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Addressing the challenges posed by energy poverty in Latin American countries

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Abstract

Many of the energy systems functioning across the developing world are poorly designed and largely inadequate to meet a country's commercial and domestic energy needs. This is especially so in Latin America, where poverty trends have been exacerbated by limited access to energy, which could be used towards supporting industrial and small-scale commercial activities. This has characterised the widespread trend of energy poverty. This phenomenon poses a major barrier towards achieving the UN Sustainable Development Goals (SDGs) and addressing climate change, since lack of access to reliable energy generation systems hinders the development of economic activities and limits the comfort of living conditions. This paper reports on a study aimed at catering to a better understanding of the challenges related to energy poverty in

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Latin America and identifying some of the tools that may be deployed to address them. The methodological procedures used were bibliometric analysis and survey. The main findings of this research evidence that reducing energy poverty in Latin American countries is crucial to alleviating household costs since a considerable part of family income is used to pay the energy needs. Less use of coal, greater access to electricity—including those from renewable generation—as well as the use of technologies and programs subsidized by governments would significantly contribute to increasing the Latin American citizens' quality of life and achieving the SDGs.

Keywords Energy development · Energy poverty · Posed challenges · Bibliometric analysis · Survey · Latin America

1 Introduction: energy and development

The 17 sustainable development goals (SDGs), launched in 2015 by the United Nations, can be characterised as important drivers for debates and conjoint projects to be implemented and developed by developed countries towards a better future [1]. In particular, SDG7 establishes targets related to the provision of clean and accessible energy for all people on Earth [1, 2]. According to the [3], the demand for energy in the world is increasing considerably, and at the same time, the fossil-based energy models widely used in the world are proving to be inadequate in order to contribute to an economy aligned with sustainable development. Climate change is the clearest example of how these models are inadequate [4, 5].

It is recognised that energy, in its global conception and if properly used and accessible for all people, can provide well-being and a better quality of life. This reduces poverty and promotes economic and social development [5–7]. Energy is a key element for developing countries, and energy provision helps to construct resilient economies [8]. In a report published by the [9], energy was called "The Oxygen of the Economy" [9]. In the real world, however, the energy production model causes many environmental impacts, and energy benefits are not accessible to many people. [10] showed that energy access for a greater number of people in a country is directly correlated not only with macroeconomic conditions, but also with transparency of companies' financial information and audit mechanisms.

For [7, 11], global energy production needs to be expanded to consider a change towards renewable energy modalities. It is expected that world energy consumption will grow by 50% by 2050, according to projections [5], and renewable energy modalities are the sustainable path to meet this demand without compromising environmental issues [4, 5, 12]. It is also important to emphasise that the generation of renewable energy also has the potential to generate other benefits, such as jobs and economic production [13].

To increase the use of renewable energies around the world, particularly in developing countries, governments should pay closer attention to energy policies, which are critical to ensuring clean and affordable energy for all projects [14]. Energy policies need to be developed that consider the context of each country, according to [4], and they should better consider renewable energy sources as part of their energy matrix [14]. A detailed analysis of energy policies trends needs to include the current and future demands in terms of domestic, commercial and industrial consumption; in addition, it also needs to take into account the need to provide better living conditions for all citizens [15–17]. As already emphasised by [4], the aspects associated with energy policies may vary from nation to nation.

Unfortunately, in many countries, barriers are still observed, which prevent debates and a better definition of an adequate energy policy as well as its implementation [14]. Adelaja [14] cites some examples of barriers: lack of a clear and pragmatic vision of national objectives; lack of an integrated structure of regulatory agencies; corruption problems; fragmentation of powers; excessive focus on regimentation; inadequate focus on incentives to investors and stakeholders, and lack of transparency in agency activities, among others. All of these problems contribute to unequal energy resource access and the promotion of energy poverty.

Focusing mainly on Latin American countries, [18] highlight that more than half of the region's residents do not reach an adequate energy efficiency standard, and there are still many problems related mainly to rural electrification and access to quality energy in more remote regions; as a consequence, these regions end up developing precariously and at a slower pace when compared to other regions. González and Ibáñez-Martín [19] mention that there has been an evolution in some indicators related to the supply and distribution of energy in Latin America in recent decades; however, there is still a lot to be done, especially in terms of the quality of the energy offered and accessibility. Mohsin et al. [18] also emphasise that Latina America's energy matrix corresponds to 25% of the global energy matrix, with 41% of the sources coming from petroleum; solving problems associated with this matrix and making it even more renewable can significantly contribute to reducing energy poverty in the world.

It is also essential to highlight the taxes charged for energy supply in Latin American countries (higher than in other regions of the world); such taxes burden the budget of low-income Latin American families, making their lives increasingly difficult. In the same, high-energy costs also discouraged, for example, the creation of small new enterprises, which could significantly improve the financial situation of family groups [18, 19] also highlight other problems in Latin American countries, such as the long time to obtain electrical connections in some economies (Bolivia, for example).

Structuring public policies to have more agile, clean, and inclusive energy sectors, means that governments in Latin American countries need be more active in engaging in efforts to reduce energy poverty [18, 19].

1.1 Objective and research approach

To fill this research gap, this paper aims to provide a better understanding of the challenges related to energy poverty in Latin America and identify some of the tools that may be deployed to address them. Therefore, we seek to answer the following research question: What are the possible barriers and challenges posed by energy poverty in Latin American (LA) countries? The findings of the study will be used as an information source for policymakers to overcome the recent barriers in the studied LA countries.

Therefore, to achieve these goals, this research is structured as follows. Section 2 presents the theoretical background which reviews the concept of energy poverty and its challenges from a global perspective, focusing on Latin American countries. The third section entails the main methods used for data collection as well as data analysis. The bibliometric analysis that was used to select the methods for assessing the challenges of energy poverty is described. Section 3 also identifies the variables of the study for collecting survey data and provides an explanation of the detailed methodology for using them in the analysis. The evaluation of energy poverty outcomes is used to interpret the results, the main discussion and key findings show the actual challenges of energy poverty in LA countries in Section 4, and lastly, the conclusions and recommendations are presented in Section 5.

2 Energy poverty in Latin America

2.1 Concept and challenges of energy poverty

The concept of energy poverty by the Energy Poverty Advisory Hub (EPAH) & European Commission (EU) highlighted the significant financial strain that energy bills place on consumers, along with the negative impact on their ability to meet other financial obligations and maintain their overall health and well-being. This definition mainly highlights the significance of affordability and the consequences of excessive energy costs on households. Likewise, many scholars provide a precise and concise explanation of energy poverty in developing nations and LA, which refers to the lack of access to modern energy services or the inability to afford sufficient energy for basic needs such as cooking, heating, lighting, and using appliances [20–22]. This condition affects a substantial number of people worldwide, particularly in developing nations, where there is a scarcity of reliable and affordable energy sources. The same authors mention that EP in Latin America denotes the state in which individuals or households do not have access to energy services that are reasonably priced, dependable, and environmentally friendly [21]. This lack of access has negative consequences on their quality of life, health, and socio-economic welfare. This idea incorporates multiple dimensions, such as the price, accessibility, reliability, and quality of energy services.

Energy poverty in Latin America is noteworthy, affecting a substantial portion of the population who have challenges in affording sufficient energy services. The concept is exacerbated by the limited availability of dependable electricity and clean cooking fuel, impeding growth, and intensifying social inequality [23]. Hence, resolving the issue of energy poverty in LA necessitates customised solutions that take into account the distinct requirements and conditions of the region. In order to prevent misunderstandings and guarantee the success of initiatives aimed at tackling energy poverty in Latin America, it is crucial for researchers and policymakers to enhance and customise definitions and strategies to fit specific local circumstances [24]. When establishing interventions and policies to improve energy access and affordability, it is important to take into account the socio-economic conditions of each country, and their communities. This is especially important in Latin America, a region characterised by a great socio-economic diversity. This will enable them to build more precise and impactful policies, thereby improving the well-being of populations throughout the region [25].

On the contrary, considering the relevance of energy for sustainable development, energy poverty is one problem which is associated with it, and which needs to be better understood. [26]. The concept of energy poverty was first described in 1979 after the petroleum crisis caused inflation in fuel prices. It was later defined briefly as having an adequate amount of energy for 10% of income [27] and termed as the inability to maintain a level of energy consumption that is sufficient to meet basic needs, such as maintaining a residence at the appropriate temperature or preparing food. This is complemented by the fact that more than 1 billion people do not have access to electricity [28]. Reliable, sustainable, modern and affordable energy access is part of the United Nations (UN) 2030 Agenda, representing the seventh Sustainable Development Goal (SDG) [84].

Energy poverty has also an associated term, namely energy access. This refers to an inability to meet energy needs at affordable rates. This is influenced by several factors, including low income, the high cost of energy, limited access to energy, and outdated technologies. Both energy poverty and energy access have further implications, such as health issues (e.g., mass winter deaths) and mental health issues [29]. Admittedly, it is not an easy task to define energy poverty, as the concept varies according to the energy resources from one country to another [30]. However, [31] asserted that a scientific assessment of energy poverty may serve as the foundation and assurance for developing and enacting public measures aimed at mitigating the issue.

Energy poverty is a problem, especially relevant to households with low income, which often struggle to afford adequate energy services, leading to inadequate heating, cooling, and lighting. This is mostly attributed to poor household insulation and low income [32, 33]. Domestic energy poverty, a widespread global problem, is especially acute in developing countries [34], since many people there are affected by unemployment or underemployment. They often have reduced financial capacity to cover energy costs and, unlike in rich countries, have no government social net they can reply on. Nevertheless, it is important to recognise that energy poverty is a worldwide problem that impacts both emerging and developed countries, albeit in different ways and to different extents. Emphasising the initiatives and strategies, especially in the EU, to combat and measure energy poverty could provide a more holistic perspective on the global approach to this problem.

In this line of reasoning, [35] emphasise the importance of considering contextual issues to evaluate energy poverty, such as economic, geographic, and cultural aspects. According to the authors, measurements based on access or quality standards may overestimate or underestimate the reality. Among the regions that should be carefully analysed, developing economies are highlighted. Analysing three developing country regions, [36] verified that despite differences among studies, energy poverty is a widespread reality for Sub-Saharan African, South and Southeast Asian, and Latin American and Caribbean populations.

Access to energy is central to overcoming several development challenges, including poverty, gender inequality and climate change, in addition to food security, health and education [37]. Concepts such as economic development and measurements such as the Human Development Index (HDI) are also linked to energy use, as they are often measured by terms such as electricity consumption in each home and CO_2 emissions. In addition, the literature shows that economic advancement and development have a high impact on a country's energy use, as exemplified by the case of China: between the years 1970 and 2010, during which China demonstrated great economic growth, it also started to consume up to 20 times more electricity [30, 38].

2.2 Challenges posed by energy poverty in Latin American countries

The main corpus of this study was concerned with the topic of energy poverty in LA countries. A number of studies have shown recent problems, the barriers created by energy poverty, and how to overcome the challenges in LA countries [37–40]. For instance, as remarked by [41], several studies have investigated energy poverty challenges in Spain, Scotland, Mexico, and Ecuador until 2020, which may indicate that energy poverty needs ongoing research to carry out assessments [40]. Energy poverty affects many people in Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, French Guiana, and other Latin American countries, but there are no survey investigations on energy poverty-posed challenges in this entire region that assess multi-scale mapping of fuel poverty, vulnerability of households, energy development, affordability and sustainability, emissions, security transport impacts, winter incidence, and improvement in mortality, and related issues. However, a scientometric analysis for seven LA countries were performed by [39] recently.

