Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

# Energy poverty in African countries: An assessment of trends and policies

Walter Leal Filho [a,b], Andrea Gatto [c,d,e,*], Ayyoob Sharifi [f,g], Amanda Lange Salvia [h], Zeus Guevara [i,j], Samuel Awoniyi [k], Carelle Mang-Benza [l], Cosmos Nike Nwedu [m], Dinesh Surroop [n], Kevin Ovita Teddy [o], Usman Muhammad [p], Victoria R. Nalule [q], Izael da Silva [r]

[a] European School of Sustainability Science and Research, Hamburg University of Applied Sciences, Germany
[b] Department of Natural Sciences, Manchester Metropolitan University, Chester Street, Manchester M1 5GD, UK
[c] College of Business & Public Management, Wenzhou-Kean University, Wenzhou 325060, China
[d] Division of International Studies, College of International Studies, Korea University, 145 Anam-ro, Seongbuk-gu, Seoul 02841, Republic of Korea
[e] Center for Studies on Europe, Azerbaijan State University (UNEC), Baku, Azerbaijan
[f] The IDEC Institute & Network for Education and Research on Peace and Sustainability (NERPS), Hiroshima University, 1-5-1 Kagamiyama, Higashi-Hiroshima City, Hiroshima, 739-8529, Japan
[g] School of Architecture and Design, Lebanese American University, Beirut, Lebanon
[h] Research and Transfer Centre "Sustainable Development and Climate Change Management", Hamburg University of Applied Sciences, Ulmenliet 20, D-21033 Hamburg, Germany
[i] Department of Civil and Sustainable Technologies, School of Engineering and Sciences, Tecnologico de Monterrey, Mexico City 01389, Mexico
[j] MARETEC—Marine, Environment and Technology Center, LARSyS, Instituto Superior Tecnico, Universidade de Lisboa, Lisbon 1049-00, Portugal
[k] Department of Agricultural Economics, Joseph Ayo Babalola University, Ilesa, Osun State 233121, Nigeria
[l] Department of Geography and Environment, University of Western Ontario, 1151 Richmond St, London, ON N6G 2V4, Canada
[m] Faculty of Law, Federal University Ndufu-Alike Ikwo, Abakaliki, Ebonyi State, PO Box 1010, Nigeria
[n] Department of Chemical and Environmental Engineering, Faculty of Engineering, University of Mauritius, Réduit 80837, Mauritius
[o] Wasanii Mtaani & Made In Afrika™, Nairobi, PO Box 57737, 00200 City Square, Kenya
[p] Centre for Renewable Energy and action on Climate Change, Gusau, PO Box 379, Zamfara State, Nigeria
[q] Institute for Oil, Gas, Energy and Sustainable Development (OGEES), Ado Ekiti, Ekiti State 360101, Nigeria
[r] Strathmore University, Ole Sangale Rd, Madaraka Estate, Nairobi, Kenya

ARTICLE INFO

*Keywords:*
Energy poverty
Africa
Energy access
Bibliometric analysis
Survey

ABSTRACT

Energy poverty, understood as the lack of access to adequate and sufficient energy services, constitutes a severe development problem for the African continent. Even though several policies and alleviation measures have been implemented in the last few decades, African countries still face multiple challenges. Therefore, this paper aims to identify these challenges related to energy poverty alleviation in Africa and the suitable solutions to address them. Using a mixed methods approach, involving a bibliometric analysis and a survey of involved actors, the study identifies the current constraints, obstacles and measures to address the problem in African countries. Findings point out to governance-related issues, including corruption and poor policy implementation, as the most indicated reasons for energy poverty in Africa, more than technological, financial, and policy issues. The results also confirm the fact that energy poverty has various roots and addressing it needs to take into account challenges related to outdated infrastructure, limited accessibility, and high prices. Moreover, there is often a lack of awareness about the benefits of renewable energy sources and energy-efficient practices, which suggests research in this field is also needed. The novelty of this study resides in the fact that it reviews the literature on the topic, describes its variables associated with the problem, and presents the views and perspectives from people familiar with the topic. The insights from this research can inform policymakers and infrastructure planners, helping them to prioritise investments and design interventions that address the root causes of energy poverty and its various manifestations.

* Corresponding author at: Wenzhou-Kean University (US-CN), Wenzhou, Zhejiang, China.
*E-mail addresses:* walter.leal2@haw-hamburg.de (W. Leal Filho), agatto@kean.edu (A. Gatto), sharifi@hiroshima-u.ac.jp (A. Sharifi), Amanda.Lange-Salvia@haw-hamburg.de (A.L. Salvia), zeus.guevara@tec.mx (Z. Guevara), sawoniyi@jabu.edu.ng (S. Awoniyi), cmangben@uwo.ca (C. Mang-Benza), d.surroop@uom.ac.mu (D. Surroop), idasilva@strathmore.edu (I. da Silva).

https://doi.org/10.1016/j.erss.2024.103664
Received 13 October 2023; Received in revised form 20 May 2024; Accepted 27 June 2024

## 1. Introduction

It is well known that energy is key to our everyday life but millions of people in Africa do not have access to it [1]. The former United Nations Secretary-General, Ban Ki-moon, rightly described it as follows: "Energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive" [1]. Energy is not only essential for ensuring basic social services, food security, and women and vulnerable empowerment, but also for industrialisation, general economic development, and good governance [2]. Although there are various initiatives to ensure the achievement of universal energy access, many people lack access to modern energy, especially in developing countries where per capita income is low, hence low standards of living with a very high burden of unemployment and poverty.

In this context, energy poverty is a concept that encapsulates the inability to access safe, convenient, and affordable energy at the required and adequate quality and quantity when needed [3,4]. The absence of a choice of the type of energy to consume is, in a way, a manifestation of energy poverty [5]. This can take different forms, including the lack of access to modern and clean energy services, the lack of reliability, concerns about the affordability of access and the determination to unshackle oneself from the natural resource curse [6]. While energy poverty is totally connected with aspects of the provision of energy services, its ramifications extend to critical areas such as health, education, and social well-being, with implications for energy justice [7]. In this context, energy poverty remains intertwined with the broader and multi-faceted problem of poverty in general [7]. Today, it is widely acknowledged in legislation, policy, and research that energy poverty, spread across all regions globally, is one of the biggest 21st century challenges humanity is facing [9,10]. Energy poverty spurs five energy transition trajectories to energy access, energy transition, and the enabling of energy-realted Sustainable Development Goals (SDGs), energy fintech, and energy innovation with Artificial Intelligence (AI) analytics [8,9]. The energy poverty concept has also been changing over time due to technological innovations and the attention of the international community and researchers [10].

Assessing energy poverty is the crucial trigger for unleashing advocacy, awareness diffusion, and concrete commitments on the five energy trajectories towards SDG 7 by 2030 and carbon neutrality by 2050 [11]. Energy poverty is, indeed, closely related with energy justice and energy security: vulnerable countries and vulnerable socio-economic groups are the most endangered [12,13,14]. However, it is imperative to note that energy poverty is not happening only in developing countries but is a global issue. To tackle it and ensure energy justice for all, institutional quality and regulation are paramount [15]. Good governance and the rule of law can boost entrepreneurship and create positive loops, accelerating electrification even in the most remote rural areas of the poorest world regions [16].

Africa is particularly affected by energy poverty – especially in sub-Saharan Africa – which adds to its many other development challenges. Not only does this negatively affect the continent, but it also contributes to the global threat regarding sustainable development and climate change [17]. Alarming inequality in Africa also affects energy security [18]. Energy security, as indicated by [19], has a contextual and dynamic definition that should be revisited periodically. According to the International Energy Agency [20], uninterrupted availability of energy sources at an affordable price", and the context of vulnerability is also considered by [21] in their broader definition of energy security as "low vulnerability of vital energy systems". About 44 % of the 1.2 billion people worldwide who are without access to modern energy are in Africa, and about 548 million people had no access to electricity in 2018 [22,23,24]. Nevertheless, energy access figures in developing nations are improving [14]. This evidence is due to several factors, including the rapid technology and business diversification that occurred in the last few years in developing economies, and expanding local electricity access [10]. In this transition, sub-Saharan Africa is one of the hottest regions. However, electricity access in rural areas of Africa is still low [25]. Electrification of remote areas of poor regions – especially mountainous ones – is the crux for ensuring long-lasting development for these communities [26,27].

Given the context of energy generation, distribution, and access in Africa, we describe the energy poverty challenge in this region. The energy poverty pattern in Africa faces the popularity of carbon-benign renewables vis-à-vis emission-spewing fossil fuel-based energy. In this respect, the present paper aims to identify: a) the challenges related to energy poverty in Africa and b) the policies and tools that may be deployed to address them. To do so, it digs into the literature concerning energy and the energy poverty context in Africa, and it implements a bibliometric analysis and an exploratory online survey that strove to identify current constraints and opportunities across a set of developing countries in Africa.

The paper is structured as follows. Section 2 and Section 3 give an overview of the energy context and energy poverty situation on the continent. Section 4 describes the characteristics of the bibliometric analysis and online survey. Section 5 discusses and synthesises the results, and Section 6 presents the general conclusions and implications of the study.

## 2. The energy context in Africa

The 2019 Africa Energy Outlook [28] is the fifth comprehensive report exclusively dedicated to Africa by the International Energy Agency (IEA), a testament to Africa's strategic place on the global energy map [29]. Surrounding the report's extensive analysis is an energy context fraught with dichotomies between potential and realisation, between the North and South of the Sahara, between urban and rural areas, as well as between female and male households. This context is best understood by looking at the energy value chain in Africa, from raw resources to energy access. Even as Africa is characterised by diversity, contextually challenging issues such as corruption and weak governance remain common in many African countries.

### 2.1. Energy resources and production

All conventional fossil fuels are available on the continent. Africa houses less than 10 % of the global oil reserves, but this share has been on an upward trend since the 1980s [30]. Natural gas is mainly found in North and West Africa [31]. While covering half of the energy needs in North Africa, natural gas remains a niche fuel south of the Sahara, occupying 5 % of the energy mix [28]. The continent holds about 4 % of the global coal reserves, mainly concentrated in South Africa [31]. Meanwhile, three of the world's largest uranium reserve-holders are African countries: Namibia, Niger and South Africa. Nuclear energy is only used in South Africa [28].

Large hydropower plants are installed across Africa, accounting for half of the electricity generation in sub-Saharan Africa [3]. The Central African region benefits from an extensive hydrological network, being home to the powerful Congo River. The hydropower potential in DR Congo alone is estimated at 100 GW, which drives the plan to develop the 44 GW Grand Inga Dam [32]. Should the plan materialise, the Grand Inga Dam could provide electricity to half of the continent [32]. The continent is also rich in biomass resources that are generally burned in a traditional and inefficient manner. Biomass represents more than 60 % of Sub-Saharan Africa's total energy supply [23,28]. Large-scale electricity production from biomass is limited because it is more expensive than power generation from gas and hydropower [28].

