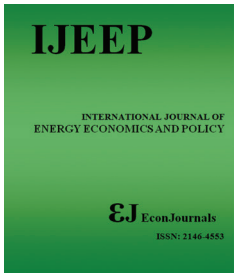

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Energy Transition and Renewable Energy Industry: A Bibliometric Analysis of Literature

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ABSTRACT

The energy transition has emerged as a critical response to climate crises, fossil fuel dependency, and sustainability imperatives. This study explores the intersection between the energy transition and the renewable energy industry, emphasizing the role of RE technology integration into industrial value chains. This article aims to conduct a literature review to map scientific literature on the integration of renewable energy technologies within industrial value chains. It identifies key research themes, methodological trends, and the economic, technological, and policy challenges shaping this domain. This study combines bibliometric analysis with qualitative content analysis, accessed through leading databases. The selection process, through clear inclusion and exclusion criteria, used the PRISMA 2023 protocol. Through VOSviewer, Bibliometric mapping identified significant authorship and thematic clusters patterns, with NVivo enabling consideration of conceptual relationships and dominant research themes across literature. The review identifies five dominant thematic clusters: renewable energy & energy transition, carbon neutrality, supply chain economics, technological innovation, and public policy. It highlights increasing interdisciplinarity, a convergence of qualitative and modeling approaches, and the need for deeper exploration of governance and social impacts. The study contributes a structured mapping of the RE-industrial integration literature and provides a valuable foundation for future research.

Keywords: Energy Transition, Renewable Energy Industry, Value Chain, Bibliometric Analysis
JEL Classifications: T2, Q5

1. INTRODUCTION

In response to the climate emergency and the increasing strain on fossil fuel resources, renewable energies have progressively emerged as a cornerstone of the global energy transition (*Statistiques de Capacité Renouvelable 2020*). Research and development in this field have experienced rapid growth, driven by adoption sustainability policies and new industrial strategies aimed at integrating renewable energy technologies into value chains (*Global Energy Review 2021 – Analysis*, 2021). Studies show that such integration is a key pathway to enhancing nations' energy sovereignty, improving their competitiveness, and reducing their carbon footprint (IRENA, 2021).

However, this transformation comes with significant challenges. On one hand, the evolution of energy technologies and their adoption require the development of a new value chain. On the other hand, resource management and the increasing interdependence among actors within these chains introduce new dynamics of governance and competitiveness. This situation is even more pronounced in developing economies, which strive to build integrated, efficient, and resilient local value chains for their renewable energy industries (Kenny et al., 2024).

The existing literature reveals a significant gap in the current body of knowledge. Only a few articles have addressed the impact of the renewable energy industry on the energy transition. Therefore, this paper presents an extensive literature review on the renewable energy industry, with a particular focus on the integration of renewable energy into value chains and its impact on the energy transition. The main objective is to provide an overview of the

key drivers of the energy transition, including innovative strategies and technologies. Special attention will be given to analyzing how structuring value chains that integrate renewable energies influence energy transition.

To address this question, a scoping review was conducted, analyzing a total of 74 articles selected from an initial pool of 630, drawn from reputable databases: Scopus, Web of Science, Cairn, ScienceDirect, and Springer. The analysis relied on bibliometric techniques using VOSviewer to identify citation co-occurrences and collaboration networks among authors, as well as on a qualitative content analysis using NVivo software. The article selection was based on inclusion and exclusion criteria focusing on relevant publications from 2014 to 2024.

The study of publications on the renewable energy industry allows for the analysis of author collaborations and the structure of co-authorship networks in this field. It also aims to trace the evolution of publications on the energy transition over the years and to identify the main databases used to index them, evaluating their relative contribution. In addition, it examines the most common types of publications and the most influential scientific journals publishing on this topic. Identifying dominant concepts and keywords helps establish relationships between them and provides a better understanding of research dynamics. Finally, the analysis of major thematic clusters highlights the main trends and recurring themes in academic work on the energy transition.

The article begins with a detailed presentation of the methodology adopted for the literature review. This includes rigorous article selection criteria, the consulted databases, as well as analytical tools such as VOSviewer, used for scientific mapping, and NVivo, used for qualitative data analysis. The article selection process was structured using the PRISMA diagram, ensuring a transparent and reproducible approach. The results of the analysis are then presented, covering various aspects such as author relationships, annual publication trends, distribution by reference type, and analysis of scientific journals. Special attention is also given to keyword co-occurrence analysis and the most frequently used methodologies by authors. The article concludes with a synthesis of the main findings of the study and opens avenues for future research.

2. LITERATURE REVIEW

The analysis of recent scholarly articles offers a rich, nuanced, and multidimensional perspective on the global energy transition and the development of renewable energy value chains. Across a wide range of contexts, approaches, and case studies, several cross-cutting trends emerge that shed light on both the challenges and the transformative levers involved.

Many studies emphasize the effectiveness of well-targeted public policies. For instance, improvements in public transport infrastructure are often linked to significant reductions in air pollution, while other measures, such as expanding lanes for private vehicles, tend to contradict climate goals (Bampatsou et al., 2024). At the same time, the potential of renewable energy sources is frequently highlighted. Offshore wind power, for example, is projected to meet up to 70% of a region's electricity demand with a 300 MW installation, provided that investments in complementary infrastructure are also made (Stančin et al., 2022).