As argued by [39], although Latin America presents great problems related to energy poverty, there is little research about this in the literature. These authors, using the MEPI (Multidimensional Energy Poverty Index), analysed seven Latin American countries (Peru, Colombia, Honduras, Guatemala, Dominican Republic, Mexico and Haiti) and verified that there is a strong correlation between MEPI and HDI, showing that addressing energy poverty can also be important to improving HDI levels, although further investigation is necessary and the connection between these concepts might oversimplify the complex interactions among various social, economic, and environmental factors. In addition, the study also verified that, among these countries, Haiti presents the lowest MEPI level: more than 97% of its population does not have a basic energy service. The critical situation in Haiti is corroborated by the [42] report, which shows that only 39% of Haitians had access to electricity in 2019. Also using MEPI, proposed by [37, 43] adapted the index to analyse thermal comfort in Mexico, considering the relevance of this energy element in different regions of the country. In [40], the authors proposed their own index for assessing energy poverty in Ecuador and compared it with MEPI.

Moreover, considering the challenges faced by Latin American countries regarding energy poverty, [44] emphasise the need for the governments of these countries to use renewable energy technologies as tools to facilitate access to cheap energy (e.g., solar).

Focusing on five Latin American countries (Argentina, Colombia, Brazil, Mexico, and Cuba), [23] combined literature and documents review to analyze the current context of these Latin American countries. In their analysis, the authors indicate the need to separate different dimensions of energy poverty, since exclusive focus on service-based or expenditure-based approaches can generate incomplete analyses and conclusions. The authors also emphasise the lack of qualitative studies focused on the region.

Despite the difficulties of energy access for families living in remote areas, Latin American countries also present these difficulties for low-income families living within urban centres. This is the case of the Brazilian favelas, which are communities with high levels of energy poverty [45]. Regarding energy supply structure improvements for the sector in this region, and in analysing changes in electricity sector governance in Latin American countries and the Caribbean, [46] argue that energy poverty was not significantly affected by these changes. However, energy poverty is termed energy injustice [47] and is one of the difficulties of social justice [41], where energy is consumed by individuals for human needs in Latin America [48].

Despite the problems evidenced in developing economies, energy poverty is also observed in developed countries such as Germany and Belgium, where energy efficiency remains a problem [34]. Aside from this, studies have shown that a large percentage of households are unable to achieve adequate indoor temperatures through their heating or cooling systems due to energy poverty. This has serious implications for the physical and mental health of individuals as well as for productivity. This is a common problem in developed countries. The problem is further influenced by global warming, as many regions are experiencing increased temperatures and extreme heat waves [49]. Taking this into consideration, energy poverty can be broken down into two main categories, namely availability and affordability. Developing countries often fall under the availability category, as there is a lack of access to basic energy needs such as electricity. However, developed countries, including Latin American countries, have high costs for socially necessitated energy such as heating or cooling systems, thus they belong to the affordability category of energy poverty [48, 85].

In conjunction with energy poverty, energy vulnerability refers to factors that influence the precariousness of people or areas [34]. These factors include the composition of the household (number of old or young people), the professional status of household members, whether the property is rented or owned (rented property is generally less energy efficient), and the health status of members (who may require additional heating or cooling). These factors increase a household's susceptibility to energy poverty [50], and the findings mentioned that losses and damages incurred energy poverty rather than overcoming it [39].

Due to the burden placed on households by increased energy tariffs, researchers have stated that a decrease in energy poverty is essential for alleviating pressure on household income. Studies have shown that one of the major ways to reduce energy poverty is by investing in modern energy sources, especially renewable energy such as solar energy, which may be used to improving life quality and access to income generating activities such as conservation of produce and trade. Furthermore, the use of biomass energy and other renewable energy sources (e.g. wind) can significantly alleviate pressure on household incomes [83]. Provided that more renewable energy may be made more widely available to households, problems such as those seen in Mexico, where high energy costs are taking a larger portion of people´s income [39] may be avoided.

This review also shows gaps in the literature and highlights the scarcity of papers focusing on energy poverty, especially focusing on LA countries. Accordingly, as mentioned, the main objective of the present study is to evaluate the challenges of energy poverty in Latin American populations by identifying their current trends. Hence, the study indicators, variables, and indices are the key elements for scrutiny in the study and in addressing tailored policies. Nevertheless, detailed information regarding the literature reviews can be found in the proposed methodology for bibliometric analysis by [37], whose energy poverty indicators were used for the analysis of the study. Additionally, this inquiry is distinctive because it includes a random sample from a wide range of Latin American countries, and the types of questions addressed give information on the current situation in Latin American families to fight energy poverty.

3 Methodology

3.1 Approach used in the bibliometric analysis

To gain an overview of the state of knowledge on global energy poverty in Latin America, we conducted bibliometric analyses using VOSviewer. This software tool is designed to map, among other things, scientific literature and highlight major focus areas. The input data was the literature published on energy poverty, indexed in the Web of Science (WoS) [51]. WoS was used due to its wide coverage of quality peer-reviewed articles on this topic. To gain global as well as Latin American-based perspectives, we developed two databases: one with a global focus that included 2021 articles, and another one focused on Latin America that only included 129 articles. The search strings used to develop these input databases are available in Appendix 1. The term co-occurrence analysis of VOSviewer was used to identify dominant research topics in energy poverty. This analysis maps the co-occurrence frequency of terms related to the topic. It can also be used to identify major research clusters. The results are presented in the form of nodes and links, where node size is proportional to the frequency of occurrence, and link width is proportional to the strength of the connection between two terms. Additionally, the terms that are located near each other have co-occurred more frequently and form research clusters.

3.2 Online survey

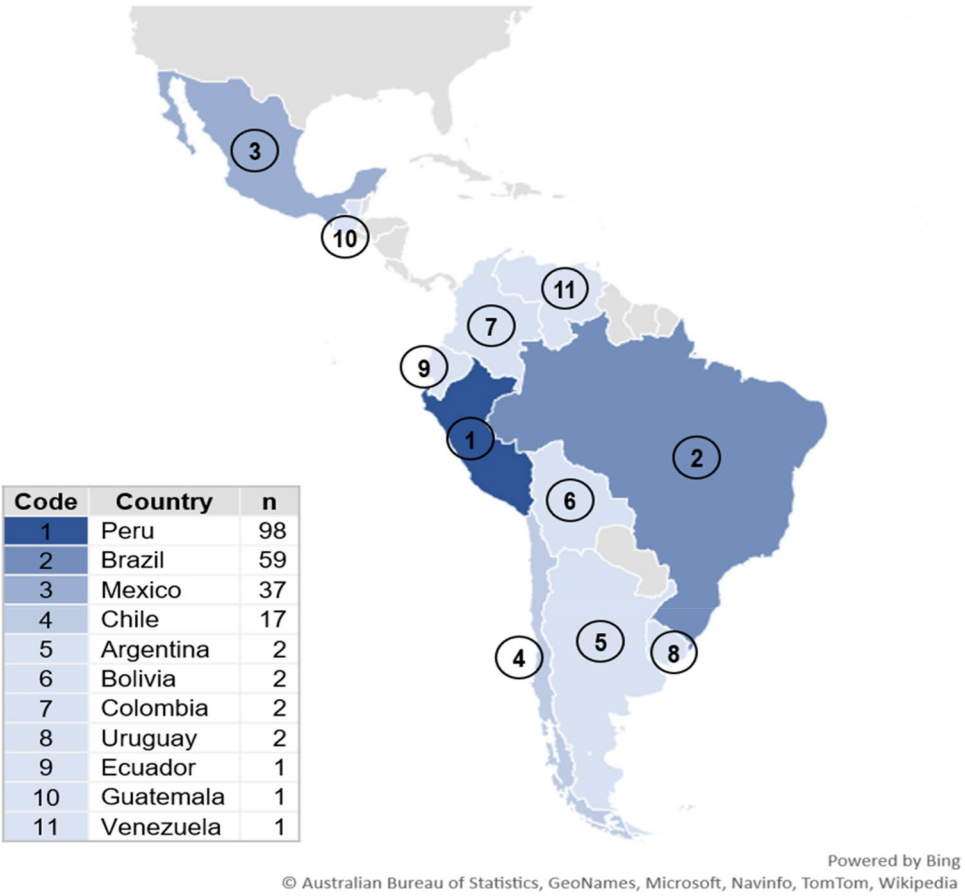
An online survey was applied to establish 'the Challenges Posed by Energy Poverty in Latin American Countries' for the exploratory component. The questionnaire was developed, comprising 26 questions and 3 main sections. A set of 26 questions was presented to the participants in order to report the extent of the problem, list the challenges they have been facing, the impacts of limited energy access, the availability of fossil fuel and renewable energy, and some of the measures they feel are needed to address the problem. The survey also asked which changes are needed to provide more adequate, reliable, and affordable energy services. Nonetheless, the three main sections included:

Part 1—The demographic profile of the respondents.

Part 2—Household's importance and challenges in receiving adequate, reliable and affordable energy services to fight energy poverty.

Part 3—Household's level of consumption and access to energy, lighting, heating appliances, information and communication technology appliances, air conditioning, cooking appliances, refrigeration appliances.

The Chair of the "Association of Medical Ethics Committees in Germany" approved the questionnaire, confirming that the study complied with all regulations and that informed consent was obtained (see Appendix 2). The questionnaire was validated by a group of researchers and then shared with several networks to reach the LA country's households, through the team of the Inter-University Sustainable Development Research Programme (IUSDRP, https://www.haw-hamburg.de/en/ftz-nk/programmes/iusdrp/), which surveyed more than 10 countries in LA. The study followed a non-probability sampling methodology, as the researchers shared the survey with their networks and contacts. The questionnaire remained active between March and August 2021 and collected 222 responses after data clean-up, removing countries not in the area of study, from 11 LA countries—Peru, Brazil, Mexico, Chile, Uruguay, Colombia, Bolivia, Argentina, Venezuela, Guatemala, and Ecuador—as shown in Fig. 1.



Code	Country	n
1	Peru	98
2	Brazil	59
3	Mexico	37
4	Chile	17
5	Argentina	2
6	Bolivia	2
7	Colombia	2
8	Uruguay	2
9	Ecuador	1
10	Guatemala	1
11	Venezuela	1

Fig. 1 Participating countries and number of respondents (n) per country

The final sampling consisted of 222 respondents out of a hidden online population. As non-probability sampling methods through Internet recruitment of hidden populations traditionally reach small samples [82], this sampling size is considered acceptable for the purpose of this paper. However, it is not possible to make inferences over broader populations.

Participants in this survey were from eleven Latin American countries, with greater representation from Peru (44.1%), Brazil (26.5%), Mexico (16.6%), Chile (7.66%), Uruguay, Colombia, Bolivia, and Argentina respectively (1%), Venezuela, Guatemala, and Ecuador (0.5%) respectively; see Table 1. The overall gender distribution among the respondents was 53% male and 47% female.

Regarding their age, 38% of the respondents are between 18 and 29 years of age, 14% are 30–39, 22% are 40–49, 17% are 50–59, and 9% are 60 years of age or older. 24% of the respondents earn a net monthly household income of US $600 to $1350. A monthly income of more than US$4000 is achieved by 17% of the respondents. About 12% of participants earn US $1350–2000, and 11% of them make US $2700–3400. 8% of respondents earn a net monthly income in the range of US $2000–2700, US $3400–4000, or below US $680. A considerable number of respondents hold a postgraduate or graduate degree, 49% and 42% respectively. However, only 9% finished high school. The occupations of the respondents were distributed as follows: student 32%, administrative staff 11%, trained professional 14%, junior management 12%, self-employed/partner 9%, upper management 7%, consultant 6%, retired 4%, temporary employee 3%, unemployed 2%. The respondents predominantly live in a flat, 43%, but a considerable segment of them live in detached houses, 36%. A few more live in semi-detached houses, 18%. Predominantly, there are two adults per house in 43% of the sample, although a considerable percentage (30%) of the sample declared four or more per house. 55% of the respondents claimed that no minors live in their homes, and 31% of the participants indicated one child living at home. A summary of the demographic characteristics of the respondents is shown in Table 1.

