areas cool down faster than urban areas because there are fewer buildings in the former areas. Hence, this discrepancy creates thermal discomfort, specifically for vulnerable social groups such as the elderly and children [162]. As a result, it is difficult to attain urban sustainability based on SDG targets and principles without solving the above concerns.

5.3. Economic Dimension

Global poverty can be measured through the incorporation of monetary aspects such as income or expenditure levels. After that, by constructing poverty cut-off points that create a threshold below which a person or household can be deemed poor. Typically, such measures are created based on "a bundle of basic goods" [176] that include food needs, BENs, and BCNs. Headcount poverty, the poverty gap, or poverty severity indices are common measures of global poverty [39,139,177].

In parallel, how can pure monetary aspects be indirectly linked to energy poverty? Mirasgedis et al. [178] found that energy efficiency interventions can be impacted—positively or negatively—by employment effects. These effects have been monitored through cost-benefit analysis (CBA). Further economic aspects of EP have been noted on the EPMI index of Bollino and Botti [131] and the HER index by Sánchez-Guevara Sánchez et al. [179]. Song et al. [5] distinguished three economic-driven approaches: (i) the energy budget share, (ii) the energy consumption of people in proximity to the poverty line, and (iii) the energy demand that is extricated from income pressures. These approaches can be linked to the expenditure-based approaches that have been mentioned before in Section 4.

Electricity prices in households have risen in 2019 compared to 2009 levels in almost all groups, except for the higher prices in the BRICS and the lower prices in the OECD

(Figure 11). In essence, based on 2019 maximum electricity prices, the EU and OECD had about €300/MWh, whereas in the BRICS, the maximum values were about €200/MWh. Additionally, the minimum prices in the EU are double compared to both the OECD and BRICS, making it clear that the electricity prices are lower in BRICS, followed by OECD (non-EU) countries, and with greater prices in EU member states.

