

Net Zero Emissions in Developing Countries: A Scholarly Mapped Bibliometric Analysis of Energy Policy and Sustainable Development

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Abstract

Sustainable Development Goals, along with climate change, have received global attention as the world attempts to realize a sustainable and clean environment that not only lets future generations flourish but also actualizes equity. The concept of NZE: Net Zero Emission has been a trending topic for years, yet the study regarding the effort and progress to realize it is still scarce. Hence, this study contributes to the development and identification of key themes that underlie Net Zero Emission scholarly literature through bibliometric analysis. Based on 643 English-language literature from 1993 to 2026, showing how the broad concept of energy policy and emission control is evolving towards further focused discussion regarding decision-making and climate change. Increased interest in research has shed light on socio-economic matters, policy frameworks, and technology innovations. This study contributes prominent mapping regarding Net Zero Emission while also advancing gaps and guidance through valuable insights for those regarding Net Zero Emission, such as academics, practitioners, researchers, and policymakers.

Keywords: *Net Zero Emissions, Sustainable Development, Energy Policy, Developing Countries, Bibliometric.*

INTRODUCTION

The global energy system will change continuously regarding the needs and concerns to promote sustainability. Facing climate change and realizing the energy transition. This transition towards new and sustainable energy, for developing countries, proves to be a challenge as well as a huge chance when done precisely. The need for transition is urgent, knowing global warming and climate change have yet to familiarize itself to stopping; on the contrary, it only worsens with time, a consequence of the emission level that's yet to decrease. (Mortazavi et al., 2008). Based on this realization, the concept of SDGs or Sustainable Development Goals, followed by Net Zero Emissions, is one of the pillars to realize SDG 7 and 13 as an effort to decarbonize. Decarbonization is our critical reaction towards climate change, where this effort initially starts with the reduction of greenhouse gas followed by its annihilation, either from its source, known as Point Source Capture, or directly from

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the air, Direct Air Capture (Ali et al., 2019). There are varying factors that could underlie the stalling of developing countries to achieve a net zero emission state, some of it being policies that tend to be short-term and subsidy giving the illusion that fossil fuel is cheaper and better compared to renewable and sustainable energy. (Mortazavi et al., 2008). Based on NASA's published data, it's stated that the temperature on Earth went up as high as 1.1 Celsius, meaning the rise of heat, worsening of heat waves, prolonged dry season, permafrost melting, and water surface rising from 20 to 30 cm. This temperature will continue to rise if man refuses to afford change. Net zero is backed by two sustainable goals development, SDG 7 regarding clean energy, and SDG 13 of action towards climate. Unfortunately, in its realization tends to be colored by cherry picking and trade-offs where a country will choose certain goal or mission that will benefit them, in the end causing the prioritizing of one of the goals (Khan et al., 2025; Satrovic et al., 2025). For example, a country that chooses to focus more on economic development will sacrifice the environment which is also one of the focuses in SDGs (Coscieme et al., 2023; Kemp et al., 2020).

Consequences that follow climate change are real, and it will be difficult to reverse such effects, stated by the World Wildlife Fund, even if emissions were successfully reduced, its effect stays; what happened, happened. One third of glaciers will melt (Watts et al., 2015). The more ice melting phenomenon happening wherever it is, the ocean's surface level will increase, despite the number of efforts being realized by countries, climate change will continue, 11 thousand disasters, 2 million deaths, and 3,64 billion of loss as a consequence to famine, followed by flood, hurricane, and extreme weather (Leung et al., 2025). Countermeasure that prioritizes equity in its realization needs to be given attention to. Net zero emission also known as net-zero. This concept derives from the urgency and realization to avert the effects caused by global climate change. The revolution of industry undeniably followed and backed by the development and the general use of fossil fuel. However, the use of non-renewable resources, with times, results to the excess of greenhouse gas, resulting in the earth being hotter as a consequence of climate change (Chilukuri et al., 2023; Gan et al., 2023; Shakya et al., 2023). The Paris agreement is one of the, if not the main, treaty regarding efforts put to transition towards the use of renewable and sustainable energy, along with putting an end to global warming and realizing net zero (Lacey-Barnacle et al., 2020).

Net zero in concept might sound similar to carbon neutrality. In reality, however, they are far different despite having the same base mission to reduce or stabilize the amount of carbon emissions that exist (Bose et al., 2001). The difference lies in its management where net zero necessitates the effort of emission reduction to 90%, the rest tackled by carbon offset as much as 10%, in opposite, carbon neutrality allows carbon offset without making the effort of emission reduction mandatory from its own source, in other words, equating effort. This equating effort later on will be done by carbon offsetting, which contains carbon credits

(De et al., 2006). Tools or means that could be sold, stating the ownership or claim that the relevant parties owning carbon credits have avoided greenhouse gas or increase the effort to reduce more so annihilate greenhouse gas from the atmosphere is called carbon credits (Ajagun et al., 2022; Peña et al., 2022). Carbon credit will then be carried in carbon offsetting, an effort to compensate for carbon that's produced by either company or individuals to be mitigated through participation in the Global Environment Project investment, for example expense of 10 tons of emissions, equated to the action of planting 20 trees.