Table 1 Respondent´s demographic characteristics

Demographic characteristics		Number of respondents	Share of respondents
Gender	Male	117	53%
	Female	105	47%
Age	60+	20	9%
	50–59	38	17%
	40–49	48	22%
	30–39	31	14%
	18–29	85	38%
Educational level	Post-graduate	109	49%
	Graduate	94	42%
	High school	19	9%
Occupation	Student	72	32%
	Middle and upper management	35	16%
	Trained professional	32	14%
	Administrative staff	24	11%
	Self-employed/partner	21	9%
	Consultant	13	6%
	Retired	9	4%
	Temporary Employee	6	3%
	Junior management	6	3%
	Unemployed	4	2%
Net monthly household income	Prefer not to say	23	10%
	More than US$ 4000	38	17%
	Below US$ 680	18	8%
	US$ 2000 to 2700	21	9%
	US$ 680 to 1350	54	24%
	US$ 1350 to 2000	26	12%
	US$ 3400 to 4000	17	8%
	US$ 2700 to 3400	25	11%
Type of housing	Semi-detached house	41	18%
	Flat	96	43%
	Detached house	80	36%
	Others	5	2%

Source: Developed by the authors—survey output

4 Results and discussion

4.1 Results of bibliometric analysis

Results of the global term co-occurrence analysis for a minimum occurrence threshold of 13 keywords are shown in Fig. 2. It can be seen that, in addition to energy poverty, terms such as fuel poverty, climate change, consumption, renewable energy, energy, rural electrification, energy access, households, efficiency, and health are frequently used in the literature. Four major clusters can be identified. In the largest cluster (in red), renewable energy and rural electrification are central and have strong connections with terms related to accessibility and different types of renewable energy, and with location-based terms such as Africa, Sub-Saharan Africa and India. This indicates a major emphasis on the importance of electrification and renewable energy sources for addressing energy poverty in a sustainable manner [30, 52]. Renewable energy and the electrification of rural areas play a significant role in improving access to energy and combating energy poverty, particularly in developing regions [53]. The utilization of renewable technologies directly addresses the issue of electricity scarcity, which impacts many people globally, especially in Sub-Saharan Africa and India [54]. By harnessing

local resources like solar, wind, and hydro power, rural communities can circumvent traditional centralized energy systems without requiring expensive and time-consuming grid extensions. This decentralized approach not only grants immediate access to electricity but also fosters long-term economic development by facilitating education opportunities, improving health outcomes, and enhancing agricultural productivity [55, 56, 86]. Furthermore, involving community participation ensures that the benefits of accessing energy are equitably distributed based on each community's specific needs—making rural electrification through renewable sources a sustainable solution for addressing energy poverty while empowering communities to meet their energy requirements aligning with global environmental goals [57, 58]. In the second noteworthy cluster (green), terms such as fuel poverty, indicators, and households are central. Also, the term COVID-19 is highly linked to the other terms in this cluster. The term fuel poverty has co-occurred frequently with the term Europe and is closely linked to others such as justice and vulnerability from the same cluster and health and thermal comfort from the yellow cluster. The connection to Europe indicates that energy poverty may also occur in developed countries, thereby causing health problems. Appropriate policies are needed to ensure energy justice and minimise impacts on vulnerable groups [59, 60]. Fuel poverty could have significant consequences for households, especially in terms of vulnerability and justice. Households struggling with fuel poverty often face difficult decisions about heating/cooling versus other basic needs. This dilemma exacerbates existing vulnerabilities, impacting children, the elderly, and individuals with underlying health conditions by increasing their susceptibility to respiratory issues, inadequate nutrition, and mental health challenges. The concept of energy justice emphasizes the inequities in energy access and the unequal burden of energy costs on already marginalized groups, highlighting the need for policies to address these inequalities [40, 61–63].

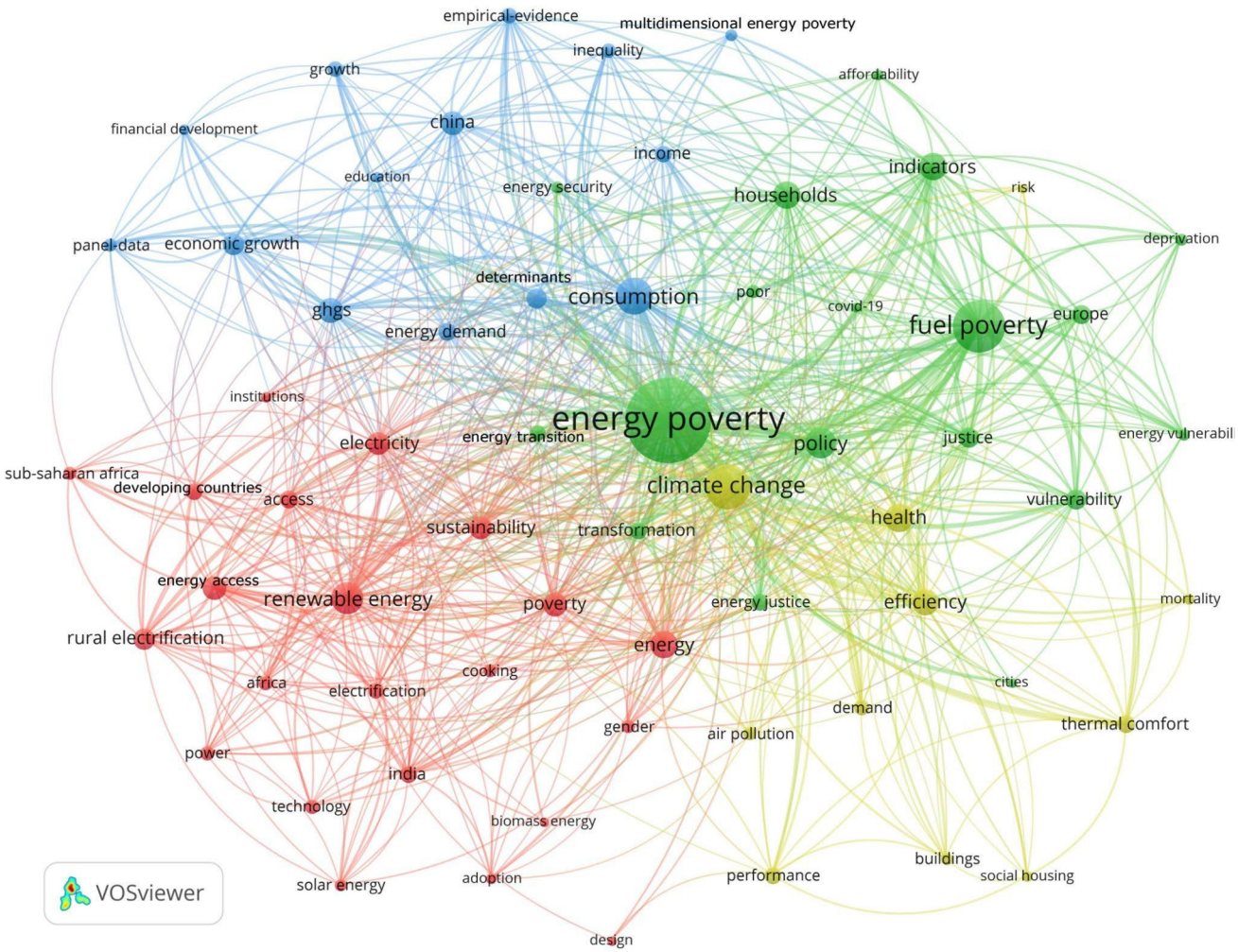


Fig. 2 Output of the term co-occurrence analysis

The COVID-19 outbreak has exacerbated the challenges linked to fuel poverty. Higher home occupancy and lockdowns have led to increased domestic energy consumption, while income reductions due to the pandemic have made it even harder for many people to afford energy expenses. Consequently, more households have grappled with fuel poverty, leading some to resort to unsafe heating and lighting methods or face heightened financial difficulties. The pandemic has underscored the significance of tackling fuel poverty as a matter of public health and social justice [64]. Terms in the green cluster are closely linked to those in the yellow cluster which is mainly focused on climate change, efficiency, and health. The issues of climate change and energy poverty are closely interconnected, especially in developing nations. Limited access to modern energy services makes communities more vulnerable to the adverse effects of climate change. As extreme weather events and unpredictable seasons become more frequent due to climate change, those dealing with energy poverty lack essential resources such as heating or cooling systems [65]. Moreover, relying on traditional biomass for energy in impoverished areas contributes to deforestation and greenhouse gas emissions that worsen climate change further [66]. Transitioning towards renewable energy sources can mitigate the impacts of climate change while enhancing the resilience and adaptability of populations most affected by these challenges [65, 66]. There are concerns about climate mitigation ramifications of energy poverty alleviation measures. Mitigation and poverty alleviation efforts should, therefore, be complementary, and major efficiency improvements are needed to ensure energy poverty challenges are addressed using renewable and sustainable energy solutions [67, 68]. Well-designed policies can offer opportunities to maintain thermal comfort in buildings while minimizing trade-offs for health and climate change mitigation [43, 49, 69].

Finally, there is a blue cluster that is dominated by terms such as consumption, economic growth, GHGs, income, inequality, and multidimensional energy poverty. Consumption patterns, income levels, and inequality are closely interconnected with the complex nature of energy poverty and the wider concept of energy security. Energy poverty extends beyond mere lack of access to energy; it encompasses various issues such as the quality, affordability, and reliability of energy services. Lower-income households often bear a disproportionate burden when it comes to energy expenditure, spending a larger portion of their income on meeting their energy needs [70]. This can lead them to limit their use of energy in order to avoid financial strain, which could exacerbate health risks and social disparities. Furthermore, income inequality can escalate energy insecurity by creating disparities in both access to and usage of energy within communities as well as between them—often leaving disadvantaged groups trapped in enduring states with insufficient access to adequate sources of energy [71]. Economic growth, education, and financial development are closely connected to the challenges of energy poverty. While economic growth can drive up energy demand, it may not necessarily result in better access to energy for the impoverished without comprehensive policies. Education plays a critical role in promoting awareness about energy efficiency and the advantages of renewable energy, empowering individuals and communities to make well-informed decisions. Financial development through initiatives like microfinance and subsidies can facilitate access to modern energy services by addressing initial cost barriers linked with renewable energy technologies [72, 73]. Overall, it is clear that addressing these issues requires a comprehensive approach that takes into account the complex interplay among consumption patterns, income levels, and inequality in order to ensure fair energy security and mitigate the multifaceted elements of energy poverty.

