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Bibliometric Study of Renewable Energy Technology Development: Application of VOSviewer in Identifying Global Trends

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Abstract

This article presents a bibliometric study on developing renewable energy technologies using VOSviewer software. The study identifies key global trends in renewable energy research and maps collaboration networks among researchers, institutions, and countries. Data were extracted from major scientific databases, including Scopus and Web of Science, covering publications from the last decade. The results reveal that research on renewable energy technologies has significantly increased, with a growing focus on innovation, sustainability policies, and the economic impact of clean energy adoption. Notably, recent studies emphasize "green finance" and its role in accelerating the transition to renewable energy. Furthermore, this study highlights the shift from purely technical research towards interdisciplinary approaches that integrate policy, economics, and environmental sustainability. Unlike previous studies, this research employs a comprehensive bibliometric analysis combined with network visualization to provide a clearer picture of the evolution of research topics and international collaboration patterns. These findings offer valuable insights for strengthening global partnerships and fostering clean and sustainable energy innovation.

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1. Introduction

In recent decades, renewable energy technologies have become a significant focus of global efforts to reduce the environmental impact of fossil fuel use and accelerate the transition to cleaner, more sustainable energy sources. The need to address climate change and ensure long-term energy sustainability has driven the development of renewable energy technologies such as solar, wind, and bioenergy (Al-Shetwi, 2022; Erdiwansyah, Mamat, Sani, & Sudhakar, 2019; Jaiswal et al., 2022). Research and innovation in this field have snowballed, resulting in many scientific publications supporting technological progress and implementation (Bresciani, Ciampi, Meli, & Ferraris, 2021; Jorzik, Klein, Kanbach, & Kraus, 2024; Li, Ikram, & Xiaoxia,

2025; Shen, Wang, & Yang, 2020). With the rapid growth of renewable energy research, it is essential to understand how research trends and developments are occurring globally. Bibliometric analysis can provide crucial insights into collaboration patterns, research distribution, and the evolution of topics related to renewable energy technologies (Arias-Cárdenas, Lacasta, & Haurie, 2024; M. Cui, Feng, & Wang, 2023; Sang, He, Shen, & Xu, 2024). By analysing scientific publication data, we can gain a clearer picture of the critical actors in the field, be they individuals, institutions, or countries, and identify themes of current interest.

VOSviewer is a popular bibliometric analysis tool that allows researchers to visualise collaboration networks and topic distributions in scientific research (Azizoğlu & Terzi, 2024; Maghfirah, Yusop, & Zulkifli, 2025; Sun, Zhang, & Zhu, 2024; Wen et al., 2024). The software facilitates the analysis of relationships between researchers and research themes, ultimately providing a comprehensive view of how the renewable energy technology field is developing globally. This visualisation helps identify collaboration patterns and uncover new and innovative topics emerging in scientific literature. This article aims to conduct a bibliometric study on developing renewable energy technology using VOSviewer to map global trends (Chadha et al., 2023; W. Cui, Wei, & Ji, 2024; Irhamni, Kurnianingtyas, Muhtadin, Bahagia, & Yusop, 2025; Tamala, Maramag, Simeon, & Ignacio, 2022). This study will focus on identifying significant trends in renewable energy technology research, including the development of critical topics and patterns of collaboration between countries and institutions. By conducting network mapping and topic evolution analysis, this study aims to reveal the future direction and focus of renewable energy technology development (Gani et al., 2025; Kuzior & Sira, 2022; Mostafa Hatami, Sabour, Haj Babaei, & Nematollahi, 2022; Xiao, Wu, Wang, & Mei, 2021).

The results of this study are expected to provide strategic insights for researchers, policymakers, and stakeholders in the development of renewable energy technology. By understanding global trends in this study, international collaboration can be strengthened, and innovation in renewable energy can be more focused on accelerating the transition to clean and sustainable energy. The novelty of this article lies in its approach, which combines bibliometric analysis with network visualisation using VOSviewer to comprehensively identify global trends in renewable energy technology development. This study not only focuses on the trend of keywords or main themes but also provides an in-depth analysis of collaboration patterns among researchers, institutions, and countries that play an essential role in advancing renewable energy technology. In addition, this study introduces a new perspective by highlighting the evolution of research topics over time, which has yet to be widely reviewed in previous studies. This approach is expected to provide a more complete picture of the dynamics of global research and future collaboration opportunities in clean and sustainable energy.

2. Methodology

This study uses a quantitative approach with a bibliometric analysis method to examine the development of renewable energy technology. The data used in this study were taken from major scientific databases, namely Scopus and Web of Science, which provide collections of scientific publications from various journals, proceedings, and books related to renewable energy technology. The publications analysed cover the last 10 years, focusing on research on solar energy, wind, bioenergy, and other renewable energy technologies. Data collection was conducted through specific keyword searches such as "renewable energy technology," "solar energy," "wind energy," and "bioenergy." The data obtained from these searches were extracted in a format suitable for further analysis using VOSviewer software. The selected publications included relevant articles based on title, abstract, and keywords. These steps ensure that only pertinent publications on developing renewable energy technologies were analysed.