Africa holds considerable untapped renewable energy resources [23]. While renewable energy contributes to less than 25 % of the continent's energy [33,34] production, the installed capacity is rapidly increasing, increasing from 28 GW in 2010 to 50 GW in 2018 [28,34]. Africa's wind energy potential is substantial but diversely distributed, with most resources found along the northern and southern coasts and

close to mountain ranges [31]. The total installed wind power capacity grew from 1 GW in 2010 to 5.5 GW in 2018, with North and South Africa accounting for 2.6 GW and 2 GW respectively [24]. In a continent that receives bright sunlight more than 300 days a year, the potential solar PV capacity is estimated at 10 terawatts (TW), but the installed capacity is still below 5 GW [28,31]. East Africa holds most of the geothermal resources, thanks to its tectonic regime. Kenya has the bulk of the installed geothermal capacity, around 600 MW, with an additional 1000 MW in planning [28]. With over 80 transboundary lakes and rivers, the continent could deploy more than 20 TW through small-scale hydropower installations, especially in rural areas, but as of 2011, merely 1.5 GW were installed [28].

Other renewable resources, like biofuels and biogas, are marginally used [31]. Tidal energy is at a nascent stage, although the potential could be significant in East Africa [31]. In West Africa, Ghana started the deployment of an undersea wave energy converter in 2015 that could produce up to 1000 MW when fully operational [31,35].

Africa has a crucial role to play in the low-carbon transition, being home not only to renewable energy resources but also to the minerals that form the building blocks of the renewable energy surge via batteries, storage equipment, wind turbines, and solar panels. DR Congo supplies two-thirds of the global production of cobalt; South Africa produces 70 % of the world's platinum; and vast reserves of bauxite, aluminium, chromium, manganese, and more are found across the continent [28,36,37]. Despite this impressive mineral reservoir, Africa's development needs are still suppressed by a failing distribution system and unequal access to energy [38].

Given that the cost of renewable energy technology has been decreasing for more than four decades, Africa would likely profit from it and no longer use fossil fuel-based energy systems when considering the mere economic aspect of it [39]. For example, despite that Africa's renewable energy is currently at around 25 %, a country such as Kenya is doing very well in the adoption of renewable energy, especially geothermal, wind, and utility-size grid-tie solar PV systems. More than 80 % of the electricity produced in Kenya comes from renewable energy sources, mainly geothermal and hydropower [40]. Since 2016, investment in oil and gas in Africa has been overtaken by investment in renewables, mainly wind, and solar PV [41], and researchers foresee that investment in fossil fuel exploration may reduce precipitously shortly [42]. This is aligned with the global trend towards net-zero carbon emissions by 2050.

### 2.2. Access

Access to modern energy is a development catalyst. Yet, in 2018, the rate of electrification was only 45 % in sub-Saharan Africa, whereas North Africa was almost fully electrified. The rate is much lower in rural areas, with 70 % of them not connected to the grid [43]. Though the electrification pace beats the IEA's 2014 projections, even outpacing population growth for a few years, the rapid population growth, fast urbanisation, and changing lifestyles require prompt investment in the energy sector [23,43]. The access deficit situation more strongly impacts women, who head about 25 % of African households and are generally more financially constrained than men [43]. In rural areas, women are the worst hit by the binary of energy and economic poverty due to their traditional roles [44,45].

Furthermore, the continent inherited structural problems in electricity distribution during colonisation, as grid lines were initially installed to feed colonial industrial projects, not local settlements [46]. After the independence gained in the 1960s and 1970s when electricity was subsidised, state-led projects focused on large population centres where households could afford electricity costs [46]. As a result, most rural areas remained off-grid. In addition, the poor maintenance of assets and lack of investment in transmission lines hamper the expansion of the grid's infrastructure, which results in high tariffs for the few grid-connected households [28].

## 3. Methods

In the present paper, we perform a bibliometric analysis to identify trends in the literature on energy poverty in Africa (Section 4.1) and an online survey to identify challenges and needed measures to counter the problem (Section 4.2). This multi-methods approach is commonly used [47,48] as the combination of approaches allows for a better overview of the topic. Additionally, the literature overview provides key topics to be considered in the data collection instrument, as presented below.

### 3.1. Bibliometric analysis

Bibliometric analysis is often used to gain an overview of the state of knowledge in a specific field. For instance, co-citation can be used to identify influential references, authors, and sources that have contributed to the development of the field. More so, bibliometrics are used to show the overall illustration of a particular field of research at the macro level, and can further be applied to analyse crucial issues at micro level, and so various researchers have used it in their work [34,35]. Here, we want to find out what major topics have been discussed in the literature regarding energy poverty in the African continent. For this purpose, we used the term co-occurrence analysis, which helps identify common clusters and their interactions. Interpreting interactions within and between the clusters helps understand the landscape of research fields and highlights key thematic areas [49].

Various software tools are available to do this analysis through text mining of articles. Among those, VOSviewer is commonly used due to its user-friendly platform and its capacity to present the results in an easy-to-understand manner [50]. The input data for term co-occurrence analysis in VOSviewer was downloaded from the Web of Science. While various other academic databases exist, we chose the Web of Science due to its reputation for indexing quality peer-reviewed academic articles. In addition, the bibliometric export format of the database provides better outputs in the VOSviewer. A broad search string was developed to retrieve documents related to the topic (see Appendix B).

The search returned 203 articles that were screened for their relevance to the study. Out of these, 112 were selected. This number is aligned with other bibliometric analyses performed on similar topics [51,52]. The main screening criterion was to have a specific focus on energy poverty in the context of Africa. Also, 47 relevant articles that were not retrieved from the original search were added to the database. These were either identified from the cited references of the 112 articles or the energy poverty database by [53]. Of the final list of documents, 71 % are journal articles, 11 % are books and book chapters, 9 % are reports, 5 % are conference papers, and 4 % are academic theses and dissertations. Key journals publishing on this topic are Energy Policy, Energy for Sustainable Development, Renewable and Sustainable Energy Reviews, Journal of Energy in Southern Africa, Energy Research & Social Science, Energy and Buildings, and Applied Energy.

Results of the term co-occurrence analysis are presented in the form of nodes and links, where node size is proportional to the occurrence frequency, and link width is proportional to the strength of the connection between two nodes. Terms that are closely related often form a cluster and are presented using a specific colour. These clusters indicate thematic research areas that have received relatively more attention in the literature.

### 3.2. Online survey

An online survey was designed to develop a better understanding of the challenges related to energy poverty in Africa, along with the identification of some of the policies and tools that may be deployed to address them. The intended sample was comprised of colleagues working/living in African countries, as well as those whose work has centred on the energy sector and energy issues in these countries.

The questionnaire consisted of 10 questions, as presented in Appendix A. The basis for the development of the instrument as well as the definition of energy poverty considered in it was the one used by [4]. It covered questions on demographic details to characterise the sample (country, gender, age, and level of education) and the respondents' views on the national contexts of their countries regarding energy poverty, measures that are needed to provide more adequate, reliable, and affordable energy services, challenges for combating energy poverty, and perceptions of government efforts.

The survey was disseminated via Google Forms to the networks of the European School of Sustainability Science and Research (ESSSR) and the Inter-University Sustainable Development Research Programme (IUSDRP), as well as with academic lists focused on sustainability and energy-related content.

The nature of the research, the methods used, and the fact that no personal data was stored or can be traced back to individuals, conforming with General Data Protection Regulation (GDPR) standards, means that the study is not subject to an ethics permit, as specified by the Association of Medical Ethics Committee in Germany, the body responsible for such assessments in the country leading this study. In any case, all respondents willingly agreed to participate in the study, confirmed through an additional question added to the beginning of the questionnaire.

The questionnaire collected 120 responses between February and April 2022. The respondents are based in 23 countries (18 in Africa, 2 in Europe, and 2 in Asia), but their experience with the topic of energy poverty in Africa covers 32 African countries. The geographical distribution of the experience of the respondents is presented in Fig. 1. As the survey was open, the authors had no influence on the countries that are represented in the paper, and participation was completely voluntary.

In terms of demographic characteristics (Table 1), the sample is mostly composed of male (73 %) and post-graduate (78 %) respondents, with the age group 40–49 years being the most expressive one, comprising almost 40 % of the respondents.

The descriptive analysis presented in the following section summarises the sample's views on the topic of energy poverty and gives an overview of the potential measures to address the problem in African countries.

## 4. Results

### 4.1. Bibliometric analysis

The output of the term co-occurrence analysis is shown in Fig. 2. Three major clusters can be identified from the figure: access to electricity (in red), justice, development and technological solutions (in green), and access to modern cooking fuels (in blue).

The largest cluster (in red) is dominated by terms related to electricity and electrification. The close connection to the term "access" indicates the significance of electrification for facilitating equal access to energy and overcoming energy poverty [54]. Electrification plays a crucial role in addressing energy poverty in Africa, impacting millions of people without access to modern energy services. By enabling economic development, social well-being, and environmental sustainability, electrification can provide reliable and affordable electricity to households, businesses, and public services. This supports productive activities and improves health and education outcomes while also reducing greenhouse gas emissions. Several academic papers have explored the challenges and opportunities associated with electrification in Africa

**Table 1**
Sample demographic details.

| Gender | Frequency (n) | Percentage (%) |
|---|---|---|
| Female | 33 | 28 % |
| Male | 87 | 73 % |
| Total | 120 | |
| **Age** | **Frequency (n)** | **Percentage (%)** |
| 18–29 | 10 | 8 % |
| 30–39 | 25 | 21 % |
| 40–49 | 46 | 38 % |
| 50–59 | 25 | 21 % |
| 60+ | 14 | 12 % |
| Total | 120 | |
| **Level of Education** | **Frequency (n)** | **Percentage (%)** |
| Graduate | 26 | 22 % |
| Post-Graduate | 94 | 78 % |
| Total | 120 | |