The term co-occurrence analysis for Latin American countries is shown in Fig. 3. Overall, the clusters are similar to the global clusters. However, a unique characteristic of the term co-occurrence map for Latin America is that issues related to air pollution and gender, which are also addressed globally, are more highlighted. In Latin American nations, the connection between air pollution and energy poverty is a critical environmental and societal concern. Energy poverty often leads to limited availability of clean and affordable energy resources, causing households to rely on traditional biomass and other polluting fuels for cooking and heating. This dependency significantly contributes to indoor and outdoor air pollution, with adverse effects on health and the environment. In urban areas, the lack of access to clean energy worsens pollutant emissions from informal settlements where inefficient combustion processes are prevalent. Economic limitations related to energy poverty hinder the adoption of cleaner technologies, perpetuating a cycle of pollution and health hazards. Therefore, efforts aimed at addressing energy poverty in this region should prioritize transitioning towards cleaner energy sources not only for improving air quality but also considering broader implications for environmental justice and equity [23, 74, 75]. Issues related to fuel poverty and gender are closely linked to wider concerns of vulnerability and justice. Women, especially those in low-income or rural settings, are disproportionately affected by fuel poverty due to a combination of socio-economic factors and traditional gender roles. The "female poverty penalty" is evident as women, particularly during their most productive years, experience higher levels of financial hardship compared to men. This is exacerbated by their caregiving responsibilities and the lack of

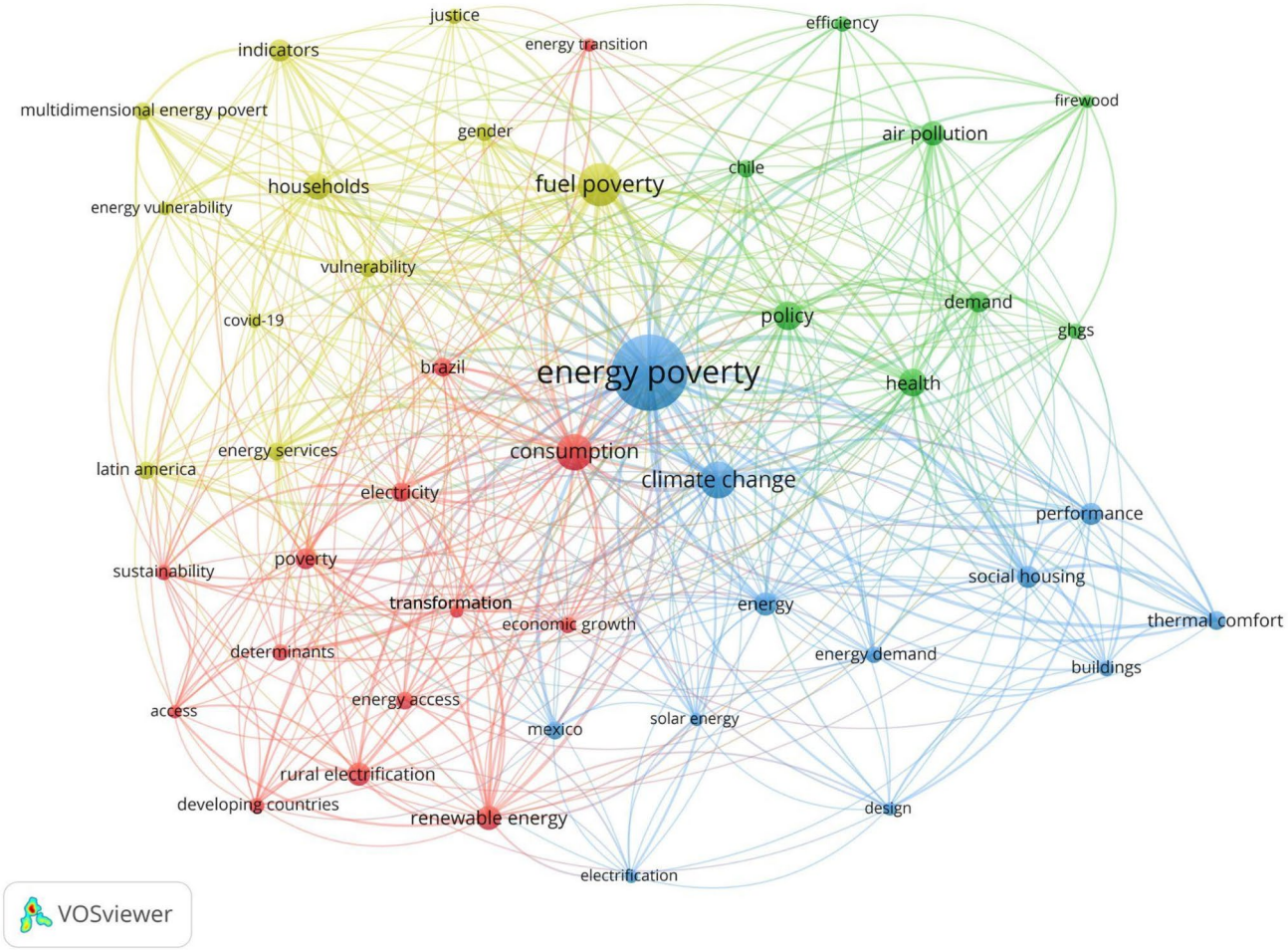


Fig. 3 Output of the term co-occurrence analysis for Latin American countries

alternative care options. Additionally, the situation is complicated by women's tendency to work part-time jobs, face job segregation based on gender, and encounter barriers in their career paths. As a result, households led by single mothers or where women take on primary caregiver roles are more likely to experience fuel poverty and subsequently higher rates of overall poverty within these families. This not only exposes women to greater health risks due to inadequate heating and cooking facilities but also restricts their opportunities for economic progress. It is crucial to address these gender-specific aspects of fuel poverty to promote energy justice and reduce vulnerability among the most affected population in Latin America [76–78].

An important issue to note is that, as can also be understood from the limited number of papers (only 129 compared to 2021 for the global analysis), existing knowledge on energy poverty in Latin American countries is relatively limited. The limited available knowledge emphasises the need for electrification and renewable energy-based measures to tackle energy poverty issues. Such measures and policies may also provide co-benefits in terms of health and air quality improvement [79]. Overall, this overview analysis indicates that understanding and addressing energy poverty in Latin America warrants further research, and this research aims to contribute to providing a better understanding in this regard.

4.2 Fighting energy poverty

Tackling energy poverty is amongst the most urgent issues that our societies are called to solve. To this end, both the Global South and the Global North are required to face energy poverty by adopting multi-layered strategies, targeting diversified societal, economic, and environmental aspects [80]. Latin America is no exception to this. This part of the paper reports on the results of the survey.

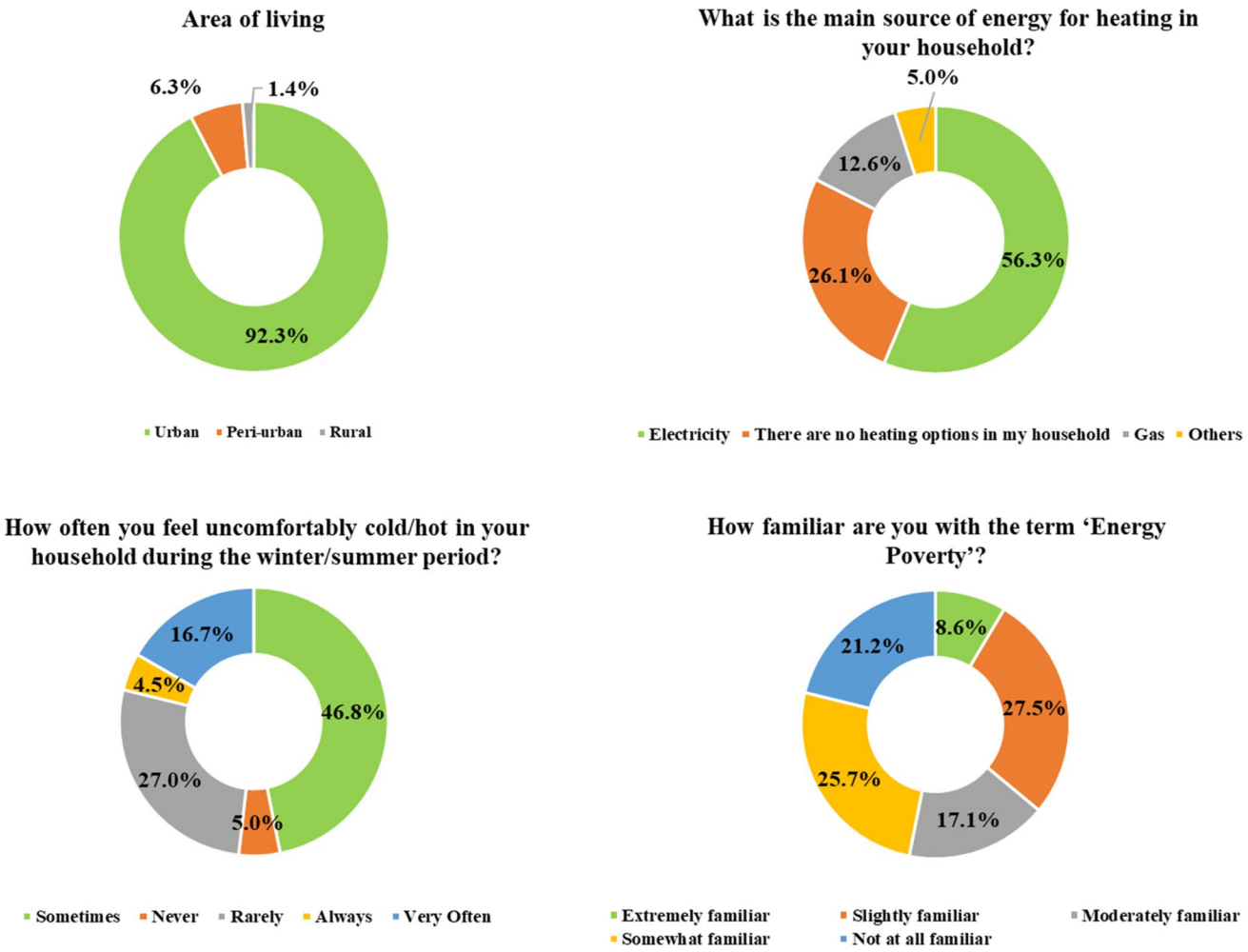


Fig. 4 Overview of housing energy conditions and characteristics

Figure 4 presents an overview of the housing characteristics and its energy conditions. Of the 222 survey respondents, 92.3% described their living areas as 'urban', 6.3% as 'peri-urban' and 1.4% as 'rural'. The majority stated that the main energy source for heating their household was electricity (56%), followed by gas (13%), and heating oil and wood/pellets, both at 1%. 27% reported that there were no heating options in their house, and less than 1% answered that they used solar, or a combination of gas, electricity and wood.

Among the respondents, 27% reported they were slightly familiar with the term 'energy poverty. 26% were somewhat familiar with it, 21% were not at all familiar, 17% were moderately familiar, and 9% were extremely familiar with the term.

Regarding how often they felt uncomfortably cold or hot in their household during the winter or summer period, the majority of respondents (47%) answered 'sometimes'. 27% answered 'rarely', 17%, 'very often', 5%, 'never', and 4%, 'always. Of these, 26% stated that the main reason for the uncomfortable temperature was that the house lacked an efficient cooling system, 23% stated that the house's construction material did not favour thermal comfort, and 10% said that their house lacked insulation. 18% cited varying combinations of all three of the previous factors, and 3% of answers cited more specific reasons for discomfort, including house design, power shortages and climate. On the other hand, 18% stated that they never felt uncomfortable, and 2% said that they rarely felt uncomfortable.