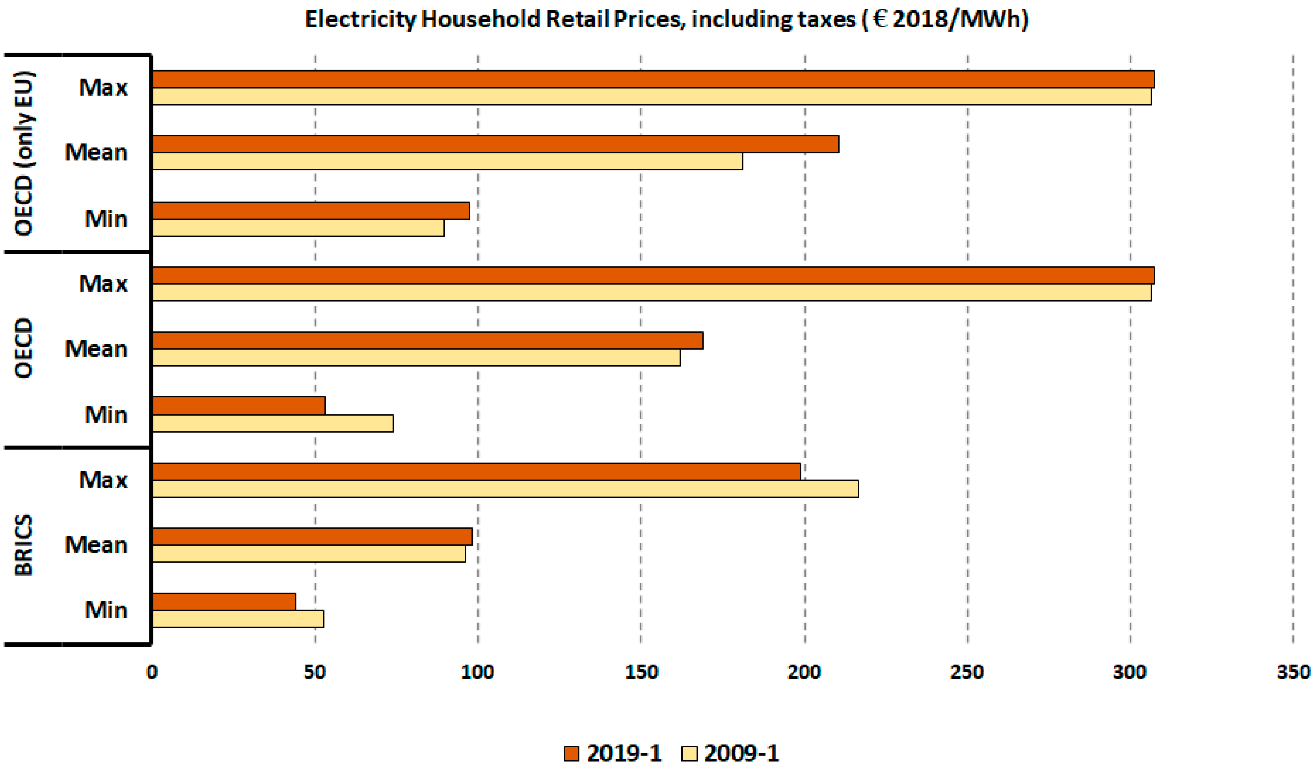

Figure 11. Electricity household retail prices in January 2009 and 2019. Note: No values for Iceland and Australia in 2009; no values for India in 2019. Source: Figure produced by the authors, relying on data from EC [180].

Another economic aspect that ought not be neglected is the adoption of renewable energy sources for electricity, for several reasons. Firstly, the more the GDP per capita rises, the more the utilization of fossil fuels in final energy consumption is diminished, and vice versa; also, the more the renewable share is rising, the more a household can adequately be kept warm [63,71]. Secondly, it is a matter of what the state is going to subsidize; it has been proposed that the state ought to promote economic incentives and subsidies for the adoption of renewables [181]. Based on the previous publication, it was made apparent that if renewable energy adoption costs were implemented as a *regressive tax*, that would be detrimental for vulnerable people and would aggravate EP.

Undoubtedly, the energy and natural gas prices have augmented their interrelationships with the EP levels, as the higher expensive the prices become, the more expenses on energy-related fuels are going to be. As a result, a greater share of households ought to spend more of their income on BENs and BCNs. The following figures are going to show several alterations in retail prices, either for electricity or natural gas.

In Figure 12, in 2019, the prices of natural gas have increased in the BRICS and EU, but not in the OECD, compared to 2009. The highest rise took place in maximum EU natural gas prices, whereas the highest decrease has been noted in maximum OECD countries, making the differences in EU and OECD to be trimmed and attaining about € 120/MWh.

