

“A bibliometric analysis of green finance research related to Indonesia: A decade study”

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A BIBLIOMETRIC ANALYSIS OF GREEN FINANCE RESEARCH RELATED TO INDONESIA: A DECADE STUDY

Abstract

The growing attention to sustainability is driving the development of green finance studies. However, the distribution of such research remains geographically uneven, particularly in developing countries. As one of the major contributors to global emissions, Indonesia plays a critical role within the broader discourse of green finance, both as a national context and as part of cross-country analyses. Therefore, a comprehensive understanding of green finance research related to Indonesia is essential, especially given the Indonesian government's commitment to reducing greenhouse gas emissions. This study aims to conduct a bibliometric analysis to map the development of green finance literature related to Indonesia over the period 2015–2025. Using 194 Scopus-indexed publications, the results reveal a substantial increase in research output over the last four years. Indonesia recorded the highest publication output, with authors affiliated to institutions in China and Malaysia occupying important positions within the international co-authorship network. Keyword co-occurrence analysis identified four major thematic clusters: (1) Green financial systems, (2) Economic growth and environmental sustainability, (3) Green finance in energy transition, and (4) Climate finance and environmental governance. This study provides a more accurate representation of the scientific landscape of green finance literature involving Indonesia. It highlights key research trends, identifies emerging themes, and offers insights into future research directions and policy implications, particularly in contexts where Indonesia is positioned within both national and cross-country discussions of green finance.

Keywords

bibliometric analysis, green finance, sustainable finance, Indonesia, VOSviewer

JEL Classification

Q01, Q54, Q56

INTRODUCTION

Green finance has become an increasingly important area of research as the financial sector is increasingly linked to environmental sustainability and broader economic development. The expansion of this field has generated research across different disciplines and contexts, covering financial systems, economic activities, energy transition, and environmental concerns. However, the growing body of literature does not necessarily provide a clear picture of how research on green finance is developing as a field, particularly when studies are dispersed across different countries and research contexts. This issue is relevant to Indonesia, which appears in the green finance literature both as a specific national context and as part of broader cross-country research. Consequently, research involving Indonesia may address different aspects of green finance and be connected to different research communities, making its overall development difficult to assess from individual studies. The scientific problem, therefore, concerns the lack of a consolidated understanding of how green finance research involving Indonesia has developed, who has contributed to its development, and how its research themes have

evolved and become connected over time. A clearer understanding of these patterns is important for identifying the structure and direction of research involving Indonesia within the broader development of green finance literature.

1. LITERATURE REVIEW

Discussions on the relationship between financial development and sustainable economic development have increased in international literature, in line with growing global concerns over environmental degradation, financial stability, and Sustainable Development Goals (SDGs) (Afzal et al., 2022). This increased global commitment to environmental sustainability has encouraged the financial sector to play a strategic role in supporting the sustainable development agenda (Khan et al., 2022). In this context, sustainable finance directs capital flows toward sectors that support green economy objectives. This is done by integrating environmental risks into financial risk management (Lanqi & Yanli, 2021), accommodating the costs associated with environmentally sustainable changes in production and consumption patterns (Bylo, 2025; OECD, 2025), and allocating investment to environmentally friendly projects and initiatives in the sustainable development agenda (Ahmad, Boumaiza, Yazici, et al., 2025). Furthermore, the green economy supports the acceleration of green innovation by alleviating financing constraints (Alam & Ullah, 2025), as the transition toward a green economy requires substantial investment, particularly for innovation and the development of sustainable infrastructure (OECD, 2025).

In addition, increasing attention to sustainability issues has led to the growing prominence of green finance in recent academic literature (Wang et al., 2025). According to Wang et al. (2025), publications on green finance have expanded, with primary attention given to ESG issues, green banking, renewable energy, green bonds, and their relationship with carbon emissions and environmental sustainability. Widespread environmental degradation has intensified the urgency to implement green finance as an instrument to mitigate negative environmental externalities (Khan et al., 2022). When appropriately designed and implemented, green finance can reduce the environmental impacts of economic activities (Brandi et al., 2020). This is because green

finance represents an innovative financial mechanism aimed at environmental protection and the efficient and sustainable use of natural resources (Wang & Zhi, 2016). Furthermore, Miyan et al. (2024) confirm that green finance plays an important role in promoting long-term economic and environmental resilience.

The development of green finance reflects a shift from a primarily conceptual approach toward policy instruments and market mechanisms that actively support the transition to a low-carbon economy (Ahmad et al., 2025). In line with this shift, research on green finance has increased since 2017 (Al-Zoubi, 2024; Joaqui-Barandica et al., 2025), with China emerging as the dominant contributor to the literature (Alqudah et al., 2024; Al-Zoubi, 2024; Joaqui-Barandica et al., 2025; Kumar et al., 2024; Minh Sang, 2024; Muhmad et al., 2024; Uwuigbe et al., 2024). In contrast, Africa and several parts of Asia remain underexplored in studies on sustainable finance practices (Judijanto et al., 2024). Within this broader landscape, Indonesia is increasingly positioned as an important context in green finance research, particularly in relation to energy transition and greenhouse gas emission reduction (Hermala et al., 2025).

Several studies indicate that the implementation of green finance in Indonesia has experienced notable growth, particularly through instruments such as green bonds, green sukuk, and sustainable bonds used to support environmental projects and the energy transition (Hutabarat et al., 2025). This trend is reflected in the substantial increase in green sukuk issuance in Indonesia, which reached USD 2.35 billion by 2024, more than double the amount of previous issuances (Kementrian Keuangan, 2024). According to Zin Lin et al. (2026), the successful implementation of green sukuk in Indonesia is closely linked to the strategic role of the government and financial institutions through policy frameworks such as the Sustainable Finance Roadmap, which positioned Indonesia as a model for green financing development that can be replicated across the ASEAN region.

In the Indonesian context, several studies highlight the contribution of sharia-based instruments, such as green sukuk, Islamic social finance, and green banking, in supporting the green finance agenda and the energy transition. Faizi et al. (2024) examine these contributions using a qualitative approach, while Hermala et al. (2025) employ a bibliometric analysis to explore the relationship between green finance and Islamic finance in the context of the energy transition. Other studies emphasize policy and institutional dimensions, identifying structural challenges such as weak policy coordination and limited incentives for financial actors to promote green finance practices (Wati & Fasa, 2024).

Although the number of publications on green finance has increased significantly over the past decade, its geographic distribution remains uneven. Existing studies are largely dominated by contributions from developed countries such as China, the United States, and the United Kingdom (Al-Zoubi, 2024), while research focusing on developing countries and less-explored regions remains relatively limited (Alqudah et al., 2024; Judijanto et al., 2024). In this context, a comprehensive understanding of green finance literature related to Indonesia is essential, particularly as Indonesia appears both as a primary context and as part of broader cross-country analyses. This issue is particularly relevant given the Indonesian government's demonstrated political commitment to reducing greenhouse gas emissions through the establishment of national emission reduction targets (Azhgaliyeva et al., 2020).

Using a bibliometric approach, this study aims to map the development of green finance literature related to Indonesia from 2015 to 2025, providing a systematic overview of the research landscape. Following the bibliometric research framework proposed by Öztürk et al. (2024), research questions should be formulated in line with the research aim and the scope of the bibliometric analysis. Accordingly, this study addresses the following research questions:

- RQ1: *How has green finance research related to Indonesia evolved between 2015 and 2025?*
- RQ2: *What are the key contributors shaping green finance research related to Indonesia?*

RQ3: *What are the most dominant themes discussed in green finance literature involving Indonesia?*

RQ4: *What are the policy implications of the main themes of green finance involving Indonesia?*

RQ5: *What are the directions for future research in green finance literature related to Indonesia?*

2. METHOD

This study adopts bibliometric analysis techniques to explore research trends and map academic literature from large-scale data collections. The stages of this study follow the bibliometric standards developed by Donthu et al. (2021) and Öztürk et al. (2024), as shown in Figure 1. This study conducted a literature search on the Scopus database using the TITLE-ABS-KEY (("green financ*" OR "green investment" OR "sustainable financ*" OR "climate financ*") AND "Indonesia"). The search results showed 293 related documents. The search strategy was designed to capture green finance literature related to Indonesia, encompassing not only studies that focus exclusively on Indonesia but also those that include Indonesia within cross-country comparisons, regional analyses, or global datasets. This approach enables a broader mapping of the research landscape in which Indonesia appears as a relevant empirical or contextual component. Focusing on observing trends in the last decade, the study filtered literature from 2015 to 2025. Then, to limit the eligible and reliable literature for this research topic, the literature screening focused on peer-reviewed articles that had been finalized and undergone a rigorous curation process in accordance with the scientific standards of Scopus-indexed journals. In the end, 194 articles met the criteria for further analysis.