Respondents were also asked a series of questions about the priorities for tackling energy poverty in their respective countries (Fig. 5). Regarding the importance of keeping the infrastructure of a house free of the types of problems that can cause additional energy expenditure, for example, broken windows or leaks in walls, 43% saw this as being extremely important, 29% as very important, 19% as moderately important, 6% as slightly important, and 3% as not at all important. 43% saw electricity produced from renewable energy sources as an extremely important factor in combating energy

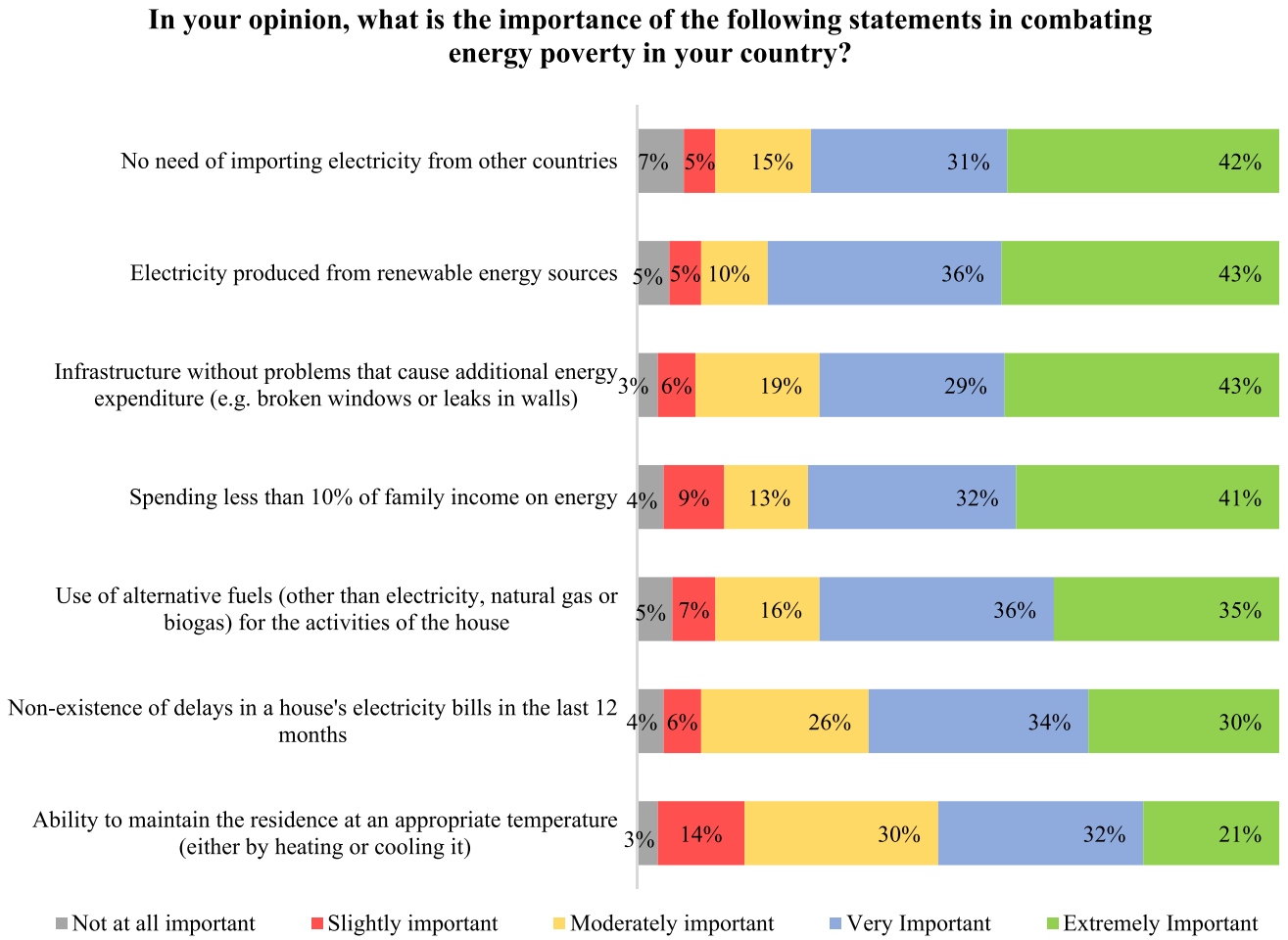


Fig. 5 Priorities for tackling energy poverty

poverty, 37% saw it as being very important, 10% as moderately important, 5% as slightly important, and 5% as not at all important.

In terms of rating the importance of their country in becoming self-sufficient in electricity production and not relying on imports from other countries, 42% of respondents saw this as being extremely important. 31% rated this as very important, and 15% as moderately important. It is worth noting that a relatively high proportion of the respondents—7%—rated energy self-sufficiency as not at all important, and 5% saw it as being slightly important. Similarly, [59] claimed that producing one's electricity is necessary for long-term energy development.

Based on their country's context, respondents were asked which changes they felt were needed to receive more adequate, reliable and affordable energy services (Fig. 6). In response, 44% felt that making investments in electrification on and off the grid was extremely important as in solar energy systems for homes. 40% saw this as being very important, 10% as moderately important, 5% as slightly important, and 1% as not at all important. Regarding creating financing structures that are well adapted for the electrification of cities and communities, 51% saw this as being extremely important, 32% as very important, 11% as moderately important, 5% as slightly important, and 1% as not at all important. In terms of improving energy efficiency, the overwhelming majority—58%—rated this as extremely important. 26% saw this as being very important, 12% as moderately important, 3% as slightly important, and 1% as not at all important. Likewise, [39] claim the fact that Latin America has enormous challenges related to energy poverty that need to be resolved in a sustainable manner. A high majority—55%—felt that improving the use of renewable energies in electricity generation was an extremely important change to make. 34% saw this as being very important, 7% as moderately important, 2% as slightly important, and 2% as not at all important. Regarding using public policies to promote energy security, 51% saw this as being extremely important, 27% as very important, 18% as moderately important, 3% as slightly important, and 1% as not at all important.

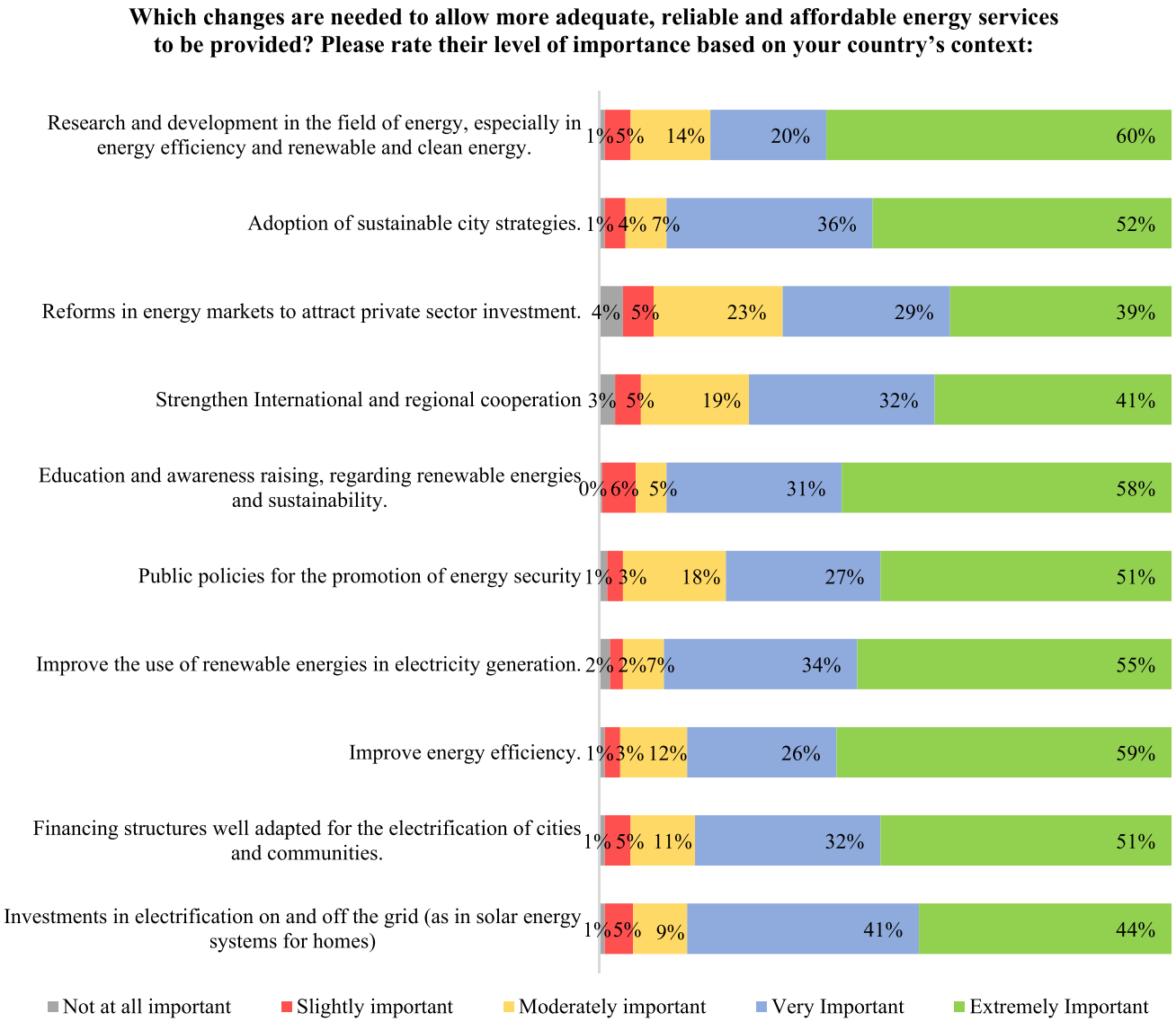


Fig. 6 Desired changes to receiving reliable and affordable energy services

Over half—58%—of the respondents rated education and awareness raising as extremely important in terms of renewable energies and sustainability changes. 31% saw this as very important, 6% as slightly important, 5% as moderately important, and less than 1% rated this as unimportant. In terms of strengthening international and regional cooperation, 41% saw this as extremely important, 32% as very important, 19% as moderately important, 5% as slightly important, and 3% as not at all important.

Approximately 39% saw making reforms to energy markets to attract private sector investment as extremely important. 29% saw this as very important. 23% as moderately important, 5% as slightly important, and 4% as not at all important. 52% rated the adoption of sustainable city strategies as extremely important. 36% saw this as being very important, 7% as moderately important, 4% as slightly important, and 1% as not at all important.

Finally, 60% of respondents stated that research and development in the field of energy, especially in energy efficiency and renewable and clean energy is an extremely important change. 20% rated research and development as very important, 14% as moderately important, 5% as slightly important, and 1% as not at all important.