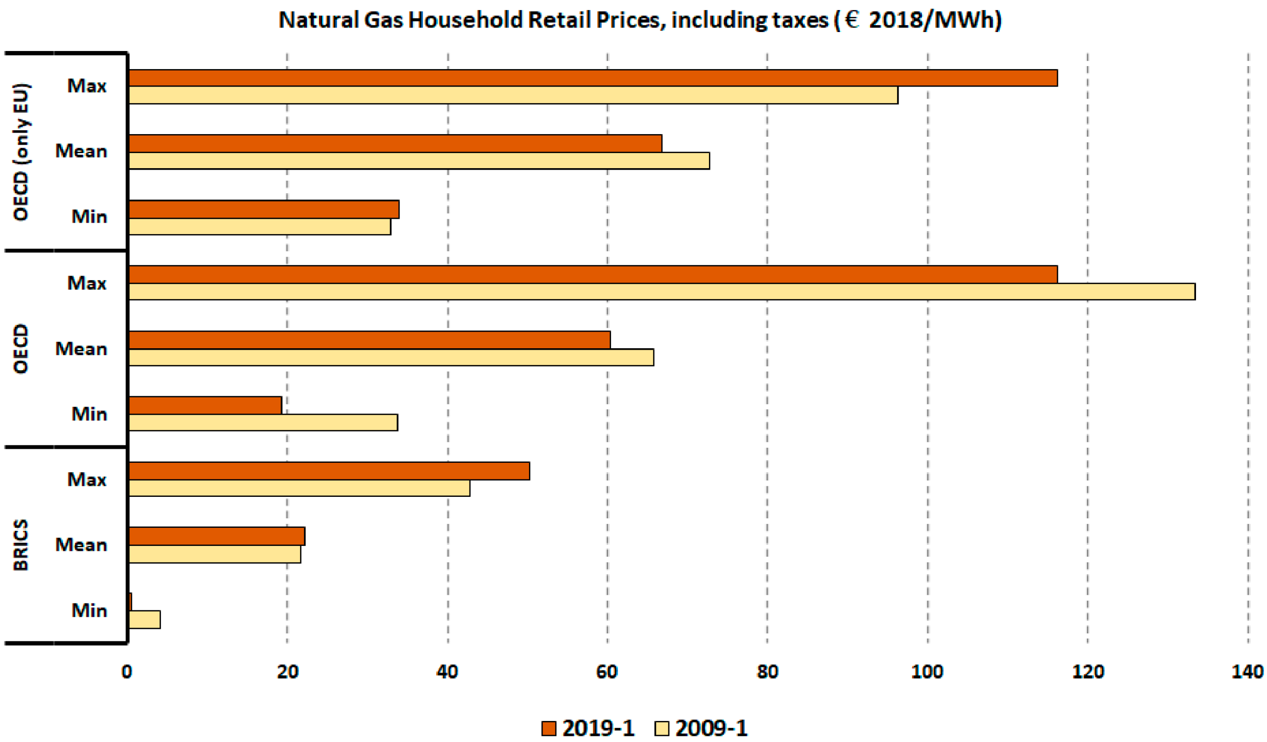

Figure 12. Natural Gas Household Retail Prices in January 2009 and 2019. Note: The values for Brazil are December 2008; there are no values for Greece and Finland in 2008; no values for Mexico in 2019; and no values for Norway and Iceland for both years. Source: Figure produced by the authors, relying on data from EC [180].

In essence, the economic dimension of EP is an important issue for academic society and policymakers as well. The economic dimension creates complex interconnections with the other dimensions; hence, it was important to simplify these intertwined relations on the basis of the SDG agenda.

5.4. Institutional Dimension

It is an inclusive institution (institutions can be generally categorized into inclusive (or open or democratic) and exclusive (or authoritarian), the former providing incentives and opportunities to citizens while the latter not to such an extent (for more information, please see Acemoglu and Robinson [182]) that takes people's needs into account. Non-direct democracy might be an indication of exclusive institutions, particularly the planned economy systems, which were adopted by seemingly exclusive institutions. For example, the former socialist states were some special case studies on how much EP was apparent.

The academic literature found that former communist countries had higher levels of EP than western European democracies [4,62,153]. The reason was the transition from a controlled economy to a free market as well as the stoppage of energy subsidies in order to create commercial energy markets.

The answer to EP from an institutional perspective is the building of a self-sufficient, secure, and sustainable system. Furthermore, promotion of public participation and eradication of corruption are integral parts of the LNOB idea and sustainability.

5.5. Environmental Dimension

The environmental dimension of EP sheds light on affairs involving either indoor or outdoor pressures that destabilize a decent life full of energy self-sufficiency. For example, clean energy utilization is intertwined with EP [111,183], as shown in the energy ladder (Section 3.2). The reason why is mainly due to the emission of PM 2.5 and GHGs if rudimentary—cooking or healing—means are utilized, such as solid fuels [113,114].

Furthermore, the number of cooling degree days (CDD) and heating degree days (HDD) are decisive for a household's proper maintenance, as they are potential indicators that show how much energy is needed to have an adequately warm (during winter) or cool (during summer) house. Nevertheless, the impact of EP can provoke destabilization of a household's adaptive capacity during heatwaves in the summer [172,183]. This is linked to the UHI effects when, especially at night, the temperatures do not cool down due to the adjacency and density of buildings, which withhold and cannot reject the temperature related to the sun's radiation [74,116,117].

The environmental dimension elaborates complex linkages to EP; however, the main indoor and outdoor factors that can aggravate EP, referring to the environmental dimension, are the aforementioned. Naturally, the socioeconomic dimensions can also destabilize a household's energy efficiency through income reduction, inflation in energy retail prices, and phenomena such as social exclusion and aporophobia. As a result, the core environmental dimension is crucial for SDG policymaking, as it is an intrinsic part of just transition and sustainable development.

6. Green Deals and Their Impacts on Energy and Fuel Poverty

The present section will delve into the interlinkages of *green deals* related, directly or indirectly, to energy issues and specifically to EP. Since 2007, a series of discussions have ignited on the need for a new deal based on Franklin D. Roosevelt's idea, not solely an economy-driven new deal but a "*Green new deal*" (GND) [184]. The idea has roots that can be found in the 1990s, but again, T. Friedman [185] in 2007 called for "ending the addiction to oil" and turning towards the adoption of renewables based on two crucial factors: *government regulation* and *prices*. Nowadays, the GND in the USA necessitates establishing energy-efficient and smart power grids that can safeguard affordability for electricity prices [34].

The GND debate has two phases: GND 1.0 and GND 2.0, which might partially deny the orthodox economic nomenclature that tries to cope with externalities, but the GND takes as a basis that "climate emergence . . . is part of a social crisis" [184]. This is also the basis of the question that Mastini et al. [184] posed: a GND without growth? Because it is possible that in order to achieve the targets of the GND, it might be a question of whether there should be a growth-oriented or a degrowth-oriented agenda.

