

Energy Research in Malaysia: A Bibliometric Analysis

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Abstract

This study reports on the bibliometric analysis of energy research in Malaysia from 1994 to 2022 (28 years) from the Elsevier Scopus database. Through bibliographical analysis of 1,207 Scopus-indexed documents, the review found that this is very recent literature, with over 93% of the relevant documents published since 2010. The contributions of institutional energy publications by affiliation showed that Universiti Teknologi Malaysia (UiTM) had the highest number of publications. Meanwhile, the Journal of Renewable and Sustainable Energy Reviews published the most significant number of publications related to energy research. To the best of the researchers' knowledge, this is the first bibliometric study to analyze energy research in Malaysia.

Keywords: Energy, Malaysia, Bibliometric Analysis, Scopus Database

Introduction

The study of energy attracts the attention of several scientific institutions, economists, and stakeholders who stand to gain from using energy technology around the globe. Energy is considered the most critical factor in a nation's economic and industrial growth (Abedayo et al., 2021). Malaysia has a diverse range of energy resources, including oil, natural gas, coal, and renewable energy sources such as biomass, solar, and hydro. Despite its abundant resources, the nation remains reliant on fossil fuels for industrial and transportation purposes. In 2018, 92.8% of power was produced from fossil fuels such as natural gas, coal, diesel, and fuel oil (Energy Commission, 2020). Malaysia remains a net energy exporter. Concerns about energy security, fluctuating crude oil prices, and climate change are pushing substantial changes in how energy, notable electricity, is created, delivered, and used in Malaysia. Renewable energy options are becoming more appealing for Malaysia's sustainable energy development. It is because renewable energy sources are numerous in Malaysia, with biomass and solar being the most prominent (Shafie et al., 2011).

Malaysia's economy's expansion relies on a steady flow of energy. Therefore, it suggests that any energy supply shock or conservation regulations will have a negative impact on economic development. Figure 1 shows that the industry sector (39.6%) was Malaysia's primary energy

user during 1998. However, in 2018 the transport sector accounted for 36.4% of the total energy consumed, surpassing the industry sector at 29.5% (Energy Commission, 2020). For the transport sector, petroleum products were the leading form of energy. Malaysia’s electricity energy sector continues to grow; the electricity demand is increasing from 63,029 GWh in 1999 to 175,164 GWh in 2019 (Energy Commission, 2020). Malaysia requires an increasing number of resources due to its rapidly growing economy to sustain industrial growth and increase the productivity of labour, capital, and other production-related elements.

In Malaysia, the electricity sector is dependent on fossil fuel sources. In 2010, almost 94.6% of electricity was generated using fossil fuels such as natural gas, coal, and oil. The balance was generated by hydroelectric (Energy Commission, 2020). Figure 2 shows the Malaysia generation mix of electricity for the years 1999 and 2019. It seems that fossil fuel dominates the majority of energy generation in Malaysia. The generation of electricity in Malaysia climbs almost 178% in 20 years from 1999 to 2019. Among them, coal shows an increasing percentage in Malaysia’s electricity generation, from 7.2% (1999) to 42.8% (2019). The growth is attributable to the construction of new coal-fired power plants and the government’s approval of independent power producers (IPP). Alternative energy sources such as hydroelectric and coal are being developed to meet Malaysia’s power requirements.