VOSviewer visualises and analyses collaborative networks between researchers, institutions, and countries. Co-authorship analysis is performed to identify collaboration patterns in renewable energy technology development, where the size of the nodes in the network map indicates the contribution of a particular entity. At the same time, the connecting lines reflect the strength of collaborative relationships between entities. In addition, keyword co-occurrence analysis is performed to identify key themes and topic evolution in this field. This study also analyses the frequency of keywords used in publications to map global trends. Using temporal analysis techniques, this article observes changes in the focus of research topics over some time, allowing the identification of emerging renewable energy technology trends. This analysis helps us understand how research topics shift and develop over time. The results of this bibliometric analysis are then interpreted to provide insights into global trends in renewable energy technology research. This study's conclusions will help identify opportunities for more effective collaboration and guide researchers and policymakers in directing future renewable energy technology research and development.

The selection of Scopus and Web of Science as the primary data sources in this study was based on several key considerations. Both databases are extensive and reputable scientific repositories, covering high-quality publications that have undergone a rigorous peer-review process. In addition, Scopus and Web of Science have robust bibliometric features, including citation analysis, h-index, and collaboration network visualization, which are highly relevant to this study. By using both databases, we obtained a more comprehensive coverage of the research and avoided potential bias that might arise if only one source was used. Compared with other databases, such as Google Scholar or IEEE Xplore, Scopus and Web of Science offer more structured and reliable metadata for bibliometric analysis using VOSviewer. In addition, to ensure that only relevant articles were used in the study, we applied several filtering steps. Initially, more than [initial number] publications were found based on keywords such as “renewable energy technology”, “solar energy”, “wind energy”, and “bioenergy”. Next, the screening process was carried out by setting inclusion criteria, namely journal articles and conference proceedings published in the last 10 years, and focusing on technology, innovation, and collaboration in renewable energy. Irrelevant articles were excluded from the analysis, such as those that only discuss policy aspects without technological relevance or those from non-reputable sources. After screening, several [final number] publications were analyzed using VOSviewer to identify research trends and collaboration patterns. With this approach, we ensure that the results of this study are based on valid and representative data from global developments in renewable energy technology research.

3. Result & Discussion

Table 1 in this document provides an overview of various parameters related to renewable energy and sustainability research divided into clusters, including the number of links, total link strength, frequency of occurrence, and average year of publication for each parameter. In this table, some key terms such as "renewable energy," "system," "technology," and "impact" have a very high number of links and strengths, indicating the importance of these topics in current research. For example, "renewable energy" appears 148 times with a total link strength of 268, indicating that this topic is a significant focus in renewable energy and sustainability studies. In addition, parameters such as "Development", "Innovation", and "Study" also have significant link counts and link strengths, respectively, indicating that renewable energy-related technology development and innovation is a rapidly growing field. The average year of publication for these parameters is mostly around 2022, indicating that this is a very new and developing research area. For example, "Innovation" has 45 links with a total strength of 136

and an average year of publication of 2022.4872, reflecting the urgency of innovation in this sector.

In contrast, some parameters, such as fossil fuel, non-renewable energy, and Pakistan, have lower link strength and several occurrences. This may indicate that topics related to fossil fuels and non-renewable energy are experiencing a decline in attention among researchers compared to renewable energy. This trend aligns with the global focus on clean energy transition and carbon emission reduction, as seen from the low publication frequency and link strength.

Table 1. Overview of various parameters related to renewable energy and sustainability research

Parameter	cluster	Links	Total link strength	Occurrences	Avg. pub. Year
Analysis	4	41	124	63	2022.1429
Application	3	36	86	40	2022.175
Assessment	5	24	48	30	2021.7667
Biomass	3	20	23	13	2020.6154
Carbon emission	1	19	32	8	2022.625
Case	4	24	35	11	2022.1818
Case study	2	29	53	11	2022.0909
Challenge	2	29	60	13	2022.4615
Chapter	3	29	47	8	2022.25
China	1	28	60	27	2022.2593
Co2 emission	4	21	33	8	2022
Comparison	2	20	27	10	2021.2
Cost	3	33	68	17	2021.9412
Country	1	43	113	29	2021.7931
Development	2	41	98	36	2022.4722
Economic Growth	4	19	32	13	2022.1538
Economy	1	26	63	27	2022.1481
Effect	1	30	42	23	2021.5652
Empirical evidence	1	22	33	11	2022.6364
Energy	5	43	129	58	2021.7586
Energy storage	4	13	33	19	2021.5789
Evidence	1	25	51	25	2022
Financial development	1	18	37	11	2022.0909
Fosil fuel	3	23	43	8	2021.75
Future	2	31	51	10	2022.2
Generation	3	41	99	35	2022
Green finance	1	22	39	10	2023
Hybrid renewable energy system	5	4	5	12	2022
Icdret	2	2	4	10	2023.4
Impact	1	45	110	42	2022.3095
India	5	11	14	9	2021.7778
Information	1	22	37	8	2022.125
Innovation	1	45	136	39	2022.4872
Nexus	1	21	39	11	2022.1818
Non-renewable energy	1	12	24	9	2021.7778

