Energy poverty: discover research gaps through a bibliometric analysis

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DOI: 10.24427/az-2022-0062

Abstract

This study aims to discover research gaps in the literature on energy poverty. Through this bibliometric analysis, six research gaps were identified. Identified first research gap is that there is no theoretical and empirical evidence of the variables of Climate Change, Energy Poverty, Government Mediation, Solar Power, and Sustainable Power Development in a nomological network/conceptual framework in the Sri Lankan context perhaps in the international context. There is no empirical study of the impact of Climate Change on Energy Poverty in the Sri Lankan context is the second research gap. There is no theoretical and

empirical study of the mediating effect of Energy Poverty on the relationship between Climate Change and Solar Power in the Sri Lankan context perhaps in the international context is the third research gap. Identified fourth research gap is that there is no theoretical and empirical study of the mediating effect of Energy Poverty on the relationship between Climate Change and Government Mediation in the Sri Lankan context perhaps in the international context. There is empirical evidence about the mediating effect of Government Mediation on the relationship between Energy Poverty and Sustainable Solar Power Development is the fifth research gap. There is empirical evidence about the mediating effect of Solar Power on the relationship between Energy Poverty and Sustainable Solar Power Development is the identified sixth research gap.

Key words

energy poverty, sustainable solar power development, bibliometric analysis, nomological network

Introduction

According to Neacsa et al. [2020] the reduction of accessibility to energy for certain categories of the population has generated international debates in various forums. Energy poverty can be defined as a lack of opportunities to access sustainable energy services and products [Johansson, 2012]. Berry [2018] points out that people need energy for various purposes like heating, lighting, food preparation, air conditioning, refrigerating, etc. hence, people expect reasonably priced, trustworthy, quality, safe, and ecologically sound energy services. The present situation in Sri Lanka is reported worst due to load shedding over 13 hours/day [Farzan, 2022]. Hence, the households struggle to manage their domestic affairs conveniently. Looking for alternatives is also pointless as the country is running out of fuel. Ceylon Electricity Board (CEB) has recently increased the electricity costs which further worsens the situation. Low-income people repeatedly report that they cannot afford the high energy costs, therefore they manage to live with low energy efficiency. Sri Lanka is one of the countries that has provided 100% grid electricity, but the service is highly unreliable and vulnerable [Kumarawadu, 2018].

The purpose of this study is to offer the main state of research on energy poverty, with the subsequent research objectives, interpreting the scope of the study; (1) To ascertain the current publication trends in energy poverty literacy in terms of time, authors, and affiliated countries; (2) To identify the prominent studies and themes of

the research area called energy poverty; (3) To identify the research gaps in the literature on energy poverty.

1. Research Method

On 28th January 2022, the researcher browsed the term "energy poverty" and found 587 articles. Initially, the articles and scholarly works written in English were shortlisted separately. Later, they were further shortlisted for 426 articles for bibliometric analysis.

The first article on energy poverty was published in 2000, hence the time of this study ranges from 2000 to 2022 (Table 1).

Tab. 1. Main Information about research data

DESCRIPTION	**RESULTS**
MAIN INFORMATION ABOUT DATA	
Timespan	2000:2022
Sources (Journals, Books, etc)	123
Documents	426
Average years from publication	3.27
Average citations per document	18.05
Average citations per year per doc	3.667
References	22229
DOCUMENT TYPES	
Article	426
DOCUMENT CONTENTS	
Keywords Plus (ID)	1929
Author's Keywords (DE)	1116
AUTHORS	
Authors	989
Author Appearances	1302
Authors of single-authored documents	62
Authors of multi-authored documents	927
AUTHORS COLLABORATION	
Single-authored documents	70

Documents per Author	0.431
Authors per Document	2.32
Co-Authors per Documents	3.06
Collaboration Index	2.6

Source: author's research.

In 2011, an increasing number of annual scientific publications related to energy poverty were found The definition related to energy poverty was introduced by the World Economic Forum in 2010. In 2015, under the sustainable development goal 07, access to energy was defined. Thereafter, the rate of publications related to energy poverty was further increased. In 2021, an increasing number of 151 publications related to energy poverty was found mainly due to the world's energy requirement increase with the COVID-19 pandemic.