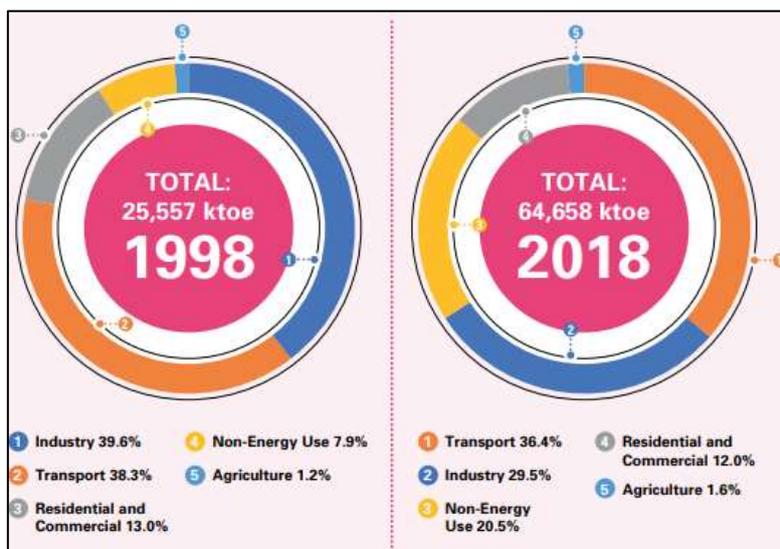


Figure 1: Final Energy Consumption by Sector

Source: Energy Commission, 2020

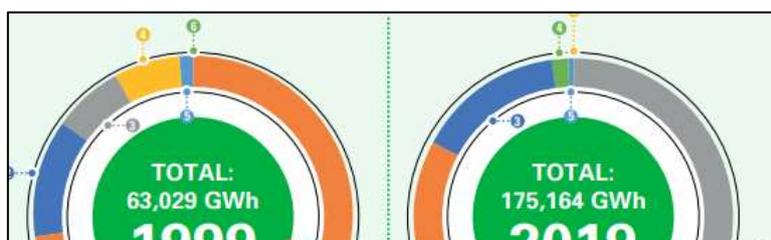


Figure 2: Malaysia's generation mix of electricity for the years 1999 and 2019

Source: Energy Commission, 2020

This study aims to investigate the state of Malaysia's energy research and its trends in the last 28 years, using a bibliometric approach to assist the research communities in understanding the present condition and predicting the dynamic changes that could occur in the energy field for prospects.

Methodology

This study gathered all data from the Scopus database as of September 13th, 2022. The Scopus database was chosen since it is the "largest single abstract and indexing database ever built" (Burnham, 2006) and the most searchable citation and abstract source of literature searches (Chadegani et al., 2013).

The Elsevier Scopus database was thoroughly searched using "renewable energy" and "nonrenewable energy" as the keyword and "Malaysia" as the affiliation country. It is possible to find papers on energy-related subjects where Malaysian academics, organisations, institutions, and their colleagues have made significant contributions. Scopus is a useful tool for extracting information about energy searches (KEY, COUNTRY, AND PUBYEAR), and other scholars have used it in the past to do energy research in other nations (Adedayo et al., 2021; Hernandez-Escobedo et al., 2018; Montoya et al., 2014; Aleman-Nava et al., 2014). The search covered the years 1994 to 2023, and a total of 1,225 papers were found and carefully examined before being narrowed down to 1,207 items. This was accomplished by eliminating unrelated terms, as seen in the search term in Table 1 and Figure 3. The Scopus search had no start date selected, enabling the search engine to find the oldest publications in the literature. Based on the document type, other papers were also rejected. At this point, everything like letters, short surveys, notes, editorial, and errata were dropped. All papers on the list had their abstracts scanned, and further exclusions were made based on subject relevancy. Table 2 displays the template created using several characteristics calculated and taken from the Elsevier Scopus database. This template has given enough information for each publisher listed.

Table 1

Malaysia Energy search string for the test case

TITLE-ABS-KEY("renewable energy" OR "nonrenewable energy" AND "Malaysia") AND (EXCLUDE (PUBYEAR,2023)) AND (EXCLUDE (DOCTYPE,"no") OR EXCLUDE (DOCTYPE,"sh") OR EXCLUDE (DOCTYPE,"ed") OR EXCLUDE (DOCTYPE,"er") OR EXCLUDE (DOCTYPE,"le"))

Note: Filter by the year 2023 and by document type which "no" refer to a note, "sh" refers to a short survey, "ed" refers to the editorial, "er" refer to erratum and "le" refer to a letter.