Aside from the existing obstacle, effort to achieve net zero is also hindered by inadequate infrastructure and funding. IPCC (Intergovernmental Panel on Climate Change) predicts rising up to 6 degrees Celsius in the next 100 years. In concept, the source of emission is split into three scopes or fields (Mondal & M., 2024). Scope 1 derived from companies and industries, scope 2 originates from the purchase of electricity, cooling, or steam, meanwhile scope 3 covers other emissions, upstream (e.g., goods purchased from suppliers) and downstream (use of the product by customers). In an effort to realize net zero there is also another obstacle known as greenwashing or green sheen, an effort by PR or the promoting on behalf of renewable energy and green industry to attract attention from consumers and publics (Cadman et al., 2022). Unfortunately, policy regarding Net Zero is less binding, in the end resulting in the emergence of uncertainty regarding efforts that are claimed to have been done, there is a considerable number of net zero achieving programs that focus more on benefiting political elites compared to those who really need it (Yue et al., 2001). This concept alone emerges aside from urgency realization, leading to findings regarding the accumulated effects caused by CO₂ emission and global warming. The knowledge regarding the dynamic state of climate in the end found a meeting point at the Paris Agreement, where effort to find a balance between source and emission reduction is pressed and given attention to. However, neutrality in net zero is not as simple as realizing commitment and targets (Bhardwaj et al., 2019). Moreover, net zero requires continuous effort aligned with the main goal of the Paris Agreement, a point of view, from climate action that supports instead of hinders, endurance and development from vulnerable countries and marginalized communities, a point of view that brings attention to the loss and effect caused by climate change (Islar et al., 2017).

Despite the rapid expansion of research on net-zero emissions, important knowledge gaps remain within the existing literature. Previous studies have predominantly examined technological innovation, renewable energy deployment, carbon reduction strategies, and global climate commitments, while comparatively limited attention has been given to how these themes evolve specifically within the context of developing countries. This distinction is important because developing countries face unique structural challenges, including limited financial capacity, institutional constraints, technological dependence, and the need to balance economic development with climate commitments.

Consequently, findings derived from global bibliometric studies may not adequately capture the intellectual structure and research priorities that characterize developing-country contexts. A dedicated bibliometric investigation focusing on developing countries is therefore necessary to identify the evolution of scholarly attention, dominant research themes, and emerging knowledge gaps that remain insufficiently explored. Some scientists have stated that, in practice, the concept of net zero has had a negative impact on emissions reductions. This is caused by our dependence on the future, big, unproven innovations, one of them being the annihilation of carbon dioxide (Pietrosemoli et al., 2013). Net zero now tends to put asides reality that emission continues to rise even after all these years, there has yet to be net zero policy that could endure or stop global warming to a point of 1.5 Celsius, because its main goal has been wrong from the start, net zero tends to be guided towards business interest compared to real interest on creating stability in realizing transition towards renewable and sustainable energy (Hsiao et al., 2024). It requires further study between efforts and programs that are promised and implemented across countries either developed or developing, most importantly developing, in effort to achieve net zero with the existing reality, what underlies the hindering of realizing net zero, policies, infrastructures, or whether it's the concept of net zero that is too ambitious to achieve and realize. This study bridges previous researchers that tends to discuss technical effort in actualizing net zero emission, all the while only briefly mentioning the importance of policies and real possibilities of whether net zero could actually be realized or is it mere ambitions. Building upon these research gaps, this study conducts a comprehensive bibliometric analysis of publications on net-zero emissions, energy policy, sustainable development, and developing countries indexed in the Scopus database. Unlike previous bibliometric reviews that primarily emphasize global trends or single thematic dimensions, this study integrates these interconnected topics into a unified analytical framework to reveal the intellectual structure, thematic evolution, and emerging research directions within developing-country contexts. The study makes four principal contributions. First, it systematically maps the development of scientific publications in this research field. Second, it identifies the dominant themes, conceptual clusters, and thematic evolution that shape current scholarly discussions. Third, it highlights underexplored research areas and emerging trends that warrant further investigation. Finally, the findings provide evidence-based insights for researchers, policymakers, and practitioners in designing future research agendas and policy strategies to support the transition toward net-zero emissions in developing countries. Serving a holistic or overall view regarding the development in an effort to realize net zero emission as its main goal, followed by the second goal to guide and give basis for further research in this rather fast-developing field either for researchers, policy maker, or practitioners in their participation to navigate the urgency and complexity of net zero emission (Stevović et al., 2020).

This study aims to analyze the evolution of scientific literature on net-zero emissions in developing countries over time, identify the dominant intellectual structures, thematic clusters, and research trends shaping the field, and map existing research gaps and future research directions through bibliometric analysis to strengthen the knowledge base and support the transition toward net-zero emissions in developing countries.

METHOD

The application of bibliometric analysis in this study is used to obtain an understanding and knowledge regarding thematic and scholarly development in this field of study regarding net zero emissions (Cheng, Cai, and J. 2026). The methodological framework is derived from bibliometric research practice, guaranteeing transparency and rigor (Guo K. 2026).

The thematic evolution analysis was conducted using the thematic evolution function available in the Bibliometrix package. The study period was divided into three consecutive time slices (1993–2014, 2015–2021, and 2022–2026) to capture major changes in the development of the literature over time. The first period represents the formative stage of the research field, the second reflects the expansion of scholarly interest following the growing international climate agenda, while the third captures the most recent developments in net-zero emissions research. These time intervals were selected to ensure a balanced representation of publication growth while facilitating the visualization of thematic transitions across different periods.