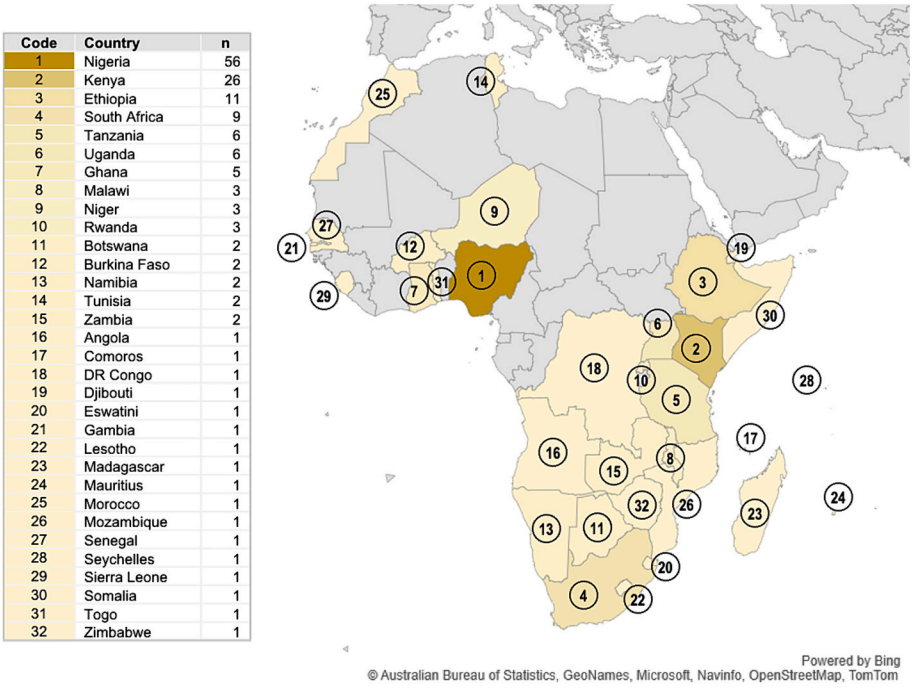


**Fig. 1.** Geographical distribution of the experience of survey respondents. Note: The map was generated in Microsoft Excel, powered by Bing, © Australian Bureau of Statistics, GeoNames, Microsoft, NavInfo, OpenStreetMap, and TomTom. We are neutral with regard to jurisdictional claims in this map.

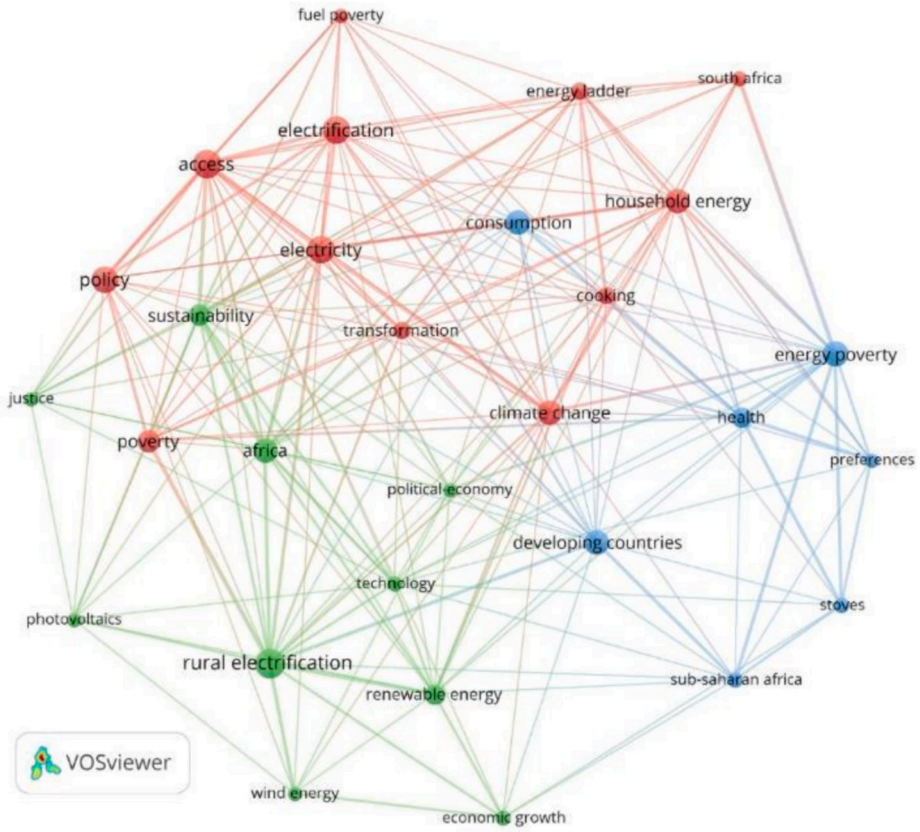


**Fig. 2.** Term co-occurrence analysis network.

from various perspectives using different methodologies. For example, [54] highlights the importance of financial inclusion and education while [55] work examines experiences with achieving universal electricity access across multiple African countries. [56] proposes cost-effective rural electrification options that could eradicate persistent energy poverty in Sub-Saharan Africa. These articles offer valuable insights and recommendations for advancing electrification efforts as well as alleviating energy poverty throughout the continent. This is consistent with the main conceptualisation of energy poverty in less developed countries, which mainly focuses on the households' deprivation of modern energy services supply, particularly electricity [57,58,59,42]. "Energy ladder" is another frequently occurring term in this cluster, which has strong connections with terms such as electrification, access, electricity, household energy, and transformation. This indicates that the concept of the energy ladder, which deals with the relationship between improvements in household economic conditions and the fuel type that it uses, has been widely discussed in the context of African cities [60,61]. Particularly, as electricity is positioned at the highest level of the energy ladder for the provision of most energy services [62,63], the majority of energy poverty alleviation programmes in the continent focus on electrification; for example, see [64]. However, the concept of "energy ladder" has been questioned by empirical evidence and alternative perspectives such as "energy stacking" and "energy transition," which acknowledge the diversity of energy use patterns in different contexts [65,66,67]. In the African context, understanding the potential benefits and challenges of electrification through the lens of the "energy ladder" can be valuable for household energy transformation. Electrification offers access to various services like lighting, communication, education, health care, entertainment, and income generation that can enhance people's quality of life. Yet obstacles like affordability, reliability, and sustainability may limit its adoption and impact. Therefore, electrification should be viewed as a dynamic process requiring an integrated approach to address diverse needs. Various academic articles have explored links between electrification, the "energy ladder'" electricity access, and transformation in Africa. [68,69,70] These publications offer important insights and recommendations for advancing electrification and reducing energy poverty in Africa.

The second major cluster (in green) is also tightly linked to the first one and has a major focus on rural electrification and its importance for energy justice. Here there is a clear emphasis on renewable energy technologies, such as photovoltaics, solar home systems, and wind systems for overcoming energy poverty in Africa, which are well discussed in the literature (e.g., [71,72,73]). The role of renewable energy in overcoming energy poverty in less developed countries is widely recognised as significant [74], especially when viewed under the environmental and social considerations of the energy justice framework [75,76,77]. Moreover, these terms are closely linked to the term sustainability and the term climate change from the first cluster, indicating that renewable energy-based electrifications can also provide multiple benefits for sustainable development and for climate change mitigation [78,79], which could counteract the negative externalities of energy poverty alleviation (see [80,81]). Additionally, the connection to economic growth is in line with arguments in the literature regarding the significance of overcoming energy poverty for economic development [82]. The rationale in this respect is that improving energy access (or reducing energy poverty) through electrification and renewable energy technologies triggers spillovers in education, gender equality, health, productivity, and poverty reduction [83,84]. Overall, the literature shows that rural electrification can play a role in the transition to renewable energy, economic development, and social equity in various ways. It can contribute to increasing the proportion of renewable energy sources like solar, wind, hydro, and biomass in the energy mix by utilising off-grid and mini-grid systems that are more suitable and cost-effective for remote communities. Additionally, rural electrification

has the potential to boost the productivity and income of rural households and businesses through access to modern appliances, equipment, and lighting options, as well as services related to communication technology education, with enhanced entertainment options along with improved healthcare facilities that are key for agriculture advancements. Furthermore, providing electricity improves the quality of life while reducing exposure risks such as indoor air pollution, thus enhancing health standards and impacting on educational outcomes, especially among marginalised groups including women, as discussed in multiple studies [85,86,87,88,89].

In the third cluster, the term "health" has a central position and has strong connections with terms such as energy poverty, household energy, cooking, and stoves. It mainly encompasses the second most common energy poverty concern in less developed economies, namely, access to modern cooking fuels [89]. Health issues caused by the household use of traditional biofuels and non-clean energy sources are frequently discussed in the African context [90,91], as well as the role of cooking fuel preferences and individual resistance to fuel shifting [92,93,94]. To address health issues related to the lack of access to clean energy, many initiatives have been launched to promote the transition to cleaner cooking fuels and technologies. However, adoption and the sustained use of these solutions face barriers such as high costs, limited availability, cultural preferences, and lack of awareness. Various studies have explored factors affecting consumer preferences and behaviour regarding cleaner cooking fuels in different contexts [66,95,96]. For example, a study on the cook stoves market in Ghana found that the strengths of imported improved stoves include lower emissions and enhanced efficiency, but weaknesses like high prices and limited rural market penetration have caused challenges [95]. Another study examined determinants of household energy choice in Ghana, revealing that education, housing conditions, employment type, and high income influence the adoption of cleaner energy alternatives, while a higher dependency ratio and informal employment increase unclean energy usage [96].

### 4.2. Online survey

When asked if they think energy poverty is a recurrent figure in their countries, over 80 % of the respondents responded in the affirmative, as shown in Fig. 3. Respondents that answered to the contrary (11 out of 120) are from non-African countries (i.e., Singapore and the UK) and from Kenya, Nigeria, Ghana, South Africa and Eswatini. As an open-ended question, respondents could also indicate potential factors responsible for this condition.

According to the sample, governance-related issues are the most indicated reason for the condition of energy poverty in their countries. This aspect included references to low levels of investment, lack of political will, corruption, misplaced priorities, and poor implementation of energy policies. All of these aspects are associated with a reduction in the quality of service provided and in technical efficiency [97]. Problems associated with planning and infrastructure were also reported, such as the lack of energy diversification, lack of maintenance, and insufficient or interrupted power supply. Some respondents also indicated reasons connected with cost, such as the lack of or limited capital to finance energy, rural communities being unable to afford energy, and the high cost of energy. These challenges represent barriers to electrification as well, as Africa does not have sufficient infrastructure to ensure adequate and universal access to electricity by 2030 [98]. Interestingly, some responses also mentioned factors such as the lack or limited awareness of energy efficiency, poor behaviour usage, and energy illiteracy. Table 2 presents these aspects and some quotes from the responses.