There are two main techniques in bibliometric analysis, namely performance analysis and science mapping. Performance analysis focuses on assessing scientific output in terms of quality and quantity indicators for items (authors, journals, countries, institutions/universities), including citation analysis of the literature collection in the downloaded dataset (Donthu et al., 2021; Öztürk et al., 2024). Meanwhile, science mapping combines the

processes of “analyzing” the similarity matrix of relationships among items (authors, words, papers, journals, etc.) and “visualizing” the network of relationships/collaborations among relevant items (Donthu et al., 2021; Öztürk et al., 2024). To display the results of the bibliometric analysis, this study used VOSviewer software.

This study performed co-occurrence and co-authorship analyses. Co-authorship analysis, with countries as the unit of analysis, was applied to identify cross-national research collaborations by analyzing the geographical affiliations of authors in green finance literature related to Indonesia. Among the 49 countries affiliated with the au-

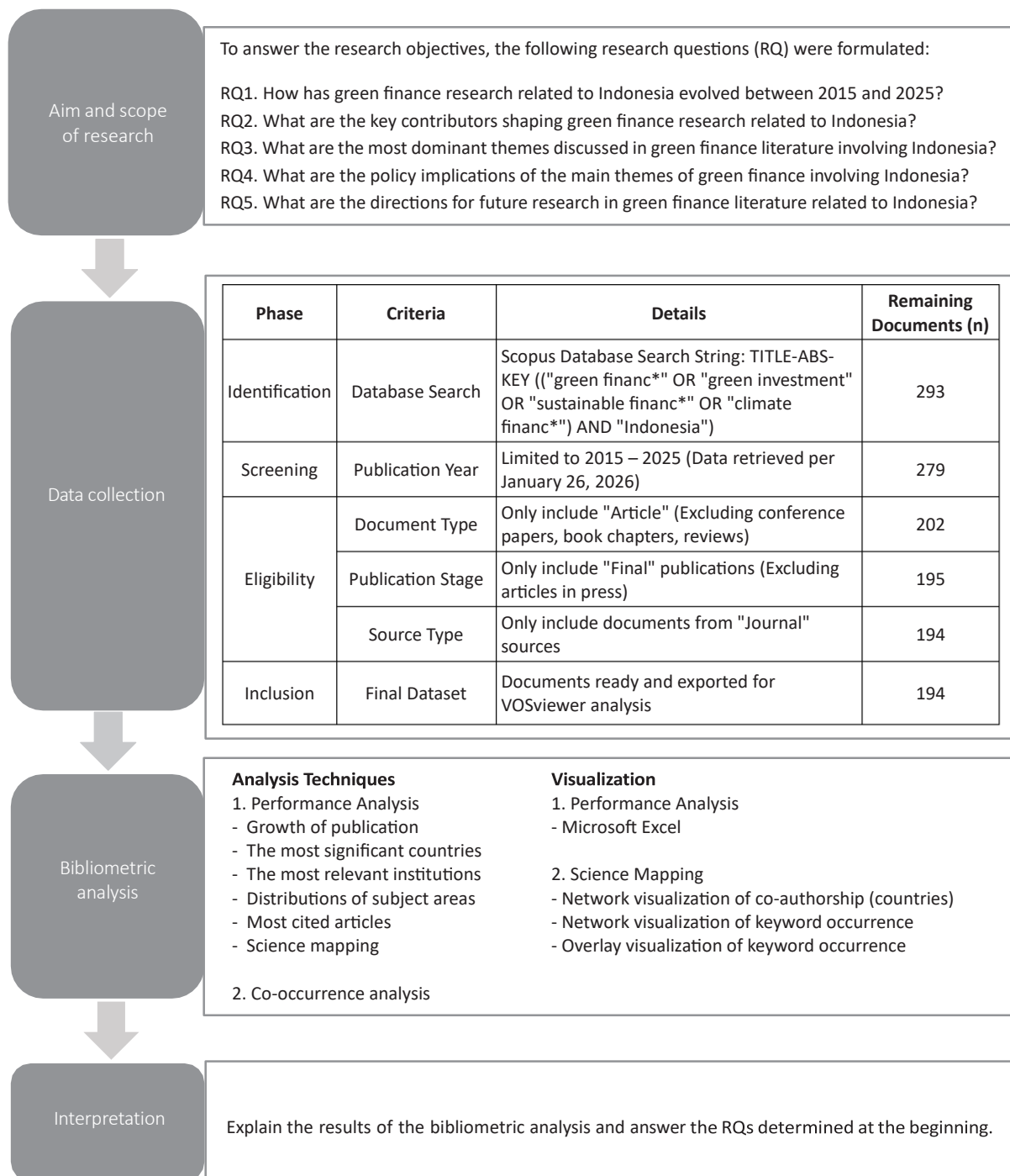


Figure 1. Stages of the bibliometric analysis

thors, 10 countries met the minimum threshold of 5 documents and 5 citations. In addition, co-occurrence analysis was also employed, with the unit of analysis being all keywords, evaluated using the full-counting method.

Before the visual mapping stage, a data cleaning process was conducted, and keywords were normalized using the thesaurus feature in VOSviewer to merge synonymous terms and standardize singular and plural forms to prevent clustering bias. For instance, the term “economy growths” was standardized to “economy growth,” “renewable energies” to “renewable energy,” “green financing” to “green finance,” and plural forms such as “investments” were adjusted to “investment,” and “sustainable development goal” to “sustainable development goals”. To obtain representative and significant clusters, the threshold for keyword occurrence was set to a minimum of 6 times. Of the total 1,114 keywords successfully extracted from the document, 48 keywords met this threshold and were retained for network analysis.

3. RESULTS AND DISCUSSION

The analysis of the Scopus dataset shows an upward trend in articles on green finance related to Indonesia, particularly in the last four years (Figure 2). It indicates that researchers’ interest and focus on green finance involving Indonesia are developing in line with the need for innovation and empirical findings related to green finance to address contemporary challenges. These results can be explored further in relation to the scope of themes that are developing and dominating in the science mapping section.

This study examines green finance literature related to Indonesia rather than being limited to studies conducted strictly within Indonesia. The Scopus dataset shows that countries beyond Indonesia have also contributed significantly to this field (Appendix A, Figure A1). Indonesia dominates the number of publications, while China and Malaysia emerge as active contributors to studies involving Indonesia in the context of green finance research. In addition, several countries from different regions, including the United States, the United Kingdom, Pakistan, Australia, the Netherlands, Saudi Arabia, and Nigeria, have also contributed, although to a lesser extent.

Consistent with these results, the co-authorship analysis based on countries in Table 1 also identifies that, besides Indonesia, China and Malaysia are the most significant collaborative contributors to this research field. The analysis of the co-authorship network reveals 10 countries of origin for authors’ institutional affiliations that meet the threshold criteria of having at least 5 publications and receiving at least 5 citations. Although authors affiliated with China have a very high number of citations, authors affiliated with Malaysia have a higher TLS value. This indicates that institutions in Malaysia have a higher intensity of cooperation or a greater number of collaborative relationships that are more widespread within this network, as shown in Figure 3.

Contributions from other regions are also significant, given the high number of citations. Authors affiliated with institutions in Pakistan (9 documents, 478 citations) and Australia (9 documents, 430 citations) demonstrate a high citation-per-

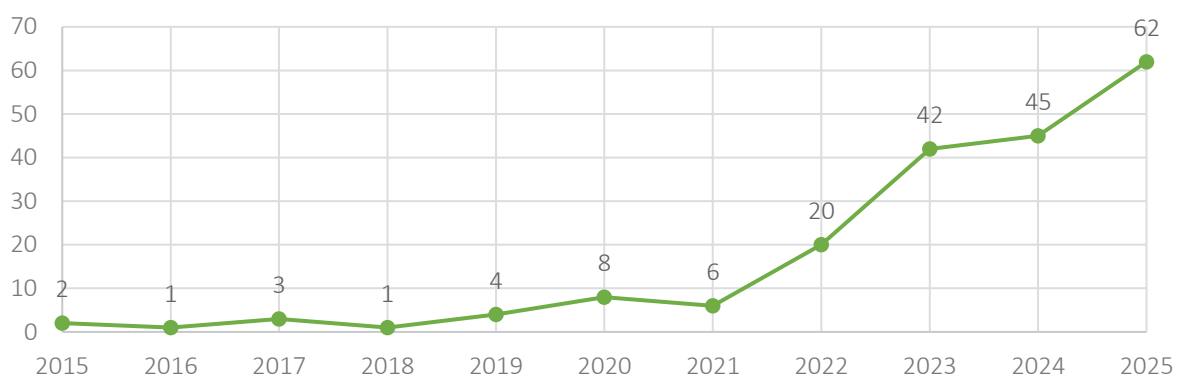


Figure 2. Growth of publications on green finance related to Indonesia (2015–2025)

document ratio, indicating that collaborative research with these countries serves as an important reference in this field. The presence of other countries such as the United Kingdom, the United States, Saudi Arabia, Nigeria, and the Netherlands further illustrates that research on green finance related to Indonesia has attracted international scholarly attention and highlights its relevance within a broader global perspective.