Parameter	cluster	Links	Total link strength	Occurrences	Avg. pub. Year
Consumption	4	9	15	8	2021.125
Optimisation	4	15	26	18	2021.6111
Pakistan	6	9	16	8	2021.375
Paper	2	32	64	11	2021.8182
Performance	3	20	34	25	2021.76
Relationship	1	31	52	9	2021.5556
Renewable energy	1	52	268	148	2022.0203
Renewable energy consumption	1	19	36	18	2021.8333
Renewable energy development	1	19	27	15	2022.6667
Renewable energy policy	5	7	8	8	2023.25
Renewable energy source	3	36	84	37	2021.6216
Renewable energy system	2	31	72	25	2022
Renewable energy technology	2	28	45	26	2021.5385
Renewable energy technology innovation	1	25	39	12	2022.6667
Research	1	31	52	10	2022.5
Review	5	26	67	45	2021.9556
Role	1	43	127	40	2022.25
Solar energy	3	21	36	14	2021.5714
Storage	2	20	29	14	2022.6429
Study	2	44	131	37	2022.2703
Sustainability	5	29	51	15	2022.4667
Sustainable development	1	23	40	14	2022.4286
System	4	42	155	97	2021.6392
Technology	5	51	220	137	2022.0876
Turkey	4	17	27	12	2021.5833
Use	3	30	61	16	2020.625
Wind	3	22	36	9	2022

In **Table 1**, the number of links in the bibliometric analysis indicates how often a keyword or topic is connected to other studies in the scientific network, reflecting the level of relevance and collaboration in a particular field. For example, a keyword with many links, such as "renewable energy," indicates that this topic has broad relevance to various aspects of research, including technology, policy, and economics. In addition, a high number of links tends to correlate with a greater frequency of publications, indicating that this field has received significant attention from the scientific community and has grown rapidly in recent years. Conversely, topics with fewer links may reflect a more specific research area or one still in its early stages of development. By understanding the relationship between the number of links and publication trends, bibliometric analysis can provide further insight into the direction of renewable energy research developments and identify potential research areas that are still underexplored.

Fig. 1 is a bibliometric visualisation created using VOSviewer software, showing a network map of keywords frequently used in research on renewable energy and sustainability. Each node in this diagram represents a keyword, while the node's size indicates the frequency of occurrence of the keyword in the research dataset. Different colours indicate clusters formed

based on the relationship between keywords, where keywords with the same colour appear more often in the same research. Connecting lines, called links, represent the relationship between keywords, and the thickness of the lines indicates how strong the relationship is between the keywords. The keyword renewable energy dominates this visualisation, as seen from the much larger node size than other keywords. This shows that renewable energy is a significant topic in research, with many studies focusing on aspects of renewable energy. This keyword is connected to many other terms, such as technology, innovation, impact, and economic growth, indicating that research in renewable energy is closely related to technological development, innovation, impact, and economic growth.