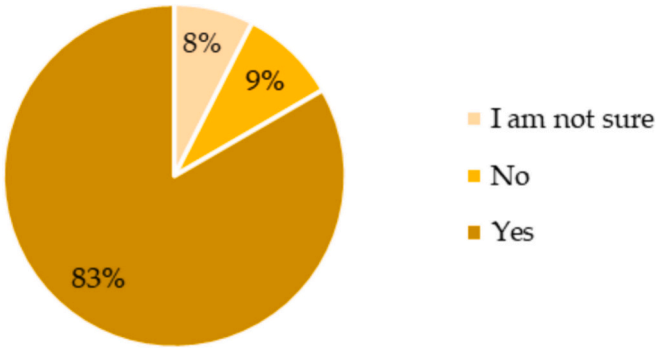


**Fig. 3.** Sample responses to the question "Is Energy Poverty a recurrent figure in your country?"

The question of universal energy access on the continent is largely associated with the governmental structure, including the lack of governmental engagements and policy frameworks. Corruption and political issues in Africa: (i) discourage capital injection of investors due to volatile business environments, (ii) constrain funds to address electrification, and (ii) impact the energy markets. Distanced and poor areas experience a lack of investment due to the high upfront costs of energy technologies, including power grids. The high operational costs of standalone systems are not affordable for rural communities unless subsidies are centrally defined and provided. Consequently, energy prices become a burden, and limited energy access impacts socio-economic services, such as education and health facilities, among others. Additionally, underinvestment in education and training leads to inadequate knowledge sharing about innovative energy technologies.

The provided responses make it clear that the topic of energy poverty in Africa is accompanied by a series of challenges. Our study was also interested in assessing the importance given by respondents to measures needed in their countries to provide more adequate, reliable, and affordable energy services (Fig. 4). All measures were considered highly important, with over 50 % of the respondents choosing either very or extremely important (except for 'Energy aid from external organisations'). The results are well aligned with the previous question, as good governance, renewable energy deployment, appropriate funding mechanisms, and regulations and policies are the measures that received higher rates of importance. Lower levels of importance seem to be attributed to educational measures, the review of energy prices, and investment or support from the private sector or external organisations.

When it comes to challenges for combating energy poverty (Fig. 5), three of the given options stand out. Firstly, the challenges associated with access to modern and clean energy services were indicated by 80 % of the sample. The second and third most indicated options were the reliability of the energy services and the concerns about affordability, indicated by 73 % and 70 % of the respondents, respectively. Socio-economic development and energy access are closely interlinked. Lower levels of energy access are equivalent to stagnated economic development. Other factors that further exacerbate the energy poverty situation comprise job insecurities and lower standards of living in rural communities. Energy prices can negatively impact energy access across Africa, especially if connected to low-income and low-quality of life. Expensive energy prices negatively affect energy affordability for the vulnerable population. The low-income communities choose to use traditional energy sources to the detriment of renewable energy development and their health. The more competitive prices of fossil fuels when compared to renewable resources could also hinder investments in the sector, thus limiting access to clean energy. In terms of energy-generating resources, fossil fuels are the leading fuel in Africa due to their relatively low cost, but the potential growth of renewables is increasing as their costs are declining.

However, to a lesser extent, the need for financial support and a clear understanding of important concepts were also reported by over 50 % of the sample. While the lack of investments can hinder developments in infrastructure renewable energy and energy efficiency, particularly in rural areas, the issue of having concepts clearly defined and applied –

**Table 2**
Aspects indicated by respondents as potential reasons for the energy poverty in their countries.

| Aspect | Quotes from respondents | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Governance | "Poor policy formulation and implementation on supply and distribution, bad governance"<br>"Poor implementation of energy policies and strategies, low investment in decentralised renewable energy which can ensure the connection of rural communities where the grid connection is low"<br>"Low levels of investment, lack of capacity building training to adopt modern management of the electricity sector, political instability, poor operation and maintenance." | 44 | 46 % |
| Planning and Infrastructure | "Lack of infrastructure and inadequate supply from the national grid"<br>"Insufficient electricity generation, dominant use of dirty energy sources, low purchasing power to afford clean sources of energy, low energy access"<br>"Lack of proper electric infrastructure; No energy diversity (underdeveloped renewable and green energy sector); Non-existing energy professional board to discuss challenges and to propose solutions related to energy poverty" | 34 | 36 % |
| Cost | "Costs are too high and accessibility is very limited, especially in rural areas"<br>"Majority of poor people in rural areas cannot afford to pay for electricity"<br>"Inadequate capital to finance energy"<br>"The cost of energy is increasing" | 17 | 18 % |

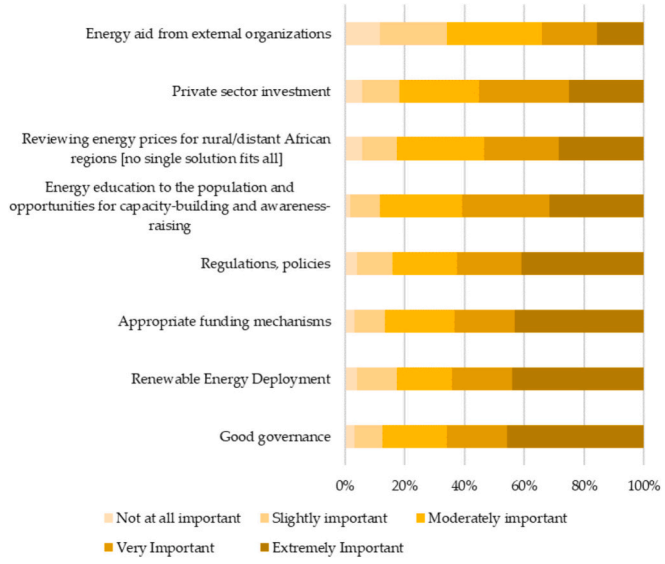


**Fig. 4.** Importance given by respondents to measures needed in their countries to provide more adequate, reliable, and affordable energy services.

such as energy poverty and energy justice – is fundamental in order to better understand inequalities and support policy development. Gender inclusion in energy policy was reported by only 27 % of the respondents, which can be related to the unbalanced sample in this study.

The final two questions of the survey focused on the perceptions of respondents about the efforts of local governments. As expected and as aligned with the previous results around governance and the lack of proper planning and infrastructure, 40 % of the sample think that the government efforts are not at all adequate to address the challenges of

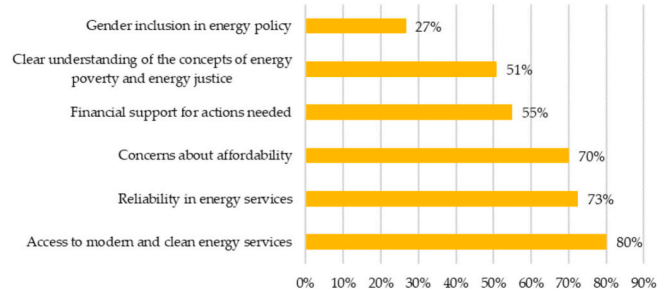


**Fig. 5.** Challenges indicated by respondents for combating energy poverty.

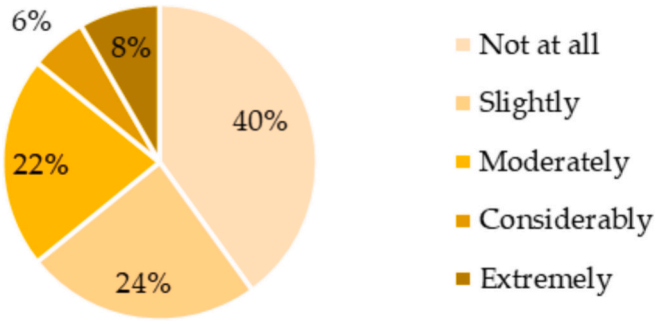


**Fig. 6.** Sample responses on efforts of local governments in being adequate to address challenges of preventing energy poverty in Africa.

preventing energy poverty in Africa (Fig. 6). Another similar share consists of 'slightly' and 'moderately' adequate responses (24 % and 22 %, respectively), and only 10 out of 120 (8 %) respondents indicated that the efforts are extremely adequate.

The final open-ended question asked respondents about which prospects and possible strategies they think could be put in place by the government and society to overcome energy poverty in their countries. Almost all respondents (116 out of 120) provided their views on the possible strategies, which are mostly connected with governance, infrastructure, education, and funding, as summarised in Table 3.

In terms of governance-related prospects and strategies (indicated by 46 % of the sample), some responses are quite general ("Good governance" or "Energy Poverty Strategy"). A few responses ($n$ = 10) mentioned the need for privatisation ("By privatising energy sector", "Total privatisation of the sector", "Allowing private investors to come in") as a solution for energy poverty-related challenges. Fighting fraud and corruption was also among the responses, as well as the need for clear regulations and improved human resources and institutional capacity. While funding aspects could also be considered as part of the governance role, this additional category was analysed, as there were considerable references to adequate funding and investments in the energy sector.

As far as infrastructure is concerned, the responses include two main topics: renewable energy ("Improve electricity supply via solar energy", "Broaden up the energy sector to renewable energy as well") and energy efficiency ("Efficiency in energy generation and distribution", "Energy efficient appliances"). Both strategies are acknowledged by the respondents as key factors in the process of tackling energy poverty. The responses also reflect the importance given by the sample to improved energy access, distributed energy resources, and off-grid solutions. This category represented 38 % of the sample views.

**Table 3**
Strategies that government and society could develop to overcome energy poverty.

| Aspect | Quotes from respondents | Frequency (n) | Percentage (%) |
|---|---|---|---|
| Governance | "Accountability and political will delivery"<br>"Appropriate institutional and regulatory frameworks"<br>"Energy prices should be subsidised, society should be educated on how to protect the grid from vandalism and weather-related downtimes, more training be provided for local engineers on the maintenance of renewables"<br>"Privatize all aspects of energy delivery - generation, transmission, and distribution."<br>"Total commitment from all stakeholders" | 61 | 46 % |
| Infrastructure | "Improve the existing electrical infrastructure."<br>"Creation of an energy professional board to help in regulations and policies as well as in developing new technologies to improve the energy sector"<br>"Access to clean energy development"<br>"Decarbonization, Decentralization and Digitalization"<br>"Deployment of distributed energy sources and off-grid solutions"<br>"More access to electricity" | 44 | 38 % |
| Education | "Adequate sensitization"<br>"Awareness and educating rural dwellers"<br>"Energy literacy"<br>"Provide public education on matters concerning energy"<br>"Energy usage education" | 11 | 9 % |
| Funding | "Adequate budget monitoring and implementation should be enhanced"<br>"Adequate funding"<br>"Good policies and investment to implement them"<br>"Invest more in the energy sector and encourage international partnership"<br>"Investment in energy generation projects." | 8 | 7 % |

Although energy poverty refers to the lack of access to energy services, the sample also values the role of education-related strategies ("education and awareness creation", "education of the citizenry on optimum consumption strategy"), particularly to empower the communities through consumption strategies, promote awareness of all processes involved, and generate knowledge to lead to problem-solving behaviour.