Table 1. Country affiliation analysis based on co-authorship and citation impact

No.	Country	Total link strength (TLS)	Documents	Citations
1	Indonesia	28	130	1145
2	China	21	26	1028
3	Pakistan	14	9	478
4	Australia	7	9	430
5	United Kingdom	12	11	301
6	Malaysia	24	24	224
7	Netherlands	5	8	144
8	United States	11	9	116
9	Saudi Arabia	10	6	81
10	Nigeria	6	6	64

Furthermore, the analysis of institutional contributions reveals that Indonesian universities dominate the research output on green finance related to Indonesia (Figure A2), with institutions such as Universitas Airlangga, Universitas Indonesia, and Hasanuddin University appearing among the most productive. However, several foreign institutions also contribute to this area of research, includ-

ing Universiti Teknologi MARA, The Australian National University, and Universiti Malaya. This pattern suggests that, although domestic institutions primarily drive the research, the topic has attracted international academic interest and reflects a growing cross-border engagement in addressing green finance issues involving Indonesia.

Beyond geographical and institutional patterns, it is also important to consider the thematic focus of the research. Green finance research related to Indonesia reflects a highly multidisciplinary field (Figure A3). The literature is largely concentrated in social sciences (23%) and economics, econometrics, and finance (20%), followed by environmental science (16%), energy (14%), and business, management and accounting (13%). This distribution shows that green finance is examined not only from economic and managerial perspectives but also in relation to environmental sustainability. In addition, the presence of fields such as agricultural and biological sciences (3%) and computer science (3%) indicates that the research is gradually expanding into sector-specific contexts and technological applications. Overall, this pattern highlights the importance of cross-disciplinary collaboration in addressing sustainability challenges in contexts involving Indonesia.

Table 2 lists the 10 most cited articles in green finance research related to Indonesia. This list is dominated by recent research conducted within

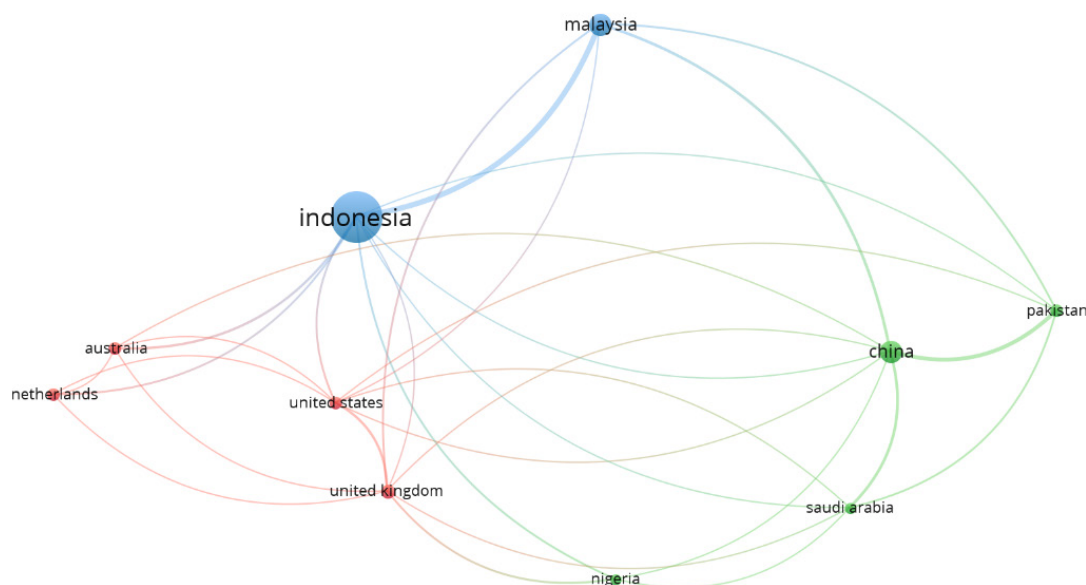


Figure 3. Network visualization of co-authorship by countries

Table 2. Most cited articles

No.	Author (Year)	Title	Source	Total Citation	Citation per year
1	Wang et al. (2022)	Green financing role on renewable energy dependence and energy transition in E7 economies	Renewable Energy	274	68.50
2	Sun et al. (2023)	Green innovation for resource efficiency and sustainability: Empirical analysis and policy	Resources Policy	183	61.00
3	Azhgaliyeva et al. (2020)	Green bonds for financing renewable energy and energy efficiency in South-East Asia: A review of policies	Journal of Sustainable Finance and Investment	179	29.83
4	Indriastuti and Chariri (2021)	The role of green investment and corporate social responsibility investment on sustainable performance	Cogent Business and Management	109	21.80
5	Setyowati (2021)	Mitigating inequality with emissions? Exploring energy justice and financing transitions to low-carbon energy in Indonesia	Energy Research and Social Science	106	21.20
6	Ronaldo and Suryanto (2022)	Green finance and sustainability development goals in Indonesian Fund Village	Resources Policy	93	23.25
7	Li et al. (2022)	The role of green finance and energy innovation in neutralizing environmental pollution: Empirical evidence from the MINT economies	Journal of Environmental Management	93	23.25
8	Dharmayanti et al. (2023)	Exploring sustainability management control system and eco-innovation matter sustainable financial performance: The role of supply chain management and digital adaptability in Indonesian context	Journal of Open Innovation: Technology, Market, and Complexity	92	30.67
9	Setyowati (2020)	Mitigating energy poverty: Mobilizing climate finance to manage the energy trilemma in Indonesia	Sustainability (Switzerland)	82	13.67
10	Guild (2020)	The political and institutional constraints on green finance in Indonesia	Journal of Sustainable Finance and Investment	80	13.33

the last five years, indicating that green finance involving Indonesia has become increasingly relevant and represents a field experiencing rapid acceleration in research development, in line with the publication growth trend shown in Figure 2. The dominance of recent articles in the list of most-cited articles indicates that researchers are highly responsive to current issues. Overall, these articles discuss green financing instruments in contexts involving Indonesia, including innovation, energy efficiency, energy transition, renewable energy, and carbon emission reduction, ultimately contributing to environmental sustainability.

Beyond the most-cited articles, the thematic structure of green finance research related to Indonesia was examined using keyword co-occurrence analysis. Figure 4 presents the network visualization of keyword occurrences, showing the relationships among the main themes and keywords identi-

fied in the literature. The network provides a basis for identifying the thematic clusters and their interconnections, which are further examined using keyword occurrences and total link strength (TLS) in Table 3.

Furthermore, the occurrences and TLS of each keyword that forms each cluster are detailed in Table 3. Cluster theme analysis was conducted based on keywords representing each cluster and related literature. Cluster 1 is characterized by the presence of keywords such as “Indonesia,” “sustainability,” “green economy,” “sustainable finance,” “green investment,” “green bonds,” and “green banking,” which exhibit relatively high frequency and strong interconnections within the network. The keyword “Indonesia” has the highest TLS in this cluster (395), indicating its central role in the keyword network structure.