Another recurring finding concerns the role of energy communities. These structures show promise in promoting decentralization and citizen engagement, yet their growth is hindered by limited institutional support and low public awareness (Li et al., 2024). On the technological side, interruptible loads are increasingly seen as a key tool to enhance energy security and reduce dependence on thermal plants, while also facilitating the integration of intermittent renewables (Fan et al., 2022).

Several studies draw attention to the issue of critical raw materials. The case of copper is especially telling: in a strict energy transition scenario, cumulative demand between 2010 and 2050 could reach nearly 89% of the currently known reserves, highlighting a strong dependency on countries such as China and Chile (Seck et al., 2020). In parallel, some authors suggest that rising demand can foster technological learning, particularly when paired with strong industrial policies (Landini et al., 2020).Others explore the use of sustainable raw materials, such as used cooking oil for biodiesel, which can reduce costs while promoting more responsible resource management (Munir et al., 2023).

Other studies highlight the role of regional energy trade and mechanisms such as feed-in tariffs (FIT), which have proven effective in boosting renewable energy investments (Nakano et al., 2017a). Sectoral integration, such as linking green hydrogen production to ammonia synthesis, is also shown to be technically feasible, as long as it is adapted to local industrial realities (Pan et al., 2023).

On the industrial side, the electrification of manufacturing processes using renewables is seen as a win-win strategy: it reduces emissions while boosting productivity (Sletterød et al., 2021). However, the implementation of such strategies must remain socially balanced, requiring fair fiscal systems and accessible financing (Wang et al., 2023). Local capacity-building efforts are also essential and depend heavily on enabling regulatory frameworks (Rixhon et al., 2022). Under specific cost and infrastructure conditions, the development of green hydrogen also appears economically viable (Landini et al., 2020).

Energy modelling confirms the overall feasibility of the transition, while stressing the magnitude of investments needed, particularly in smart grids and infrastructure (Zheng et al., 2022). Decentralized microgrids are emerging as promising alternatives in underserved areas, while the digitalization of energy management systems contributes to more flexible and responsive demand management (Datta and Krishnamoorti, 2019).

From an economic standpoint, the declining cost of solar and wind technologies has made them increasingly competitive. However, volatility in the markets for key materials such as lithium and silicon persists (Chen et al., 2023). In this context,

skill development and technical training are seen as key levers for sustainable local adoption (English et al., 2022).

The social dimension is also critical. Public acceptance, especially of wind energy projects, remains essential to project success. When citizen participation is well-structured, it enhances transparency and encourages public support. Conversely, some rural communities perceive the transition as a threat to their way of life, highlighting the need for equitable benefit-sharing (Connelly and Xydis, 2021; Zou et al., 2023).

In terms of industrial strategy, several studies stress the need to relocate strategic activities to improve supply chain resilience (Yu, 2024). Regarding hydrogen development, return on investment is estimated to become tangible within 10 to 15 years, depending on the scenario (Wang et al., 2023).

Regional energy integration, particularly in North Africa and Asia, emerges as a promising avenue for economic and geopolitical cooperation, especially through shared infrastructure (Fattahi et al., 2021). Cross-border projects could also facilitate access to international climate financing (Mu, 2024; Selmi et al., 2021).

Regulatory frameworks play a central role in shaping energy system performance, as shown in several regions, including Latin America (Shinkevich et al., 2021; Simbolon and Simbolon, 2024). Meanwhile, predictive energy management technologies, including artificial intelligence, are helping to better integrate intermittent renewables into national grids (Sgarbossa et al., 2023).

Finally, fiscal tools—when combined with compensation schemes for energy-intensive industries—are critical for maintaining industrial competitiveness without undermining climate goals (Sen and Mokkhamakkul, 2022; Serrano-Puente, 2021). The development of green industrial clusters with integrated local governance is also identified as a transformative lever for sustainable growth (Sam et al., 2024; Seck et al., 2020).

The findings from numerous additional studies ((Munim et al., 2023; Mustikaningsih et al., 2019; Nekrasov, 2023; Olanrele et al., 2020; Peneder et al., 2022; Petavratzi et al., 2022; Prochaska and Schiller, 2021; Proctor, 2023; Purnomo et al., 2020; Rachidi et al., 2021; Rafei et al., 2022; Sam et al., 2024) reinforce these conclusions. They highlight the importance of involving stakeholders early in the project lifecycle, embedding innovation into local practices, and maintaining alignment between social, economic, and environmental goals. Comparisons between countries in the Global North and South (Martín-Marroquín et al., 2024; Mathews et al., 2023; Matsuo and Schmidt, 2019; Meyer et al., 2023; Michieka et al., 2022; Motowidlak and Bukowska-Piestrzyńska, 2024; Muangmee et al., 2022; Munim et al., 2023; Mustikaningsih et al., 2019; Nekrasov, 2023) reveal persistent disparities in access to finance, technology, and skills. Recent studies (Eneis et al., 2022; Erazo-Cifuentes et al., 2022; Falbo and Ruiz, 2019; Gan et al., 2022; Generalov, 2024; Gholipour et al., 2024; Hagelüken and Goldmann, 2022; Hansen et al., 2022; Jenniches et al., 2019; Lamadrid et al., 2024; Lema et al., 2021) warn of emerging risks such as speculation, technological monopolies, and the marginalization of certain regions when transitions are not managed inclusively.

Overall, the literature confirms that a successful energy transition requires an integrated, inclusive, and context-sensitive approach, anchored in systemic thinking, multi-level coordination, and strategic foresight.