In parallel, in 2019, there was the proposal of the "*European green deal*" (EGD), whose aim is to tackle energy poverty and promote just transition [33]. The EGD frames a series of actions that deal with affordability of energy services and prices as well as the financing of renovation schemes. Bloomfield and Steward [186] found several common grounds between the GND and the EGD; additionally, they distinguished an opportunity for the promotion of green deals in the post-COVID-19 era.

"Energy in China's New Era" is a white paper from the Chinese Ministry of Ecology and Environment that gives prominence to the eradication of poverty and commitment to the "*energy revolution*". More specifically, this is the first of the guiding philosophies on energy policies that is called "putting people first" [43]. Nonetheless, this white paper is not called a green deal, but it incorporates many elements, principles, and characteristics that a green deal has. Furthermore, China in the new era aspires to increase its energy projects, as it recognizes the energy element as a driving force that impedes poverty alleviation. These projects target the installation of photovoltaic panels; more specifically, China inaugurated solar power stations that generate almost 26.6 million kW and about 1.25 million jobs each year. In essence, relative to EP, China deals with poverty via the adoption and utilization of renewable energy sources.

Another initiative is the network of the 100 world-leading cities, the "C40" that inaugurated the "*global green new deal*" (GGND) [187]. The GGND endeavors to scale up actions on the climate crisis and the promotion of urban sustainability. For example, the GGND aims to phase out fossil or solid fuel heating and cooking in more detail; only one city has achieved that in 2011, but 10 cities have reached this goal in 2021. Other aspects in 2021 center on renewable energy mandates for buildings (i.e., 10/100 cities), improvement of water system efficiency (i.e., 14/100 cities), and retrofitting programs for private buildings (i.e., 26/100 cities), to name but a few. In general, the GGND aims to ameliorate of urban agglomerations and advance urban sustainability.

The present section mentions three green deals and one white paper that have common characteristics. To recapitulate, the most practical seems to be the GGND due to its applicability in the 100 leading cities that have the know-how to apply radical changes. However, the GND, the EGD, and the Chinese white paper ought to be accompanied by more detailed mentions of EP, not only on theoretical background but primarily on applicability concerns. In essence, all four frameworks are well-rounded, but it is necessary to adopt a more hands-on nature.

7. Discussion and Future Directions

EP has multifaced impacts on SED as it comprises notions such as vulnerability, deprivation, and insecurity due to accessibility and affordability issues during pandemics, inflation, and wartime. More specifically, EP drivers such as augmented energy losses due to inefficiency in building infrastructure, divergence between stakeholders' needs, high share of energy-related expenditure in comparison to the level of disposable income, and exogenous pressures such as climate and energy crises provoke severe implication on human psychology and social wellbeing [4,71,172].

Undoubtedly, the rudimentary cooking and heating appliances might aggravate human health if there are emissions such as CO, CO_2, or other GHGs [122–125]. However, this is more typical in developing countries. The developed countries cope with affordability issues that are linked to inadequacies in keeping homes warm during the winter and cool during the summer. Another indoor aspect is the appearance of mold on the walls or roofs. Mold is not totally harmful, but if there is expansion of mold, it can provoke illnesses, such as Pontiac fever, as mentioned before [128,188].

The HVAC aspects ought to follow standards provided by ASHRAE. By having well-structured HVAC elements implemented, it is possible to ameliorate indoor conditions and hence, to some extent, reduce EP. Necessary are also the directives and initiatives such as the EED and EPBD; this framework is not yet applied exclusively in the EU [173,174].

Furthermore, the UHI effect reveals interconnections between poor building performance and climate change pressures on urban areas; hence, energy audits are a novel need that ought to be clarified [116,168]. Energy audits might provide useful information on how to improve a building's performance and conserve electricity from a circular economy perspective.

Governance policies that deal with carbon neutrality, just transition, and green deals are directly or indirectly linked with EP as well [64,109,110,145,180]. The multidisciplinary nature of EP has made it apparent in almost every policymaking agenda related to environmental problems. EP combines socioeconomic and environmental elements, as noted before.