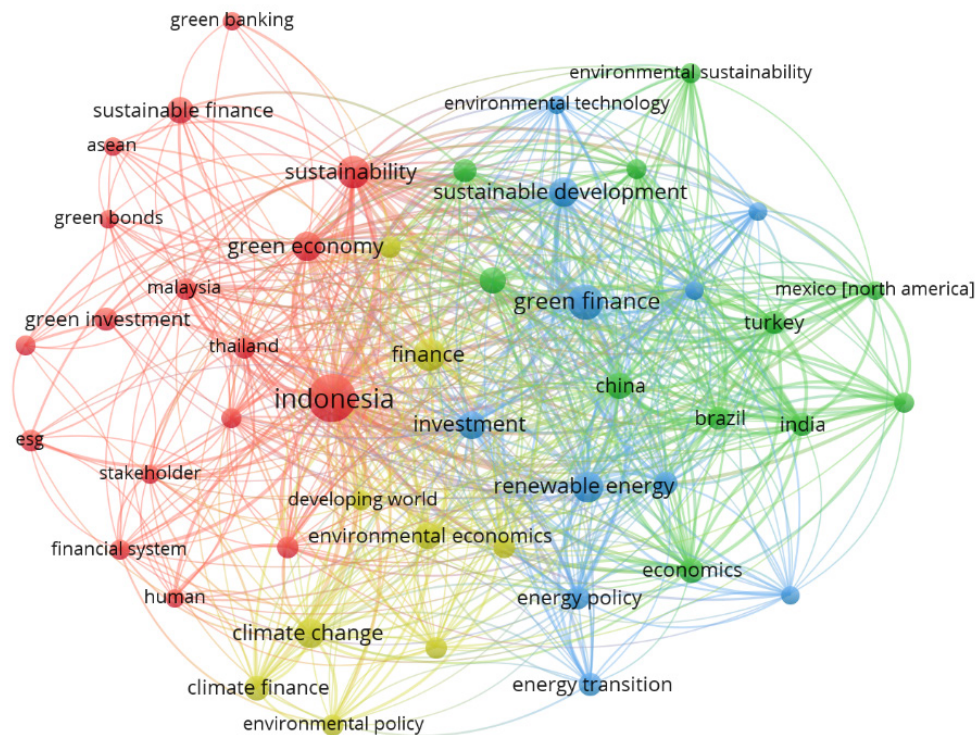


Figure 4. Network visualization of keyword occurrence

Next, Cluster 2 is dominated by countries, with China having the highest TLS (145) in this cluster and other emerging or E7 countries, namely Brazil, Indonesia, India, Mexico, Russia, and Turkey. The keywords “economic growth,” “economics,” “innovation,” “natural resource,” and “environmental sustainability” indicate efforts to expand economic capacity alongside sustainability considerations.

Cluster 3 represents the core of this bibliometric mapping, with “green finance,” “renewable energy,” and “sustainable development” showing the highest occurrences and TLS. The cluster also includes closely related keywords such as “investment,” “alternative energy,” “energy policy,” “energy transition,” “energy efficiency,” “economic development,” and “environmental technology.” The co-occurrence of these terms indicates a strong thematic linkage between green finance and renewable energy development, particularly in terms of financing, policy support, and energy transition.

Meanwhile, Cluster 4 highlights that the main drivers of green finance research stem from the urgency of “climate change” and the reduction of “carbon emissions.” The keywords “climate finance” and “developing countries” indicate that

developing countries are widely researched in relation to the challenges of climate change and efforts to achieve the SDGs.

Indonesia plays a strategic role in the global discourse on green finance, particularly as an emerging economy undergoing a transition toward sustainable development and financial system transformation. This position is reflected in its involvement in regional groupings such as ASEAN, as well as in broader comparative frameworks that include emerging economies, such as the E7 and MINT. In line with this, the bibliometric mapping indicates that the analyzed literature is situated within a broad international research network, where Indonesia appears as one of the recurring contextual cases alongside other developing countries. This reflects the dominance of a comparative and cross-country research orientation, linked by similar structural characteristics and sustainability challenges. In this context, many studies adopt a comparative approach involving countries within these groupings, thereby reinforcing Indonesia’s position within the global research landscape on green finance. The structure of the literature reveals interconnections among key themes, including sustainable finance, economic growth, energy transition, and climate policy.

Table 3. Top 10 most frequent keywords

Cluster	Keywords	Occurrence	Total Link Strength (TLS)	Theme
1 (Red)	Indonesia	395	82	Green financial systems
	Sustainability	177	28	
	Green economy	121	20	
	Sustainable finance	23	15	
	Green investment	12	10	
	Article	53	8	
	ESG	20	8	
	Malaysia	57	8	
	Thailand	69	8	
	Financial performance	16	7	
	Financial system	31	7	
	Philippines	47	7	
	ASEAN	16	6	
	Green banking	6	6	
	Green bonds	17	6	
	Human	28	6	
	Stakeholder	31	6	
2 (Green)	economic growth	116	15	Economic growth and environmental sustainability
	China	145	14	
	Economics	123	13	
	Innovation	78	11	
	Brazil	91	10	
	India	116	10	
	Turkey	118	10	
	environmental sustainability	53	7	
	natural resource	81	7	
	russian federation	83	7	
	mexico [north america]	81	6	
3 (Blue)	green finance	183	36	Green finance in energy transition
	renewable energy	148	25	
	sustainable development	163	22	
	Investment	142	18	
	energy policy	83	11	
	alternative energy	106	10	
	energy transition	45	10	
	economic analysis	60	6	
	economic development	67	6	
	energy efficiency	40	6	
	environmental technology	54	6	
4 (Yellow)	Finance	169	28	Climate finance and environmental governance
	climate change	77	21	
	environmental economics	91	14	
	climate finance	49	13	
	carbon emission	61	9	
	developing countries	51	9	
	sustainable development goals	61	9	
	environmental policy	39	8	
	developing world	41	7	

Cluster 1 (red) highlights the role of sustainable finance in supporting green economy development, particularly within emerging and regional contexts. The pattern observed in this cluster suggests that financial systems are increasingly positioned

as key enablers of environmental sustainability, rather than merely a supporting mechanism. The presence of ASEAN-related contexts indicates that the literature extends beyond a single-country focus and reflects a broader regional dynamic. This

pattern points to both shared opportunities and common constraints in developing sustainable finance ecosystems across emerging economies. In particular, these challenges are often linked to institutional capacity, regulatory development, and the level of private-sector engagement. At the country level, Indonesia continues to face structural challenges related to institutional readiness and limited private-sector participation in advancing green finance (Guild, 2020). At the regional level, existing studies suggest that the adoption of sustainable finance practices, such as green banking, may also contribute to improved banking performance across ASEAN economies (Rahma & Wedari, 2024). Overall, this cluster underscores the importance of institutional strengthening, financial innovation, and regional collaboration in shaping the development of sustainable finance and its role in advancing the green economy.

Cluster 2 (green) reflects the relationship between economic growth and environmental sustainability across emerging economies. The prominence of countries such as China, India, Brazil, Mexico, the Russian Federation, and Turkey suggests that the literature is largely centered on major emerging markets. Notably, the countries represented in this cluster collectively constitute the E7 economies, a group frequently associated with rapid economic growth, industrial transformation, and increasing sustainability challenges. Some of these countries are also associated with broader groupings of emerging economies (e.g., MINT), which are often discussed in the literature in the context of rapid industrialization and globalization. This pattern indicates that the literature is structured around macro-level discussions of development and environmental trade-offs in large emerging economies. Studies in this area (such as Sun et al. (2023) and Zhu et al. (2024)) emphasize the role of green innovation and resource efficiency in supporting environmentally sustainable growth. Overall, the cluster highlights green innovation and sustainable development as key mechanisms for reconciling economic growth with environmental objectives in emerging economies.

Cluster 3 (blue) is characterized by a strong thematic convergence between green finance and the energy transition agenda. This convergence suggests that the literature increasingly recognizes

the importance of financial mechanisms in accelerating the shift toward low-carbon energy systems. In this context, financial instruments appear closely linked with energy system change and environmental innovation, indicating that green finance functions as an enabling mechanism for both technological and policy-driven transitions toward sustainability. Studies in this area (such as Wang et al. (2022)) emphasize the contribution of green finance, renewable energy, and energy efficiency in supporting long-term sustainable economic development. Taken together, this cluster highlights the growing role of green finance in facilitating energy transition and advancing broader sustainability objectives.

Cluster 4 highlights how climate finance has become increasingly integrated into discussions of climate change mitigation and sustainable development. This pattern suggests that the literature in this cluster is primarily structured around the financial and policy responses to climate-related risks in the context of economic development and environmental vulnerability. The presence of terms related to developing countries further indicates that the literature places particular emphasis on climate finance challenges and opportunities in emerging and developing economies, where institutional capacity and policy implementation play a critical role. Within this context, climate finance is positioned as a key mechanism for supporting both mitigation and adaptation strategies, particularly through instruments aimed at reducing carbon emissions and strengthening environmental policy effectiveness. Studies in this area (such as Chavarría-Flores and Warren (2024)) highlight the importance of innovative financing instruments and institutional frameworks in channeling investments toward climate-related objectives. This cluster illustrates the evolving role of climate finance as a strategic tool for advancing low-carbon and sustainable development.