2. Literature review – research results

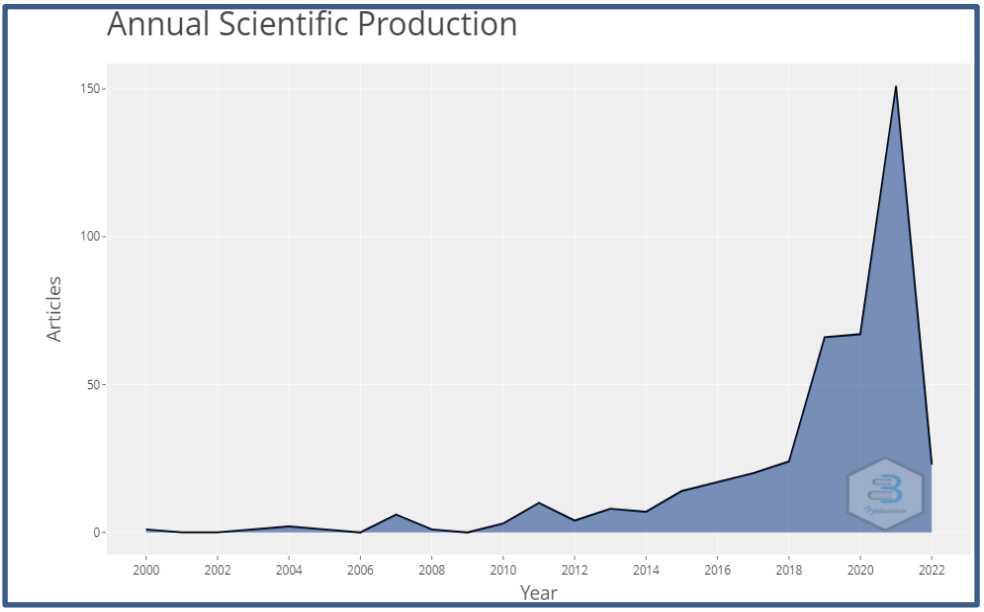


Fig. 1. Annual Scientific Production

Source: author's research.

Annual mean total citations are listed in Table 2. Here it indicates the number of citations per article. In the year 2000, there was only one article. Therefore, the mean total citation per year is zero and citable years is 22. There are no articles in 2001 and 2002, but in the year 2003 mean total citations per article were 2. Then the mean total citations per year are 0.105. The highest mean total citation per year was recorded in 2012 and 2015, respectively.

Tab. 2. Main Information about Data

Year	Number of Publications	Mean Total Citation per Article	Mean Total Citation per year	Citable Years
2000	1	0	0	22
2001	0	0	0	0
2002	0	0	0	0
2003	1	2	0.11	19
2004	2	93	5.17	18
2005	1	115	6.76	17
2006	0	0	0	0
2007	6	48	3.2	15
2008	1	36	2.57	14
2009	0	0	0	0
2010	3	4.67	0.39	12
2011	10	57.1	5.19	11
2012	4	90	9	10
2013	8	29.88	3.32	9
2014	7	30.29	3.79	8
2015	14	44.64	6.38	7
2016	17	49	8.17	6
2017	20	41.9	8.38	5
2018	24	21.38	5.34	4
2019	66	20.61	6.87	3
2020	67	12.01	6.01	2
2021	151	4.57	4.57	1
2022	23	0.17	0	0

Source: author's research.

The most relevant sources are given in Figure 2. Over 30 publications written on Energy Policy, Energy Economics, Energy Research, Social Science, and Energy Buildings have cited energy poverty. Over 400 citations can be found in most of the locally cited Journals written on Energy Policy, Energy Research, Social Science Energy Economics, and Energy Buildings.

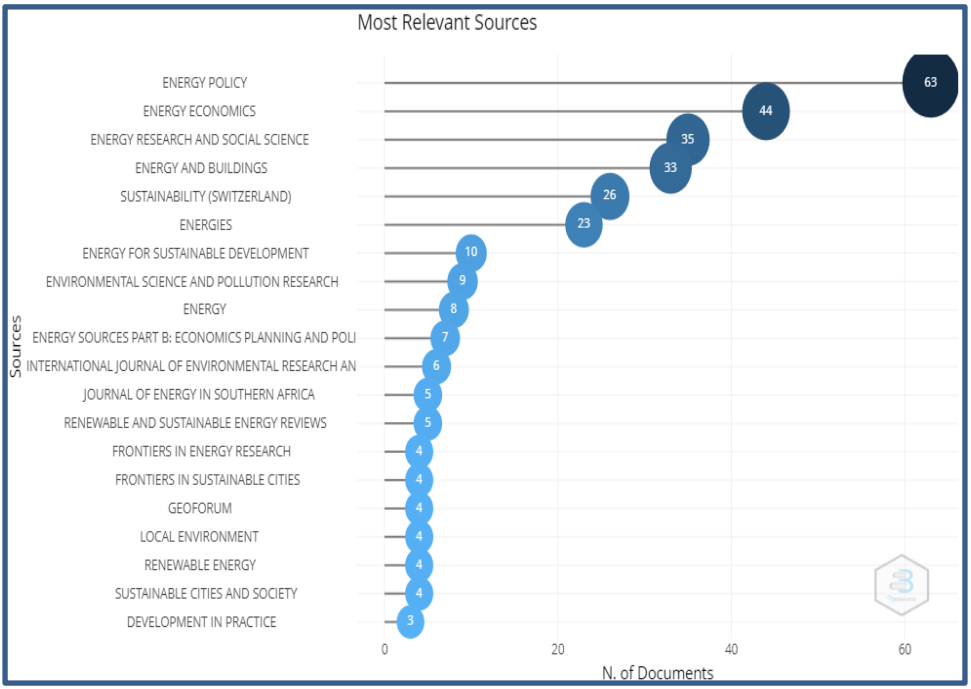


Fig. 2. Most Relevant Sources

Source: author's research.