Respondents were also asked to indicate their sources of information on energy poverty (Fig. 7). The vast majority of interviewees reported that they heard about it from the internet and social media (77%) and traditional media (45%)

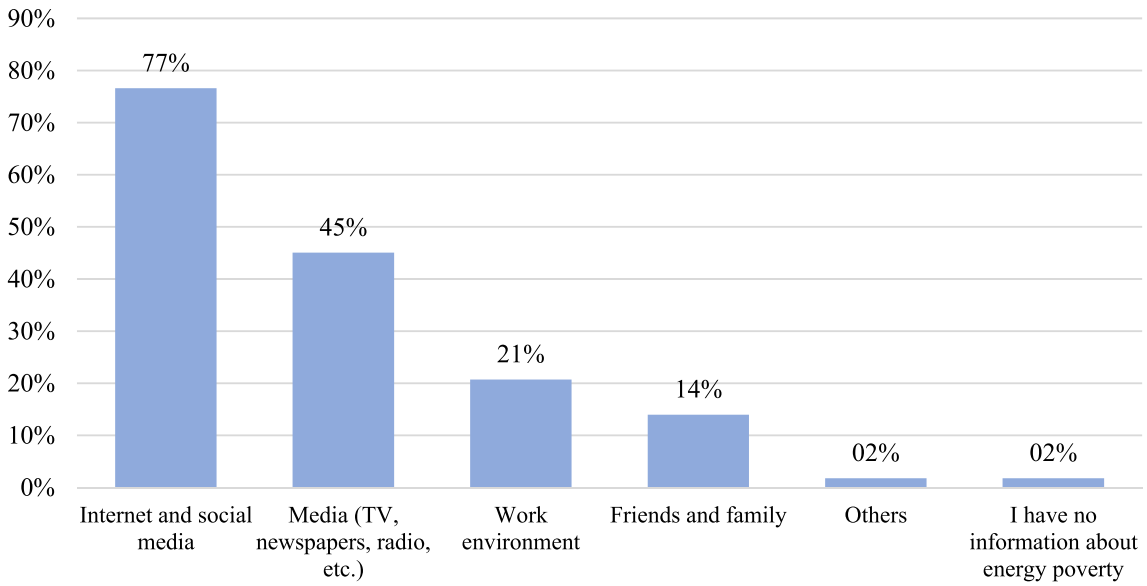


Fig. 7 Information sources on energy poverty

such as newspapers, TV and radio. Approximately 21% of them declared that they had received information from the work environment, and 14% indicated that they received information from friends and family.

The survey also aimed to understand the lack of capacity to cope with electricity expenses and the frequency of this occurrence. Figure 8 brings this scenario where the vast majority of respondents declared not to have faced difficulties in the past 12 months (77%). Following this, 17% of the sample announced that they had issues lasting between 1–4 months. The remainder of the inquired population replied that they experienced issues for 5–8 months, or for 8 months or more (3% per each group).

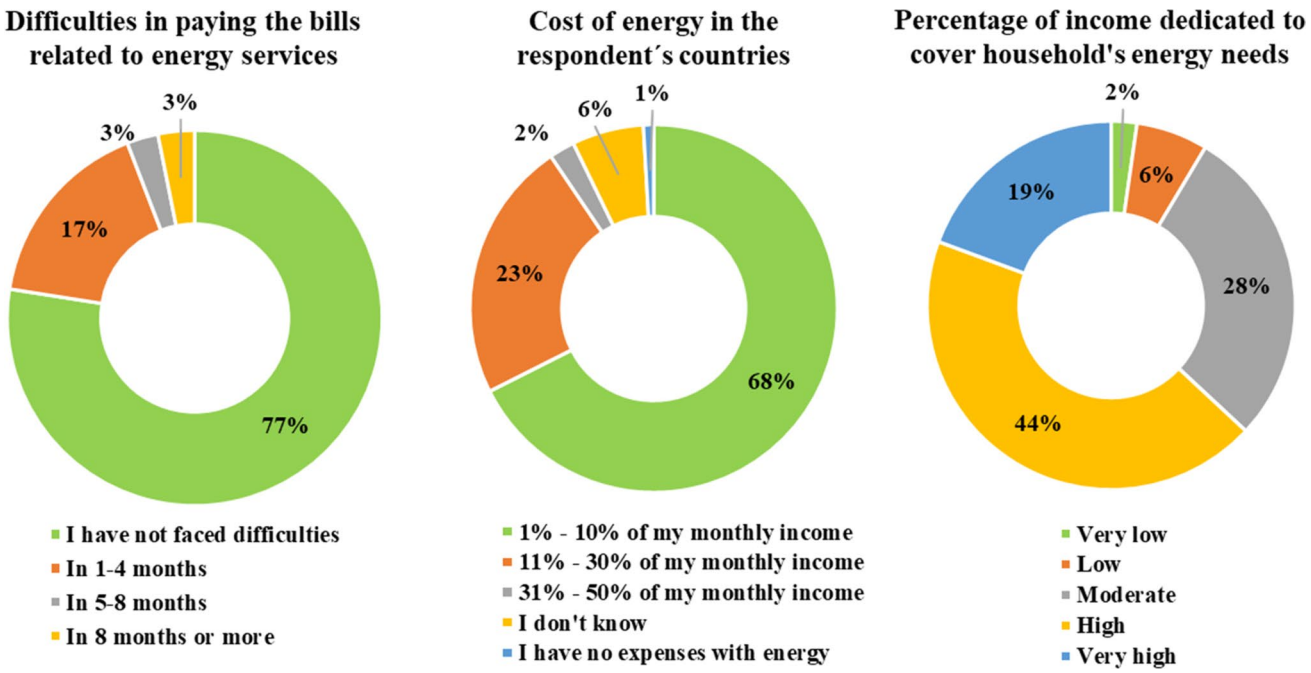


Fig. 8 Domestic purchasing power of energy

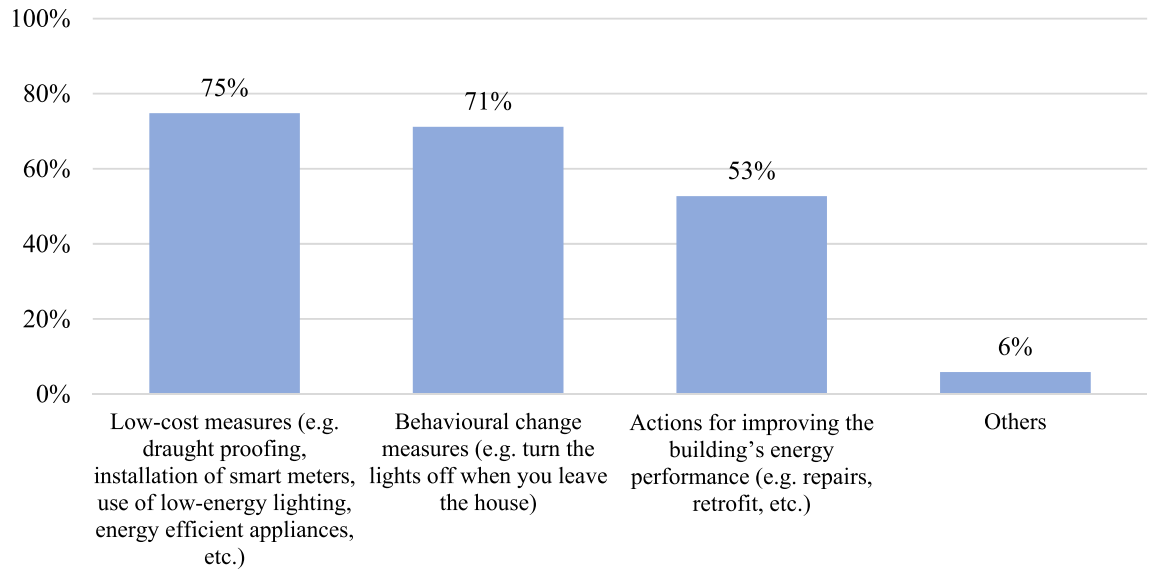


Fig. 9 Effective measures to tackle energy poverty

Similarly, the interviewees were asked about their perceptions regarding the domestic purchasing power connected with energy expenses. A large portion of the surveyed population perceived the prices to be high when compared to their income (44%). Conversely, 28% of respondents had the perception that the expenses were moderate. Another 19% of participants assessed the prices as very high. Lastly, 6% of the inquired people said that the prices were low, and for 2% of the population these were very low.

In order to deepen our knowledge on this issue, panellists were asked about the share of their income used to fulfil the monthly household's energy needs. The vast majority (68%) of the respondents declared spending around 1–10% of their income for their household's energy needs. Next, 23% of respondents said their energy costs were circa 11–30% of their income. 2% of the sample assessed the ratio as about 31–50%. 6% of the sample was not aware of this issue, whereas only 1% of them declared not to have expenses.

Lastly, respondents were asked about possible strategies to overcome energy poverty, where low-cost and behavioural change measures were among the most frequent answers (75% and 71%, respectively) in Fig. 9. Also, approximately 53% of the respondents stated that improving the building's energy performance is essential for tackling energy poverty, and another 6% provided different answers. The replies included: Behavioural change measures, low-cost measures, and actions for improving the building's energy performance combined with solar PV, optimising energy supply systems to reduce user costs. The study found renewable energy projects to improve the poor's well-being or use of energy consumption indicators, as [52] also emphasised the use of renewable energy sources for sustainability. Behavioural change measures, low-cost measures, and either boosting low-cost access to foster solar energy or gas use. Behavioural change measures, actions for improving the building's energy performance, and government policies. Actions to improve the building's energy performance and an extensive drop in expenses for the poor. Affordable financing to change the lighting and appliances in the house. Financial contributions. Inversion of energy sources and distribution in poor areas. Low-cost measures, actions for improving the building's energy performance and either public policies for renewables implementation; or clear policy on the promotion of low-cost energy sources, focusing on the consumer and production of clean and efficient energy. Lowering gas and light prices. On the other hand, [30] findings highlight the need to produce clean and efficient renewable energy sources to address energy poverty.

4.3 Levels of energy consumption

The survey also aimed to identify the level of energy consumption among the 222 respondents. Figure 10 shows the answers regarding the access to items/appliances that require electricity to function. Accordingly, approximately 95% of the participants reported having access to lighting and 85% full access to energy. In comparison, only 20% of the

respondents indicated that they have full access to energy and to all appliances such as lighting, heating, information and communication technology, air conditioning, cooking, and refrigeration, which according to [81], are essential in ensuring comfort. In addition, 44% of the 222 respondents mentioned not having air conditioning and 40% heating appliances, while all other listed items (cooking, refrigeration and information, and communication technology appliances) were individually found present in more than 93% of participants´ answers.

The respondents were also asked about the types of household energy they use (Fig. 11). About 31% mentioned using only electricity; electricity and liquefied gas (20%); natural gas and electricity (18%); natural gas, electricity, candles and batteries (11%); natural gas, electricity, and liquefied gas: (1%); natural gas, electricity and liquefied gas, candles and batteries (1%); natural gas, electricity, firewood (2%); natural gas, electricity, firewood, candles and batteries (1%); solar energy, natural gas, electricity (2%); solar energy, natural gas, electricity, firewood (1%); solar energy, and electricity (1%). On the other hand, the panellists also rated their consumption levels of energy at their houses as users of solar energy, electricity, coal energy; candles, batteries, natural gas (1%); solar energy, and electricity (1%); solar energy, electricity, coal energy (1%); solar energy, electricity, liquefied gas, candles, and batteries (1%); carbon energy, electricity, candles, batteries, kerosene (2%); electricity, candles and batteries (5%) etc. Nonetheless, there is a preference for using kerosene (1%) with electricity. Regardless, the findings revealed that a small percentage of respondents use coal, which is often associated with low living standards [67, 68].

The participants also rated the share of renewable energy use in their households. 61% of the respondents declared that no share of renewable energy is used in their household, but 21% of the interviewees do partially use renewable energy (between 1 and30%), 3% use between 30 and70%, 14% do not know, and 1% indicated that 70% of their energy use is renewable (Fig. 12).

The interviewees were also asked about their perceptions regarding approximate monthly fuel costs for their vehicle, such as gasoline, diesel or kerosene (Fig. 13). Among the 222 respondents, only 201 respondents answered, indicating that the different cost ranges were: below US$50 (22%), US$51–100 (9%), US$101–150 (28%), US$151–200 (10%), above US$200 (0%), and some participants (7%) were unaware or not usually track the monthly fuel costs.