Table 2

The pattern of extraction and computation from the Elsevier Scopus database

Specialization	Allocated Data
Title	Renewable energy policies and initiatives for a sustainable energy future in Malaysia
Author name	Hashim, H., Ho, W.S.
Publication	Renewable and Sustainable Energy Reviews
Publisher	Elsevier Ltd
Year	2011
Volume	15
Issue	9
Start page	4780
End page	4787
Citation	179
Citation per year	16.27
Affiliation	Universiti Teknologi Malaysia
Author keyword	Renewable energy (RE), Malaysia, RE policies, RE programmes, RE incentives, RE funding and schemes
Original language	English
ISSN	13640321
Document type	Article
Source	Scopus
Reference	Complete list of references
Link	https://www.scopus.com/record/display.uri

Similarly, Google Scholar was investigated as an additional indexing source on Malaysian energy scholarly papers within the customary period 1994-2022, as demonstrated by the advanced search query in Table 3. When the term "Energy in Malaysia" was searched without any filters, 162,000 results were returned. Although Google Scholar retrieved a total of 162,000 results when utilising advanced search, it has a fundamental technical constraint that prevents metadata-export for further bibliometric research. Due to inadequate information regarding the document by author, publishing type, year of publication, and the institution of author and collaborator, the data is difficult to utilise with the Scopus findings. The data from Google Scholar proved challenging to use with big data sets since many essential data points were missing. As a result, the retrieved data from the Scopus database was utilised for additional study. The objective is that these findings will assist energy researchers and other stakeholders (local and international) in making educated decisions about this subject area.

Table 3

Google Scholar advanced search

Advanced search	Filter
Find articles	
with all of the words	Energy in Malaysia
with the exact phrase	
with at least one of the words	Renewable non-renewable
without the words	
where my words occur	<input checked="" type="radio"/> anywhere in the article <input type="radio"/> in the title of the article
Return articles authored by	
Return articles published in	
Return articles dated between	1994 - 2022

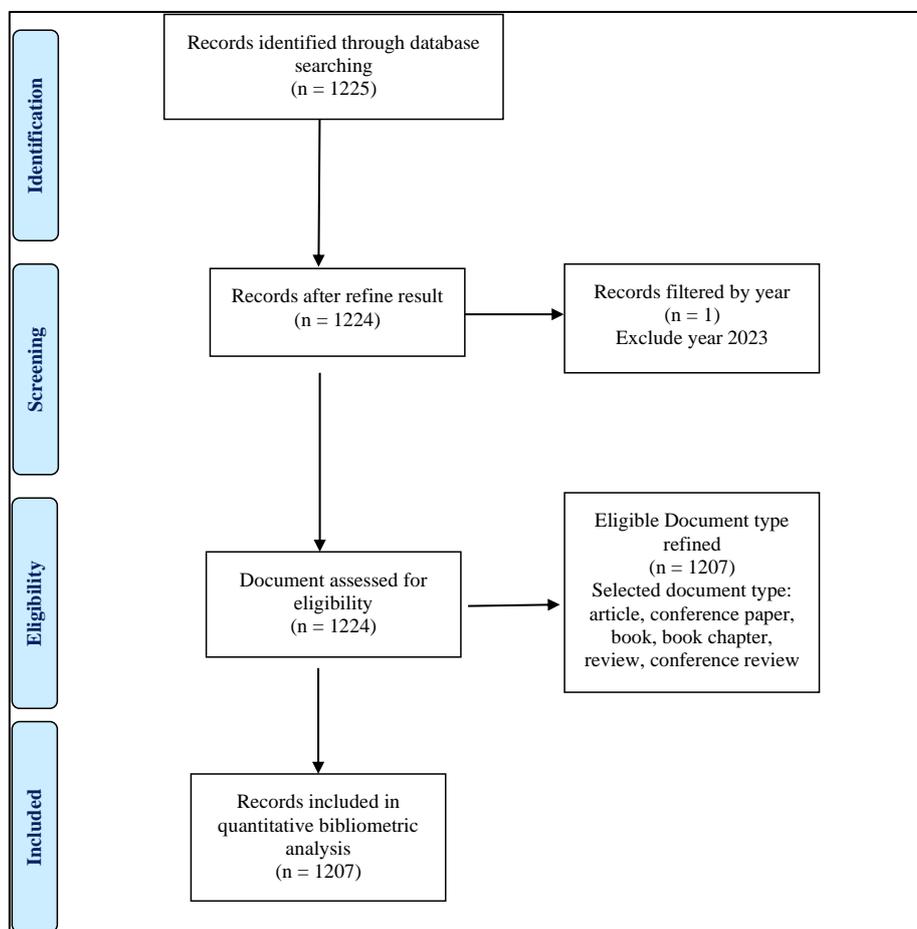


Figure 4: PRISMA Flow Diagram
Source: Adapted from Moher et al (2009)

Results and Discussion

The bibliometric methodology demonstrates the use of a statistical method to analyse the energy publishing results and trends in postulating the gap, remedy, and active areas of study while providing some input to the research community. The documents were retrieved from 1994 to 2022, and 1207 results were obtained based on document types, source types, annual

growth, languages, subject areas, keywords, authorships, and citations. The results are described in further detail in the subsections that follow.