Tab. 3. Most Local Cited Sources

Sources	Articles
Energy Policy	2711
Energy Research Social Science	513
Energy Economics	460
Energy Buildings	456
Renewable and Sustain Energy Reviews	394
Energy	320

Sources	Articles
Energy Sustain Development	211
Sustainability	198
Applied Energy	150

Source: author's research.

Bradford Law is also an important criterion. According to Bradford Law, most of the articles are published in three leading journals, namely 'Energy Policy', 'Energy Economics', and 'Energy Research & Social Science'. These are the 'core sources'. In other words, even though there are many journals, most of the articles are published in three leading journals. Refer to Figure 3.

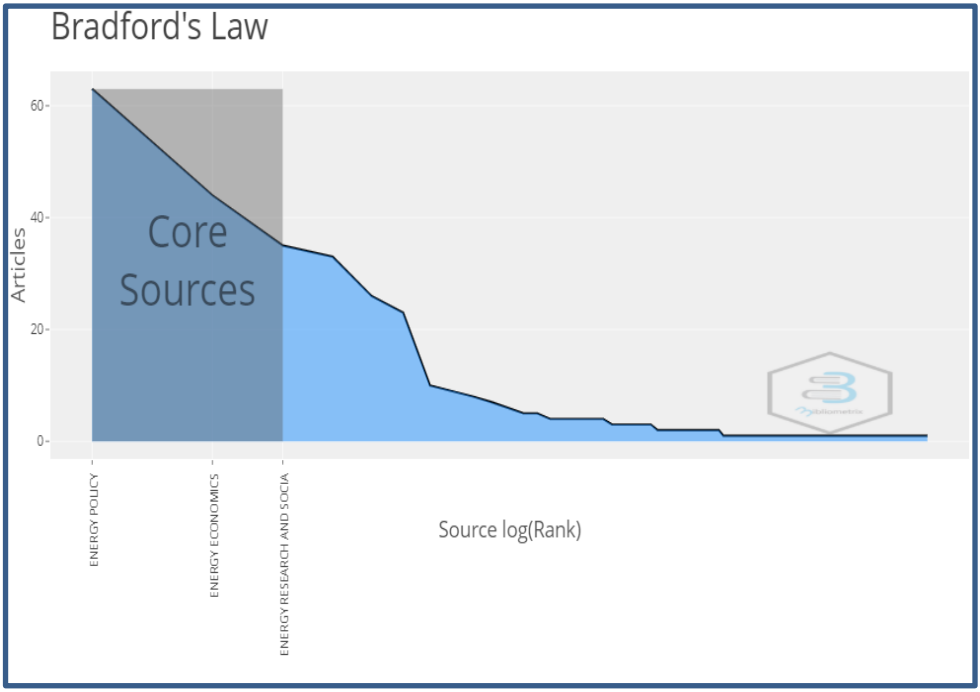


Fig. 3. Bradford Law

Source: author's research.

The top Authors' production over time is elaborated in Figure 4. Bouzarovski started his publications in the year 2012. In the year 2017, there were three articles and in the year 2021 also Bouzarovski had published articles. The dark blue circle depicted in figure 4 represents 2017 due to the higher number of citations (59). In 2021, Bouzarovski earned 15 citations so there is a light blue circle. The size of the circle depicted the number of articles. Papadal is the second author who had written three articles in 2021 and one article was in between 2017 and 2019.