The development of green finance research related to Indonesia has grown rapidly in recent years, as shown in Figure 5, which displays the dominant keywords that have appeared over the last 10 years. The early period, reflected in the darker colors, is less prominent than the later period, confirming that this topic is a rapidly expanding area of research. Furthermore, the presence of the main key-

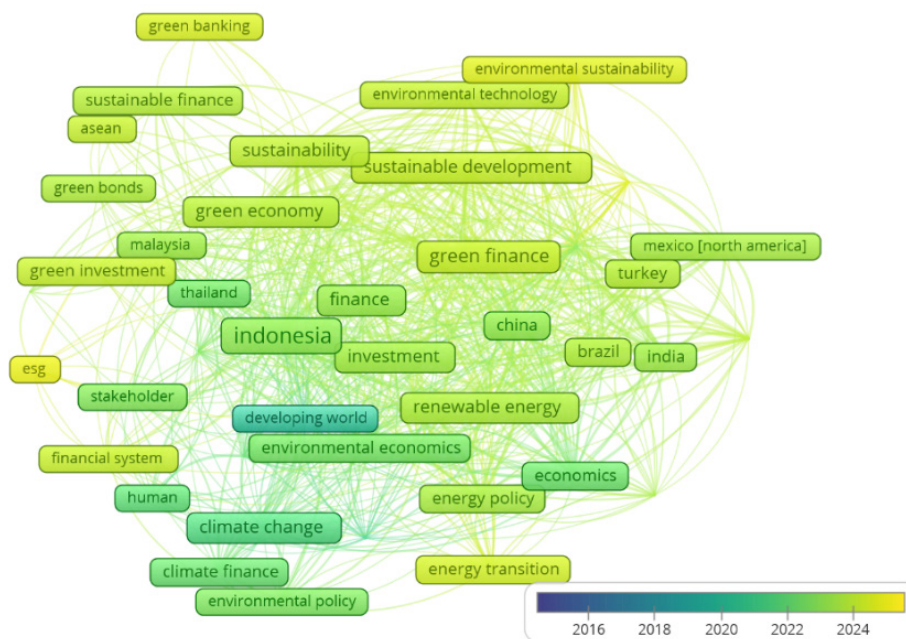


Figure 5. Overlay visualization of keyword occurrence

word “green finance” in lighter colors indicates its emergence as a prominent and increasingly studied topic in recent years. In contrast, the darker appearance of the keyword “Indonesia” suggests that earlier studies more frequently emphasized Indonesia as a primary context, while more recent research tends to position Indonesia within broader comparative and global discussions.

3.1. Future research directions and implications

Based on the identification of key topics representing each cluster, the challenges, opportunities, and implications of several relevant literature were also mapped to provide direction for further research (Appendix B, Table B1). Theoretically, this study

provides insight into key topics in green finance research related to Indonesia within a broader international context. Mapping key topics not only provides an overview of the dominant issues discussed but also direction for further research. From a practical perspective, this study also identifies the policy implications arising from the issues discussed in each cluster theme. The results of this mapping are expected to make it easier for researchers and stakeholders involved to identify the main issues of green finance, including those in which Indonesia appears as part of comparative and cross-country analyses, and the strategic steps that must be taken. This will ensure that the resulting research and policies are more targeted and relevant to the evolving role of Indonesia within the global green finance landscape.

CONCLUSION

The study aimed to map of the development, thematic structure, and research trends of green finance literature related to Indonesia over the period 2015 – 2025 using bibliometric analysis. The findings provide a more comprehensive understanding of this literature, which has received limited attention in previous studies. The number of publications has increased significantly over the last four years, indicating a growing scholarly interest in green finance within contexts involving Indonesia and highlighting its increasing relevance in both national and cross-country discussions. The Scopus dataset further reveals that, in addition to Indonesia, countries such as China and Malaysia have made substantial contributions to the development of this body of literature. This finding underscores that green finance

research related to Indonesia is not confined to domestic scholarship but is also embedded within a broader international research network. Several foreign institutions, including MARA University of Technology (UiTM), The Australian National University, and University of Malaya also play important roles in advancing this research area. Furthermore, the Scopus database covers a wide range of disciplines. The broad scope of green finance encompasses not only socio-economics but also the environment, energy, and technological dimensions. This is in line with global developments that emphasize that financial systems should deliver economic and social benefits without compromising environmental sustainability.

Among the most cited articles, the top five positions are dominated by studies published within the last five years, indicating that green finance research involving Indonesia has become increasingly relevant in recent periods. Furthermore, the network co-occurrence analysis identifies four main clusters: (1) Green financial systems, (2) Economic growth and environmental sustainability, (3) Green finance in energy transition, and (4) Climate finance and environmental governance. The overlay visualization highlights “green finance” as a prominent and emerging keyword, reinforcing its significance and continued growth within the academic landscape.

This study focuses on a bibliometric analysis of green finance literature related to Indonesia. Therefore, the findings should be interpreted within this scope and cannot be generalized beyond the literature examined. In addition, this study relies solely on the Scopus database, which may exclude relevant studies indexed in other databases. Future research could expand the dataset by incorporating sources such as Web of Science and Google Scholar, as well as applying alternative bibliometric tools beyond VOSviewer. Furthermore, combining bibliometric approaches with qualitative methods, such as expert interviews and focus group discussions, may provide more comprehensive and practically relevant insights into the development of green finance research involving Indonesia.

AUTHOR CONTRIBUTIONS

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REFERENCES

1. Abbas, S., Dastgeer, G., Nasreen, S., Kousar, S., Riaz, U., Arsh, S., & Imran, M. (2024). How financial inclusion and green innovation promote green economic growth in developing countries. *Sustainability*, 16(15), Article 6430. <https://doi.org/10.3390/su16156430>
2. Abubakar, A., Azwar, P., Pardede, R. S. F., Fathoni, S., & Triandini, N. A. (2025). Financial policy for a green economy in a resource-rich emerging economy. *Monetary and Banking Economics Bulletin*, 28(2), 229-260. <https://doi.org/10.59091/2460-9196.2328>
3. Afzal, A., Rasoulinezhad, E., & Malik, Z. (2022). Green finance

- and sustainable development in Europe. *Economic Research-Ekonomska Istraživanja*, 35(1), 5150-5163. <https://doi.org/10.1080/1131677X.2021.2024081>
4. Ahmad, F., Boumaiza, A., Sanfilippo, A., & Al-Fagih, L. (2025). A comprehensive review on green finance and its impact on net zero energy transition: From the perspective of renewable energy development. *Energy Strategy Reviews*, 62, Article 101948. <https://doi.org/10.1016/j.esr.2025.101948>
 5. Ahmad, F., Boumaiza, A., Yazici, M., Taştaltın, N., & Özmen, S. (2025). From global mapping to local action: Green finance, regulatory frameworks, and policy transformation for sustainable energy transition in Qatar and Türkiye. *Sustainable Development*, 34(2), 1648-1684. <https://doi.org/10.1002/sd.70373>
 6. Alam, M., & Ullah, S. (2025). Greening the economy: Green finance and innovation nexus in developing countries. *Sustainable Futures*, 10, Article 101448. <https://doi.org/10.1016/j.sfr.2025.101448>
 7. Alqudah, H., Al-Qudah, M., Huson, Y. A., Lutfi, A., Alrawad, M., & Almaiah, M. A. (2024). A decade of green economic literature: An analysis-based bibliometric. *International Journal of Energy Economics and Policy*, 14(3), 497-511. <https://doi.org/10.32479/ijeep.15579>
 8. Al-Zoubi, W. K. (2024). How sustainable is environmental economics? A review of research trends and implications. *International Journal of Energy Economics and Policy*, 14(2), 319-334. <https://doi.org/10.32479/ijeep.15494>
 9. Apeaning, R. W., & Labaran, M. (2025). Does financial development moderate the impact of climate mitigation innovation on CO2 emissions? Evidence from emerging economics. *Innovation and Green Development*, 4(2), Article 100211. <https://doi.org/10.1016/j.igd.2025.100211>
 10. Azhgaliyeva, D., Kapoor, A., & Liu, Y. (2020). Green bonds for financing renewable energy and energy efficiency in South-East Asia: A review of policies. *Journal of Sustainable Finance & Investment*, 10(2), 113-140. <https://doi.org/10.1080/20430795.2019.1704160>
 11. Brandi, C., Schwab, J., Berger, A., & Morin, J.-F. (2020). Do environmental provisions in trade agreements make exports from developing countries greener? *World Development*, 129, Article 104899. <https://doi.org/10.1016/j.worlddev.2020.104899>
 12. Bylo, A. (2025). Assessing the impact of green finance on sustainability in emerging markets: Trends, challenges, and future prospects (2000–present). *International Scientific Journal Monte*, 10(1), 8-18. Retrieved from <https://journalmonte.com/archives/3288>
 13. Chamdani, M. C., & Santoso, B. S. (2023). The central bank's policy justification in mitigating climate change. *Journal of Central Banking Law and Institutions*, 2(1), 93-122. <https://doi.org/10.21098/jcli.v2i1.36>
 14. Chavarría-Flores, A., & Warren, P. (2024). Sovereign climate bonds: Policy innovation for just transitions in developing countries. *Journal of Climate Finance*, 7, Article 100041. <https://doi.org/10.1016/j.jclimf.2024.100041>
 15. Chien, F., Hsu, C.-C., Moslehpour, M., Sadiq, M., Tufail, B., & Ngo, T. Q. (2024). A step toward sustainable development: The nexus of environmental sustainability, technological advancement and green finance: Evidence from Indonesia. *Environment, Development and Sustainability*, 26(5), 11581-11602. <https://doi.org/10.1007/s10668-023-03424-5>
 16. D'Orazio, P., & Thole, S. (2022). Climate-related financial policy index: A composite index to compare the engagement in green financial policymaking at the global level. *Ecological Indicators*, 141, Article 109065. <https://doi.org/10.1016/j.ecolind.2022.109065>
 17. Dharmayanti, N., Ismail, T., Hanifah, I. A., & Taqi, M. (2023). Exploring sustainability management control system and eco-innovation matter sustainable financial performance: The role of supply chain management and digital adaptability in Indonesian context. *Journal of Open Innovation: Technology, Market, and Complexity*, 9(3), Article 100119. <https://doi.org/10.1016/j.joitmc.2023.100119>
 18. Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285-296. <https://doi.org/10.1016/j.jbusres.2021.04.070>
 19. Faizi, F., Kusuma, A. S., & Widodo, P. (2024). Islamic green finance: Mapping the climate funding landscape in Indonesia. *International Journal of Ethics and Systems*, 40(4), 711-733. <https://doi.org/10.1108/IJOES-08-2023-0189>
 20. Farabi, A., Putri Kurniadi, A., Dasilva, H., Thoha, M., Karimi, K., Suhendra, A., Abinda Firdaus, I., Setiawan, S., Asrori, A., & Salim, Z. (2025). Islamic banking finance and environmental sustainability: Sector-level analysis from Indonesia. *International Journal of Energy Economics and Policy*, 15(5), 695-704. <https://doi.org/10.32479/ijeep.20331>
 21. Guild, J. (2020). The political and institutional constraints on green finance in Indonesia. *Journal of Sustainable Finance & Investment*, 10(2), 157-170. <https://doi.org/10.1080/20430795.2019.1706312>
 22. Hermala, I., Sunitiyoso, Y., & Sudrajad, O. Y. (2025). Green financing using Islamic finance instruments in Indonesia: A bibliometrics and literature review. *International Journal of Energy Economics and Policy*, 15(1), 239-248. <https://doi.org/10.32479/ijeep.17208>
 23. Hutabarat, D. E. M., Said, F. F., Karim, Z. A., & Yan, W. W. (2025). Greening Indonesia: The role of green finance in achieving Sustainable Development Goals. In *Proceedings of the 8th International Research Conference on Economic and Business (IRCEB 2024)* (pp. 219-226). https://doi.org/10.2991/978-94-6463-722-9_19