### 4.3. Discussion

The problem of energy poverty persists, especially in developing countries, where most people still rely on traditional forms of energy such as charcoal and firewood for cooking and light. The problem was escalated due to the growing energy demand resulting from geometric population growth, the rise in urbanisation and industrialisation, technology gaps, oil price volatility, and the reduced levels of finance for energy projects, as well as the rising impacts of climate change on energy infrastructure [99]. Some challenges which exacerbate the problem of energy poverty in Africa include:

a) Underdeveloped distribution networks, with the lack of the necessary infrastructure for energy distribution and the absence of grid connections, which make it difficult to deliver electricity, even when generation capacity exists.
b) Where infrastructure does exist, it is often outdated and inefficient, leading to significant energy losses during transmission and distribution.
c) The initial investment required for establishing or expanding energy infrastructure (such as power plants, renewable energy farms, and grid networks) is substantial. Financing these projects is a significant challenge for many African countries due to limited access to capital and high-interest rates.
d) Even when energy is available, the cost can be prohibitive for a large segment of the population, keeping energy services out of reach for the poorest households.

Also, climate change impacts such as droughts and flooding can affect energy production, especially in regions reliant on hydroelectric power. Extreme weather events can also damage infrastructure, leading to disruptions in energy supply. Moreover, overreliance on biomass (such as firewood and charcoal) for energy contributes to deforestation and environmental degradation, which can lead to a vicious cycle of resource depletion and increased energy poverty. In addition, to the best of our knowledge, no conclusive evidence about the effects of the COVID-19 pandemic and the war in Ukraine on energy poverty in Africa has been gathered yet. While the significant disruption of global energy markets caused by the pandemic and the war would have likely affected the situation of energy poverty in the continent, several African governments' responses to the energy sector, see [100], could have helped reduce negative effects on the energy poor and emphasize the crucial role of local renewables. However, the overall effect is not evident, prompting the need for additional research on how global phenomena may influence energy poverty in Africa.

A special aspect of energy poverty that should be given extra attention in Africa is the issue of affordability, as mentioned above. Whereas governments have made efforts to establish energy infrastructure (this addresses the aspects of accessibility), the high costs of energy have made it hard for poor communities, particularly in rural areas, to afford accessible modern energy. This clearly brings out the nexus between the SDG 7 on Energy Access and SDG 1 on poverty eradication. Additionally, even communities that can easily access and afford to pay for modern energy are often faced with the challenge of reliability, hence forcing them to jointly rely on both modern energy and traditional energy. The problems of corruption, and weak governance, are common in many African countries and are the root causes of many problems, including energy poverty. This means that attempts to address it need to take such wide-spread problems into account. There is a perceived need for reliable governance to address energy poverty. This entails developing and implementing policies, coordinating stakeholder efforts, allocating resources, ensuring compliance with regulations, facilitating data-driven decision-making, engaging the public, and participating in international cooperation. Without effective governance, efforts to combat energy poverty may be fragmented, inefficient, or insufficiently scaled. Energy poverty in Africa's context is relatively and endemically characterised by systemic challenges, compounded by multi-layered factors discernible by different indicators. The situation encompasses upstream and downstream challenges for most countries [101,102]. While energy poverty is endemic on the continent, only poor rural households bear the

brunt of such a phenomenon [103]. More generally, energy poverty unleashes doom and ramifications that remarkably reflect slow progress in both human and economic development in Africa [71]. This systemic problem can be tackled, and it requires inclusive, country-specific, or tailored policies and appropriate market measures that take into consideration all the dimensions of energy poverty, which is critical to keep pace with the various SDGs and country-specific commitments under the Paris Climate Agreement [93,104]. Effective policy must target the energy needs of the poor Africans [105]. The need for financial consideration of gender inclusion and ethnicity [87,88,94] in energy policy and a clear understanding of the concepts of energy poverty and energy justice cannot be ignored in efforts to address energy poverty [106,107].

### 4.4. Policy recommendations

Addressing energy poverty in Africa requires a multifaceted approach that involves local, regional, and international stakeholders.

Alleviating energy poverty should be anchored to energy transitions less dependent on fossil fuels and driven by aggressive investment in, and implementation of, distributed technologies based on low-carbon or renewable energy resources [102,108]. This will create a pathway for the needed energy diversification and grid decentralization in locking the energy supply and access gap among rural, semi-urban, and urban communities, even in a more cost-effective system [109,110].

Some recommendations which may help to move this forward are:

* an increase in investments in renewable energy, both from national budgets and development aid;
* a greater use of the abundant renewable energy resources, including solar, wind, hydro, and geothermal energy;
* an encouragement of further partnerships between governments and private sector players to finance and implement renewable energy projects.
* the deployment of off-grid and mini-grid solutions, especially solar home systems and community mini-grids, to provide energy access in remote locations where grid extension is not feasible.

The energy poverty transition to energy value creation can take place at three main levels: local, regional, and international. Partnerships and investment initiatives such as the New Deal on Energy for Africa (NDEA), the Power Africa Initiative, and the Desert to Power enabled by the African Development Bank (AfDB) can synergise with equivalent initiatives by the Asian Development Bank (ADB) and the Inter-American Development Bank (IDB), among others. The World Bank serves as the overarching development partner to weave in multilateral, bilateral, regional, local, private, and public energy poverty amelioration [111]. Uganda introduced energy privatisation [112]. Kenya, Nigeria, and Ethiopia's initiatives with solar PV, renewable energy, and effective carbon sequestration with carbon capture utilisation and storage add to the momentum. The power pooling at sub-regional blocks – with the East African Power Pool, the South African Power Pool, and the West African Power Pool – has triggered energy value-creating projects. ADB's Fintech could be a good symbiosis for aligning bilateral agreements with regional agreements [104].

Another dimension of energy poverty is energy and environmental justice. A good deal of grassroots impact occurs through community-responsive energy awareness. Energy poverty is articulated as ecological debt, termed the poor person's environmentalism. Online movements gather momentum, blazing through the internet from other parts of the globe outside Africa [113]. Energy poverty and implications for gender [114] resounded the groundswell of energy for justice in North Africa. In 2021, the World Bank authorised a US$500 million loan targeted at erasing energy poverty in Nigeria. Energy distribution losses would be curbed with initiatives on energy efficiency, biomass, and grid and off-grid sources.

Energy poverty impairs community expectations. When energy access is reasonable and affordable, it extends to cooperation with energy providers, local institutions, and relevant stakeholders. Notably, the grassroots policy interventions at the marginal rural and urban levels in Africa underscore that energy poverty eradication solutions emanate beyond electrification and renewable infrastructure. The issues of gender, the elderly, education-seeking groups, and vocational needs should be factored in. Energy use segmentation should focus on energy for development, energy for livelihoods, energy for resilience, and energy for security.

An emphasis on the transition from a focus on energy supply to the details of energy needs, perceptions, and desires would be important as Africa braces to implement sustainable development goals on energy, environment, well-being, and self-sustenance. Universal access to affordable, reliable, and modern energy services by 2030 [82] needs to be redesigned. Energy could be integrated into the family's economic budget. Local policy institutions, financial investors, and renewable technology providers could present future energy possibilities to consumers. The consumers need to learn to appreciate how they could be energy entrepreneurs themselves, such as in the examples of solar rooftop and car batteries for vocational needs, as seen in the cities of Joburg, Cape Town, and Polokwane Municipality and artisanal and mini scale gold mines in Ghana [115]. Solar lights, solar food processors, and solar passive heating can appeal to African energy stakeholders and unequivocally address energy poverty in Africa [115]. These initiatives are gathering momentum in Central Africa, such as in Cameroon, where climate adaptation is incorporated along with energy value creation [126].

## 5. Conclusions

Energy poverty is a multidimensional and multidisciplinary concept, bridging urgent energy policy issues that are essential for achieving sustainable livelihoods [116,117]. Research on energy poverty is on the rise and calls for supplementary analyses – especially focusing on developing areas [116,125]. Against this backdrop, this paper provided a better understanding of the challenges related to energy poverty in Africa and identified some of the policies and tools that may be deployed to address them. We found that governance-related issues, including corruption and poor policy implementation, are the most indicated reasons for energy poverty in Africa, more than technological, financial, and policy issues. However, all these issues need to be promptly addressed holistically to combat energy poverty.

Sub-Saharan Africa is witnessing encouraging electricity access results, seen in the lives of billions of people improved and assistance in getting them out of poverty loops. Nonetheless, the African region necessitates financial support to achieve these results rapidly and curb abrupt energy poverty trends. A multi-layered strategy is the crux to speed up this process. On the one hand, support from multilateral organisations is needed to sustain regional electrification. Fair energy aid is necessary to overcome energy vulnerability [118]. On the other hand, fostering local entrepreneurship and energy communities is nowadays a necessity, and micro initiatives like energy microfinance can provide important credit support, promoting financial inclusion and empowering the vulnerable [119,120,121].

At the same time, sub-Saharan Africa needs considerate electrification planning for achieving sustainable development and resilient livelihoods – above all in the most remote regions. This process needs to embed ethical and fair aspects to avoid the spread of energy infrastructures that neglect the most vulnerable socio-economic groups and hamper just energy transitions [103,122]. To assist just energy transition, rural electrification, vulnerable empowerment, and energy security and tackle energy poverty in Africa, tailored initiatives promoted by intergovernmental organisations can be of help [123,124]. This is the case of solar mini-grid energy cooperative projects that are promoted and implemented in many areas of Africa.

The bibliometric analysis revealed that the literature on energy poverty in Africa is mainly focused on issues related to electricity and electrification and their role in facilitating equal access to energy and overcoming energy poverty. Other studies have also been focusing on the aspects of rural electrification, household energy, and energy justice, as well as the role played by renewable energy in achieving sustainability goals and climate action. Due to the nature of energy poverty and its many ramifications, it is important to expand the literature basis on the topic.

The online survey complemented the bibliometric analysis by collecting views of respondents with experience in 32 African countries and by analysing their perceptions of the challenges and measures to fight energy poverty. Governance-related issues are the most indicated reason for the condition of energy poverty in Africa, including aspects of low investments, corruption, and poor implementation of policies. In terms of the importance of measures that can provide more adequate, reliable, and affordable energy services, those of good governance, renewable energy deployment, appropriate funding mechanisms, and regulations and policies are the ones that stand out. These measures seem appropriate to deal with the main challenges reported by the sample for combating energy poverty, which include energy access, reliability, and affordability. Finally, the efforts of local governments are considered not at all adequate to tackle energy poverty, and much more should be done, particularly in terms of governance, better infrastructure, energy education initiatives, and appropriate funding.

A further aspect associated with the novelty of the study, resides in the fact that it reviews the literature on the topic, describes its variables associated with the problem, and presents the views and perspectives from people familiar with the topic. Insights from research on energy poverty can inform policymakers and infrastructure planners, helping them to prioritise investments and design interventions that address the root causes of energy poverty and its various manifestations. This is because energy poverty is closely linked to broader issues of global inequality and justice. Addressing energy poverty can be a step towards reducing global disparities and promoting a more equitable distribution of resources.