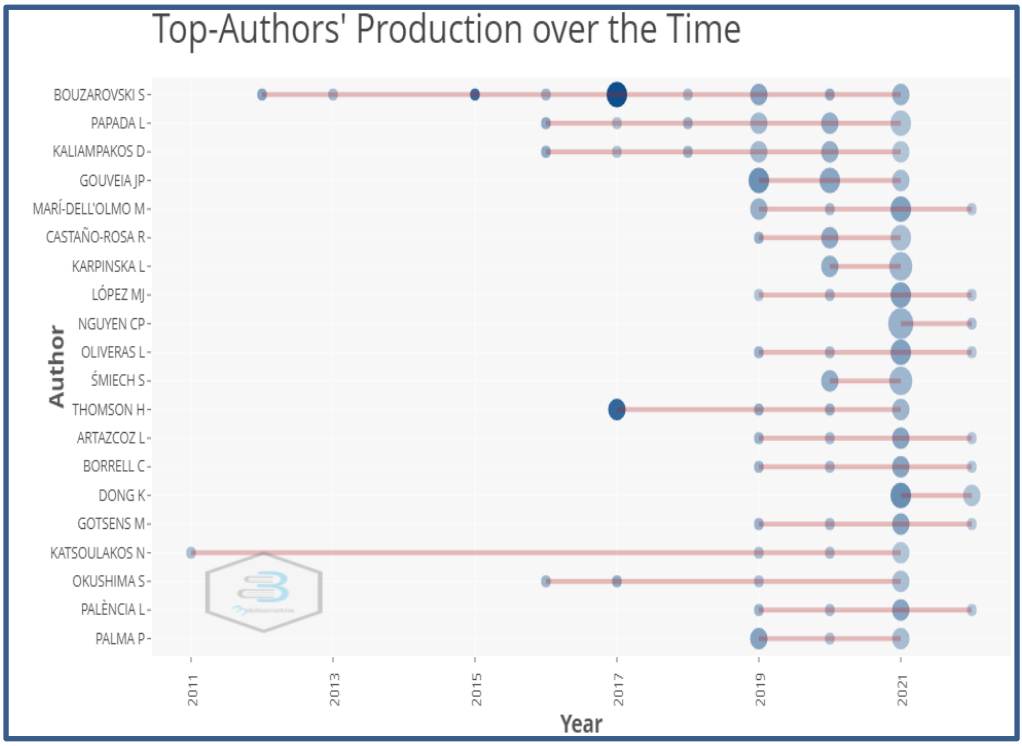
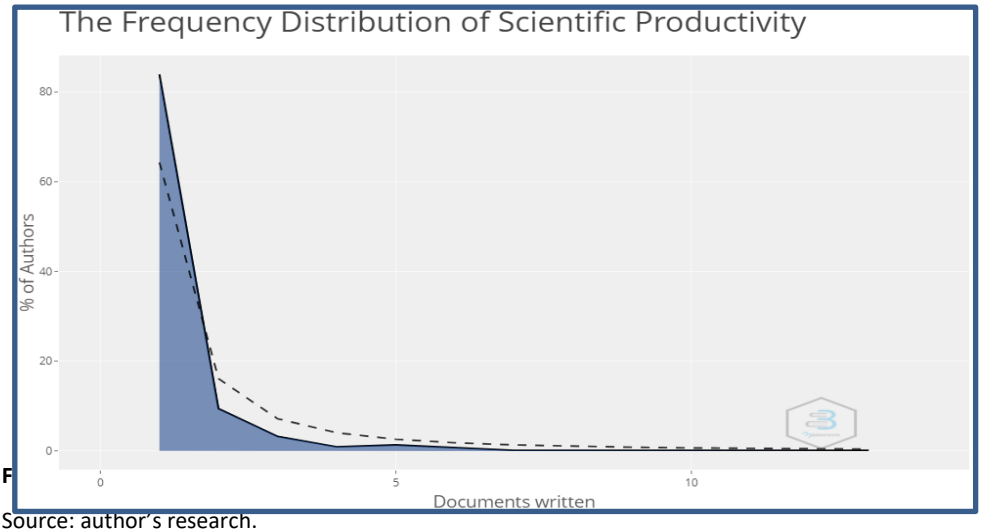


Fig. 4. Top Authors' Production Over the Time

Source: author's research.

Lotka Law is elaborated in Figure 5. In total, only 12 authors published more than six publications. 93 authors published exactly two publications, while 830 authors contributed only one. 83% of authors have written only one article. Therefore it can be concluded that Lotka Law can be applied to our database.



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Source: author's research.

The authors' analysis is available in Table 4.

Tab. 4. Author analysis

Element	h_index	g_index	m_index	TC	NP	PY_start
Bouzarovski S	12	13	1.091	1120	13	2012
Petrova S	5	5	0.455	673	5	2012
Thomson H	5	6	0.833	376	6	2017
Pachauri S	4	4	0.211	364	4	2004
Snell C	3	3	0.5	340	3	2017
Spreng D	2	2	0.105	313	2	2004
Simcock N	3	3	0.429	311	3	2016
Day R	2	3	0.286	278	3	2016

Source: own elaboration.

The top authors on energy poverty include Bouzarovski S and Petrova A. with more than 600 citations. Bouzarovski has the highest h-index rate, i.e., 12, G-Index rate, i.e., 13, and M-Index rate, i.e., 1.091, and several publications (NP) is 13. The first article was published in the year 2012.

The corresponding authors' country is available in Figure 6. Spain has the highest number of publications. Most countries have multiple collaborations. The most productive countries are Spain, China, the United Kingdom, Australia, and Greece, which are considered developed economies. In contrast, the most cited countries are the United Kingdom, Spain, Greece, China, and Australia, with more than 300 citations.