Given the richness of the literature reviewed and the complexity of the issues surrounding the energy transition, it became essential to adopt a clear and structured methodological approach. This study aims precisely to move beyond fragmented perspectives by offering a cross-cutting analysis that brings political, economic, social, industrial, and technological dimensions into dialogue. In doing so, it makes an original contribution to literature by highlighting the deep interconnections between these facets. To achieve this, a twofold methodology was employed: a bibliometric analysis, used to identify major research trends and scientific networks, and a qualitative content analysis, designed to explore in greater depth the recurring ideas, concepts, and themes across the selected publications.

3. METHODS

To identify the various studies on the relationship between the energy transition and the renewable energy industry, a scoping review of scientific articles was conducted, based on comprehensive content analysis.

To complement this literature review, a dual analysis was carried out: a bibliometric analysis using VOSviewer, which enabled the visualization of scientific trends and networks, and a qualitative analysis using NVivo, which structured the content and highlighted the main recurring concepts in the analyzed publications.

3.1. Article Collection

A bibliographic search was first conducted covering the period from 2014 to 2024 across five indexed scientific databases: Scopus, Web of Science, Cairn, ScienceDirect, and Springer. The following search queries were used:

("Value chain") AND ("renewable energy industry"),

("Energy transition") AND ("renewable energy"),

("Life cycle") AND ("renewable energy production"),

("Renewable energy") AND ("global supply chain"),

("Energy value chain") AND ("renewable energy").

To ensure that the literature review aligns with our research objectives, the following inclusion and exclusion criteria were applied:

3.1.1. Inclusion criteria

- Articles published between 2014 and 2024, starting 1 year before the 2015 Paris Agreement.

- Quantitative articles with case studies.
- Qualitative articles and literature reviews.
- Articles written in French or English.
- Articles published exclusively in indexed journals, to ensure the relevance and quality of the information.

3.1.2. Exclusion criteria

Theses, book chapters, and conference papers.

For the initial collection, the number of articles recorded using Zotero (https://www.zotero.org/) was 630. These articles were manually and individually reviewed based on the PRISMA method. Manual screening after the search is crucial to ensure the relevance of the selected literature (Chen et al., 2024). Once this step was completed, the final result consisted of 74 articles characterized by their relevance and alignment with the objective of this study.

3.2. Prisma Diagram

The PRISMA 2020 diagram describes the study selection process for a comprehensive review (*PRISMA 2020 Flow Diagram*, s. d.) represented in Figure 1.

Studies were identified from several databases, including Cairn, ScienceDirect, Scopus, Springer, and Web of Science, with a total of 630 records. A total of 395 records were screened, and 185 were excluded. During the eligibility assessment, 200 full-text articles were examined, but a significant number were excluded for various reasons. In the end, 74 studies were included in the review.