Data Collection

The bibliographic dataset used in this study was retrieved exclusively from the Scopus database, which was selected because of its comprehensive coverage of high-quality peer-reviewed publications across multiple disciplines and its compatibility with bibliometric analysis. The bibliographic data were retrieved from the Scopus database on 15 June 2026 (n.p., 1993), covering publications indexed from 1993 to 2026. Although the search period includes the year 2026, it should be noted that this represents an incomplete publication year because the database reflects only records indexed up to the retrieval date. Restricting the dataset to the Scopus database and English-language publications ensures consistency, transparency, and reproducibility of the bibliometric analysis while providing broad international coverage of research on net-zero emissions, energy policy, sustainable development, and developing countries. This specific time frame, backward, maps out the evolution of research regarding net zero emission and its corresponding elements, such as energy, sustainable development, and developing countries, as the object focus gives a point of view that captures the emerging themes and developments regarding the matters (Benitez S. 2026). The end-time, 2026, incorporate the latest available data at the time of analysis, making such findings up to date and contextually relevant. The Scopus database is chosen over its

comprehensive coverage across disciplines. (Suryawan et al. 2026). The search query was: TITLE-ABS-KEY (“Net Zero Emission”, “Energy Policy”, “Developing Countries”, and “Sustainable Development”) AND (LIMIT-TO (LANGUAGE, “English”)). This formulation makes precise the preference by enclosing the major term “Net Zero Emission” within quotation marks. This query was also developed upon considering related terms like “Energy Sustainability”, “Energy Policy”, and “Developing Countries”. Hence, the three are a supporting element under the primary query that is Net Zero Emission.

The term developing countries refers to countries classified as developing or emerging economies according to internationally recognized classifications, particularly those adopted by the World Bank and the United Nations. During the literature retrieval process, publications were identified through search terms related to developing countries, including developing countr, developing nation, and emerging econom. The dataset consists of publications explicitly discussing net-zero emissions, energy policy, and sustainable development within developing-country contexts. This operational definition ensures that the bibliometric analysis remains aligned with the study objective and accurately represents the scholarly landscape concerning developing countries

Standard parameter settings provided by the Bibliometrix package were applied throughout the analysis. Descriptive bibliometric indicators included publication trends, citation analysis, source productivity, and country contributions. Science mapping consisted of keyword co-occurrence analysis, thematic evolution, thematic mapping, and document coupling. Threshold values for keyword occurrence, citation frequency, and visualization were adjusted according to the size of the dataset to ensure meaningful cluster formation while maintaining sufficient coverage of the literature. These parameter settings enhance the transparency and reproducibility of the bibliometric procedure

Literature Review

Net zero emissions are closely related to the global agenda that is the SDGs, specifically in the context of clean energy and climate action. A study done by Suryawan et al (2026) and Benitez & Dhakal (2026) states that NZE is an integral part of global sustainable development. Energy policy has direct influence towards a country’s energy transition as if it is done properly it could reduce a country’s dependency on fossil energy, propel investment on renewable energy, and offers a stable regulation framework, the study also emphasize that without a consistent and proper policy, net zero implementation is far from easy to realize, especially in developing countries. This aligns with the reality that policies that only focus on short term benefit ended up having a harder time striving for clean energy matters. The main key to achieving the state of net zero emissions is transition towards renewable energy. Findings are that with the increase in usage of renewable energy, a decrease in carbon emissions also happens (Tang et al., 2026). Moreover, reflect that the development of renewable energy not only affects the environment

but also increases the country's energy resistance towards changes, with the main obstacle identification being limited infrastructure, high investment cost, and dependency on technology that has yet to be proven (Benitez S., 2026). Climate change became a main theme contained in almost, if not all study regarding net zero emissions. The realization that global temperature is increasing along with the intensity of natural disasters also became the driving factor of net zero emissions (Suryawan et al., 2026). Another aspect that doesn't lack importance compared to the others is the economic aspect, as it backs the implementation of net zero emission. Market base approach, such as green investment continuously increasing in usage (Thiam & D.R., 2011). Further study also points out the same thing, though also shedding light on the obstacle within that is the domination of developed countries and the imbalanced investment access (Cheng J., 2026). Technology is the main enabler in achieving net zero emissions, existing studies also identify a number of it such as carbon capture and storage, as well as renewable energy systems (Tang et al., 2026). Developing countries face even more complex obstacles in achieving net zero emissions. Limited infrastructure and funds are also the main obstacle, social aspect also receives attention from recent literature, placing attention on how important energy justice is.

Data Screening by Inclusion/Exclusion Criteria

The inclusion criteria required publications to be written in English, indexed in the Scopus database, and directly related to the study themes of net-zero emissions, energy policy, sustainable development, and developing countries. Publications were considered relevant to developing-country contexts when they explicitly addressed developing countries, emerging economies, or individual countries internationally recognized as developing economies within their titles, abstracts, or author keywords. Publications outside these thematic criteria were excluded from the analysis (Cheng J., 2026). The study focuses solely on English-language published articles. Reflecting the dominance of the English language in scholarly matters and bibliometric certainty. The exclusion of non-English publications may appear detrimental regarding insights from non-Western regions, though many non-English publications with abstracts designed in English are indexed in a way by Scopus, hence moderately counteracting potential bias (Morsy et al., 2024).