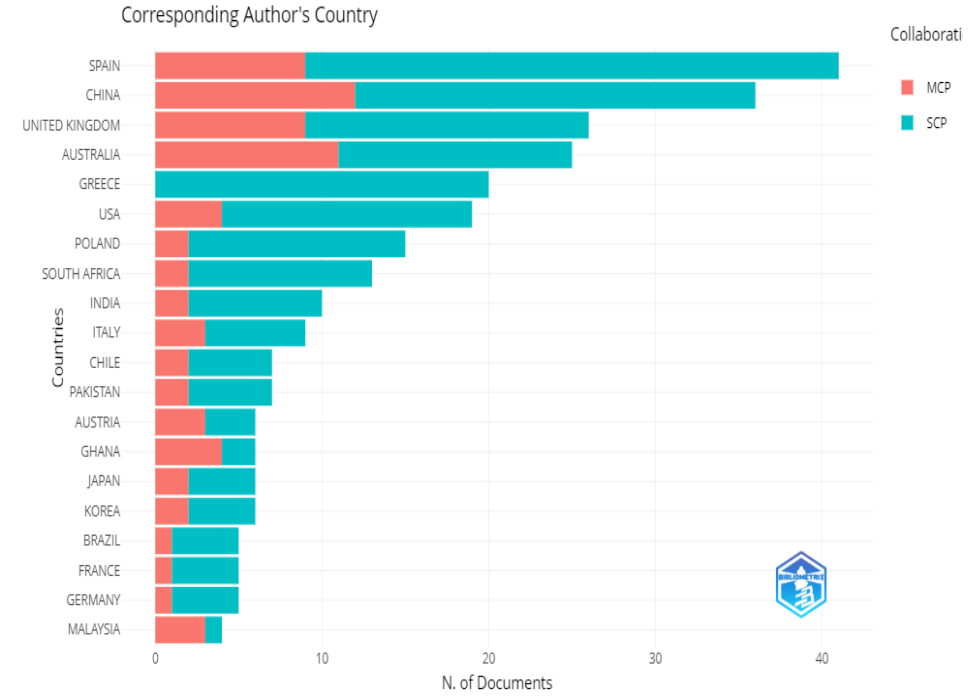

Fig. 6. Corresponding author's country

Source: author's research.

The word cloud is elaborated in Figure 7. Accordingly, energy poverty, Fuel poverty, and renewable energy are the highest frequency used author keywords, more than 20 times. This illustrates that energy poverty studies consider energy access, energy efficiency, multidimensional energy poverty, renewable energy, energy justice, energy policy, energy vulnerability, and energy consumption.

Fig. 7. Word cloud

Source: author's research.

According to the thematic map depicted in Figure 8, energy consumption, climate change, and COVID-19, energy justice, energy vulnerability, and energy transition are the motor theme that is emerging and more relevant themes. The basic themes are energy poverty, gender, fuel poverty, renewable energy, multidimensional energy poverty index, and south Asia. Composite indicators, energy poverty indicators, energy access, India, sustainable development, energy conservation, and sustainable energy are niche themes. Energy affordability, hidden energy poverty, climate change mitigation, health, education, and social development are declining themes.

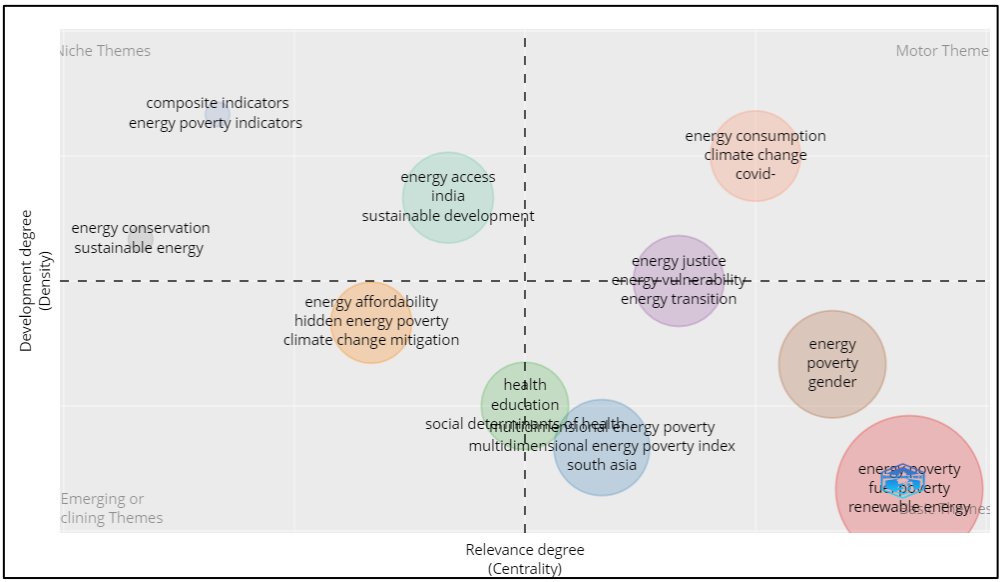

Fig. 7. Thematic Map

Source: author's research.