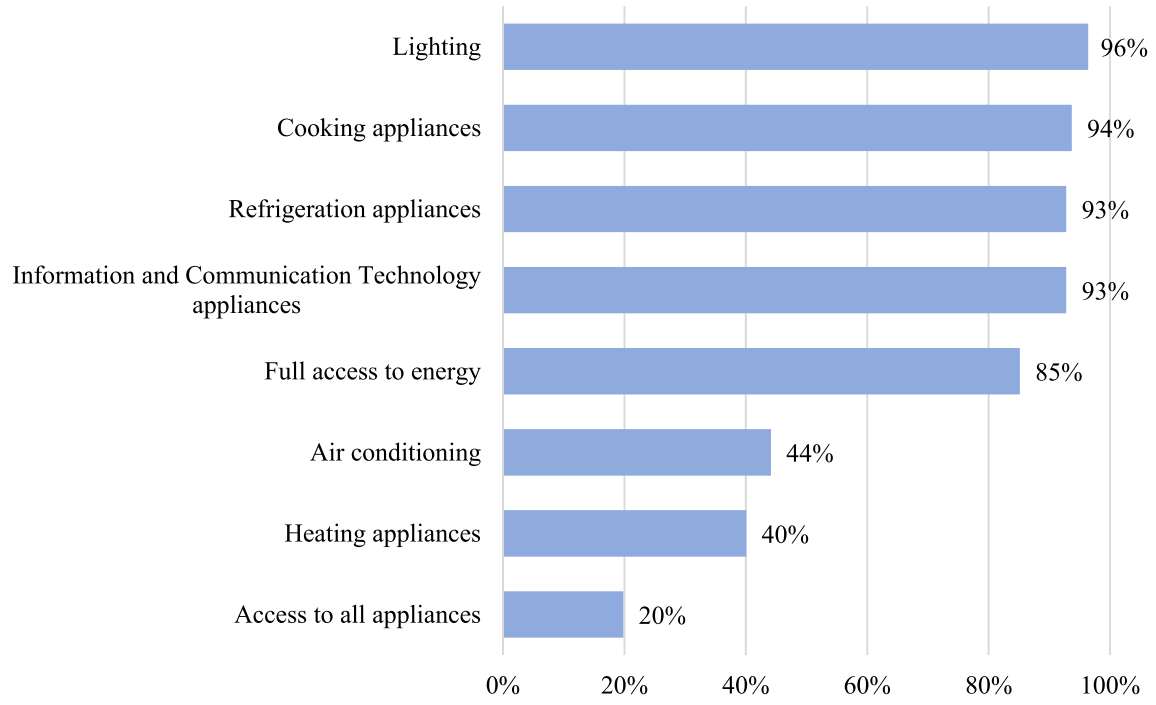


Fig. 10 Access to energy appliances

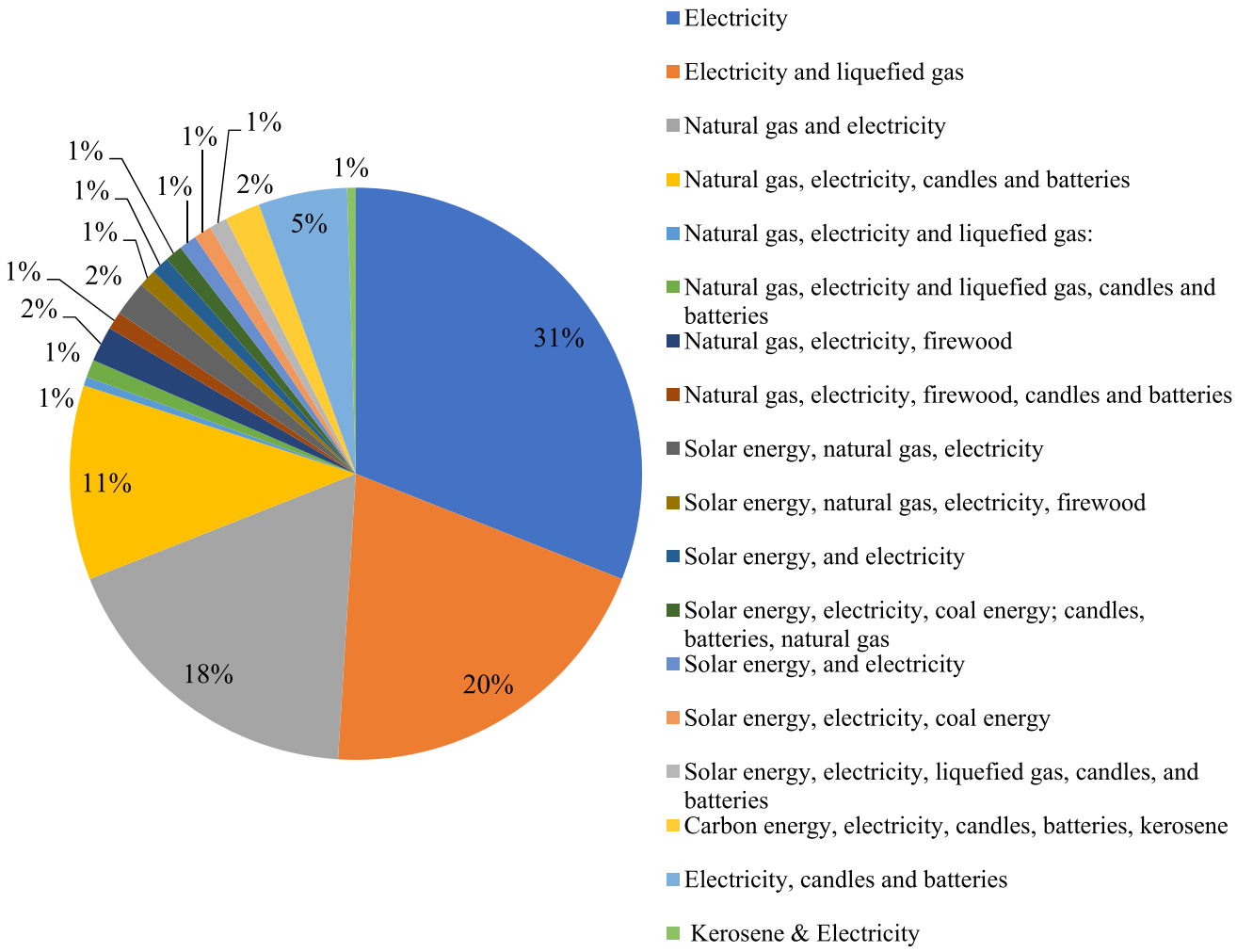


Fig. 11 The households energy consumption level

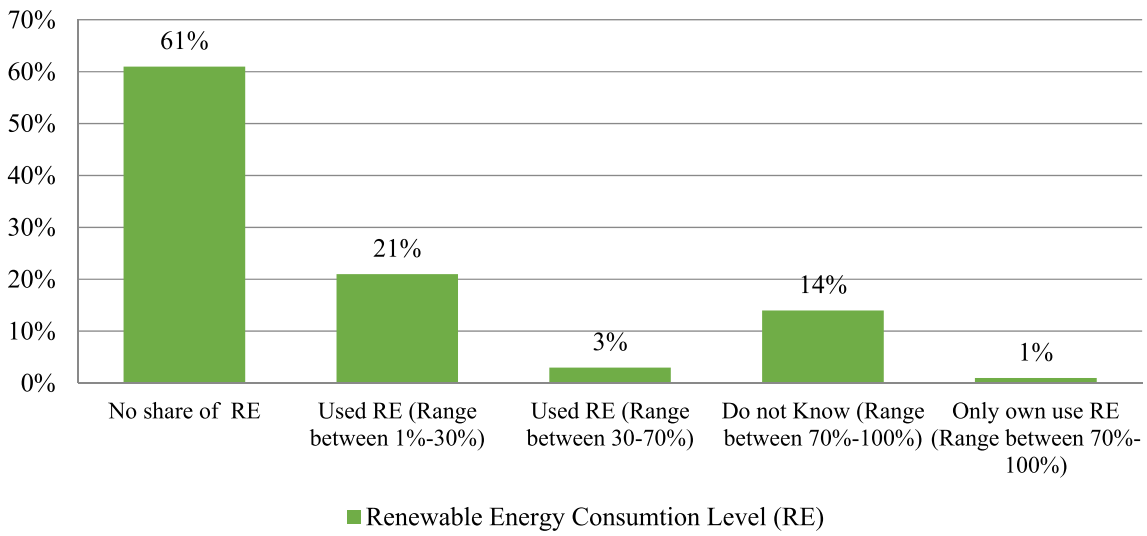


Fig. 12 The households RE consumption level

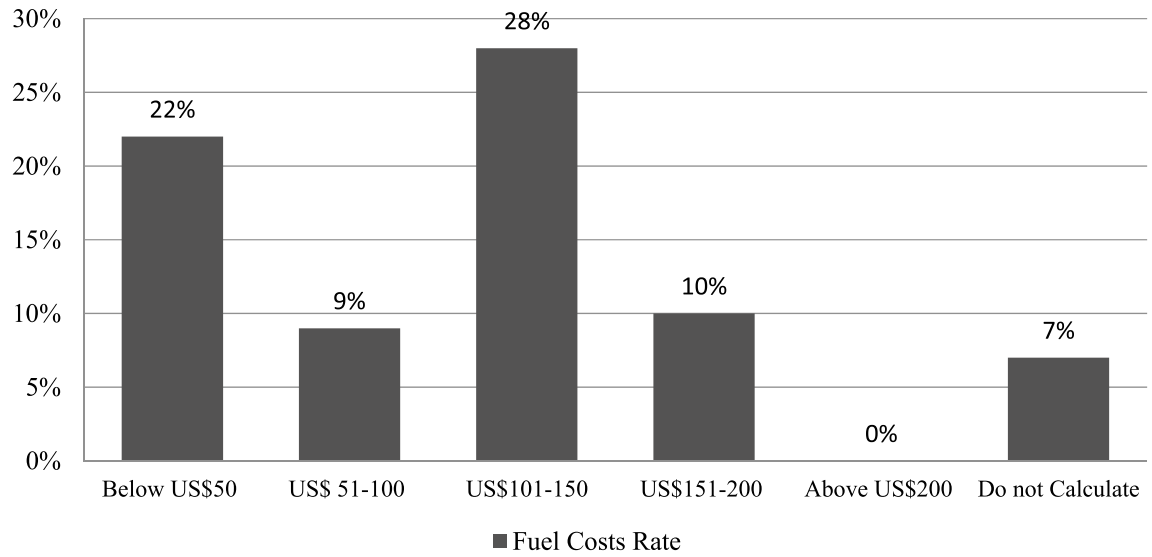


Fig. 13 The households fuel costs level

Respondents were also asked whether they use or have an energy efficiency mechanism to reduce domestic energy consumption; 80% of the respondents claimed that their households do not use any energy efficiency mechanism to reduce domestic energy consumption. However, of the 222 respondents, 20% claimed that they are using devices for energy efficiency such as thermo timers, stabilisers, timers to heat using thermal gas instead of electricity, low-consumption lighting and gas appliances, solar heaters, ventilation/lighting using windows, solar detection cells, LED lights, and motion detectors where appropriate to turn off lights and devices when not in use.

5 Conclusions and policy implications

In Latin American countries, reducing energy poverty is crucial for alleviating household cost difficulties, as the countries present great problems related to energy poverty. In order to deepen our knowledge on this issue, one must look at the household income share used to fulfil the monthly household's energy needs. This trend is detrimental to reaching the United Nations Sustainable Development Goals since a lack of access to reliable energy generation systems inhibits economic growth and affects living comfort. In order to combat energy poverty, households should have greater access to electricity, but also to natural gas or biogas for household activities. The less they depend on coal, the greater the health benefits are. In addition, the use of thermo timers, stabilisers, low-consumption lighting and gas appliances, and solar heaters, may lead to additional gains. Indeed, a greater use of renewable energy may be a positive step forward and be part of a possible strategy to overcome energy poverty in urban and rural areas of Latin American countries—which could be a potential topic for future investigations. One of the advantages is that renewable energy may also provide some co-benefits through significant reductions in pollution levels.