Data Processing and Data Analysis Using Bibliometrix

The bibliometric analysis was conducted using the Bibliometrix package implemented in RStudio, which provides a comprehensive framework for quantitative science mapping and bibliometric analysis. The analysis was performed using R (version [insert version]) and Bibliometrix (Wang et al., 2020) with Biblioshiny employed as the graphical user interface to facilitate data exploration and visualization. The bibliographic records were exported directly from the Scopus

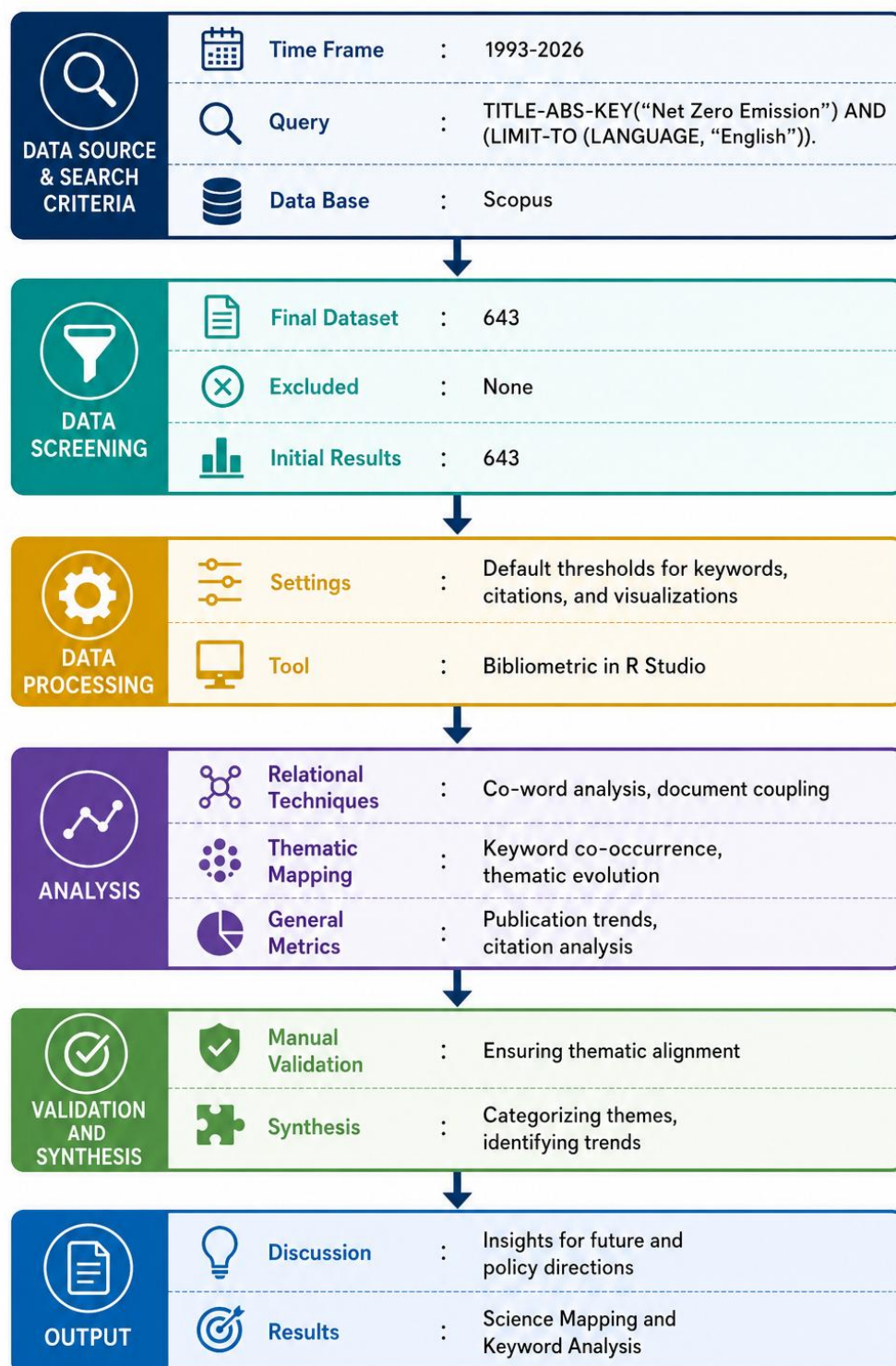
database in BibTeX format, ensuring full compatibility with the Bibliometrix package. Assuring consistency and compatibility all the while eliminating human error and addressing essential bibliometric tasks. The analysis consisted of General Metrics, which analyzed the dataset for publication trends, citation counts, and source contributions, mapping an overall view of the research landscape. Following behind are the usage of Keyword Co-Occurrences and Thematic Mapping to cluster principal and prominent thematic trends alongside research themes, giving an overview of how those themes have changed over time (Princiotta et al., 2014). To reveal the link between publications and thematic groupings, techniques such as co-word analysis and document groupings were utilized. To further minimize researcher bias, standard citation thresholds and keyword inclusion parameters are included as well.