3. Discussion – literature survey with key studies of energy poverty

Energy poverty can be defined as a lack of opportunities to access sustainable energy services and products [Johansson, 2012]. Reddy [2000] and Obeng et al. [2008] state that the deficiency of electricity to assist the socio-economic development of a country is termed energy poverty. Meanwhile, Berry [2018] states that energy poverty is the inability to achieve essential capabilities resulting directly or indirectly from insufficient access to affordable, reliable, and safe energy services. Phimister, Vera-Toscano, and Roberts [2015] illustrate a few measuring tools of energy poverty; energy expenditure, consumers' perceptions of heating their homes, paying utility bills, and housing conditions. Hills [2012] argues that energy-poor households are considered a category deprive of heating their homes adequately. Turai, Schmatzberger, and Broer [2021] show the driving factors of energy poverty; the income of households, the energy efficiency of buildings and appliances, and energy markets coupled with much weaker social systems. Okushima [2017] illustrates a Multidimensional Energy Poverty Index (MEPI) that comprises energy cost,

income, and energy efficiency of housing from which energy poverty can be measured. Condeianu, Nicolae and Iorgovan [2021] point out that the evolution of the human society and implicitly of the economy has recorded significant changes, marked by the necessity of adaption to the exigencies imposed by globalization. Condeianu, Nicolae and Iorgovan [2021] further point out that in this context the sustainable development representing an essential factor in harmonizing the interests and the internalization of the benefits. Nussbaumer, Bazilian, and Modi [2012] indicate the provision of modern energy services through effective policies is essential for sustainable development, and to enhance the living standards of people. Papada, and Kaliampakos [2016] state that income support measures are required to alleviate the energy poverty of households and enhance their living conditions. Bouzarovski [2017] points out that energy poverty takes place when a domestic is incompetent to secure a level and quality of domestic energy services like space cooling and heating, cooking, use of appliances, and IT-related material.

Sattler [2016] states that worldwide, 1.4 billion people live in lack access to electricity, and 2.7 billion people depend on outdated biomass for cooking, this surely leads to an energy crisis. Similarly, González-Eguino [2015] indicates that in a few decades, the energy sector will have to encounter three major transformations related to climate change, security, supply, and energy poverty. Herington et al. [2017] state that across the world, about two-thirds of the population persist with traditional cooking practices. One of the theories to do away with this practice is to adopt social practice theory which helps them to think of adopting alternative, modern energy practices. Further Pellicer-Sifres, et al. [2021] argue that energy poverty can bring detrimental impacts on multiple aspects of people's well-being and quality of life and this can be well studied using Nussbaum's normative theory of Central Capabilities. Moreover, energy poverty can directly harm health, emotions, affiliation, play, practical reason and senses, imagination, and thought process. Accordingly, it can be said that the lack of avenues for sustainable energy services to enhance people's well-being and quality of life can be termed energy poverty. Energy cost, income, and energy efficiency of housing are some of the key measures of energy poverty. Hence a multi-dimensional approach from the highest possible authority is required to motivate people to acquire solar energy to meet the energy crisis in the future. The research team extensively explored a sufficient number of peer-reviewed articles to identify the gaps in energy poverty to conduct this study.

Bouzarovski and Petrova [2015] state that poor access to energy carriers is one dimension of energy poverty. They highlighted that the primary renewables, mechanical power, solid fuels and derivatives, liquid fuels and derivatives, natural gas

and derivatives, electric power, and secondary heat as energy carriers to meet household needs. As the demand for energy rises, people deprive of access to energy sources. Moreover, they highlighted the high ratio between the cost of fuels or other energy sources and household incomes, including taxes people find it difficult to afford energy infrastructures. Thomson, Bouzarovski, and Snell [2017] point out that households often find it difficult to switch from one energy service to another due to a lack of knowledge and the initial investment. People feel this better when load shedding occurs during essential hours. Although many studies related to energy have been conducted, public awareness of renewable energy is poor. Moreover, the knowledge of polytechnic lecturers on the government's policies on renewable energy is also poor [Derasid et al., 2021]. Dusmanescu et al. [2014] states that renewable energy sources represent an alternative to fossil fuels like coal, oil and gases. Dusmanescu et al. [2014] further states that The pollution generated burning fossil fuels for industrial development and the limited character of energetic fossil resources imposes the necessity to replace them with other sources of energy.