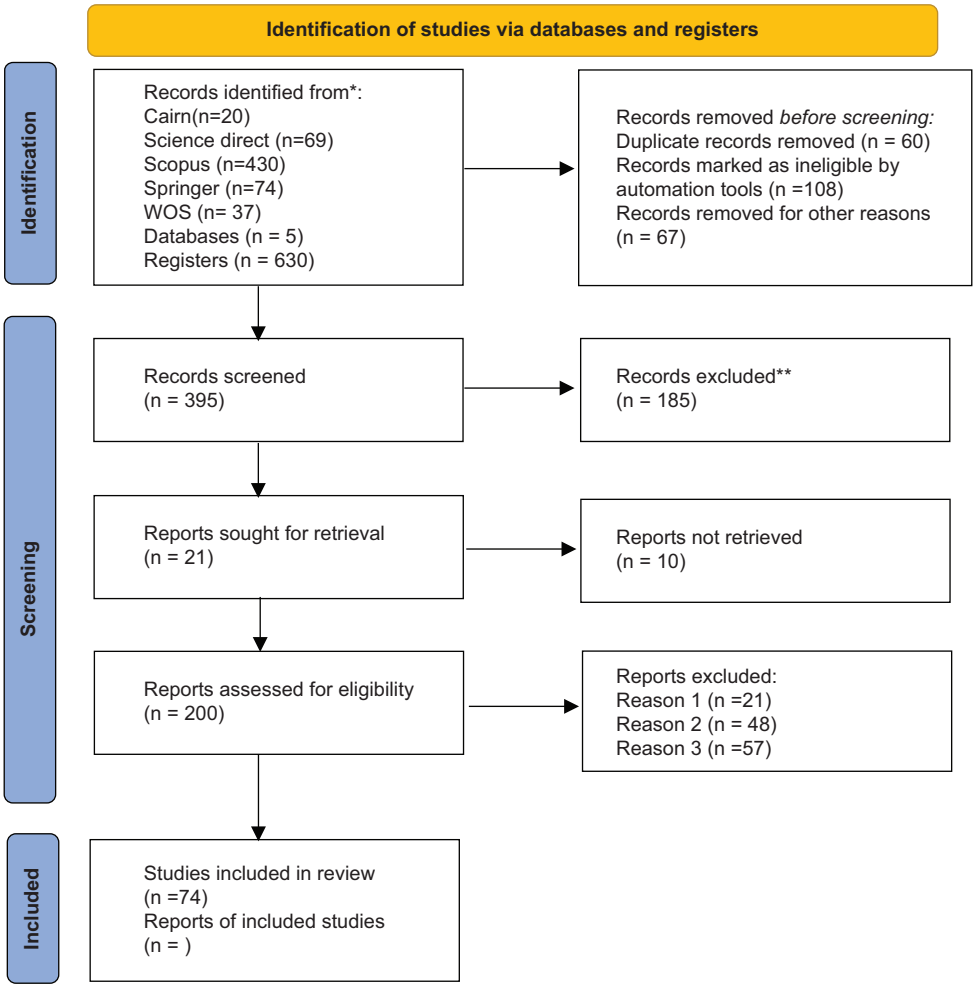
4. RESULTS AND DISCUSSION

4.1. Co-authorship

To analyze the relationship between authors, we set a minimum threshold of two publications per author. The results are illustrated in Figures 2 and 3. The co-authorship analysis performed using reveals a network of collaborations among researchers working in the field of renewable energy. The visualization shows several distinct clusters, each represented by a different color, with each cluster corresponding to a group of researchers who frequently collaborate.

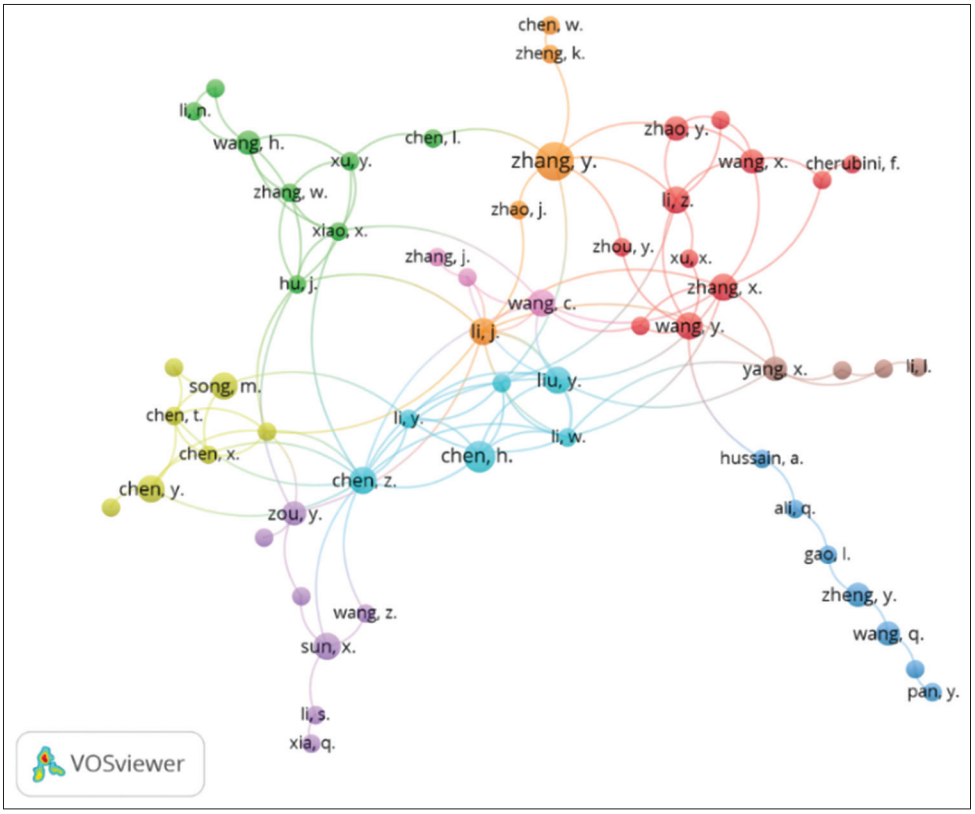
The graph highlights approximately 5 to 6 main clusters, suggesting that research in this field is driven by several research groups with strong internal collaboration and, in some cases, inter-cluster interactions. For example, the red cluster appears to represent a dense network centered around researchers such as Zhao Y. and Zhang X., who are at the core of numerous collaborations.