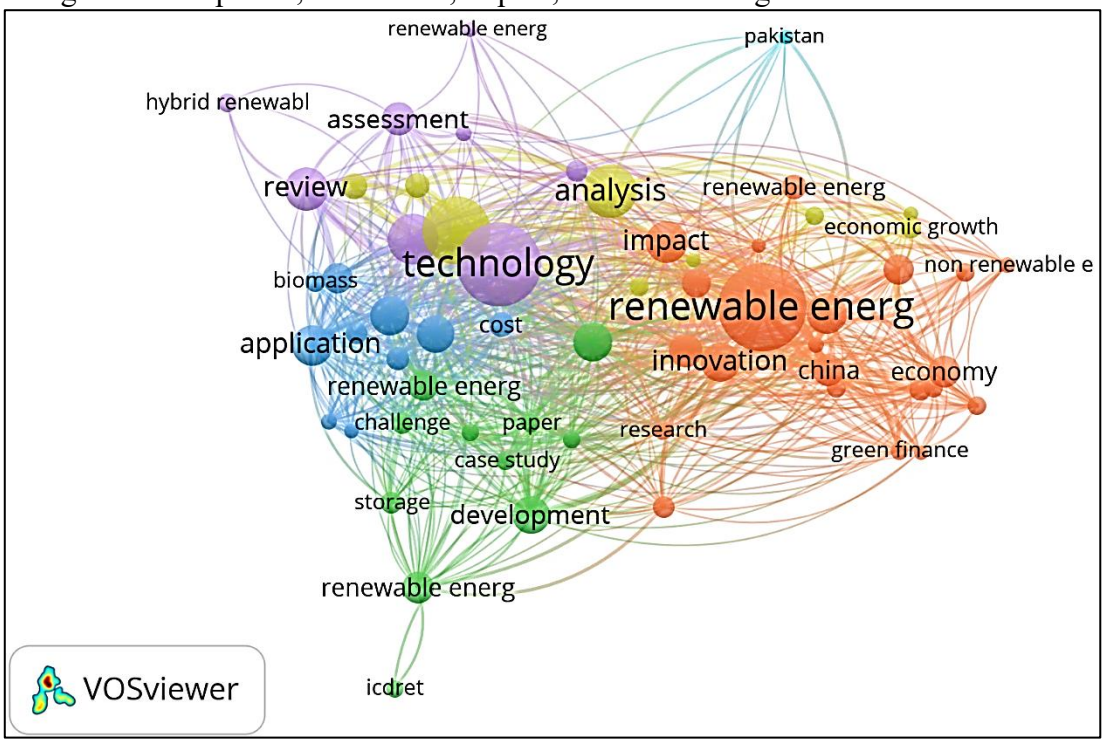

Fig. 1. Bibliometric visualisation view with VOSviewer

The visualizations and graphs generated by VOSviewer provide in-depth insights into the relationships between different research topics in renewable energy technologies. This analysis analyses the relationships between topics based on keyword co-occurrence and collaboration patterns among researchers, institutions, and countries. For example, in the network visualization, topics such as “renewable energy technology”, “innovation”, and “sustainability” form strong clusters, indicating that research in this field is increasingly integrated with innovative approaches and aspects of sustainability policy. Furthermore, the temporal mapping in VOSviewer suggests a shift in research focus from purely technical elements to more multidisciplinary studies, including green economics and policy (green finance). The implications of these findings are the need to strengthen interdisciplinary collaboration in renewable energy research in the future and provide guidance for policymakers and industry to better align their strategies with global trends. A more detailed explanation of the interpretation of these visualizations will be added to clarify how the relationship patterns between topics can be used to identify future research opportunities.

The orange cluster, which includes keywords such as China, economy, economic growth, and green finance, strongly focuses on the economic and geographical aspects of renewable energy research. This reflects the importance of global economic and financial policies in developing and implementing renewable energy. The keyword "China" shows that the country is an

essential subject in renewable energy research, perhaps due to its significant role in global energy production and carbon emissions. On the other hand, green and blue clusters tend to focus on the technical and practical aspects of renewable energy, such as technology, renewable energy systems, application, and development. The relationship between these keywords suggests that technological innovation and practical applications in renewable energy systems are a significant research focus, with ongoing technological development supporting the global implementation of clean energy. Keywords such as storage and challenge highlight the challenges in renewable energy storage and the development of efficient systems to overcome these obstacles.