Meaniwhile et al. [2017] discover that the energy-poor population living in Europe is more likely to remain in poor health, have poor emotional well-being, and have depression. Hence, an investigation into this is essential. Day et al. [2016] point out that interventions in terms of energy/fuel access, improving affordability, means of switching to alternative fuels/energy sources, providing alternatives, and enhancing existing infrastructures are necessary to alleviate energy poverty. Pachauri et al. [2004] discover that energy poverty is twofold; energy poverty and energy distribution that links the components of access to vivid energy types and the quantity of energy used. Having analyzed the Indian household survey data for 1983–2000, they discovered that there was a significant reduction in the level of energy poverty in this subcontinent. By conducting a study, Knez et al. [2022] identify a link between energy prices, Sustainable Development Goals (SDGs), and energy poverty, as these three variables are considered important. Of these, the energy prices on the domestic market are considered significant to the rise of energy poverty.

Scheier and Kittner [2022] state that the money spent on energy cannot be spent elsewhere and is therefore not useful income to the household to measure prosperity. Further, they discovered that 16% of households experience energy poverty in the USA and they have to spend over 6% of household income on energy expenditures. Thomson et al. [2018] identify that energy poverty is mostly dominant in Central, Eastern, and Southern European countries. They further highlight that energy poverty cannot be measured using a single indicator, hence it should be measured using a multi-dimensional concept covering energy expenditure, hidden energy poverty, inability to keep homes adequately warm, and arrears on utility bills. Faiella and

Lavecchia [2018] discover energy poverty in Italy as a complex and multidimensional issue as it lies at the intersection between household income, energy costs, and the energy efficiency of the housing stock. Moreover, they state that sizable people do not have inadequate access to a minimum level of energy services. They further pointed out that energy poverty is a complex interaction between low income and household energy efficiency. Mayer et al. [2014] state that low-income people in Germany spend a high cost to access energy. Hence, they identified Low-Income-High-Costs as an innovative methodology for the analysis of households' and transport sectors' energy poverty.

By analyzing the journals that scored the highest citations, Table 5 was developed.

Tab. 5. Key studies of energy poverty

Author	Year	Key points
Derasid, Tahir, Musta'amal, Abu Bakar, Mohtaram, Rosmin and Ali	2021	-Moreover, the knowledge of polytechnic lecturers on government policies on renewable energy is also poor
Sokołowski, Lewandowski, Kiełczewska and Bouzarovski	2020	Energy poverty is mostly triggered by: -having a low income -facing high energy costs - living in a home with low energy efficiency
Castaño-Rosa, Sherriff, Solís-Guzmán, and Marrero	2020	A sudy of United Kingdom Presents the validation of an innovative index for the analysis of vulnerability to energy poverty according to monetary, energy, and thermal comfort factors: The Index of Vulnerable Homes (IVH)
Yip, Mah, and Barber	2020	-Study consists of five in-depth household case studies and 14 semi-structured interviews in the Hong Kong context. -Three main findings are presented. They are: (1) The proposed integrated framework discloses that households in the Hong Kong context uncovered multiple vulnerability factors adopted numerous responses to challenges of energy poverty. (2) The traditional expenditure-based indicator is not effective in identifying energy-poor households. (3) Household responses to energy poverty impacted health, learning environment, family relationships, and dignity
Costa-Campi, Jové-Llopis, and Trujillo-Baute	2019	-A study of energy poverty in Spain -Energy policy is one of the main causes of energy poverty

Author	Year	Key points
Thomson, Bouzarovski, and Snell	2017	-Due to a lack of knowledge and the initial investment households frequently find it challenging to switch from one energy service to another
		-Public awareness of renewable energy is poor
Thomson, Snell and Bouzarovski	2017	-Energy-poor population living in Europe is more likely to continue in poor health, poor emotional well-being, and misery
Day, Walker, and Simcock	2016	-Alternative energy sources, providing alternatives while improving existing infrastructures are indispensable to improving energy poverty
Bouzarovski and Petrova	2015	-Identified the primary renewables, solid fuels and derivatives, liquid fuels mechanical power natural gas and derivatives, electric power, and secondary heat as energy carriers to encounter household needs
		-The high ratio between energy sources and household incomes, people find it difficult to afford energy infrastructures
Pachauri, Mueller, Kemmler, and Spreng	2004	-Analyzed the Indian household survey data for 1983–2000 - A significant reduction in the level of energy poverty discovered in India

Source: author's research.

Based on the Literature survey with key studies of energy poverty and details under Table 5 five, 6 research gaps were developed.

Research Gap 1: There is no theoretical and empirical evidence of the variables of Climate Change, Energy Poverty, Government Mediation, Solar Power, and Sustainable Power Development in a nomological network/conceptual framework in the Sri Lankan context perhaps in the international context.