Figure 1: PRISMA diagram



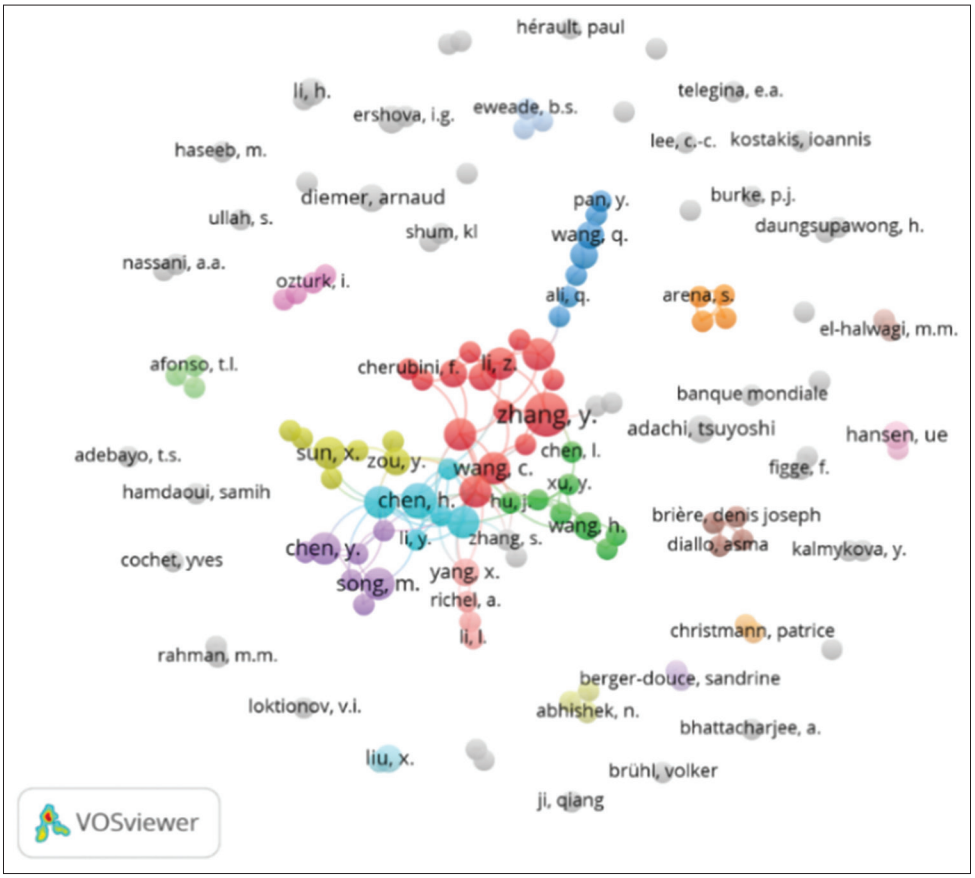
Source: Authors

Figure 2: Analysis of author relationships



Source: Authors (VOSviewer)

Figure 3: Co-authorship analysis



Source: Authors (VOSviewer)

Links between clusters (represented by lines connecting differently colored nodes) indicate that some teams collaborate beyond their respective groups, potentially reflecting multidisciplinary or international projects. For instance, Chen Z., located at the center of a large light blue cluster, collaborates with researchers across several other clusters, suggesting a central role in an international or interdisciplinary project.

Some authors, such as Li J., Wang C., and Zhang Y., appear at the intersections of multiple clusters, implying that they likely play a key role in facilitating collaboration among different research groups. Their centrality within the network may point to significant influence in advancing research in the field.

Meanwhile, a few researchers, such as Pan Y. and Zheng Y., appear relatively isolated in the network (notably in the lower right part), suggesting that they may be working in more specialized or emerging subfields, or that they collaborate less frequently with other groups represented in this analysis.

4.2. Number of articles published per year

Figure 4 shows the distribution of sources used by year. It is evident that the number of sources increased significantly in 2022, followed by a decline in 2023 and 2024. This trend indicates a peak in publications or research activity related to renewable energy during that period.

4.3. Analysis of Scientific Journals

The ranking of the top ten scientific journals based on publication frequency highlights the most influential journals in the fields of energy, economics, and sustainable development. Frontiers in Energy Research leads with 18 publications, followed by the International Journal of Energy Economics and Policy with 16 articles, illustrating their key role in disseminating research on energy transition and energy policies. Resources, Conservation and Recycling (8 articles), Mineral Economics (7 articles), and Review of Evolutionary Political Economy (6 articles) reflect the importance of economic, environmental, and evolutionary aspects in studies on resources and energy. Resources Policy and Energy Economics (6 articles each), along with Environment, Development and Sustainability (4 articles), confirm this orientation toward an approach that integrates economics, sustainability, and resource governance. Finally, World Development and the International Journal of Production Economics (4 articles each) complete the ranking, indicating a growing interest in the impact of economic development and production systems on the energy transition. This ranking, presented in Table 1, thus highlights a strong concentration of publications in a few specialized journals and underlines the interdisciplinary nature of research in this field.

4.4. Co-occurrence Analysis

4.4.1. Word cloud generated via NVivo

The word cloud generated via NVivo highlights the key terms used in the imported articles on the energy transition and the renewable energy industry, as shown in Figure 5.

Value chain, supply chain, costs, economic, investments: This cluster emphasizes the economic and logistical aspects of supply chains in the renewable energy sector, focusing on costs and required investments.

Renewable energy, energy transition, sustainable development, solar energy, wind energy: This cluster illustrates the central themes of the transition to clean and sustainable energy sources, with a strong emphasis on the crucial role of solar and wind energy.

Carbon emissions, carbon neutrality, decarbonization, greenhouse gases: This cluster reflects the challenges related to reducing greenhouse gas emissions and global efforts to achieve carbon neutrality through decarbonization strategies.

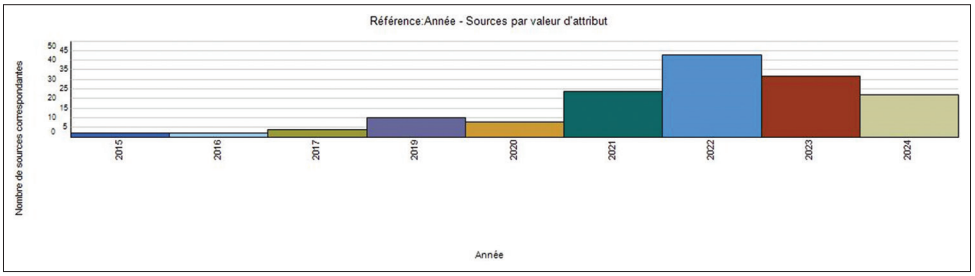
Policy, public policy, environmental sustainability, management: This cluster highlights the importance of public policy and

Table 1: Ranking of the top 10 scientific journals by publication frequency

Journal name	Number of corresponding sources
Frontiers in Energy Research	18
International Journal of Energy Economics and Policy	16
Resources, Conservation and Recycling	8
Mineral Economics	7
Review of Evolutionary Political Economy	6
Resources Policy	6
Energy Economics	6
Environment, Development and Sustainability	4
World Development	4
International Journal of Production Economics	4