Document and Source Types

This study found six documents published related to renewable and nonrenewable energy in Malaysia: articles, conference papers, reviews, book chapters, books and conference reviews. As per Table 4, most publications were from articles represented by 53.19%, followed by conference papers, 30.65%. The other types of documents are collectively represented by almost 17%. The lowest two types were conference reviews and books, with 1.24% and 0.41%, respectively. Table 5 presents five source types, where the highest represented type is journals (64.95%), followed by conference proceedings with 27.17%. Book series, books and trade publications contribute a total of 7.87%.

Table 4

Document Type

Document Type	Total Publications (TP)	Percentage (%)
Article	642	53.19
Conference Paper	370	30.65
Review	135	11.18
Book Chapter	40	3.31
Conference Review	15	1.24
Book	5	0.41
Total	1207	100.00

Table 5

Source Type

Source Type	Total Publications (TP)	Percentage (%)
Journal	784	64.95
Conference Proceeding	328	27.17
Book Series	60	4.97
Book	27	2.24
Trade Journal	8	0.66
	1207	100.00

Year of Publications - Evolution of Published Studies

The 1,207 Scopus-indexed documents published over the past 28 years represent a large and rapidly growing knowledge base on Malaysia's renewable and nonrenewable energy. The first research on renewable energy was published in 1994 by Kuranami and Winston (1994) in their paper titled, "Factors influencing ownership and use of nonmotorized vehicles in Asian cities." Interest in renewable and nonrenewable energy emerged slowly during the 1990s (7 documents) but picked up the pace with the publication of 79 documents during the 2000s. 93% of this literature was published between 2010 and 2022, leading to the conclusion that this is a rapidly emerging literature (see Figure 5).

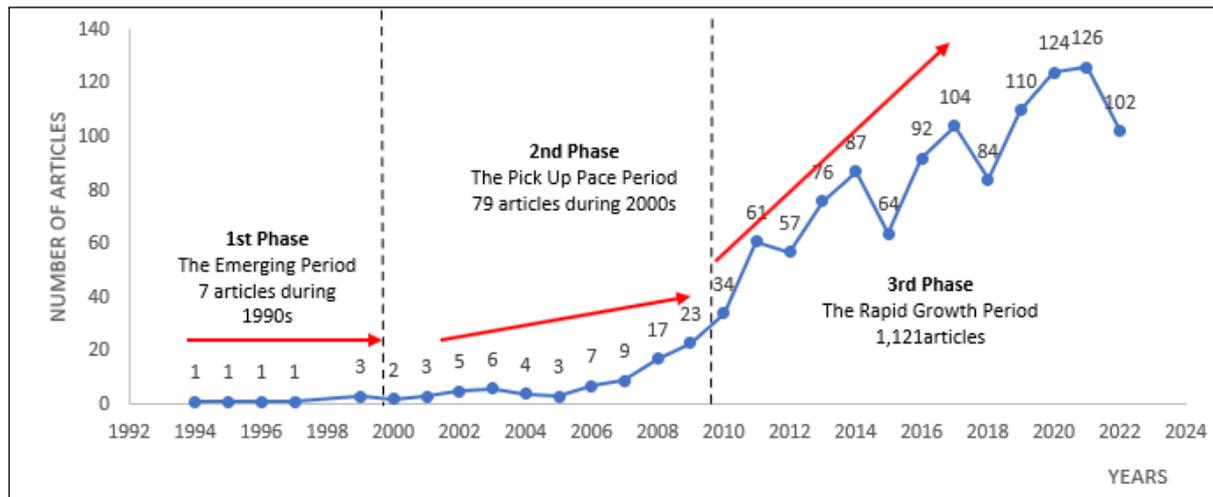


Figure 5: The growth of renewable energy and nonrenewable energy in Malaysia publication, 1994-2022 (n=1207)

Languages of Documents

The collected data sets have also been examined to identify the language used in the published documents. According to Table 6, most publications on renewable and nonrenewable energy are written in English (99.67%). It is interesting to note that publications were also written in French, Korean, and Malay. The least utilised languages for publishing, at 0.08% each, were Korean and French.