Prior to analysis, the bibliographic dataset underwent a data-cleaning procedure to improve consistency and analytical accuracy. Duplicate records were examined and removed where necessary, while author names and keywords were standardized to minimize inconsistencies caused by spelling variations, abbreviations, and singular-plural forms. Author Keywords and Keywords Plus were harmonized through manual normalization to ensure that conceptually identical terms were analyzed as single entities. Only peer-reviewed English-language publications retrieved from the Scopus database were included in the final dataset

Validation and Synthesis

Manual validation is carried out by matching selected documents against the research objectives and thematic verification, such as title, abstract, and keyword contributions to net zero emission, alongside energy policy, sustainable development, and developing countries were checked. Lined up with past studies and researches to validate the systematic literature reviews. Specifying methodical procedures is necessary in order to minimize bias (Zaman et al., 2018). Inclusion and exclusion criteria, search strategies, assessment of homogeneity and heterogeneity are referred by internal validity (Mehmood et al., 2023). Meanwhile, external validity is obtained by describing the research scope and its limitation hence giving us a generalization of our findings and how far that generalization could be applied. Suiting the research objectives of the study, these analytical techniques are all carefully applied. The co-word analysis approach highlighted major clusters such as “energy policy”, “sustainable development”, and “developing countries”. The techniques themselves shed light on the connections between publications that show the conceptual overlaps and foundation in the field, with the shared references. A gradual change in focus of research could be reflected by thematic evolution analysis as it tracks trends over time. Citation impact-based studies, timeframes identification, and themes clustered publication are involved in the synthesis of findings alongside highlighting the emerging trends and gaps

for directions on future research (Elavarasan et al., 2020). Each phase of study and analysis is documented in detail to maintain transparency. The query parameters, analytical steps, and dataset numbers are outlined explicitly.



RESULTS

Science Mapping

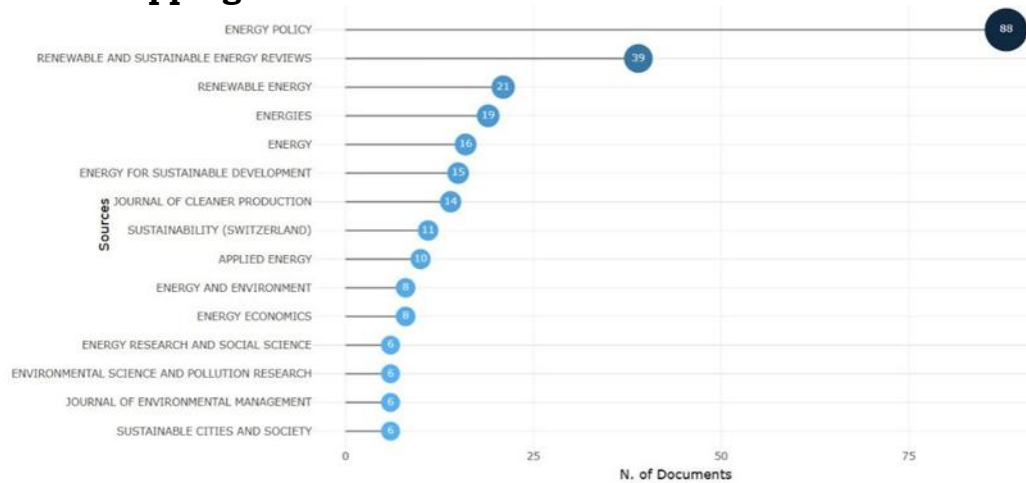


Figure 1. Most Relevant Sources

Figure 1 Number of documents are the number of journals along with literatures that's cited and referenced based on the data that shows prominent tendency from sources that are tightly correlated to policy, so does reviews regarding sustainable and renewable energy, counting up to 88 literatures followed by renewable and sustainable energy reviews with 39 literatures and 21 literatures from renewable energy as the three main sources. This is in accordance to the main focus from the study implemented and enough to fulfill the source of data used to decides outcome and guidance in the study relating to sustainable energy and the realization of SDGs towards achieving net zero emission in which is inseparable from the related countries' policy. It contains the most relevant sources of publication in the field of study, making a great contribution of knowledge regarding the themes and topics. The largest number of documents belongs to "Energy Policy," placing attention on its lead role for research into this topic. The rest such as "Renewable and sustainable energy reviews", "Renewable energy", and "energies", give further volume to the documents. Sources as listed suggest the role of analysis conducted in its policy. This figure also underlines the increasing interest and knowledge regarding SDGS and renewable energies across disciplines, along with key journals as the core of this study. All throughout, each finds coexist and supports the interdisciplinarity between each source.