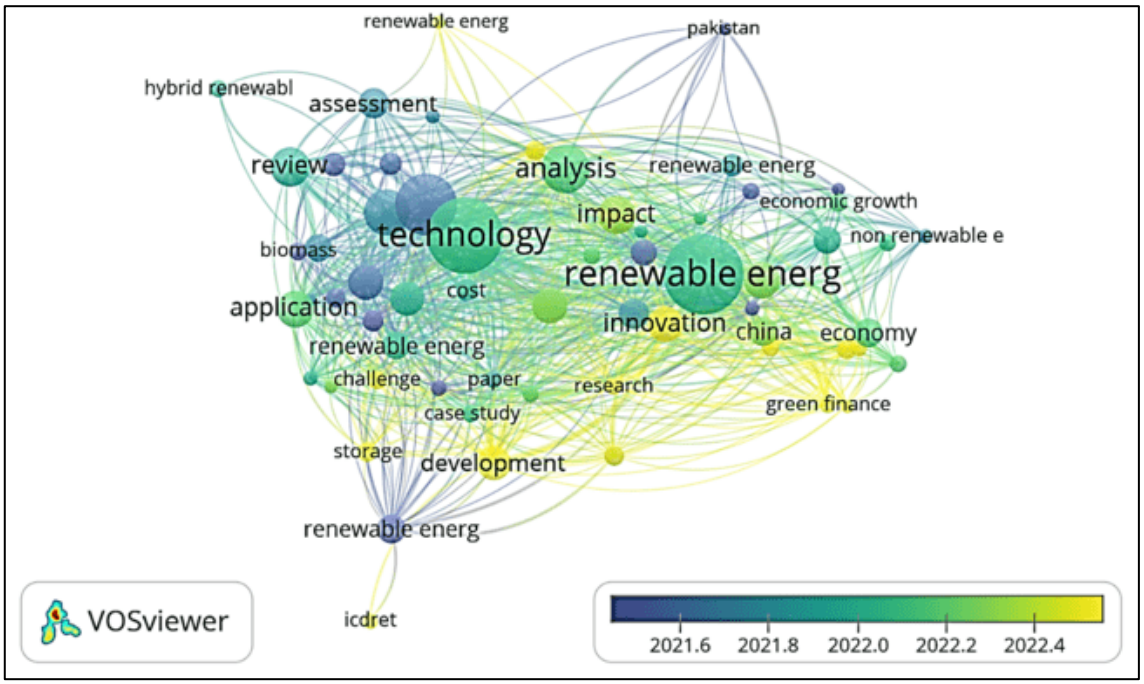

Fig. 2. Color scale showing the time range from 2021 to 2022

Fig. 2 is also a bibliometric visualisation created using VOSviewer, but this time, it adds a temporal dimension that illustrates the evolution of research topics based on publication time. The colour scale at the bottom of the figure shows the period from 2021 to 2022, where blue represents earlier publications and yellow represents more recent publications. This allows us to see how research focus changes over time. This visualisation shows that keywords such as technology, renewable energy, and application are coloured blue-green, indicating that research began earlier (around 2021) and has continued into more recent times. The continued focus on renewable energy technologies and applications shows the importance of technical innovation in clean energy development. Furthermore, these keywords are closely linked to other topics, such as cost and storage, indicating that the practical and economic aspects of renewable energy technologies are a significant focus of this research.

In contrast, keywords such as innovation, impact, and green finance tend to be more yellow, indicating that these topics have received renewed attention in 2022. This reflects the growing attention to innovation in financial policy and its impact on renewable energy adoption. The keyword green finance is closely linked to the economy and economic growth, indicating a strong focus on how sustainable finance can drive economic growth through investments in clean energy. Additionally, a few other keywords stand out but fall outside the central cluster, such as assessment and biomass, which are in the top left. These topics are coloured bluer, indicating that research was primarily conducted before 2022. The keyword biomass, for

example, may have been related to early research on more specific renewable energy sources before evolving towards broader energy technologies and innovations, as seen with the keyword's technology and innovation. As such, this visualisation provides a deeper insight into how renewable energy research has evolved, with the focus shifting from practical topics in the early years to policy innovation and economic impact in more recent years.

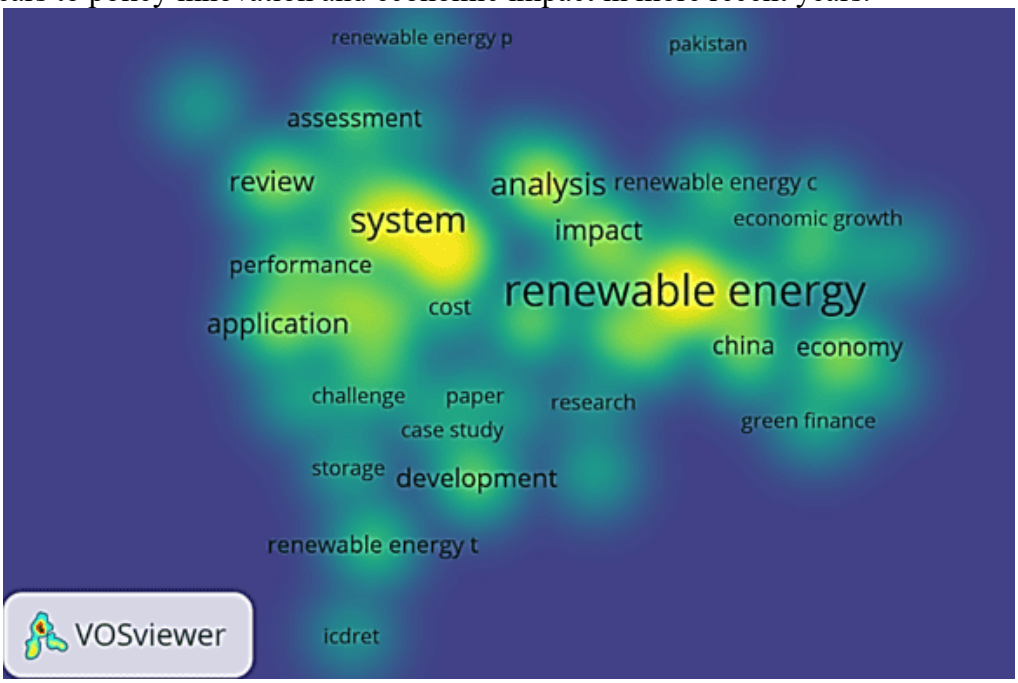

Fig. 3. Density map of keywords that frequently appear in research related to renewable energy