Table 6

Languages Used for Publications

Language	Total Publications (TP)*	Percentage (%)
English	1204	99.67
Malay	2	0.17
French	1	0.08
Korean	1	0.08
Total	1208	100.00

*One document has been prepared in dual languages

Subject Area

Table 7 summarizes the publications based on the subject area. It demonstrates that the largest number of publications were categorized under “energy,” with a total of 562 (24.91%) publications. This is followed by “engineering” (19.73%), “environmental science” (14.54%) and “computer science” (5.90%). Other subject areas were below 5% of the total publications, including social sciences, mathematics, chemical engineering, materials science, business, management and accounting, physics and astronomy, economics, econometrics and finance, agricultural and biological sciences, earth and planetary sciences, chemistry and decision sciences. The top three subject areas are energy, engineering, and environmental science because the research is on renewable and nonrenewable energy.

Table 7

Subject Area

Subject Area	Total Publications (TP)	Percentage (%)
Energy	562	24.91
Engineering	445	19.73
Environmental Science	328	14.54
Computer Science	133	5.90
Social Sciences	110	4.88
Mathematics	94	4.17
Chemical Engineering	93	4.12
Materials Science	84	3.72
Business, Management and Accounting	73	3.24
Physics and Astronomy	66	2.93
Economics, Econometrics and Finance	65	2.88
Agricultural and Biological Sciences	49	2.17
Earth and Planetary Sciences	39	1.73
Chemistry	26	1.15
Decision Sciences	26	1.15

Note: Top fifteen subject area

Most Influential Institutions

Figure 6 shows the ranking of Malaysia's top 10 most prolific institutions in energy research. Universiti Teknologi Malaysia (UiTM) is the most influential institution, with 216 publications. It is followed by Universiti Malaya and Universiti Kebangsaan Malaysia, with 110 and 108 publications, respectively. Furthermore, Universiti Tenaga Nasional, Universiti Putra Malaysia, Universiti Sains Malaysia, Universiti Malaysia Perlis, Universiti Teknologi PETRONAS, The University Nottingham Malaysia and Universiti Teknikal Malaysia Melaka amount to less than 100 publications per institution.

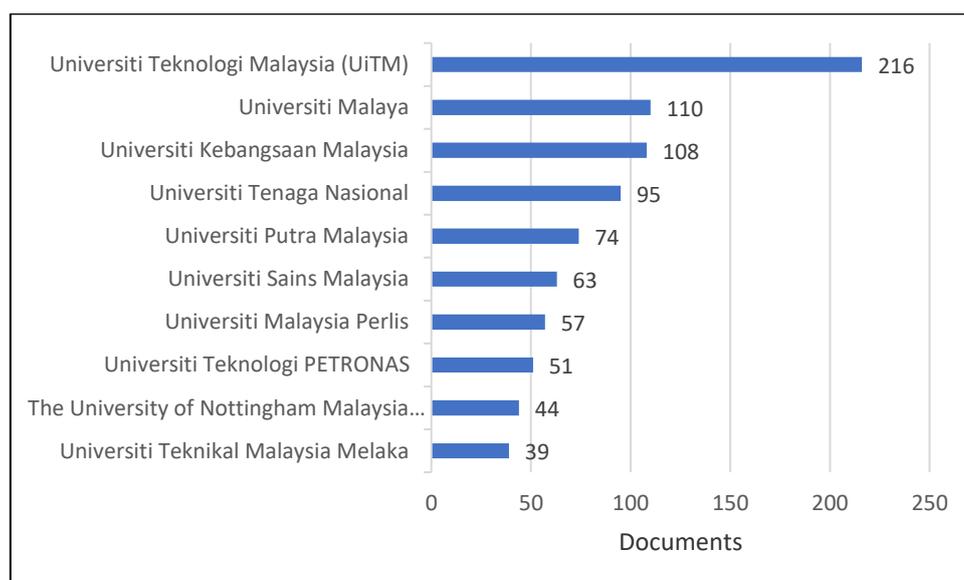


Figure 6: Documents by the Institution

Most Active Source Titles

Table 8 addresses the most active source titles on renewable and nonrenewable energy. The total publications in this table show that the highest source was Renewable and Sustainable Energy Reviews, with 86 (9.52%) publications. The second and third highest was Renewable Energy with 38 publications and Iop Conference Series Earth and Environmental Science, Iop Conference Series Materials Science and Engineering, and Journal of Cleaner Production with 26 publications per source.