Although the small sample and the profile of the respondents of the online survey could be seen as limitations of this study, the results provide a welcome contribution to the literature since they present an overview of potential challenges and strategies to tackle energy poverty in Africa. Among the international studies on this topic, the scientific novelty of this paper is based on a) the data generated for the African context, b) the possibility of replication in other regions, and c) the up-to-date insights on prospects to deal with the challenge of energy poverty.

As the matter of central interest and concern in this paper, addressing energy poverty needs not only a sound political and governance framework, but also the adoption of modern, efficient, and renewable energy technologies, which is often hindered by high costs, lack of technical expertise, and inadequate maintenance services.

As to the future, it is important that further studies look at the specific variables that influence energy poverty in Africa. Also, studies are needed that may support the design of strategies aimed at supporting decentralised energy generation, especially solar and wind, as well as geothermal. The many opportunities for income generation and gainful employment that derive from them may not only reduce the levels of energy poverty but also contribute to an improvement of the living conditions of millions across the African continent.

## CRediT authorship contribution statement

**Walter Leal Filho:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Andrea Gatto:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ayyoob Sharifi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Amanda Lange Salvia:** Writing – review & editing, Writing – original draft, Visualization, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Zeus Guevara:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Samuel Awoniyi:** Writing – review & editing, Writing – original draft. **Carelle Mang-Benza:** Writing – review & editing, Writing – original draft. **Cosmos Nike Nwedu:** Writing – review & editing, Writing – original draft. **Dinesh Surroop:** Writing – original draft. **Kevin Ovita Teddy:** Writing – original draft. **Usman Muhammad:** Writing – original draft. **Victoria R. Nalule:** Writing – original draft. **Izael da Silva:** Writing – original draft.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments: Andrea Gatto wishes to acknowledge funding from the Internal Faculty Start-Up Research Grant of Wenzhou-Kean University Project No. ISRG2023014. This paper is part of the "100 papers to accelerate climate change mitigation and adaptation " initiative led by the International Climate Change Information and Research Programme (ICCIRP).

## Data availability

Data will be made available on request.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.erss.2024.103664.

## References

[1] United Nations, Sustainable Energy 'Golden Thread' Connecting Economic Growth, Increased Social Equity, Secretary-General Tells Ministerial Meeting. https://www.un.org/press/en/2014/sgsm15839.doc.htm, 2014.
[2] D. Surroop, P. Raghoo, F. Wolf, K.U. Shah, P. Jeetah, Energy access in small island developing states: status, barriers and policy measures, Environ. Dev. 27 (Sep. 2018) 58–69, https://doi.org/10.1016/j.envdev.2018.07.003.
[3] IEA, World Energy Outlook 2014. https://www.iea.org/reports/world-energy-outlook-2014, 2014.
[4] S. Bouzarovski, Energy poverty revisited, in: Energy Poverty, Palgrave Macmillan, Cham, 2018, https://doi.org/10.1007/978-3-319-69299-9_1.
[5] K. Amulya, N. Reddy, Energy and social issues, in: World energy assessment : Energy and the challenge of sustainability, New York, 2000, pp. 39–58 [Online]. Available: https://www.undp.org/sites/g/files/zskgke326/files/publications/World%20Energy%20Assessment-2000.pdf.
[6] J.D. Sachs, A.M. Warner, The curse of natural resources, 15th Annu. Congr. Eur. Econ. Assoc. 45 (4) (May 2001) 827–838, https://doi.org/10.1016/S0014-2921(01)00125-8.
[7] D. Streimikiene, et al., Energy Poverty and Low Carbon Just Energy Transition: Comparative Study in Lithuania and Greece, in: 158 Social Indicators Research, 2021, pp. 319–371.
[8] Y. Xia, H. Wu, G. Wang, H. Mei, Mapping the Worldwide Trends on Energy Poverty Research: A Bibliometric Analysis (1999–2019), Int. J. Environ. Res. Public Health 18 (4) (2021) 1764.
[9] C.A. Bollino, F. Botti, Energy poverty in Europe: a multidimensional approach (2017) 70(283) PSL Quaterly review, 473-507. [7] M. González-Eguino, 'energy poverty: an overview, Renew. Sustain. Energy Rev. 47 (2015) 377–385, https://doi.org/10.1016/j.rser.2015.03.013.
[10] A. Brew-Hammond, Energy access in Africa: challenges ahead, Gt. China Energy Spec. Sect. Regul. Pap. 38 (5) (May 2010) 2291–2301, https://doi.org/10.1016/j.enpol.2009.12.016.
[11] United Nations, 2021 Global Champions Announced for UN High-Level Dialogue on Energy. https://www.un.org/en/desa/global-champions-announced-un-high-level-dialogue-energy, 2021.