Source: Authors

Figure 4: Number of publications classified by year



Source: Authors (Nvivo)

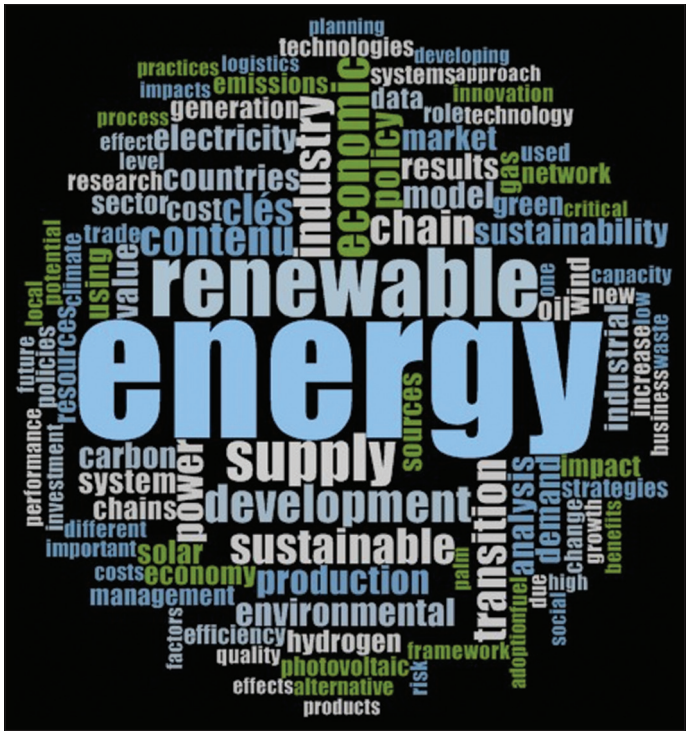
governance frameworks in promoting environmental sustainability and the responsible management of natural resources.

Technology, innovation, energy efficiency, energy storage: This cluster explores the role of technological innovations in enhancing energy efficiency and in developing new energy storage solutions.

4.4.2. Co-occurrence analysis using VOSviewer

To conduct an in-depth analysis of citation co-occurrence, the VOSviewer software was used. A maximum occurrence threshold of 7 was set, ensuring a refined and relevant analysis while guaranteeing that key terms and their relationships appear with significant frequency. This approach makes it possible to identify meaningful thematic clusters, revealing emerging trends and interconnections within the studied corpus.

Figure 5: Word cloud



Source: Authors (Nvivo)

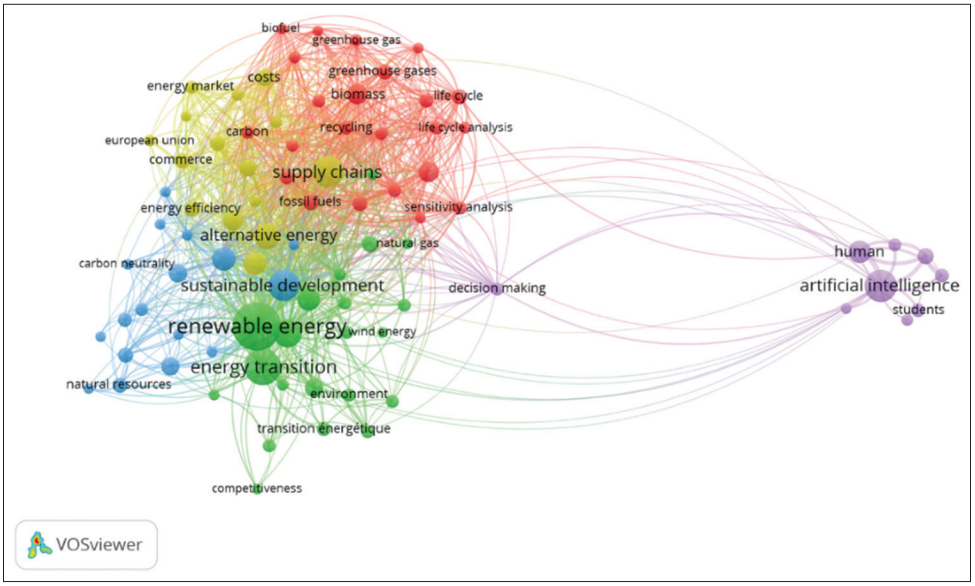
Figure 6 presents a detailed co-occurrence analysis. A total of 85 items, 5 clusters, and 1,220 co-occurrences were identified. The most frequently used keyword by the authors is renewable energy, appearing 126 times. Five thematic areas were identified, one for each cluster:

4.4.2.1. Cluster 1: Renewable energies and energy transition

This cluster addresses the dynamics of the transition to renewable energy across various regional and technological contexts. The articles explore the policies and strategies for deploying renewable energies, particularly wind and solar power, while analyzing their economic, social, and environmental impacts. For instance, authors examine the role of blue energy in the energy transition on the island of Crete (Stančin et al., 2022), Other authors analyze how industrial policies and state power influence offshore wind energy development in East Asia (Mathews et al., 2023). Other studies highlight the developments in global trade of photovoltaic modules (Cheng and Liu, 2023). The impact of renewable energy on regions formerly dependent on coal is also addressed by Bode, using the example of Lusatia in Germany (Bode et al., 2024). In Africa, others question the relevance of Chinese renewable energy investments and their benefits for the continent (Lema et al., 2021). The use of advanced technologies, such as blockchain and cloud computing, to optimize photovoltaic operations (Pan et al., 2023). These studies show that, despite significant progress, the transition to renewable energy still faces various political, regulatory, and economic challenges.