24. Indriastuti, M., & Chariri, A. (2021). The role of green investment and corporate social responsibility investment on sustainable performance. *Cogent Business & Management*, 8(1), Article 1960120. <https://doi.org/10.1080/23311975.2021.1960120>
25. Joaqui-Barandica, O., Heredia-Carroza, J., López-Estrada, S., & Agheorghiesei, D.-T. (2025). Mapping trends in green finance: A bibliometric and topic modeling analysis. *International Journal of Financial Studies*, 13(3), Article 137. <https://doi.org/10.3390/ijfs13030137>
26. Judijanto, L., Qosim, N., Syamsulbahri, Utami, E. Y., & Afandy, C. (2024). Sustainable finance: A bibliometric analysis of green finance and its role in global markets. *West Science Business and Management*, 2(04), 1206-1215. <https://doi.org/10.58812/wsbm.v2i04.1500>
27. Kementrian Keuangan. (2024, June 25). *Republic of Indonesia successfully priced a US\$ 2.35 billion global sukuk*. Kementrian Keuangan Direktorat Jenderal Pengelolaan Pembiayaan Dan Risiko. Retrieved from [https://djppr.kemenkeu.go.id/en/republicofindonesiasuccessfullypricedaus\\$2.35billionglobalsukuk](https://djppr.kemenkeu.go.id/en/republicofindonesiasuccessfullypricedaus$2.35billionglobalsukuk)
28. Khan, M. A., Riaz, H., Ahmed, M., & Saeed, A. (2022). Does green finance really deliver what is expected? An empirical perspective. *Borsa Istanbul Review*, 22(3), 586-593. <https://doi.org/10.1016/j.bir.2021.07.006>
29. Kissinger, G., Gupta, A., Mulder, I., & Unterstell, N. (2019). Climate financing needs in the land sector under the Paris Agreement: An assessment of developing country perspectives. *Land Use Policy*, 83, 256-269. <https://doi.org/10.1016/j.landusepol.2019.02.007>
30. Kumar, A., Ahuja, S., Soti, N., Saini, A. K., & Bharti. (2024). Navigating the green finance frontier: A bibliometric and content analysis of green finance and environmental sustainability. *Cogent Economics & Finance*, 12(1). <https://doi.org/10.1080/23322039.2024.2398217>
31. Lanqi, S., & Yanli, L. (2021). On the mechanism of green economy and green finance. *International Journal of Frontiers in Sociology*, 3(14), 75-79. <https://doi.org/10.25236/IJFS.2021.031416>
32. Li, C., Sampene, A. K., Agyeman, F. O., Brenya, R., & Wiredu, J. (2022). The role of green finance and energy innovation in neutralizing environmental pollution: Empirical evidence from the MINT economies. *Journal of Environmental Management*, 317, Article 115500. <https://doi.org/10.1016/j.jenvman.2022.115500>
33. Minh Sang, N. (2024). Mapping the evolution of green finance through bibliometric analysis. *Environmental Economics*, 15(1), 1-15. [https://doi.org/10.21511/ee.15\(1\).2024.01](https://doi.org/10.21511/ee.15(1).2024.01)
34. Miyan, Md. S., Cheong, C. W. H., Sharif, A., & Afshan, S. (2024). Three decades of green finance: The state of the art and way forward. *International Journal of Energy Economics and Policy*, 14(6), 88-105. <https://doi.org/10.32479/ijeep.16718>
35. Muhmad, S. N., Cheema, S., Mohamad Ariff, A., Nik Him, N. F., & Muhmad, S. N. (2024). Systematic literature review and bibliometric analysis of green finance and renewable energy development. *Sustainable Development*, 32(6), 7342-7355. <https://doi.org/10.1002/sd.3093>
36. Mukhtasor, M., Listiana, L., Hermala, I., & Fauziah, N. N. (2023). Scaling up renewable energy financing through Islamic blended finance: Case study in Indonesia. *International Journal of Energy Economics and Policy*, 13(5), 634-644. <https://doi.org/10.32479/ijeep.14710>
37. Najicha, F., Mukhlisin, M., Supiandi, S., Saparwadi, S., & Sulthani, D. (2023). The shaping of future sustainable energy policy in management areas of Indonesia's energy transition. *Journal of Human Rights, Culture and Legal System*, 3(2), 362-382. <https://doi.org/10.53955/jhcls.v3i2.110>
38. OECD. (2025). *Environment at a glance indicators*. Paris: Organisation for Economic Co-operation and Development Publishing. <https://doi.org/10.1787/ac4b8b89-en>
39. Okere, K. I., Dimnwobi, S. K., Fasanya, I. O., & Umeajaghaku, O. L. (2025). Advancing environmental sustainability through fintech, structural transformation, and resource diversification in emerging economies. *Environmental Sciences Europe*, 37(1), Article 197. <https://doi.org/10.1186/s12302-025-01209-3>
40. Owusu, S. M., & Acheampong, P. (2025). Assessing the influence of green finance, renewable energy and digitization in stimulating economic expansion: Lessons from emerging economies. *Renewable and Sustainable Energy Reviews*, 212. <https://doi.org/10.1016/j.rser.2025.115413>
41. Öztürk, O., Kocaman, R., & Kanbach, D. K. (2024). How to design bibliometric research: An overview and a framework proposal. *Review of Managerial Science*, 18(11), 3333-3361. <https://doi.org/10.1007/s11846-024-00738-0>
42. Rahma, P. N. M., & Wedari, L. K. (2024). Green banking and bank performance in ASEAN: The moderating role of bank size. *Journal of Logistics, Informatics and Service Science*, 11(9), 162-181. <https://doi.org/10.33168/JLISS.2024.0911>
43. Ronaldo, R., & Suryanto, T. (2022). Green finance and sustainability development goals in Indonesian Fund Village. *Resources Policy*, 78, Article 102839. <https://doi.org/10.1016/j.resourpol.2022.102839>
44. Setyorini, M., & Hakam, D. F. (2025). The impact of green banking activities on environmental performance: A youth-driven perception study in Indonesian financial institutions. *Journal of Risk and Financial Management*, 18(10), Article 558. <https://doi.org/10.3390/jrfm18100558>
45. Setyowati, A. B. (2020). Mitigating energy poverty: Mobilizing climate finance to manage the energy