This study reinforces several findings in previous studies while providing new perspectives on renewable energy research trends. For example, prior research by [related citations] has identified a significant increase in renewable energy-related publications in recent years, also reflected in our analysis results. However, this study further shows that research trends have shifted from a purely technical focus towards a more multidisciplinary approach, including policy, economic, and sustainability aspects, which have not been widely explored in previous studies. In addition, the VOSviewer visualization results in this study show that international collaboration in renewable energy research is increasing, with a broader pattern of partnerships between developed and developing countries, which has not been widely analyzed in previous studies. Thus, this study not only confirms previously reported trends but also provides new perspectives on the direction of future research developments, especially in the context of interdisciplinarity and global cooperation in renewable energy.

Fig. 3 shows a density map of keywords frequently appearing in renewable energy research, visualised using VOSviewer. The colours used in this map depict the keyword density level in a particular area, with yellow indicating very high density and green to blue indicating decreasing density. Density in this context reflects the frequency of keyword usage in processed literature. The keyword renewable energy appears as the focus in this map, marked by a large and intense yellow area. This shows that research on renewable energy dominates in the analysed literature. This keyword is also closely connected to other terms such as system, analysis, impact, and economy, which also show a relatively high-density level. The relationship between these keywords reflects a comprehensive research focus, where renewable energy systems, their economic impacts, and in-depth implementation analysis are the focus.

The keyword system also appears very prominent, with a significant yellow area, indicating that research on renewable energy systems is dominant. This could reflect attention to how to

design, implement, and manage effective renewable energy systems. The connection of the word system with other keywords such as application, cost, and development also indicates attention to the practical aspects and costs of implementing renewable energy technologies. In contrast, keywords such as challenge, case study, and storage are in the green to blue areas, indicating a lower density. This may suggest that although these topics are essential, they have yet to become the focus of the research analysed or are still in the early stages of development. The keyword green finance is also in the green area, indicating that research on sustainable financing to support renewable energy is still in its infancy. However, it relates to critical economic and economic growth topics.

The results of the analysis above show that the latest research on renewable energy focuses heavily on the topic of renewable energy and systems, as well as their relationship with economic and technological aspects. Several previous studies have also found similar things. For example, a study by (Alofaysan, Radulescu, Balsalobre-Lorente, & Si Mohammed, 2024; Luo, Döme, Cycak, & Matus, 2024; Uzar, 2024) stated that transitioning to renewable energy requires developing a solid and sustainable energy system involving technological innovation and effective management. This aligns with the results of the VOSviewer visualisation, which places system and technology as keywords with high density. In addition, IRENA (Gielen et al., 2021) research also highlights the importance of innovation in developing renewable energy technology to achieve the global decarbonisation target, which can be seen in the visualisation results highlighting the keywords innovation and technology.

On the other hand, more recent research has shown increasing attention to the economic impact of green finance in the context of renewable energy. According to a study by (Erdiwansyah et al., 2021; Eren, Taspinar, & Gokmenoglu, 2019; Vo, Tran, & Tran, 2022), investments in renewable energy are increasing global economic growth, further strengthening the connection between economic development and green finance, as shown in the visualisation above. This finding is also consistent with the study by (Alam et al., 2024; Erdiwansyah, Gani, MH, Mamat, & Sarjono, 2022; Xiong & Dai, 2023), which found that sustainable finance significantly accelerates the energy transition in various countries, especially developing countries. These results confirm that renewable energy is not only a technical issue but also involves broader economic and financial policy aspects.

To clarify the comparison with previous studies, we highlight key findings that differentiate this study from the existing literature. For example, earlier studies by [related citations] have focused more on analyzing specific technology trends, such as solar or wind energy, without an in-depth exploration of global collaboration patterns and the evolution of research topics. Meanwhile, other studies such as [other citations] have conducted bibliometrics on renewable energy but have focused more on policy aspects or economic impacts without looking in detail at scientific collaboration networks. Our study offers a more comprehensive approach by utilizing VOSviewer-based bibliometric analysis to identify key research trends and how collaborations between researchers and institutions have evolved in the last decade. Thus, the results of this study provide broader insights into how renewable energy research has become global and led to a multidisciplinary approach that is increasingly important for sustainable energy innovation and policy. This comparison highlights the unique contribution of our study in providing a more comprehensive mapping of research dynamics in this field.