Figure 7 further illustrates the trends of these documents per year by source with a clear observation that Renewable Energy is the only journal from 1994 until 2022. While, Renewable and Sustainable Energy Reviews show that it soared rapidly from 2008 until 2019. On the other hand, the other three sources are Iop Conference Series Earth and Environmental Science, Iop Conference Series Materials Science and Engineering, and Journal of Cleaner Production fluctuate over the stipulated period.

Table 8

Most Active Source Title

Source Title	Total (TP)	Publications Percentage (%)
Renewable And Sustainable Energy Reviews	86	9.52
Renewable Energy	38	4.21
Iop Conference Series Earth and Environmental Science	26	2.88
Iop Conference Series Materials Science and Engineering	26	2.88
Journal Of Cleaner Production	26	2.88
Aip Conference Proceedings	25	2.77
Chemical Engineering Transactions	25	2.77
Energy Policy	22	2.44
International Journal of Energy Economics and Policy	22	2.44
Energy Procedia	20	2.21

Note: Top ten most active source title

Citation Analysis

Table 9 presents the citation metrics for the retrieved documents as of September 13th, 2022. Harzing's Publish or Perish software was utilized to find the citation metric for the retrieved data from the Scopus database. The short description contains the number of citations with their citations per year, citations per paper, and citations per author. In total, there were 1207 papers with 27993 citations averaging 999.75 per year of renewable and nonrenewable energy publications. Each paper was cited 23.19 times, and the total of h-index and the g-index were 86 and 137 for all the publications. The top 20 most cited articles in renewable and nonrenewable energy were presented in Table 10 below. Solangi et al (2011), with the title "A review on global solar energy policy," was the most cited article to date, with 762 total citations. Followed by Begum et al (2015) with the article entitled "CO2 emissions, energy consumption, economic and population growth in Malaysia" and Sumathi et al (2008) with the title "Utilization of oil palm as a source of renewable energy in Malaysia" which 478

citations and 460 citations respectively. The vast majority of the top twenty papers deal primarily with renewable energy rather than nonrenewable energy.

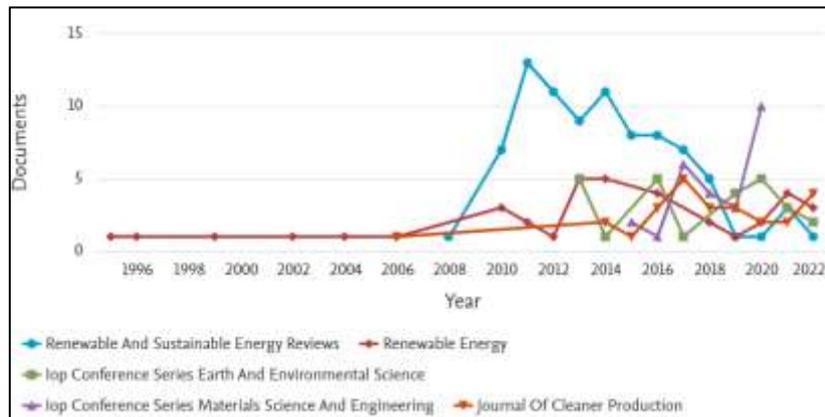


Figure 7: Documents per year by source

Table 9

Citations Metrics

Metrics	Data
Publication years	1994-2022
Citation years	28 (1994-2022)
Papers	1207
Citations	27993
Citations/year	999.75
Citations/paper	23.19
Citations/author	9217.52
Papers/author	389.88
h-index	86
g-index	137