Having in mind the research hypothesis, it has been noted that there may be no difference between the OECD and BRICS on the matter of multidimensional EP; hence, let us shed light on this hypothesis. On the pure monetary aspect of multidimensional EP, there are better conditions in BRICS compared to the OECD on the prices of electricity and natural gas for household retail prices, as shown in Figures 11 and 12. The pure economic aspect is important in defining a problem, as it is easier to compare and understand. Nevertheless, multidimensional EP also takes into account access to clean drinking water services and sanitation, as shown in Figures 5–7, in which the OECD performs better on all these elements that are linked to the health, psychological, and well-being aspects of a decent life. OECD countries seem to be in better condition when copying with multidimensional EP in comparison to BRICS economies. Furthermore, on the technical dimension, the percentage of people with less access to electricity can be found in BRICS, as shown in Figure 10.

A matter of great importance is the availability of data, as the current review utilizes data until 2021 in order to cover the impact of COVID-19 but cannot cover the aftermath of the pandemic. The same problem also relies on the impacts of inflation and conflicts that aggravate people's lives to a great extent. Future directions might show a totally different image, but the polycrisis phenomena such as public health, financial, and war crises put multidimensional EP agendas on frivolous agendas—and this is a problem. Thus, the present review tries to promote the notion of multidimensional poverty at a similar weight to other crises, as people suffer from it as well and, in many times, it is a hidden problem (as hEP in Table 3). In future developments, the matter of discussion around global multidimensional poverty might be the alignment of the indices from the World Bank and the United Nations at Table 2. This might usher in better understanding between academicians and policymakers as well. Having a common global poverty index would also enable the building of a common understanding of multidimensional energy poverty.

Human development has been linked to the technological transformation and the increase in wealth since the industrial revolution [189,190], but EP has been in the academic literature almost forty-fifty years now. After all, the green deals might provide a solution to this conundrum through the implementation of the LNOB idea and by "prioritizing the poorest of the poor" under the circular economy and SDGs (1, 6, 7, and 11) scope [65,82,98,106,107,191,192].

8. Policy Implications and Conclusions

The multidimensional nature of EP is being monitored by a multidisciplinary academic literature. Social, technical, economic, institutional, and environmental elements provide necessary aspects that ought to be covered in line with multidimensional energy poverty. There are several dilemmas that should be answered in order to eradicate EP.

On a theoretical basis:

- Consensual and expenditure-based approaches are important for framing energy poverty;
- Temperature-based or outcome-based might be subject to inner distortional problems;
- Consensus on what energy poverty really means: promotes public participation.
- On an environmental basis:
- IAQ aspects ought not to be neglected: PM 2.5 and GHG emissions due to rudimentary cooking and heating methods have detrimental effects on human health;
- Environmental aspects such as the urban heat island effect pressures, the exogenous environment of building infrastructure, and EP are intertwined with such phenomena, especially in urban areas.

On an institutional basis:

- Strengthening of democratic decision-making;
- Promotion of public participation;
- Institutional cooperation on the integration of *green deal* goals;
- Copying with corruption.

On a technical basis:

- Governmental incentives and subsidies for building renovations are necessary on a circular economy basis;
- Urban heat island effect pressures negatively affect energy poverty in cities;
- Adoption of renewable energy sources, possibly through microgrids;
- Building renovations through economic incentives is necessary.

On a socioeconomic basis:

- Social exclusion should be observed in order to minimize the psychological and mental adverse effects of social isolation;
- Inflation due to the war ought to be restricted in order to minimize the provoked impacts on further EP;
- Energy-related aporophobia might be a matter of discussion in upcoming debates.

On a multidimensional basis:

- EP creates vicious circles;
- Affordability and accessibility issues are apparent in developed and developing countries, respectively, making fuel poverty and energy poverty similar but different problems that ought to be monitored more precisely.

Briefly, energy and fuel poverty have many dimensions that should be observed before being assessed and analyzed. The book of Mack and Lansley posed the question, "how poor is too poor?" [130] and since then, the multidimensionality of energy and fuel poverty has been monitored by several academic and political institutions. As a result, a vicious energy (or fuel) poverty circle is created.

The vicious circle of high prices due to inflation creates affordability issues. Affordability problems provoke negative effects on people's well-being as they become anxious, depressed, and self-isolated. These psychological and well-being pressures lead to social exclusion, with aporophobia being the last level of this vicious circle. However, it is the vulnerability of children and elderly people that renders energy and fuel poverty an alerting problem that must be resolved.

Especially in times of inflation, COVID-19, and war, the ramifications of these exogenous phenomena on EP and people's lives are detrimental. Potential cooperation and integration of the green deals might offer a more cohesive policy framework in order to cope with EP. Above all, the monitoring of these poverties might offer a valuable framework to deal with global poverty too. In short, it is high time that sustainable energy development eradicates multidimensional poverty in all its forms based on the circular economy and SDGs.

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