4. Conclusion

The findings of this study provide significant insights into the evolving landscape of renewable energy research. The bibliometric analysis using VOSviewer has identified key trends, including the increasing focus on innovation, sustainability policies, and economic aspects such as green finance. This shift from purely technical research to interdisciplinary approaches

reflects the growing importance of integrating technological advancements with policy and financial mechanisms to accelerate the adoption of clean energy solutions. Furthermore, the study highlights the strengthening of international research collaborations, underscoring the need for enhanced global partnerships to drive innovation and implementation of renewable energy technologies. The implications of these findings suggest that future research should prioritize cross-disciplinary efforts, foster industry-academic partnerships, and explore new policy frameworks to support sustainable energy transitions. By providing a comprehensive overview of global research trends, this study offers valuable guidance for researchers, policymakers, and stakeholders aiming to contribute to the continued advancement of renewable energy technologies.

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References

Al-Shetwi, A. Q. (2022). Sustainable development of renewable energy integrated power sector: Trends, environmental impacts, and recent challenges. *Science of The Total Environment*, 822, 153645.

Alam, M. S., Dinçer, H., Kisswani, K. M., Khan, M. A. I., Yüksel, S., & Alsharif, M. (2024). Analysis of green energy-oriented sustainable development goals for emerging economies. *Journal of Open Innovation: Technology, Market, and Complexity*, 10(3), 100368. Retrieved from https://doi.org/https://doi.org/10.1016/j.joitmc.2024.100368

Alofaysan, H., Radulescu, M., Balsalobre-Lorente, D., & Si Mohammed, K. (2024). The effect of eco-friendly and financial technologies on renewable energy growth in emerging economies. *Heliyon*, 10(17), e36641. Retrieved from https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e36641

Arias-Cárdenas, B., Lacasta, A. M., & Haurie, L. (2024). Bibliometric analysis of research on thermal, acoustic, and/or fire behaviour characteristics in bio-based building materials. *Construction and Building Materials*, 432, 136569. Retrieved from https://doi.org/https://doi.org/10.1016/j.conbuildmat.2024.136569

Azizoğlu, F., & Terzi, B. (2024). Research topics on pressure injury prevention and measurement tools from 1997 to 2023: A bibliometric analysis using VOSviewer. *Intensive and Critical Care Nursing*, 80, 103557. Retrieved from https://doi.org/https://doi.org/10.1016/j.iccn.2023.103557

Bresciani, S., Ciampi, F., Meli, F., & Ferraris, A. (2021). Using big data for co-innovation processes: Mapping the field of data-driven innovation, proposing theoretical developments and providing a research agenda. *International Journal of Information Management*, 60, 102347.

Chadha, P., Yadav, P., Sharma, M., Sharma, Y., Nangia, R., Sharma, K., & Maksudovna, V. K. (2023). Global trends in waste materials: A bibliometric analysis. *Materials Today: Proceedings*. Retrieved from https://doi.org/https://doi.org/10.1016/j.matpr.2023.10.059

Cui, M., Feng, T., & Wang, H. (2023). How can blockchain be integrated into renewable energy? --A bibliometric-based analysis. *Energy Strategy Reviews*, 50, 101207. Retrieved from https://doi.org/https://doi.org/10.1016/j.esr.2023.101207

Cui, W., Wei, Y., & Ji, N. (2024). Global trends of waste-to-energy (WtE) technologies in carbon neutral perspective: Bibliometric analysis. *Ecotoxicology and Environmental Safety*, 270, 115913. Retrieved from https://doi.org/https://doi.org/10.1016/j.ecoenv.2023.115913

Erdiwansyah, Gani, A., MH, N., Mamat, R., & Sarjono, R. E. (2022). Policies and laws in the application of renewable energy Indonesia: A reviews. *AIMS Energy*, 10(1), 23–44. Retrieved from https://doi.org/10.3934/energy.2022002

Erdiwansyah, Mahidin, Husin, H., Nasaruddin, Zaki, M., & Muhibbuddin. (2021). A critical review of the integration of renewable energy sources with various technologies. *Protection and Control of Modern Power Systems*, 6(1), 3. Retrieved from https://doi.org/10.1186/s41601-021-00181-3

Erdiwansyah, Mamat, R., Sani, M. S. M., & Sudhakar, K. (2019). Renewable energy in Southeast Asia: Policies and recommendations. *Science of The Total Environment*. Retrieved from https://doi.org/https://doi.org/10.1016/j.scitotenv.2019.03.273

Eren, B. M., Taspinar, N., & Gokmenoglu, K. K. (2019). The impact of financial development and economic growth on renewable energy consumption: Empirical analysis of India. *Science of the Total Environment*, 663, 189–197.

Gani, A., Saisa, S., Muhtadin, M., Bahagia, B., Erdiwansyah, E., & Lisafitri, Y. (2025). Optimisation of home grid-connected photovoltaic systems: performance analysis and energy implications. *International Journal of Engineering and Technology (IJET)*, 1(1), 63–74.

Gielen, D., Gorini, R., Leme, R., Prakash, G., Wagner, N., Janeiro, L., … Ferroukhi, R. (2021). World energy transitions outlook: 1.5° C pathway.