Table 10

Highly cited articles

No.	Authors	Title	Year	Cites	Cites per Year
1	K.H. Solangi, M.R. Islam, R. Saidur, N.A. Rahim, H. Fayaz	A review on global solar energy policy	2011	762	69.27
2	R.A. Begum, K. Sohag, S.M.S. Abdullah, M. Jaafar	CO2 emissions, energy consumption, economic and population growth in Malaysia	2015	478	68.29
3	S. Sumathi, S.P. Chai, A.R. Mohamed	Utilization of oil palm as a source of renewable energy in Malaysia	2008	460	32.86
4	R. Sarin, M. Sharma, S. Sinharay, R.K. Malhotra	Jatropha-Palm biodiesel blends: An optimum mix for Asia	2007	448	29.87
5	S. Yusoff	Renewable energy from palm oil - Innovation on effective utilization of waste	2006	378	23.63
6	G. Sorda, M. Banse, C. Kemfert	An overview of biofuel policies across the world	2010	373	31.08
7	S.H. Shuit, K.T. Tan, K.T. Lee, A.H. Kamaruddin	Oil palm biomass as a sustainable energy source: A Malaysian case study	2009	368	28.31
8	S. Ahmad, R.M. Tahar	Selection of renewable energy sources for sustainable development of electricity generation system using analytic hierarchy process: A case of Malaysia	2014	329	41.13
9	M. Haseeb, I.S.Z. Abidin, Q.M.A. Hye, N.H. Hartani	The impact of renewable energy on economic well-being of Malaysia: Fresh evidence from auto regressive distributed lag bound testing approach	2019	296	98.67
10	H.C. Ong, T.M.I. Mahlia, H.H. Masjuki	A review on energy scenario and sustainable energy in Malaysia	2011	291	26.45
11	S. Lim, L.K. Teong	Recent trends, opportunities and challenges of biodiesel in Malaysia: An overview	2010	274	22.83
12	X. Liu, S. Zhang, J. Bae	The impact of renewable energy and agriculture on carbon dioxide emissions: Investigating the	2017	273	54.60

		environmental Kuznets curve in four selected ASEAN countries			
13	T.L. Chew, S. Bhatia	Catalytic processes towards the production of biofuels in a palm oil and oil palm biomass-based biorefinery	2008	265	18.93
14	K.Y. Lau, M.F.M. Yousof, S.N.M. Arshad, M. Anwari, A.H.M. Yatim	Performance analysis of hybrid photovoltaic/diesel energy system under Malaysian conditions	2010	263	21.92
15	T.H. Oh, S.Y. Pang, S.C. Chua	Energy policy and alternative energy in Malaysia: Issues and challenges for sustainable growth	2010	260	21.67
16	K. Sopian, W.R. Wan Daud	Challenges and future developments in proton exchange membrane fuel cells	2006	259	16.19
17	C.S. Goh, K.T. Tan, K.T. Lee, S. Bhatia	Bio-ethanol from lignocellulose: Status, perspectives and challenges in Malaysia	2010	241	20.08
18	S.K. Loh	The potential of the Malaysian oil palm biomass as a renewable energy source	2017	235	47.00
19	M.J. Chin, P.E. Poh, B.T. Tey, E.S. Chan, K.L. Chin	Biogas from palm oil mill effluent (POME): Opportunities and challenges from Malaysia's perspective	2013	233	25.89
20	S. Mekhilef, S. Siga, R. Saidur	A review on palm oil biodiesel as a source of renewable fuel	2011	226	20.55

Conclusion

This paper revealed a bibliometric analysis of the theme of renewable and nonrenewable energy in Malaysia in the current research agenda. A quantity of 1207 articles in the Scopus database published between 1994 and 2022 was analyzed. This publication number increased from 1 document in 1994 to 102 in 2022, as generally observed. Within this stipulated period, a gradual increment in the number of publications became noteworthy from 2010 to 2016, with an average of 67 publications per year, to an average of 108 publications per year from 2017 to 2022. These documents were mostly published in journal articles (784 or 64.95%) and conference proceedings (328 or 27.17%), where the prevalent language of publications is written in English (99.67%). Furthermore, Universiti Teknologi Malaysia (UiTM) is the most influential institution, followed by Universiti Malaya and Universiti Kebangsaan Malaysia.

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Paper Contribution to Related Field of Study

This paper contributes to the literature on energy research in Malaysia.

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