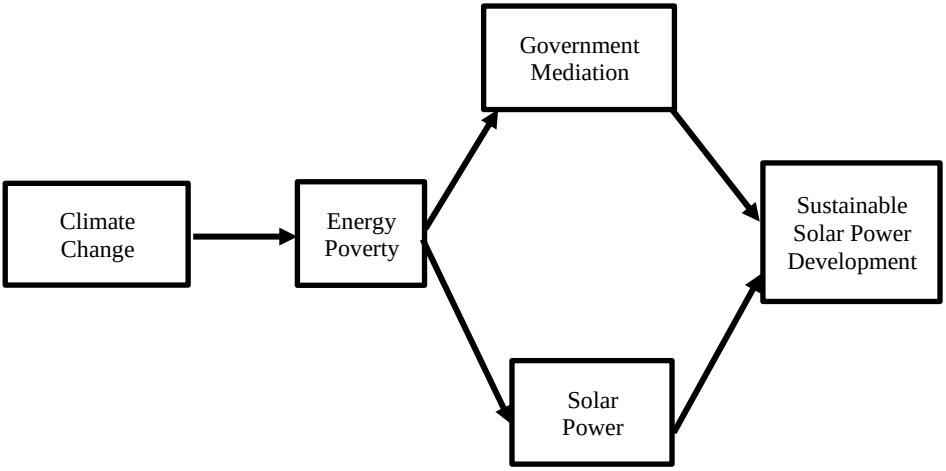

Fig. 8. Nomological network/ conceptual framework

Source: own elaboration.

The conceptual framework/nomological network is given in Figure 9. The variable called climate change was selected from the details of the thematic map. Refer to Figure 8. Under motor themes of the thematic map, the research areas which have a high development degree and high relevance degree are climate change, Covid, energy consumption, and energy justice.

Research Gap 2: There is no empirical study of the impact of Climate Change on Energy Poverty in the Sri Lankan context.

Research Gap 3: There is no theoretical and empirical study of the mediating effect of Energy Poverty on the relationship between Climate Change and Solar Power in the Sri Lankan context perhaps in the international context.

*Research Gap 4:*There is no theoretical and empirical study of the mediating effect of Energy Poverty on the relationship between Climate Change and Government Mediation in the Sri Lankan context perhaps in the international context.

Research Gap 5: There is empirical evidence about the mediating effect of Government Mediation on the relationship between Energy Poverty and Sustainable Solar Power Development.

Research Gap 6: There is empirical evidence about the mediating effect of Solar Power on the relationship between Energy Poverty and Sustainable Solar Power Development.

4. Limitation and Future Research

The limitation of this article is that the bibliometric analysis was limited to searching for an article on Scopus.

The nomological network or the conceptual framework that consists of five variables/constructs namely, Climate Change, Energy Poverty, Government Mediation, Solar Power, and Sustainable Solar Power Development can be tested in Asian Contexts, European contexts, or the African context.

The researcher intends to test this nomological network/conceptual framework with two segments: Domestics and Commercial segments in Sri Lanka. According to the Sri Lanka energy sector growth plan for 2015-2025, solar power can satisfy 32% of Sri Lanka's yearly power consumption of roughly 10,500 gigawatts, but just 0.01 percent of that potential has been achieved so far [Perera, 2021]. Hence, this sector can be strengthened by both domestic and commercial sectors. If the right strategies are used, the national grid can be nourished approximately by 30% from Solar Power, by 2030.

Conclusion

Absence of avenues to access sustainable energy services and products can be introduced as Energy poverty. Through, the Ministry of Power and Energy in Sri Lanka substantiates the entire countrymen are provided with hydroelectricity from the national grid, today, the citizens of Sri Lanka experiences power shedding for over 10 hours per day. This establishes the importance of having some form of renewable energy for Sri Lanka. In this paper, the researcher browsed the term "energy poverty" to identify the number of articles and scholarly works written in English to set up a platform for bibliometric analysis. The first article on energy poverty was written in 2000 and from then many authors had published articles on the subject. In 2011 and 2021, an increased number of articles were published which shows the commercial viability of the area of study. Six research gaps were identified through a bibliometric analysis. Research Gap one, three and four are both theoretical and empirical research gaps. Research gap two, five and six are empirical gaps. Identified nomological network going to be tested as a future research in the Sri Lankan context.

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Ubóstwo energetyczne: określenie luk badawczych przy pomocy analizy bibliometrycznej

Streszczenie

Niniejsze opracowanie ma na celu odkrycie luk badawczych w literaturze dotyczącej ubóstwa energetycznego. Poprzez analizę bibliometryczną zidentyfikowano sześć luk badawczych. Odnoszą się one do braku podstaw teoretycznych i empirycznych dowodów na istnienie zmiennych takich jak zmiany klimatyczne, ubóstwo energetyczne, mediacja rządowa, energia słoneczna i zrównoważony rozwój energetyczny w nomologicznej sieci/ramach koncepcyjnych w kontekście Sri Lanki, a może nawet w kontekście międzynarodowym.

Słowa kluczowe

ubóstwo enegretyczne, analiza, luka badawcza