[12] B.K. Sovacool, M.H. Dworkin, Energy justice: conceptual insights and practical applications, Appl. Energy 142 (2015 Mar 15) 435–444.
[13] K. Jenkins, D. McCauley, R. Heffron, H. Stephan, R. Rehner, Energy justice: a conceptual review, Energy Res. Soc. Sci. 1 (11) (2016 Jan) 174–182.
[14] W. Leal Filho, A.L. Balogun, D. Surroop, A.L. Salvia, K. Narula, C. Li, J.D. Hunt, A. Gatto, A. Sharifi, H. Feng, S. Tsani, Realising the potential of renewable energy as a tool for energy security in small island developing states, Sustainability 14 (9) (2022 Apr 20) 4965.
[15] B. Tarekegne, R. Sidortsov, Evaluating sub-Saharan Africa's electrification progress: guiding principles for pro-poor strategies, Energy Res. Soc. Sci. 1 (75) (2021 May) 102045.
[16] S. Stritzke, P.A. Trotter, P. Twesigye, Towards responsive energy governance: lessons from a holistic analysis of energy access in Uganda and Zambia, Energy Policy 1 (148) (2021 Jan) 111934.
[17] P.S. Low (Ed.), Climate Change and Africa, Cambridge University Press, Cambridge, 2005, https://doi.org/10.1017/CBO9780511535864.
[18] B.K. Sovacool, R.V. Sidortsov, B.R. Jones, Energy Security, Equality and Justice, Routledge, 2013 Dec 4.
[19] B.W. Ang, W.L. Choong, T.S. Ng, Energy security: definitions, dimensions and indexes, Renew. Sustain. Energy Rev. 42 (2015) 1077–1093, https://doi.org/10.1016/j.rser.2014.10.064.
[20] IEA, Emergency response and energy security Ensuring the uninterrupted availability of energy sources at an affordable price. https://www.iea.org/about/emergency-response-and-energy-security. Accessed May 6, 2024.
[21] A. Cherp, J. Jewell, The concept of energy security: beyond the four as, Energy Policy 75 (2014) 415–421.
[22] M.P. Blimpo, M. Cosgrove-Davies, Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact, World Bank Publications, 2019.
[23] IEA; IRENA; UNSD; WB; WHO, Tracking SDG 7: 'The Energy Progress Report 2020, International Energy Agency, Washington, DC, 2020 [Online]. Available: https://trackingsdg7.esmap.org/.
[24] S. Samarakoon, A justice and wellbeing centered framework for analysing energy poverty in the global south, Ecol. Econ. 165 (Nov. 2019) 106385, https://doi.org/10.1016/j.ecolecon.2019.106385.[23] IEA, "Africa Energy Outlook 2019", IEA, Paris, 2019. [Online]. Available: https://www.iea.org/reports/africa-energy-outlook-2019.
[25] M.O. Dioha, A. Kumar, Exploring sustainable energy transitions in sub-Saharan Africa residential sector: the case of Nigeria, Renew. Sustain. Energy Rev. 1 (117) (2020 Jan) 109510.
[26] E.R. Sadik-Zada, A. Gatto, N. Sodatshoeva, Electrification of mountainous rural areas and development: a case study of eastern Pamirs, The Electricity Journal. 36 (7) (2023 Aug 1) 107307.
[27] E.R. Sadik-Zada, W. Loewenstein, P.S. Dumbuya, Modernization through solar off-grid electrification? A mixed picture for rural Sierra Leone, Electr. J. 9 (2023 Sep) 107316.
[28] IEA, Africa Energy Outlook 2019, IEA, Paris, 2019 [Online]. Available: https://www.iea.org/reports/africa-energy-outlook-2019.
[29] G. Mutezo, J. Mulopo, A review of Africa's transition from fossil fuels to renewable energy using circular economy principles, Renew. Sustain. Energy Rev. 137 (Mar. 2021) 110609, https://doi.org/10.1016/j.rser.2020.110609.
[30] J.C. Anyanwu, A.E.O. Erhijakpor, Does oil wealth affect democracy in Africa? Afr. Dev. Rev. 26 (1) (Mar. 2014) 15–37, https://doi.org/10.1111/1467-8268.12061.
[31] UNDP, AfDB, Atlas of Africa Energy Resources, African Development Bank, Nairobi, 2017.
[32] N. Green, B.K. Sovacool, K. Hancock, Grand designs: assessing the African energy security implications of the grand Inga dam, Afr. Stud. Rev. 58 (1) (2015) 133–158, https://doi.org/10.1017/asr.2015.7.
[33] U. Deichmann, C. Meisner, S. Murray, D. Wheeler, The economics of renewable energy expansion in rural sub-Saharan Africa, Energy Policy 39 (1) (Jan. 2011) 215–227, https://doi.org/10.1016/j.enpol.2010.09.034.
[34] J.Y. Park, Z. Nagy, Comprehensive Analysis of the Relationship between Thermal Comfort and Building Control Research: A Data Driven Literature Review, 82 Renew Sustain. Energy Rev. (2018) 2664–2679.
[35] R. Ren, et al., A Systematic Literature Review of Green and Sustainable Logistics: Bibliometrics Analysis, Research Trend and Knowledge Taxonomy' (2019) 17 Int. J. Environ. Res. Public Health, 261.[34] L. B. O. Kounagbè and A. O. Salami, 'Working Paper 269-Climate Change and Renewable Energy Generation in Africa, 2017.
[36] C. Church, A. Crawford, Green conflict minerals: The fuels of conflict in the transition to a low-carbon economy, Int. Inst. Sustain. Dev. (2018) 279–304.
[37] B.K. Sovacool, When subterranean slavery supports sustainability transitions? Power, patriarchy, and child labor in artisanal Congolese cobalt mining, Extr. Ind. Soc. 8 (1) (Mar. 2021) 271–293, https://doi.org/10.1016/j.exis.2020.11.018.
[38] E. Meierding, Energy security and sub-Saharan Africa, no. 2. Institut de hautes études internationales et du développement, 2011.
[39] E. Papadis, G. Tsatsaronis, Challenges in the decarbonization of the energy sector, Energy 205 (Aug. 2020) 118025, https://doi.org/10.1016/j.energy.2020.118025.
[40] African Development Bank, Kenya goes all out for renewable energy. https://www.afdb.org/en/news-and-events/kenya-goes-all-out-for-renewable-energy-18559, 2018.
[41] KfW; GIZ; IRENA, The Renewable Energy Transition in Africa: Powering Access, Resilience and Prosperity, KfW Development Bank, Frankfurt, 2020.
[42] P.E. Brockway, A. Owen, L.I. Brand-Correa, L. Hardt, Estimation of global final-stage energy-return-on-investment for fossil fuels with comparison to renewable energy sources, Nat. Energy 4 (7) (Jul. 2019) 612–621, https://doi.org/10.1038/s41560-019-0425-z.
[43] IRENA, Scaling up renewable energy deployment in Africa: detailed overview of IRENA's engagement and impact, International Renewable Energy Agency, Abu Dhabi (2019).
[44] G. Karlsson, S. Oparaocha, The road to Johannesburg and beyond: networking for gender and energy1 1This article draws on articles by Sengendo [2002] and Branco and Roehr [2002] in ENERGIA News Vol. 5 No. 4, a special issue on the WSSD, Energy Sustain. Dev. 7 (3) (Sep. 2003) 62–67, https://doi.org/10.1016/S0973-0826(08)60366-X.
[45] Practical Action, 'Poor people's energy outlook 2018: achieving inclusive energy access at scale', Practical Action Publishing, Rugby. [online]. Available: doi: https://doi.org/10.3362/9781780447544.
[46] K. Bos, D. Chaplin, A. Mamun, Benefits and challenges of expanding grid electricity in Africa: a review of rigorous evidence on household impacts in developing countries, Energy Sustain. Dev. 44 (Jun. 2018) 64–77, https://doi.org/10.1016/j.esd.2018.02.007.
[47] W. Leal Filho, T. Wall, S.A. Rui Mucova, G.J. Nagy, A. Balogun, J.M. Luetz, A. W. Ng, M. Kovaleva, F.M.S. Azam, F. Alves, Z. Guevara, N.R. Matandirotya, A. Skouloudis, A. Tzachor, K. Malakar, O. Gandhi, Deploying artificial intelligence for climate change adaptation, Tech. Forec. and Soc. Chan. 180 (July 2022) 121662, https://doi.org/10.1016/j.techfore.2022.121662.
[48] W.L. Filho, A. Minhas, B. Schmook, et al., Sustainable development goal 13 and switching priorities: addressing climate change in the context of pandemic recovery efforts, Environ. Sci. Eur. 35 (2023) 6.
[49] A. Sharifi, Urban sustainability assessment: an overview and bibliometric analysis, Ecol. Indic. 121 (2021) 107102.
[50] N. J. van Eck and L. Waltman, 'Software survey: VOSviewer, a computer program for bibliometric mapping', Scientometrics, vol. 84, no. 2, pp. 523–538, Aug. 2010, doi:https://doi.org/10.1007/s11192-009-0146-3.
[51] I. Siksnelyte-Butkiene, A systematic literature review of indices for energy poverty assessment: a household perspective, Sustainability 13 (2021) 10900, https://doi.org/10.3390/su131910900.
[52] S. Jessel, S. Sawyer, and D. Hernández, 'Energy, Poverty, and Health in Climate Change: A Comprehensive Review of an Emerging Literature.' Front. Public Health 7:357. doi:https://doi.org/10.3389/fpubh.2019.00357.
[53] Z. Guevara, D. Mendoza-Tinoco, D. Silva, The theoretical peculiarities of energy poverty research: a systematic literature review, Energy Res. Soc. Sci. 105 (2023) 103274.
[54] H. Wang, M.W. Zafar, S. Abbas, et al., An assessment of energy poverty in sub-Saharan Africa: the role of financial inclusion and education, Econ Change Restruct 56 (2023) 4689–4711, https://doi.org/10.1007/s10644-023-09568-8.
[55] A.G. Brew-Hammond, S. Mensah, A. Owusu, Energy Poverty in Sub-Saharan Africa: Poverty Amidst Abundance, in: Antoine Halff, Benjamin K. Sovacool, Jon Rozhon (Eds.), Energy Poverty: Global Challenges and Local Solutions, 22 Jan. 2015, https://doi.org/10.1093/acprof:oso/9780199682362.003.0015. Oxford, 2014; online edn, Oxford Academic. accessed 27 Dec. 2023.
[56] S. Szabó, K. Bódis, T. Huld, M. Moner-Girona, Sustainable energy planning: leapfrogging the energy poverty gap in Africa, Renew. Sustain. Energy Rev. 28 (Dec. 2013) 500–509, https://doi.org/10.1016/j.rser.2013.08.044.
[57] P.G. Munro, A. Schiffer, Ethnographies of electricity scarcity: Mobile phone charging spaces and the recrafting of energy poverty in Africa, Energ. Buildings 188–189 (Apr. 2019) 175–183, https://doi.org/10.1016/j.enbuild.2019.01.038.
[58] B.K. Sovacool, The political economy of energy poverty: a review of key challenges, Energy Sustain. Dev. 16 (3) (Sep. 2012) 272–282, https://doi.org/10.1016/j.esd.2012.05.006.
[59] A. Urquiza, et al., Quality as a hidden dimension of energy poverty in middle-development countries. Literature review and case study from Chile, Energ. Buildings 204 (Dec. 2019) 109463, https://doi.org/10.1016/j.enbuild.2019.109463.
[60] G. Hiemstra-van der Horst, A.J. Hovorka, Reassessing the "energy ladder": household energy use in Maun, Botswana, Energy Policy 36 (9) (Sep. 2008) 3333–3344, https://doi.org/10.1016/j.enpol.2008.05.006.
[61] B. van der Kroon, R. Brouwer, P.J.H. van Beukering, The energy ladder: theoretical myth or empirical truth? Results from a meta-analysis, Renew. Sustain. Energy Rev. 20 (Apr. 2013) 504–513, https://doi.org/10.1016/j.rser.2012.11.045.
[62] B. Kebede, A. Bekele, E. Kedir, Can the urban poor afford modern energy? The case of Ethiopia, Afr. Improv. Energy Serv. Poor 30 (11) (Sep. 2002) 1029–1045, https://doi.org/10.1016/S0301-4215(02)00056-3.
[63] B.K. Sovacool, Defining, measuring, and tackling energy poverty, in: Energy Poverty: Global Challenges and Local Solutions vol. 2, Oxford University Press, Oxford, 2014, pp. 21–53.
[64] M. Madubansi, C.M. Shackleton, Changing energy profiles and consumption patterns following electrification in five rural villages, South Africa, Energy Policy 34 (18) (Dec. 2006) 4081–4092, https://doi.org/10.1016/j.enpol.2005.10.011.

[65] K. Waleed, F.M. Mirza, Examining fuel choice patterns through household energy transition index: an alternative to traditional energy ladder and stacking models, Environ. Dev. Sustain. 25 (2023) 6449–6501, https://doi.org/10.1007/s10668-022-02312-8.

[66] J. Paudel, A. Sharifi, G.D. Khan, What are the drivers of sustainable energy transition? Insights from an empirical analysis of household preferences for electric induction cooking in Nepal, J. Clean. Prod. 417 (2023) 138021.

[67] B. van der Kroon, R. Brouwer, P.J.H. van Beukering, The energy ladder: theoretical myth or empirical truth? Results from a meta-analysis, Renew. Sustain. Energy Rev. 20 (2013) 504–513.

[68] M. Grimm, A. Munyehirwe, J. Peters, M. Sievert, A first step up the energy ladder? Low Cost Solar Kits and Household's Welfare in Rural Rwanda, The World Bank Economic Review 31 (3) (October 2017) 631–649, https://doi.org/10.1093/wber/lhw052.

[69] PwC. 'Electricity Beyond the Grid. Accelerating Access to Sustainable Power for All'. PwC.

[70] D.B. Rahut, et al., A ladder within a ladder: understanding the factors influencing a household's domestic use of electricity in four African countries, Energy Econ. 66 (2017) 167–181.

[71] Z. Liu, et al., Evaluating potentials of passive solar heating renovation for the energy poverty alleviation of plateau areas in developing countries: a case study in rural Qinghai-Tibet plateau, China, Sol. Energy 187 (Jul. 2019) 95–107, https://doi.org/10.1016/j.solener.2019.05.049.

[72] D.R. Thiam, Renewable energy, poverty alleviation and developing nations: evidence from Senegal, J. Energy South. Afr. 22 (2011) 23–34.

[73] G. Zubi, F. Spertino, M. Carvalho, R.S. Adhikari, T. Khatib, Development and assessment of a solar home system to cover cooking and lighting needs in developing regions as a better alternative for existing practices, Sol. Energy 155 (Oct. 2017) 7–17, https://doi.org/10.1016/j.solener.2017.05.077.

[74] M. Pagliaro, F. Meneguzzo, Distributed generation from renewable energy sources: ending energy poverty across the world, Energ. Technol. 8 (7) (Jul. 2020) 2000126, https://doi.org/10.1002/ente.202000126.

[75] E. Banerjee, R. Sidortsov Prehoda, C. Schelly, 'Renewable, ethical? Assessing the energy justice potential of renewable electricity', *AIMS*, Energy 5 (5) (2017) 768–797, https://doi.org/10.3934/energy.2017.5.768.

[76] J.A. McGee, P.T. Greiner, Renewable energy injustice: the socio-environmental implications of renewable energy consumption, Energy Res. Soc. Sci. 56 (Oct. 2019) 101214, https://doi.org/10.1016/j.erss.2019.05.024.

[77] A.J. Nordholm, Scales of Energy Justice: Solar Power and Energy Poverty Alleviation, 2020.

[78] D. Khraibani, Energy Poverty and Justice: Using Renewable Energy in Marginalized Countries to Overcome Climate Change and Support Human Development, 2015.

[79] A. Sharifi, Co-benefits and synergies between urban climate change mitigation and adaptation measures: a literature review, Sci. Total Environ. 750 (Jan. 2021) 141642, https://doi.org/10.1016/j.scitotenv.2020.141642.

[80] I. Alloisio, et al., Energy poverty alleviation and its consequences on climate change mitigation and African economic development, in: FEEM Policy Brief, no. 02.2017, 2017.

[81] S. Chakravarty, M. Tavoni, Energy poverty alleviation and climate change mitigation: is there a trade off? Suppl. Issue Fifth Atl. Workshop Energy Environ. Econ. 40 (Dec. 2013) S67–S73, https://doi.org/10.1016/j.eneco.2013.09.022.