Some measures being applied by the most prominent countries in this study, and that should be considered by Latin American countries, including the expansion of electricity coverage, including programs that subsidise grid extension projects and electrification, especially in rural areas; the implementation of subsidised social tariffs for low-income families to facilitate their access to energy services; energy efficiency programs, with the implementation of initiatives that promote the use of energy-efficient appliances and lighting; promotion of renewable energy, with policies that encourage the development and use of renewable energy sources, especially solar.

As this paper has shown, energy poverty in Latin America is a pressing issue affecting many communities across the Region. It has significant policy implications that governments and stakeholders must address to ensure equitable access to energy resources. One of the key policy implications is the need for enhanced infrastructure Investment. Here, governments need to prioritise investments in energy infrastructure, especially in rural and underserved areas. This involves not only expanding the grid but also enhancing its reliability to reduce frequent power outages which disproportionately affect the poor. Also, in order to combat energy poverty sustainably, policies should facilitate the adoption of renewable energy sources. These are particularly relevant for Latin America given its vast potential in solar, wind, and hydroelectric power. Subsidies, incentives, and supportive regulatory frameworks can encourage both private and community-level renewable energy projects. A further policy area is related to energy subsidies reforms. While subsidies aim to make energy affordable for low-income households, they often benefit all consumers regardless of their income level. Policymakers should consider restructuring these subsidies to target the needy more effectively, ensuring that assistance reaches those in actual need without encouraging wasteful consumption. Finally, addressing energy poverty requires coordinated policies that integrate energy, economic, and social policies. This could involve linking energy access initiatives with social welfare programmes to provide comprehensive support to low-income households.

This paper has some limitations. Firstly, it focused on 11 countries in Latin America, from which four were particularly prominent, namely Peru, Brazil, Mexico, and Chile. Secondly, the sample of 222 respondents is too small to allow definitive conclusions to be made, even though some trends were identified. But despite these constraints, the paper provides a welcome addition to the literature on matters related to energy poverty in Latin America, a region characterised by deep social inequalities. Upcoming research may want to enlarge the spectrum of analysis, including additional countries.

Moving forward, the findings from the research suggest that a combination of awareness-raising initiatives on the advantages of alternatives for energy generation, along with the dissemination of low-cost solutions, may assist the ongoing efforts to overcome energy poverty in the region.

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Author contributions W. Leal Filho—Original Ideas, Revisions; H. Begum-Introduction, literature review, data collection, methods, analysis, discussion, and conclusion, Revisions, R. Anholon—Introduction, Revisions, O. Quelhas—Introduction, I. Rampasso—Literature Review, Revisions, A. Sharifi—Methods, Revisions, J. B. S. O. de A. Guerra-Questionnaire Developed, A. Gatto—Introduction, Literature Review, Analysis, Discussion & Conclusion, Revisions, Funding, M. Lovett—Analysis & Discussion, Revisions, L. Velazquez—Analysis, Pastor David Chávez Muñoz—Analysis, A. S. A. F. Alam—Questionnaire Developed, Data collection, & Revision; L. Brandli—Professionally added, A. L. Salvia—Questionnaire developed, Data collection, Revisions, Nelson Amaro—Professionally added, J. H. P. P. Eustachio—Analysis.

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Data availability Data will be available upon request.

Declarations

Ethics approval and consent to participate Consents to participate were obtained from all survey participants, who ticked a box expressing their agreement to take part in the study.

Competing interests The authors declare no competing interests.

Appendix 1. Search string for the bibliometric analysis

General search string: TS = ("energy poverty")

Search string for Latin America: TS = ("energy poverty") AND ("Argentina" OR "Bolivia" Or "Brazil" OR "Chile" or "Colombia" OR "Costa Rica" or "Cuba" OR "Dominican Republic" OR "Ecuador" OR "El Salvador" OR "Guatemala" OR "Haiti" OR "Honduras" OR "Mexico" OR "Nicaragua" OR "Panama" OR "Paraguay" OR "Peru" OR "Uruguay" OR "Venezuela" OR "central America" OR "south America" OR "latin America").

Appendix 2. Questionnaire

Addressing the challenges posed by energy poverty in Latin American countries

This questionnaire is part of the study '*Addressing the Challenges Posed by Energy Poverty in Latin American Countries*'. Your participation is voluntary, and there are no right or wrong answers. We are interested in knowing your personal understanding. The survey completion is expected to take around 15 min.
It should be noted that the answers given are strictly confidential, used only for statistical treatment. We commit to respect the protection of personal data, guaranteeing its confidentiality. Should you wish to receive a copy of the paper where the results are presented, please let us know: iusdrp@ls.haw-hamburg.de.

Thank you for your contribution!

SECTION 1: Background

1. Country: _____

2. Gender
   ( ) Female
   ( ) Male
   ( ) Prefer not to say

3. Age:
   ( ) 18-29
   ( ) 30-39
   ( ) 40-49
   ( ) 50-59
   ( ) 60+

4. Net monthly household Income
   ( ) Below US$ 680
   ( ) US $680 to 1350
   ( ) US$ 1350 to 2000
   ( ) US$ 2000 to 2700
   ( ) US$ 2700 to 3400
   ( ) US$ 3400 to 4000
   ( ) US$ 4000 US$
   ( ) Prefer not to say

5. Level of Education
( ) Post Graduate
( ) Graduate
( ) High School
( ) Less than High school

6. Occupation
Upper Management
Middle Management
Junior Management
Administrative Staff
Trained Professional
Skilled Laborer
Consultant
Temporary Employee
Self-employed/Partner
Student
Retired
Unemployed

7. Type of housing
( ) Flat
( ) Semi-detached house
( ) Detached house
( ) Other: _____

8. Number of persons or individuals in the household

	0	1	2	3	4 or more
Number of Adults					
Number of Children (less than 18 years old)					

9. Area of living
( ) Urban
( ) Peri-urban
( ) Rural

SECTION 2: Fighting Energy Poverty

10. In your opinion, what is the importance of the following statements in combating energy poverty in your country?

Statements	Extremely Important	Very Important	Moderately important	Slightly important	Not at all important
Ability to maintain the residence at an appropriate temperature (either by heating or cooling it)					
Non-existence of delays in a house's electricity bills in the last 12 months					
Use of alternative fuels (other than electricity, natural gas or biogas) for the activities of the house					
Spending less than 10% of family income on energy					
Infrastructure without problems that cause additional energy expenditure (broken windows or leaks in walls).					
Electricity produced from renewable energy sources					
No need of importing electricity from other countries					

11. Which changes are needed to allow more adequate, reliable and affordable energy services to be provided? Please rate their level of importance based on your country's context:

Statements	Extremely Important	Very Important	Moderately important	Slightly important	Not at all important
Investments in electrification on and off the grid (as in solar energy systems for homes)					
Financing structures well adapted for the electrification of cities and communities.					
Improve energy efficiency.					
Improve the use of renewable energies in electricity generation.					
Public policies for the promotion of energy security					
Education and awareness raising, regarding renewable energies and sustainability.					
Strengthen International and regional cooperation					
Reforms in energy markets to attract private sector investment.					
Adoption of sustainable city strategies.					
research and development in the field of energy, especially in energy efficiency and renewable and clean energy.					

12. What is the main source of energy for heating in your household?
( ) Electricity
( ) Gas
( ) Heating oil
( ) Wood/Pellet
( ) There are no heating options in my household
( ) Other: _____

13. How often you feel uncomfortably cold/hot in your household during the winter/summer period?
( ) Always
( ) Very Often
( ) Sometimes
( ) Rarely
( ) Never

13.1 In your opinion, which are the main reasons for the uncomfortable temperature?
( ) I never feel uncomfortable
( ) House lacks appropriate insulation
( ) House lacks efficient heating/cooling system
( ) Construction material does not favour thermal comfort
( ) Other: _____

14. How familiar are you with the term 'Energy Poverty'?
( ) Not at all familiar
( ) Slightly familiar
( ) Somewhat familiar
( ) Moderately familiar
( ) Extremely familiar

15. Energy poverty occurs when a household is unable to secure a level and quality of domestic energy services—space cooling and heating, cooking, appliances, information technology—sufficient for its social and material needs (Bouzarovski 2018). Do you think this concept applies to you?
( ) Not at all
( ) Slightly
( ) Moderately
( ) Considerably
( ) Extremely

16. Please indicate the sources of information on energy poverty you have most contact with (multiple answers possible)
( ) Media (TV, newspapers, radio, etc.)
( ) Internet and social media
( ) Work environment
( ) Friends/Family
( ) Other: _____

17. During the past 12 months, have you faced difficulties in paying the bills related to energy services? If so, how frequently?
( ) I have not faced difficulties
( ) In 1-4 months
( ) In 5-8 months
( ) In 8 months or more

18. How would you describe the cost of energy in your country in relation to your annual/monthly income?
( ) Very high
( ) High
( ) Moderate
( ) Low
( ) Very low

19. Please indicate the percentage of your income dedicated to cover your household´s energy needs per month (e.g. operation of appliances/devices, heating/cooling systems).
( ) I have no expenses with energy
( ) 1% -10% of my monthly income
( ) 11% -30% of my monthly income
( ) 31% -50% of my monthly income
( ) More than 50% of my monthly income
( ) I don't know

20. Which of the following do you consider as the most effective measures to tackle Energy Poverty? (multiple answers possible)
( ) Behavioural change measures (e.g. turn the lights off when you leave the house, use water heater less time)
( ) Low-cost measures (e.g. draught proofing, installation of smart meters, use of low-energy lighting, energy efficient appliances, etc.)
( ) Actions for improving the building's energy performance (e.g. repairs, retrofit, etc)
( ) Other: _____

PART 3: Level of Consumption

21. Please indicate the items you have in your household:
( ) Full access to energy
( ) Lighting
( ) Heating appliances
( ) Information and Communication Technology appliances
( ) Air conditioning
( ) Cooking appliances
( ) Refrigeration appliances

22. What kind of household energy you use? (multiple answers possible)
( ) Solar Energy
( ) Solar Home Systems
( ) Wind Energy
( ) Biomass Energy
( ) Coal Energy
( ) Natural Gas
( ) Firewood
( ) Electricity
( ) Liquified Gas
( ) Kerosene
( ) Candles, batteries
( ) No Energy

23. Which is the share of renewable energy use in your household?
( ) None
( ) between 1% - 30%
( ) between 30% - 70%
( ) more than 70%
( ) I don't know

24. Do you have access to personal transportation?
( ) Yes
( ) No

24.1 If so, which is approximately the Fuel Cost for Your Personal Vehicle Such as Gasoline, Diesel or Kerex (Monthly)?
( ) Below US$50
( ) US$51 to 100
( ) US$101 to 150
( ) US$151 to 200
( ) Above US$200
( ) I don't know

25. Do you receive any government subsidies/support schemes for household energy expenditure?
( ) Yes
( ) No

26. Do you use/have an Energy Efficiency Mechanism to reduce domestic energy consumption?
( ) Yes
( ) No

26.1 If so, please describe this mechanism:
_____

Thank you for your contribution!

All responses are treated anonymously. If you wish to receive a summary of the results, please send a message to: iusdrp@ls.haw-hamburg.de.

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