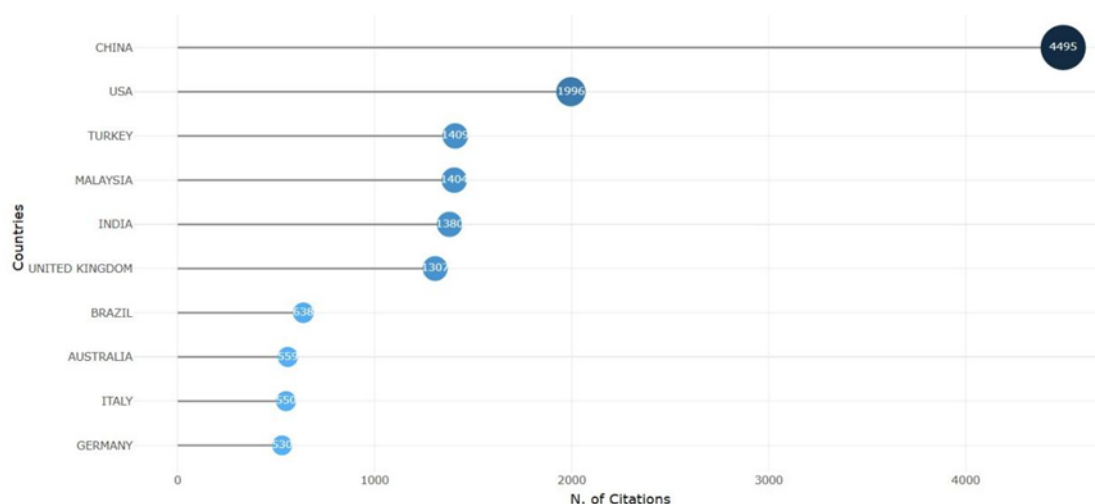


Figure 2. Most Cited Countries

Figure 2 shows the number of citations based on countries relating to SDGs and sustainable energy to realize net zero emissions. Based on the data served, it could be implied that citations regarding SDGs and sustainable energy are dominated by Asian countries, with them 2 developing countries, such as Malaysia and India, along with developed countries, that is China and Turkey. High citations from China show prominent realization across scholarly communities regarding the study. Next, the USA and Turkey also show a big enough contribution, followed by Malaysia and India. These countries are the front line in the development and implementation of studies regarding sustainable energy and SDGs. The main focus being the number of countries that have done research showing huge global attention despite the gaps between each country's capability in doing the study.

Keyword Analysis



Figure 3. Tree-Map of Keywords

Figure 3 presents a Tree-Map of keywords from countless literatures with sub-grouping keywords into somatic sub-categories. This is done to state more clearly the families of research, making interpretation easier as it separates into several groups. The first group, foreground and frameworks, energy policy (12%), sustainable developments (12%), and developing countries (11%) are the keywords countries the main research themes for this study, keywords as such place emphasis on regulatory frameworks and global attention including specifically developing countries' concern and attention that shape the trajectory of the net zero emission realization. The second group contains terms related to environmental and systemic impacts, emphasizing keywords such as renewable energy and its resources, along with the emerging role of developing countries, rising concerns, and growing awareness of sustainability and renewable energy, highlighting how the world could promote renewable energy and minimize reliance on fuels that cause emissions. The third group comprises socio-economic themes, including economics (2%), investment (2%), and planning (2%), which signify a concern with socio-economics and economic participation in the realization of net-zero emissions, indicating a future towards a participatory and market-based approach. The fourth set extends technological innovations, giving a view of technical aspects of the study, for example, wind power and electricity generation. The terms reflect advances in the technological aspect that could help the realization of net-zero emissions. The fifth group paid attention to regional and contextual studies, proven on keywords like China and India, suggesting a cluster of region-specific case studies. Providing geographical-based information and observations that are locally studied and implemented.

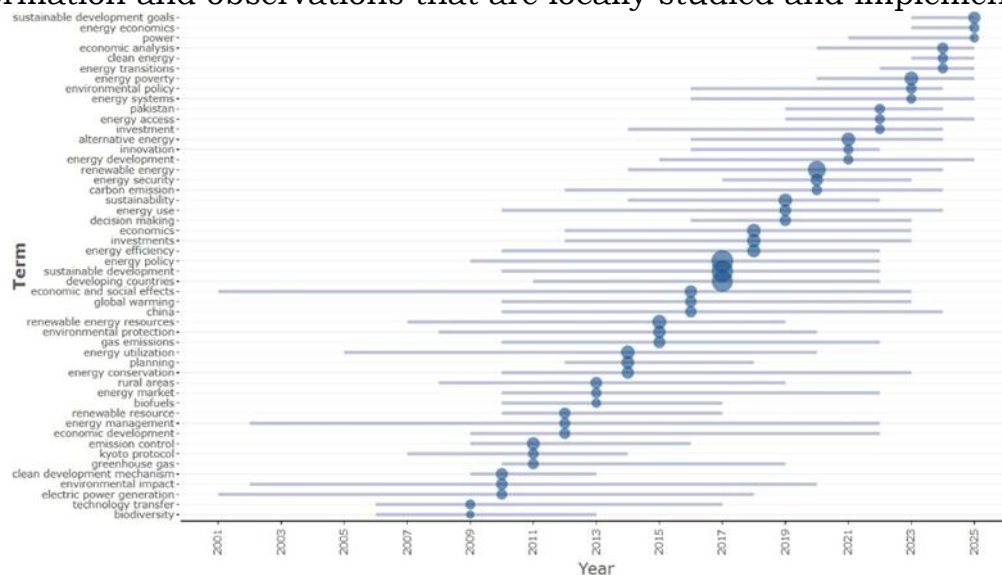


Figure 4. Trend Topics

Figure 4 shows the analysis of trend topics regarding the policy and renewable aspects of energies. The figure shows how certain terms have matured and developed, becoming more prominent as focus shifts and areas of interest emerge. "Energy policy" stands with high frequency compared to other terms, even more in the latest years, which we could

imply to growing interest in the regulatory aspect of the study. Increased usage of "renewable energy", "sustainable development", and "developing countries" reflects further concern to include environmental and global events. Pulling on the red thread, such usage of terms means increasing in recognition of the need for a transition towards the realization of SDGs and renewable energy to make net zero happen. Other key trends also include "technology transfer" to "energy economics". This trend is more general yet will obtain further attention because of the development and indication of a trend towards an approach to economic and technological dimensions. Terms regarding the SDGs and sustainable energy with time could be divided into several main topics deriving from the year 2001 to 2015, where focus is pressed on the usage and searches of terms related to the global phenomenon that is climate change, alongside energy and fuels. Next, from 2016 to 2025, shows prominent role of developing countries, followed by attention that's given to policy regarding the environment and climate.