[82] F.O. Ogwumike, U.M. Ozughalu, Analysis of energy poverty and its implications for sustainable development in Nigeria, Environ. Dev. Econ. 21 (3) (2016) 273–290, https://doi.org/10.1017/S1355770X15000236.

[83] M. Ghodsi, X. Huang, Causality between energy poverty and economic growth in Africa: evidences from time and frequency domain causality test, Int. J. Energy Stat. 03 (04) (Dec. 2015) 1550020, https://doi.org/10.1142/S2335680415500209.

[84] K. Singh, and R. Inglesi-Lotz, 'The Role of Energy Poverty on Economic Growth in Sub-Saharan African Countries', The Energy Journal, vol. 10, no. 1, doi:https://doi.org/10.5547/2160-5890.9.2.ksin.

[85] F. Yang, M. Yang, M., Rural electrification in sub-Saharan Africa with innovative energy policy and new financing models, Mitig. Adapt. Strateg. Glob. Change 23 (2018) 933–952, https://doi.org/10.1007/s11027-017-9766-8.

[86] ESCAP, Systematic Review of the Socio-Economic Impacts of Rural Electrification. United Nations Economic and Social Commission for Asia and the Pacific, Retrieved from: https://www.unescap.org/kp/2021/systematic-review-socio-economic-impacts-rural-electrification#, 2021.

[87] B.E.K. Nsafon, et al., The justice and policy implications of clean energy transition in Africa. Frontiers in environmental, Science (2023) 11.

[88] O.E. Omoju, O.N. Oladunjoye, I.A. Olanrele, A.I. Lawal, Electricity access and agricultural productivity in sub-Saharan Africa: Evidence from panel data, in: E. S. Osabuohien (Ed.), The Palgrave Handbook of Agricultural and Rural Development in Africa, Palgrave Macmillan, Cham, 2020, https://doi.org/10.1007/978-3-030-41513-6_5.

[89] M.J. Herington, P.A. Lant, S. Smart, C. Greig, E. van de Fliert, Defection, recruitment and social change in cooking practices: energy poverty through a social practice lens, Energy Res. Soc. Sci. 34 (Dec. 2017) 272–280, https://doi.org/10.1016/j.erss.2017.09.001.

[90] K. Geremew, M. Gedefaw, Z. Dagnew, D. Jara, Current level and correlates of traditional cooking energy sources utilization in urban settings in the context of climate change and health, Northwest Ethiopia: a case of Debre Markos town, Biomed. Res. Int. 2014 (2014).

[91] C. Jana, S. Bhattacharya, Sustainable cooking energy options for rural poor people in India: an empirical study, Environ. Dev. Sustain. 19 (3) (2017) 921–937.

[92] M. Balmer, Energy poverty and cooking energy requirements: the forgotten issue in south African energy policy? J. Energy South. Afr. 18 (3) (2007) 4–9.

[93] M. Manjula, G. Gopi, Universal access to clean cooking energy and the need for an inclusive policy: evidence from analysis of cooking fuel use in Odisha and Tamil Nadu, Decision 44 (3) (2017) 193–207.

[94] T. Sesan, Navigating the limitations of energy poverty: lessons from the promotion of improved cooking technologies in Kenya, Energy Policy 47 (Aug. 2012) 202–210, https://doi.org/10.1016/j.enpol.2012.04.058.

[95] I. Ackah, D. Bukari, E.Z. Banye, et al., Transitioning towards cleaner cooking fuels: an analysis of consumer preferences in Ghana's cookstoves market, Environ. Sci. Pollut. Res. 28 (2021) 54936–54949, https://doi.org/10.1007/s11356-021-14456-7.

[96] R.O. Bofah, P. Appiah-Konadu, F.N. Ngwu, Transition to cleaner cooking energy in Ghana, Clean Energy 6 (1) (February 2022) 193–201, https://doi.org/10.1093/ce/zkac004.

[97] B.E.O. Nkoa, S. Tadadjeu, H. Njangang, Rich in the dark: Natural resources and energy poverty in Sub-Saharan Africa, in: Resources Policy Vol. 80, 2023, p. 103264. ISSN 0301-4207, https://doi.org/10.1016/j.resourpol.2022.103264.

[98] B. Batinge, J.K. Musango, A.C. Brent, Perpetuating energy poverty: assessing roadmaps for universal energy access in unmet African electricity markets, Energy Research & Social Science 55 (2019) 1–13. ISSN 2214-6296, https://doi.org/10.1016/j.erss.2019.05.004.

[99] D. Olawuyi, Sustainable development and the water-energy-food nexus: legal challenges and emerging solutions, Environ. Sci. Policy 103 (Jan. 2020) 1–9, https://doi.org/10.1016/j.envsci.2019.10.009.

[100] M.M. Akrofi, S.H. Antwi, COVID-19 energy sector responses in Africa: a review of preliminary government interventions, Energy Res. Soc. Sci. 68 (2020) 101681.

[101] P.G. Munro, S. Samarakoon, G.A. van der Horst, African energy poverty: a moving target, Environ. Res. Lett. 15 (10) (2020) 104059.

[102] C.N. Nwedu, Will a transition to renewable energy promote energy security amid energy crisis in Nigeria?, in: Energy Transitions and the Future of the African Energy Sector Springer, 2021, pp. 231–263.

[103] B. Tarekegne, Just electrification: imagining the justice dimensions of energy access and addressing energy poverty, Energy Res. Soc. Sci. 70 (Dec. 2020) 101639, https://doi.org/10.1016/j.erss.2020.101639.

[104] A. Medinilla, B. Byiers, K. Karaki, African Power Pools: Regional Energy, National Power, European Centre for Development Policy Management, Maastricht, 2019.

[105] E. Kristina, S. Sabastian, The energy austerity pitfall: Linking hidden energy poverty with self-restriction in household use in Austria, 84 Energy Research and Social Science 102427 (2022).

[106] N.S. Ouedraogo, Africa energy future: alternative scenarios and their implications for sustainable development strategies, Energy Policy 106 (Jul. 2017) 457–471, https://doi.org/10.1016/j.enpol.2017.03.021.

[107] I. Koomson, M. Danquah, Financial inclusion and energy poverty: empirical evidence from Ghana, Energy Econ. 94 (Feb. 2021) 105085, https://doi.org/10.1016/j.eneco.2020.105085.

[108] G. Hilson, Y. Hu, C. Kumah, Locating female "voices" in the Minamata convention on mercury in sub-Saharan Africa: the case of Ghana, Environ. Sci. Policy 107 (May 2020) 123–136, https://doi.org/10.1016/j.envsci.2020.02.003.

[109] K.O. Odeku, E. Meyer, Socioeconomic implications of energy poverty in south African poor rural households, Acad. Entrep. J. 25 (3) (2019) 1–12.

[110] C. van Horen, A. Eberhard, H. Trollip, S. Thorne, Energy, environment and urban poverty in South Africa, Urban Energy Environ. Afr. 21 (5) (May 1993) 623–639, https://doi.org/10.1016/0301-4215(93)90045-H.

[111] Energy Sector Management Assistance Program, Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers, World Bank, 2019.

[112] E.N. Mburu, Energy Related Services in Kenya: Implications of Unbundling the Electricity Sector on Trade in Services Negotiations, 2017.

[113] J. Martinez-Alier, I. Anguelovski, P. Bond, D. Del Bene, F. Demaria, Between Activism and Science: Grassroots Concepts for Sustainability Coined by Environmental Justice Organizations, 2014.

[114] S. Pather-Elias, Y. Reddy, H. Radebe, Energy Poverty and Gender in Urban South Africa, Sustainable Energy Africa, Cape Town, 2017.

[115] T. Ningi, A. Taruvinga, L. Zhou, Determinants of energy security for rural households: the case of Melani and Hamburg communities, Eastern Cape, South Africa, Afr. Secur. Rev. 29 (4) (Oct. 2020) 299–315, https://doi.org/10.1080/10246029.2020.1843509.

[116] G. Jiglau, S. Bouzarovski, U. Dubois, M. Feenstra, J.P. Gouveia, K. Grossmann, R. Guyet, S.T. Herrero, M. Hesselman, S. Robic, S. Sareen, Looking back to look forward: reflections from networked research on energy poverty, Iscience 2 (2023 Feb).

[117] S.A. Sy, L. Mokaddem, Energy poverty in developing countries: a review of the concept and its measurements, Energy Res. Soc. Sci. 1 (89) (2022 Jul) 102562.

[118] K. Dong, Q. Jiang, Y. Liu, Z. Shen, M. Vardanyan, Is energy aid allocated fairly? A global energy vulnerability perspective, World Dev. 1 (173) (2024 Jan) 106409.
[119] A. Gatto, Can renewable energy microfinance promote financial inclusion and empower the vulnerable? International Journal of Environment and Sustainable Development. 22 (3) (2023) 368–373.
[120] B. Tarekegne, J. Kazimierczuk, R. O'Neil, Communities in energy transition: exploring best practices and decision support tools to provide equitable outcomes, Discov. Sustain. 3 (1) (2022 Apr 8) 12.
[121] M.J. Manjon, A. Merino, I. Cairns, Business as not usual: a systematic literature review of social entrepreneurship, social innovation, and energy poverty to accelerate the just energy transition, Energy Res. Soc. Sci. 1 (90) (2022 Aug) 102624.
[122] B. Tarekegne, M. Rouleau, An energy justice based approach for electrification planning-an agent-based model, in: 2019 IEEE Global Humanitarian Technology Conference (GHTC), IEEE, 2019 Oct 17, pp. 1–4.
[123] E.R. Sadik-Zada, A. Gatto, N. Blick, Rural electrification and transition to clean cooking: The case study of Kanyegaramire and Kyamugarura solar mini-grid energy cooperatives in the Kyenjojo District of Uganda, in: Sustainable Policies and Practices in Energy, Environment and Health Research: Addressing Cross-Cutting Issues, Springer International Publishing, Cham, 2021, pp. 547–562.
[124] F. Hanke, R. Guyet, M. Feenstra, Do renewable energy communities deliver energy justice? Exploring insights from 71 European cases, Energy Res. Soc. Sci. 1 (80) (2021 Oct) 102244.
[125] C, Drago, A. and Gatto, Gauging energy poverty in developing countries with a composite metric of electricity access, in: Utilities Policy 81, 2023 Apr 1, p. 101486.
[126] E. Nkiaka, J.C. Lovett, Mainstreaming climate adaptation into sectoral policies in Central Africa: insights from Cameroun, Environ. Sci. Policy 89 (Nov. 2018) 49–58, https://doi.org/10.1016/j.envsci.2018.07.012.