Despite the diversity of contexts studied, several common threads emerge. Most studies emphasize the critical role of public policy,

Figure 6: Co-occurrence analysis using VOSviewer



Source: Authors (VOSviewer)

governance, and financing in achieving a successful transition to renewable energy. However, realities vary considerably: industrialized countries tend to focus on modernizing their energy grids and repurposing post-carbon regions, while developing countries face more structural challenges, such as inadequate infrastructure and reliance on foreign investors. These contrasts highlight differing levels of maturity in national transition pathways. At the same time, certain areas remain underexplored in the literature, particularly the role of local authorities, the social impacts on vulnerable populations, and the interactions between different renewable energy sectors within a single territory. These blind spots underscore the need for future research that is more context-sensitive and locally grounded.

4.4.2.2. Cluster 2: Carbon and climate neutrality

This group focuses on strategies aimed at reducing carbon emissions and achieving climate neutrality. Several studies analyze mechanisms such as carbon capture, utilization, and storage (CCUS), exploring its application in Northeast India (Datta and Krishnamoorti, 2019). Others examine the sustainability of cobalt supply for green energy policies (Rachidi et al., 2021). The circular economy is also at the heart of the low-carbon transition, envisioning scenarios for the circular economy within the Dutch electricity system (van Oorschot et al., 2022). In parallel, the literature analyzes copper supply constraints in the context of the global energy transition (Seck et al., 2020). The interactions between investment flows and green growth are examined, assessing the role of foreign direct investment in triggering an ecological transition (Caetano et al., 2022). Finally, emerging energy technologies are examined that use forecasting models based on recurrent neural networks to improve solar energy production (Buturache and Stancu, 2021).

This group of studies focuses on strategies aimed at reducing carbon emissions and moving toward climate neutrality. The research explores a wide range of solutions, including carbon capture and storage, circular economy models, and smart technologies to enhance energy efficiency. Some studies highlight the challenges related to the supply of critical resources such as cobalt and copper, while others examine the role of international investment in accelerating the ecological transition. There is also growing interest in the application of artificial intelligence for managing and producing renewable energy. However, many of these studies tend to focus on isolated approaches, without systematically linking different strategies or analyzing how they interact within broader energy systems. This lack of an integrated vision represents a limitation that future research could help to address.

4.4.2.3. Cluster 3: Economy and supply chains

This cluster explores the economic implications of renewable energies, particularly in terms of supply chain management and industrial competitiveness. It develops a supply chain model for biodiesel production from used cooking oils (Munir et al., 2023), while others assess the economic impact of a renewable bioenergy industry (English et al., 2022). China's influence in the geopolitics of solar energy is examined, analyzing the asymmetry of interdependencies in global supply chains (de Oliveira Vasconcelos, 2021). Also, we analyze the role of the wind energy value chain in South Africa, highlighting the need to strengthen local suppliers to enhance competitiveness. Some authors investigate the impact of supply chain disruptions on the profitability of companies in the renewable energy sector (Yu, 2024). Finally, we propose an integrated biomass supply model for bioenergy production in China, illustrating the importance of optimized strategies in renewable energy logistics (Wang et al., 2022).

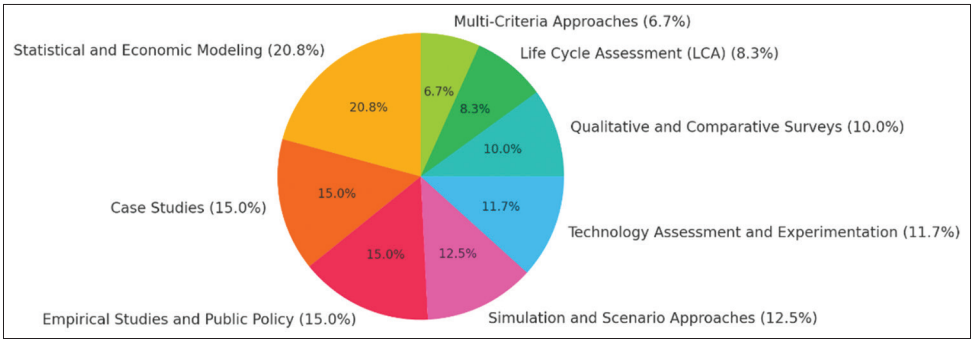
This cluster focuses on the economic implications of renewable energy, with particular attention to supply chain management and industrial competitiveness. The studies examine, among other aspects, logistical models for bioenergy production, the structuring of local value chains, and the impact of supply chain disruptions on the profitability of companies in the sector. They also highlight the growing influence of certain economic powers in global value chains, as well as the need for developing countries to strengthen their local suppliers to remain competitive. While these studies provide valuable insights into the industrial dimension of energy transition, they often remain insufficiently connected to environmental and social concerns, thereby limiting a more systemic understanding of the broader impacts of these economic transformations.