Irhamni, I., Kurnianingtyas, E., Muhtadin, M., Bahagia, B., & Yusop, A. F. (2025). Bibliometric Analysis of Renewable Energy Research Trends Using VOSviewer: Network Mapping and Topic Evolution. *International Journal of Engineering and Technology (IJET)*, 1(1), 75–82.

Jaiswal, K. K., Chowdhury, C. R., Yadav, D., Verma, R., Dutta, S., Jaiswal, K. S., … Karuppasamy, K. S. K. (2022). Renewable and sustainable clean energy development and impact on social, economic, and environmental health. *Energy Nexus*, 7, 100118. Retrieved from https://doi.org/https://doi.org/10.1016/j.nexus.2022.100118

Jorzik, P., Klein, S. P., Kanbach, D. K., & Kraus, S. (2024). AI-driven business model innovation: A systematic review and research agenda. *Journal of Business Research*, 182, 114764. Retrieved from https://doi.org/https://doi.org/10.1016/j.jbusres.2024.114764

Kuzior, A., & Sira, M. (2022). A bibliometric analysis of blockchain technology research using VOSviewer. *Sustainability*, 14(13), 8206.

Li, D., Ikram, M., & Xiaoxia, J. (2025). A brief overview of the physical layer test system: Development of an IoTbased energy storage and electrical energy distribution system. *International Journal of Engineering and Technology (IJET)*, 1(1), 131–140.

Luo, G. W., Döme, V., Cycak, W., & Matus, K. J. M. (2024). Innovation policy for sustainability transitions in small economies: Energy technology innovation in Hong Kong. *Environmental Innovation and Societal Transitions*, 51, 100841. Retrieved from https://doi.org/https://doi.org/10.1016/j.eist.2024.100841

Maghfirah, G., Yusop, A. F., & Zulkifli, Z. (2025). Using VOSviewer for Renewable Energy Literature Analysis: Mapping Technology and Policy-Related Research. *International Journal of Engineering and Technology (IJET)*, 1(1), 83–89.

Mostafa Hatami, A., Sabour, M. R., Haj Babaei, M. R., & Nematollahi, H. (2022). Global trends of VOSviewer research, emphasizing Environment and Energy areas: A bibliometric analysis during 2000-2020. *Environmental Energy and Economic Research*, 6(1), 1–11.

Sang, M., He, H., Shen, L., & Xu, X. (2024). Research evolution on low-carbon city measure study: A bibliometric analysis. *Environmental Impact Assessment Review*, 106, 107526. Retrieved from https://doi.org/https://doi.org/10.1016/j.eiar.2024.107526

Shen, Y.-C., Wang, M.-Y., & Yang, Y.-C. (2020). Discovering the potential opportunities of scientific advancement and technological innovation: A case study of smart health monitoring technology. *Technological Forecasting and Social Change*, 160, 120225.

Sun, Z., Zhang, R., & Zhu, X. (2024). The progress and trend of digital twin research over the last 20 years: A bibliometrics-based visualization analysis. *Journal of Manufacturing Systems*, 74, 1–15. Retrieved from https://doi.org/https://doi.org/10.1016/j.jmsy.2024.02.016

Tamala, J. K., Maramag, E. I., Simeon, K. A., & Ignacio, J. J. (2022). A bibliometric analysis of sustainable oil and gas production research using VOSviewer. *Cleaner Engineering and Technology*, 7, 100437. Retrieved from https://doi.org/https://doi.org/10.1016/j.clet.2022.100437

Uzar, U. (2024). The critical role of green innovation technologies and democracy in the transition to sustainability: A study on leading emerging market economies. *Technology in Society*, 78, 102622. Retrieved from https://doi.org/https://doi.org/10.1016/j.techsoc.2024.102622

Vo, D. H., Tran, Q., & Tran, T. (2022). Economic growth, renewable energy and financial development in the CPTPP countries. *Plos One*, 17(6), e0268631.

Wen, Y., Zhang, T., Zhang, B., Wang, F., Wei, X., Wei, Y., … Tang, X. (2024). Comprehensive bibliometric and visualized analysis of research on gut-liver axis published from 1998 to 2022. *Heliyon*, 10(6), e27819. Retrieved from https://doi.org/https://doi.org/10.1016/j.heliyon.2024.e27819

Xiao, Y., Wu, H., Wang, G., & Mei, H. (2021). Mapping the worldwide trends on energy poverty

research: A bibliometric analysis (1999–2019). *International Journal of Environmental Research and Public Health*, 18(4), 1764.

Xiong, Y., & Dai, L. (2023). Does green finance investment impact on sustainable development: Role of technological innovation and renewable energy. *Renewable Energy*, 214, 342–349. Retrieved from https://doi.org/https://doi.org/10.1016/j.renene.2023.06.002