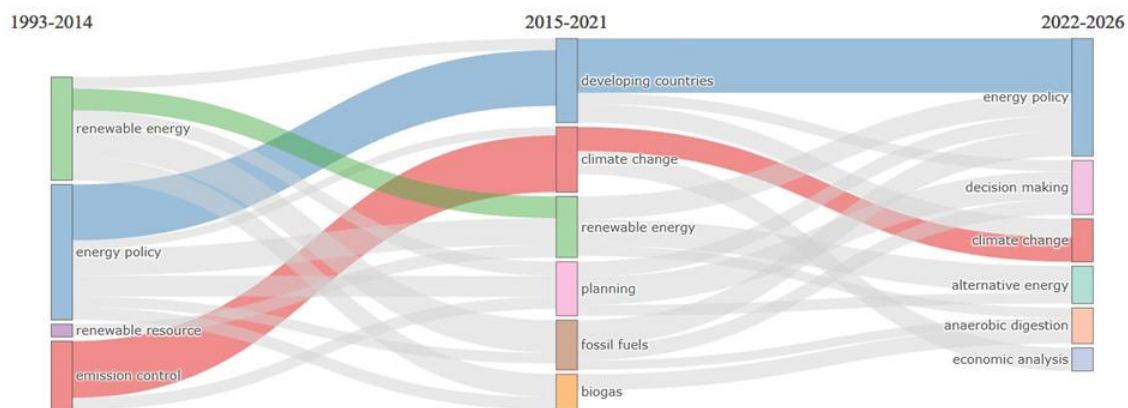


Figure 5. Thematic Evolution

Figure 5 presents the thematic evolution generated by the Bibliometrix software based on keyword co-occurrence across the predefined time periods. The connections among themes represent the continuity and transformation of research topics identified from the bibliometric mapping. The following discussion provides the authors' interpretation of these mapping results in relation to the broader development of net-zero emissions research. Figure 5 illustrates the evolution of themes on policy regarding renewable energies from the years 1993 to 2026. The diagram portrays the ups and downs of important themes within three-time frames: 1993-2014, 2015-2021, and 2022-2026. 1993-2014 as the first period shows relevant tendencies, the basic thematic knowledge where foundation regarding this study is laid, renewable sources, emission control to specifically "energy policy" shows regulatory considerations at the time to make changes and shifts to a ripe realization of development regarding talked about issues. Stepping onto 2015-2021, a diversification of problems and topics happened, the foreground make way for a more specific issue such as fossil fuels, planning and biogas but most prominently is the shredded light on climate change, this implies that bigger attentions are given concerning

emerging phenomenon that starts to cause global concerns at this point the field moves from general concepts to a more concentrated focus on multiple sectors. Ended with the scope of years 2022-2026, "energy policy" remained a connected theme with no sign of fading over time. This implies that regulatory frameworks to guide countries in their effort of realizing a sustainable and renewable energies, including efforts to net zero emission implementation, are key. This evolution shows a maturing of the theme, whereas earlier exploration on general themes gives way to diversification before finally ending with focused interest in certain aspects regarding energies, both its renewable aspect and its policy, becoming a core topic of the intended study.

Before the year of 2015, "energy sustainability" had yet to exist as an individual study discourse. Instead planted and subordinated as an energy policy framework with a more vast content. Energy policy ended up becoming one of the two dominant issues from the period of 1993-2014. Meanwhile, renewable energy is the parallel of policy that serves as an umbrella for renewable resources and emission control. From 1990 until 2000th the main focus of energy studies was centered on energy security instead of sustainability. Renewable energy and emission control are seen as goals to be achieved instead of an individual field of study, hence their position under energy policy, and why the blue ribbon is wider. The ribbon of renewable energy by the year 1990 is considered thin, as implementation of renewable energy was not realized by the year 2010. Sustainable energy was more focused on appropriateness study and pressing cost, which are all seen as energy elements instead of a sustainable framework. The emergence of the Paris Agreement in 2015 was the catalyst needed to separate sustainability as its own field of study, aimed at setting down universal goals on preventing the continuous rise of global temperature. For the first time after all those years, energy sustainability gained its own independent field of study, hence by 2015 to 2021, developing countries and climate change were given bigger attention. Reflecting that the community left its view that energy sustainability is not merely a goal but also a framework.

DISCUSSION

Covering inferences from 1993-2026 the bibliometric analysis in terms of sources is dominated by documents relating from energy policy, a field that proves to have a prominent effect on how a country decides its steps and decisions regarding net zero emission, alongside the fact that developing countries are starting to catch up to developed countries in regards to placing attention to the matter of sustainable energies and its policy as a cornerstone to realize net zero emission (Gao et al., 2007). A shift is happening from broad terminologies used, such as "energy policy" and "emission control," to a much more specialized norm like "decision making" and "climate change," reflecting the maturation of the field. Early studies and investigations focus more on general and practical implementations of energy policy alongside renewable aspects and emission control (Yue et al., 2003). One theme that retains its dominance is "energy policy," which places key importance regarding

settings on regulatory settings, supported by attention being given to decision making and socio-economic matters (Onyeneke C.C.; Nwajiuba, C.U., 2025). Shown by the thematic evolution and tree map of keywords, research regarding net zero emissions contains interdisciplinary dimensions interfacing policy, economics, technology, and social dimensions. Planning and decision making found in the trend signify an increasing recognition regarding the role of energy policy in realizing net zero emission, which will be incapable of standing solely by itself unless backed and supported by the progress and influence from economic and social aspects alongside the development of technology (Uddin et al., 2025). Environmental and energizing themes such as “renewable energy”, “climate change”, and “alternative energy” stress their prominence in the scholarly study. Studies are also done based on abstracts that is summarized as such mapped in the table below:

Table 1. Systematic Literature Review Table

No	Main Theme	Sub Theme	Research Focus	Main Findings	Research Gap
1	Energy Policy	Energy Regulation	Role of policy in NZE	Policy is a dominant factor	Implementation is still far from optimal
2	Sustainable Development	SDGs (7 & 13)	NZE integration with SDGs	NZE supports sustainable development	Trade-off happening between the economy and the environment
3	Renewable Energy	Renewable Energy	Fossil transition to renewable energy	Significant rise in clean energy	Limited infrastructure
4	Climate Change	Emission and Global Warming	Effect of climate change	NZE as the main solution	Irreversible effect
5	Developing Countries	Developing Countries	Obstacle in realizing NZE	The capacity gap between countries	Funds and technology limitations
6	Economic Factors	Investing and Market	Economic role in NZE	The market-based approach is increasing	Investment access imbalance
7	Governance	Decision Making	Government role in policy	Policy decides the direction of NZE	Lacking inclusion
8	Social Aspect	Energy Equity	Social effect of NZE	Importance of Equity	Marginal community ignored
9	Environmental Impact	Emission Control	Carbon emission mitigation	Emission reduction focuses	Adaptation lacking
10	Technology	Energy Innovation	Carbon capture and energy technology	Technology supports NZE	Most are yet to be proven

Each finding highlights prominent challenges regarding the realization of net zero emissions. Not only should attention be focused on policy solely, but a concentrated effort should also be shown on environment, technology, and socio-economic dimensions, such as economic analysis, emission control, and seeking renewable energy alternatives. The mentioned gaps should give way for future researchers to fill. Tackling the matter would require not only navigation from policymakers but also industry, government, innovators, and academia (Zhang et al., 2008). Based on prior studies pressing on energy policy followed by emission control and soon maturing to planning and decision making, the role derived from the governance and policymakers is seen as critical. Additionally, underlying themes serve as a stimulus for future planning regarding energy and environment that could back the effort of realizing net-zero emissions (Ikejemba et al., 2017). Sustainable development, along with renewable energies are enabler for net zero emissions that should be implemented, this in practice, requires investment from a viable economic system. Securing market and social stability will be a cornerstone for emerging technologies and the innovation following it (Reyes-Mercado et al., 2016). The keyword co-occurrence analysis and thematic evolution indicate that energy policy remains the dominant research theme, while governance and decision-making emerge as growing areas of scholarly attention. These findings suggest that future policy research should focus on improving governance mechanisms that support decentralized renewable-energy implementation, particularly in developing countries. The bibliometric mapping identifies technology, renewable energy, and innovation as emerging research clusters, indicating increasing scholarly attention to technological solutions for achieving net-zero emissions. The relatively limited linkage with governance and financing themes suggests that future research should examine how technological innovation can be integrated with institutional and policy frameworks in developing countries. The governance framework should stream far enough to reach rural areas that are still facing difficulties regarding energy poverty, knowing it's still a common occurrence in developing countries. Balanced central and decentralized policies along with renewable and sustainable energy-based efforts, such as the use of solar systems to hydro energy, should be given further attention; this way, the realization of net zero emissions should be achievable all the while making sure that equity is enabled (Sagar & A.D., 2005).

Table 2. Bibliometric Findings, Research Gaps, and Future Research Directions

Bibliometric Finding	Identified Research Gap	Future Research Direction
Energy policy is the dominant research theme	Limited studies on policy implementation	Comparative policy implementation in developing countries
Renewable energy research continues to expand	Financing and infrastructure remain underexplored	Green finance and investment mechanisms

Climate change becomes increasingly integrated with NZE studies	Adaptation strategies remain limited	Climate adaptation and resilience
Governance and decision-making emerge as new themes	Limited institutional analysis	Multi-level governance and institutional capacity
Technology and innovation receive growing attention	Weak integration with social dimensions	Technology adoption and energy justice

Table 2 summarizes the relationship between the principal bibliometric findings, the research gaps identified through the science-mapping analysis, and potential directions for future research. This synthesis strengthens the linkage between the empirical bibliometric evidence and the practical implications proposed in this study.

CONCLUSION

Presenting a detailed bibliometric analysis of net zero emission literatures this study presents prominent insight into the development and trends regarding this field of study. Limitations identified in this study offer opportunities for future studies and research. Starting from the fact that the study has only made contact with and considered English language publications based on the Scopus database. This might have left out other important publications regarding net zero emissions in developing countries and other scholarly published websites. The scope of the study is also solely focused on one methodology, hence unable to talk much about other methods and the point of view given by it. Impacts and the effort to realize net zero emission in developing countries has been shredded light by this study, yet marginalized communities are still barely touched. Focus on concepts and matters such as energy and net zero emission has always received attention and is still increasing till this day, yet further analysis of governmental and policy roles that's been talked and brought upfront has only been surface-level. These limitations need to be tackled in order to design a proper and equitable policy that covers all layers and aspects of a community. Dependence on technology also grows yet an innovation and media that has yet to be proven couldn't be held onto; risk mitigation and underlying factors of their success should be studied further. With the amount of literature and research referenced in this study, it reflects the development and growth of this field of study, later backed by the overcoming the limitations, if done precisely and properly, would allow the full acknowledgement and understanding of realizing net zero emissions in developing countries, if not globally.

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