- trilemma in Indonesia. *Sustainability*, 12(4), Article 1603. <https://doi.org/10.3390/su12041603>
46. Setyowati, A. B. (2021). Mitigating inequality with emissions? Exploring energy justice and financing transitions to low carbon energy in Indonesia. *Energy Research & Social Science*, 71, Article 101817. <https://doi.org/10.1016/j.erss.2020.101817>
47. Sherifdeen, M., Nurrochmat, D. R., Perdinan, & Aliyu Abubakar, H. K. (2023). Effectiveness of emerging mechanisms for financing national climate actions; Example of the Indonesia Climate Change Trust Fund. *Climate and Development*, 15(2), 81-92. <https://doi.org/10.1080/17565529.2022.2057905>
48. Shi, M., & Yu, J. (2024). Analyzing nonlinear and asymmetric effects of green finance and renewable energy on energy efficiency amidst technological innovation in E7 countries. *Heliyon*, 10(16), Article e35895. <https://doi.org/10.1016/j.heliyon.2024.e35895>
49. Sun, Y., Gao, P., Tian, W., & Guan, W. (2023). Green innovation for resource efficiency and sustainability: Empirical analysis and policy. *Resources Policy*, 81, Article 103369. <https://doi.org/10.1016/j.resourpol.2023.103369>
50. Tiawon, H., & Miar, M. (2023). The role of renewable energy production, energy efficiency and green finance in achieving sustainable economic development: Evidence from Indonesia. *International Journal of Energy Economics and Policy*, 13(1), 250-260. <https://doi.org/10.32479/ijee.13915>
51. Udo, E. S., Okoh, J. I., Ore, O., Obieze, E. S., Oziegbe, D. J., & Afrogha, O. (2025). Green finance, technological innovation and financial globalization: Assessing environmental quality in MINT economies. *Journal of Renewable Energy and Environment*, 12(2), 85-95. <https://doi.org/10.30501/jree.2025.484493.2130>
52. Uwuigbe, U., Eluyela, D. F., Martins, B. O., Uwuigbe, O. R., & Musa, S. (2024). A bibliometric analysis of green financing and renewable energy research for 2000–2023. *International Journal of Energy Economics and Policy*, 14(5), 26-34. <https://doi.org/10.32479/ijee.16172>
53. Wang, G., Cui, H., & Hausken, K. (2025). The evolution of green finance research: A comprehensive bibliometric analysis. *Heliyon*, 11(3), Article e42161. <https://doi.org/10.1016/j.heliyon.2025.e42161>
54. Wang, S., Sun, L., & Iqbal, S. (2022). Green financing role on renewable energy dependence and energy transition in E7 economies. *Renewable Energy*, 200, 1561-1572. <https://doi.org/10.1016/j.renene.2022.10.067>
55. Wang, Y., & Zhi, Q. (2016). The role of green finance in environmental protection: Two aspects of market mechanism and policies. *Energy Procedia*, 104, 311-316. <https://doi.org/10.1016/j.egypro.2016.12.053>
56. Wati, R., & Fasa, M. I. (2024). Green finance in Indonesia: A literature review. *Islamic Economics and Finance Journal*, 3(2), 100-108. <https://doi.org/10.55657/iefj.v3i2.208>
57. Zhu, H., Chen, Z., Xia, D., Nassani, A. A., & Hameed, W. U. (2024). Integrating fintech in natural resource management: Assessing the EKC hypothesis for sustainable development in E7 countries. *Resources Policy*, 93. <https://doi.org/10.1016/j.resourpol.2024.105054>
58. Zin Lin, O., Juchelkova, D., Štěpanec, L., Aye, H. Y., & Adam, K. B. (2026). Bridging the energy gap in ASEAN: Scaling green finance and carbon markets for a sustainable transition. *WIREs Energy and Environment*, 15(1), 1-20. <https://doi.org/10.1002/wene.70020>

APPENDIX A

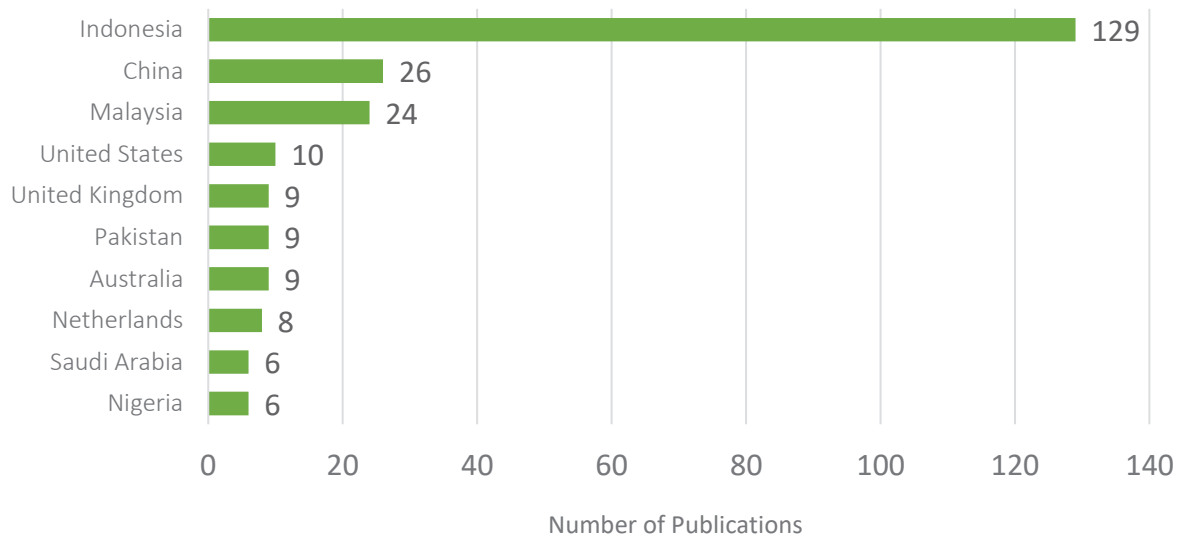


Figure A1. Most significant countries contributing to green finance research related to Indonesia during 2015–2025

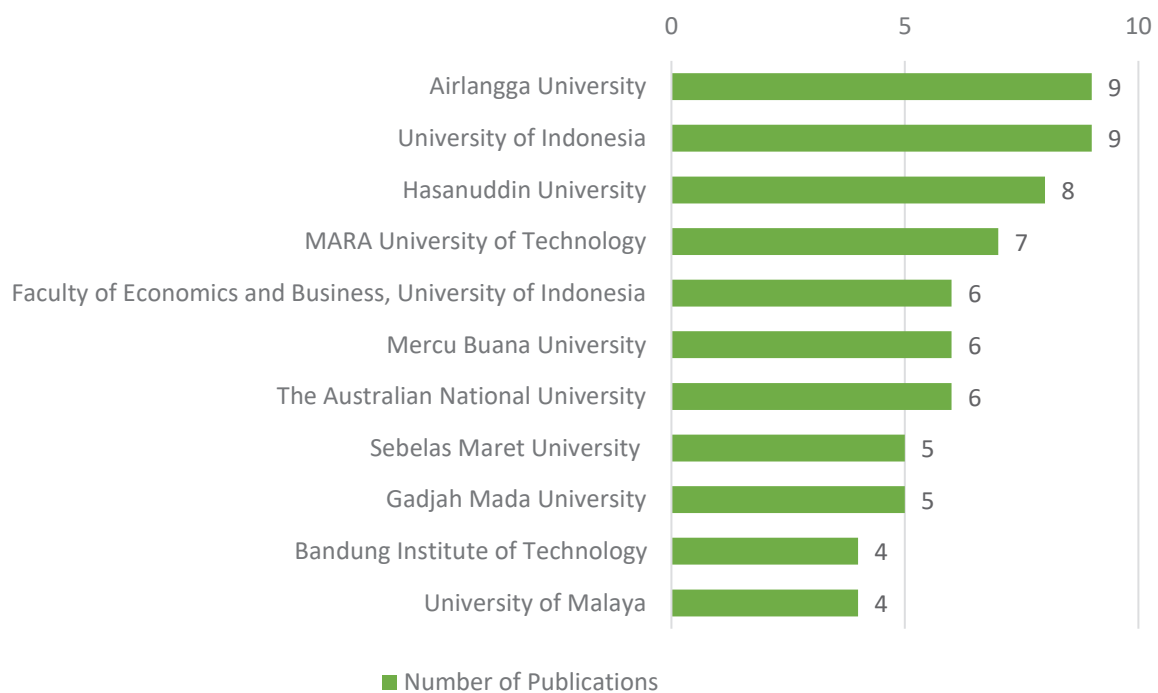


Figure A2. Most relevant institutions contributing to green finance research related to Indonesia during 2015–2025