4.4.2.4. Cluster 4: Public policies and environmental sustainability

This cluster focuses on energy policies and regulatory frameworks aimed at promoting energy transition and sustainable development. They examine the economic impact of renewable energy sector in Japan and the role of feed-in tariffs (Nakano et al., 2017b). Others analyze the adoption of energy-saving technologies in Germany, Austria, and Switzerland, highlighting the effects of policy instruments on energy efficiency (Peneder et al., 2022). Also, the literature examines the trade-offs in the design of green industrial policies, highlighting the tensions between supporting renewable energy and protecting economic competitiveness (Matsuo and Schmidt, 2019). Bougette and Charlier explore the implications of renewable energy subsidies within the framework of the World Trade Organization (WTO) and the compatibility between government support and international trade rules (Bougette and Charlier, 2015). This cluster analyzes the environmental, social, and governance (ESG) issues related to lithium extraction in the "Lithium Triangle" of South America, highlighting the socio-economic challenges of mining critical minerals for the energy transition (Petavratzi et al., 2022).

This cluster focuses on public policies and regulatory frameworks that guide and support the energy transition. The studies explore mechanisms such as feed-in tariffs, subsidies, and energy efficiency instruments, analyzing their impact on economic growth, innovation, and industrial competitiveness. They also highlight potential tensions between supporting the green transition and complying with international trade rules. Some research delves into the socio-environmental challenges related to the extraction of critical resources, pointing to the current limitations of regulatory frameworks in ensuring sustainable and equitable practices. While these studies provide valuable insights into existing policy levers,

Figure 7: Distribution of methods used



few address in depth the coherence between energy, social, and trade policies, thus limiting their systemic relevance.

4.4.2.5. Cluster 5: Technology and innovation

This group highlights technological advancements and innovations in the renewable energy sector. It explores the role of blockchain in optimizing photovoltaic operations (Pan et al., 2023), while Cicerelli and Ravetti examine the complexity of industrial systems related to renewable energy by integrating resilience and innovation approaches (Cicerelli and Ravetti, 2024). Others develop a research framework for planning renewable hydrogen supply chains, illustrating the evolution of sustainable energy solutions (Sgarbossa et al., 2023). Besides, literature focus on the management of energy storage networks by integrating energy compensation models based on performance differences among storage systems (Wang et al., 2023). These studies demonstrate that technological innovation plays a key role in improving energy efficiency and reducing production costs, although challenges remain regarding the integration and financing of new technologies.

This group of studies highlights technological innovations that are driving the transformation of the renewable energy sector. The research explores tools such as blockchain for optimizing photovoltaic production, along with advanced models for managing energy storage networks and planning hydrogen supply chains. These studies also emphasize the need to develop more resilient and adaptable industrial systems. While these innovations contribute to improving energy efficiency and reducing costs, several challenges remain, particularly regarding the integration of new technologies into existing systems, the mobilization of large-scale financing, and the coordination between technical innovation and regulatory frameworks.

4.5. Research Methodology Analysis

The analysis of the methodologies used in studies on the energy transition and the renewable energy industry reveals a diversity of approaches, each specific to its thematic cluster.

In the "Renewable Energies and Energy Transition" cluster, researchers favor case studies, statistical modeling, and qualitative and comparative surveys to assess the economic and social impacts of transition projects. The "Carbon and Climate Neutrality" cluster relies on methods such as Life Cycle Assessment (LCA), CO_2 emissions modeling, and the development of scenario-based projections to explore pathways toward carbon neutrality. For the "Economy and Supply Chains" cluster, the focus is on logistics modeling, economic analysis, multi-criteria decision-making methods, and geopolitical assessments of supply flows to enhance system resilience and efficiency. The "Technology and Innovation" cluster employs technology assessments, artificial intelligence tools, as well as pilot projects and demonstrators to foster the deployment and diffusion of innovations in the renewable energy sector. Lastly, the "Public Policy and Environmental Sustainability" cluster is based on policy analysis, economic modeling, empirical studies, and governance frameworks, to inform decisions toward sustainable and context-sensitive solutions.

Figure 7 illustrates the statistical distribution of methodologies used in the articles included in the scoping review. The results show that methodologies such as statistical and economic modeling (20.8%) and case studies (15%) are among the most commonly used, while multi-criteria approaches (6.7%) are less frequently applied.

5. CONCLUSION

This article provides a comprehensive overview of research on the energy transition and the renewable energy industry, based on a rigorous scoping review methodology. The main findings reveal a steady growth in academic publications in this field, supported by increasingly dense international collaborations, reflecting the global importance of these topics.

The study highlights several dominant themes grouped into clusters, notably decarbonization, sustainable supply chains, technological innovation, and public policies oriented toward sustainability. These clusters illustrate the diversity and complementarity of current research efforts. Furthermore, co-occurrence analyses identified strategic keywords that define the trends and scientific priorities of the field.

Despite its richness, this review presents certain limitations. The selection of publications was based on a limited set of databases, which may introduce a bias in the global representation of research. Moreover, the study focuses primarily on academic articles, thereby excluding technical reports and industrial case studies, which could offer valuable practical insights. It is also crucial to conduct further studies on effective governance mechanisms and the social impact of the transition to renewable energy, particularly in terms of job creation and social justice (Jenkins et al., 2018)

The findings of this research open the door to several avenues for further exploration.

First, a broader analysis that includes publications from additional databases and non-academic documents could enrich the conclusions. Second, empirical studies could further explore the real-world impact of public policies and technological innovations across different geographical contexts. Finally, the rapid evolution of energy technologies and regulatory frameworks calls for regular updates of the research in order to capture emerging dynamics.

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