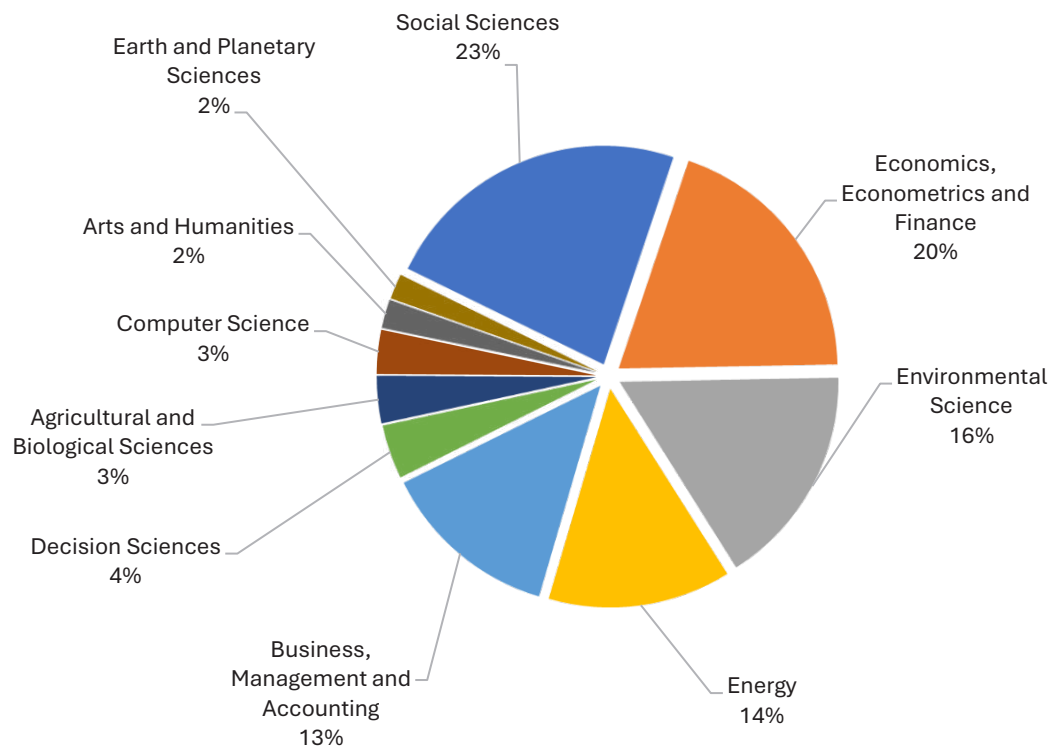


Figure A3. Distribution of subject areas in green finance research related to Indonesia during 2015–2025

APPENDIX B

Table B1. Future research directions

Challenges	Opportunities	Implications	Directions	Relevant Sources
Green financial systems				
The development of the green economy remains constrained by limited financial experience, weak participation of private capital, and the strong influence of extractive.	Given the high demand for green investment in the ASEAN region through 2030, along with rising energy demand, green bonds present significant opportunities to bridge financing gaps for energy efficiency and renewable energy projects.	Green finance policies should focus on strengthening the capacity of financial institutions, reforming institutional design to enhance the role of private capital, and optimizing regulatory frameworks to support green investment in remote areas, particularly through small-scale renewable energy projects.	In addition to financial performance, future research should examine the impact of green banking on other dimensions of banking performance, such as risk and efficiency, and analyze how sustainability disclosure and green credit policies influence financial outcomes.	Hermala et al. (2025); Azhgaliyeva et al. (2020); Farabi et al. (2025); Setyorini and Hakam (2025); Guild (2020); Rahma and Wedari (2024)
There is a potential risk of short-term declines in profitability, particularly in terms of return on equity (ROE) for large banks, when expanding green credit due to higher operational and risk management costs.	The positive perception of digital banking among younger generations can be leveraged to enhance the effectiveness of environmentally friendly behavior campaigns through green banking services.	It is important to encourage banks to leverage the strategic role of younger generations in adopting green banking through regulatory support, policy incentives, and product innovation.	The use of micro-level data, such as bank-level or project-level data, is recommended to capture variations in environmental performance and to expand environmental analysis by incorporating environmental impact indicators.	
		Beyond innovative financing mechanisms, clear regulatory frameworks and cross-stakeholder collaboration are essential to strengthen the implementation of green financing.		
Economic growth and environmental sustainability				
High dependence on traditional energy, especially fossil fuels, which tends to worsen environmental quality during the economic growth phase in emerging nations.	Technological developments, especially related to green innovation and financial technology, provide opportunities to improve environmental sustainability	Policy recommendations should align with each country's specific context.	Emerging countries have different characteristics, challenges, and opportunities. Therefore, it is necessary to explore the specific conditions and policies of each country in order to produce more relevant and targeted recommendations for sustainable growth. In addition, the study can be focused on comparing groups of other countries that have similar characteristics, such as MENA, BRICS, and other groups. Research can also group analyses based on state income levels to gain a broader perspective.	Wang et al. (2022); Zhu et al. (2024); Owusu and Acheampong (2025); Abubakar et al. (2025); Shi and Yu (2024); Sun et al. (2023); Udo et al. (2025); Okere et al. (2025)
The pressures of rapid population growth and urbanization in developing countries increase the ecological footprint and air pollution.	Green funding is an environmentally friendly investment model that can reduce the ecological footprint of traditional fossil-based industrial activities.	Diversify the use of resources.	Use a variety of other factors as variables that affect environmental sustainability to provide different perspectives	
		Adoption of green innovation and fintech to improve resource efficiency, reduce environmental impact, and drive economic growth.		
		Intervention and harmonization of fiscal, monetary, and environmental economic policies to suppress the high-carbon sector and provide incentives to the low-carbon economic sector.		

Table B1 (cont.). Future research directions

Challenges	Opportunities	Implications	Directions	Relevant Sources
Green finance in energy transition				
High advance costs for RE investments.	The development of green financing as an alternative to RE financing for the energy transition has been proven to contribute to sustainable economic development in Indonesia.	Adaptive and harmonious policy support with other areas of development (not just environment and energy) to accommodate green financing as an important component in the policy framework and investment ecosystem of sustainable projects such as RE.	Explore the effectiveness of specific financial instruments in encouraging green investment and expand strategies to finance global climate mitigation efforts.	Wang et al. (2022); Najicha et al. (2023); Chien et al. (2024); Owusu and Acheampong (2025); Guild (2020); Apeaning and Labaran (2025); Tiawon and Miar (2023); Mukhtasor et al. (2023)
Institutional barriers due to weak institutional governance, human resources, and political intervention.	The growth of Islamic financial instruments to close the funding gap for renewable energy infrastructure in Indonesia.	Institutional strengthening to combat inefficiency, corruption, and conflicts of interest.	Explore empirical studies on the Islamic Blended Finance business model on the potential of Islamic financial instruments in the RE sector.	
Policies that are not synced.	The advancement of ICT both in terms of digitalization and green funding technology (such as Fintech) and RE technology.	Optimization of digital infrastructure and technological innovations related to the environment.		
Climate finance and environmental governance				
Climate change represents a major development challenge for developing countries due to its wide-ranging impacts on socio-economic and ecological systems.	The development of green innovation creates opportunities to accelerate green economic growth through advances in environmentally friendly technologies and the creation of new employment opportunities, particularly in research and development, thereby supporting economic diversification and reducing dependence on environmentally harmful sectors.	Strengthening institutional coordination and integrating climate change risks into financial system stability frameworks are essential to support the development of green finance instruments and policies.	Future research should examine other SCB-issuing countries to assess the consistency of findings across developing economies with diverse characteristics and levels of economic development.	Sheriffdeen et al. (2023); Abbas et al. (2024); Kissinger et al. (2019); Chavarria-Flores and Warren (2024); D'Orazio and Thole (2022); Chamdani and Santoso (2023)
Limited domestic climate financing and continued reliance on international funding weaken countries' adaptive capacity.	The adaptation and replication of SCBs by other developing countries offer opportunities to expand climate finance mobilization by tailoring instrument design to national fiscal, institutional, and development conditions.	Governments in developing countries should promote green energy production and investment, particularly through the development of renewable energy projects.	Future studies should explore the relationship between the adoption of climate finance policies and credit market dynamics, including the effectiveness of these policies in managing credit cycles and maintaining financial stability under climate change risks.	
Developing countries face an ongoing dilemma in balancing economic growth objectives, development policies, and environmental protection.				