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RENEWABLE ENERGY SOURCES IN THEIR SOCIOECONOMIC CONTEXT: PROSPECTS FOR THE TRANSFORMATION OF THE GLOBAL ENERGY LANDSCAPE, A BIBLIOMETRIC ANALYSIS

Focusing on renewable energy sources (RES), this article examines their comprehensive impact on society and the economy. This publication goes beyond traditional approaches by introducing bibliometric analysis using CiteSpace. By identifying key research trends in the scientific literature, it contributes to a better understanding of areas of research interest in the field of renewable energy. Bibliometric analysis serves to systematize knowledge and identify the main research trends – a valuable contribution to the development of this important field of science. As a research tool, it highlights the dynamics and evolution of the field of renewable energy research; this can support the further development of this important branch of science and serve as a platform for identifying potential areas for further research and practical activities. Through a detailed analysis of trends in the scientific literature, the article contributes to a deeper understanding of areas of interest in the field of renewable energy. The results are a valuable starting point for future scientific research and practical initiatives, supporting the development of this key field.

Keywords: bibliometric, renewable energy, CiteSpace.

1. INTRODUCTION

Renewable energy (RES) is one of the pillars of the contemporary social, economic, and environmental debate (Boubaker, Omri, 2022; Knuth et al., 2022; Uzar, 2020). As societies become increasingly aware of the need for sustainable development, the role of

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RE becomes a key element of the energy transition, shaping not only our environment, but also social and economic structures. In this context, this paper focuses on the analysis of the comprehensive impact of renewable energy on the scientific community from the social and economic perspectives (Akella et al., 2009; Gozgor et al., 2020; Jenniches, 2018).

Contemporary society increasingly recognizes RES as a source of not only sustainable energy, but also a powerful catalyst for social change (Eagle et al., 2017; Fraser et al., 2023). Technological progress in RES not only transforms traditional energy models, but also affects social structures and local communities (Kerr et al., 2014). The analysis of these interactions requires a detailed understanding of both the technological and social mechanisms that make up the process of RES adaptation in society (Sengupta et al., 2020). On the one hand, the development of photovoltaics, wind farms, and other forms of RES generates new jobs, supporting local communities and stimulating entrepreneurship. However, challenges related to the transformation of traditional sectors also arise, which requires a sustainable approach to labor market restructuring. Furthermore, the introduction of new RES technologies creates dynamic social relations by generating benefits such as improved air quality, reduced greenhouse gas emissions, and diversification of energy sources, which contributes to the increase in society's environmental awareness (Ahn et al., 2021; Mathews, 2014).

The evolution of an RES-based economy is an essential element of the contemporary economic transformation (Chou et al., 2023; Gagnon, 2013; Wang et al., 2023). Investments in the RES sector not only stimulate economic growth, but also shape new employment aspects and generate financial benefits (Lee, 2021; Liu et al., 2023). The transition to RES affects the structure of the economy, creating new opportunities for the development of sectors related to ecological technologies, while also forcing traditional sectors to reconsider their role in the new energy reality. RES also becomes a source of economic innovation (Su et al., 2022; Wan et al., 2022; X. Zhao, J.Zhao, 2023). The development of new technologies, such as energy storage or smart grids, drives the development of new markets and creates jobs in the research and development sector (Hossain et al., 2016; Kaygusuz et al., 2013; Tan et al., 2021; Zafirakis, 2010).

In this context, bibliometric analysis can be a valuable tool for systematizing and understanding the areas of research on RE from a social perspective (García-Lillo et al., 2023; Kut, Pietrucha-Urbanik, 2022). By using tools such as the Citespace program, it is possible to track the main trends, identify key authors, and determine the central themes in research on this topic.

The following three scientific hypotheses were proposed:

- First hypothesis: What are the key research trends and thematic clusters within the scientific literature related to renewable energy sources (RES)?
- Second hypothesis: Who are the most influential authors, institutions, and collaborative networks contributing to the field of renewable energy research?
- Third hypothesis: How can the findings derived from bibliometric analysis support evidence-based decision-making and strategic planning for the sustainable integration and expansion of renewable energy sources?

The conclusions of bibliometric analysis can be significant for understanding the role that RES plays in shaping society and the economy. The complex relationships between social and economic aspects require an interdisciplinary approach, and bibliometric analysis will allow for the identification of the main research trends, contributing to the further development of this important field of the humanities.

2. BIBLIOMETRIC ANYLISIS OF LITERATURE – MATERIALS AND METHODS

Bibliometric analysis is a research method that uses statistical tools to collect, process and analyze bibliographic information from scientific publications (Chen, 2018; Ding, Yang, 2022; Moher et al., 2009). Its main goal is to assess the impact of these publications on the development of a specific field of science and to identify key authors, journals, topics and research institutions. To carry out the analysis, CiteSpace software was used. CiteSpace is a specialized software designed for bibliometric analysis, providing researchers with a robust platform to explore and visualize complex networks within scholarly literature. It operates by processing bibliographic data, extracting valuable insights, and generating graphical representations that reveal the interconnectedness among various elements of scientific research. This tool employs algorithms to identify key patterns, emerging trends, and influential nodes within citation networks. It facilitates the exploration of citation relationships between publications, authors, institutions, and keywords, offering a comprehensive understanding of the intellectual structure and evolution of a particular research domain. One of the notable features of CiteSpace is its ability to generate visual maps, such as co-citation networks and co-authorship networks. These maps aid in uncovering the central themes, pivotal contributors, and pivotal publications shaping the landscape of a specific field, enabling researchers to navigate through vast volumes of scholarly works and derive meaningful insights from the interconnected web of scientific literature.

In this study, data were taken from the Web of Science database using the search term “Renewable Energy”, “Social” and “Economics”. The total number of publications for bibliometric analysis is 3545.

3. QUANTITATIVE INSIGHTS INTO RENEWABLE ENERGY SCHOLARSHIP: A BIBLIOMETRIC APPROACH TO SOCIAL DIMENSIONS – RESULTS AND DISCUSSIONS

Figure 1 shows the analysis of publications according to the authors' affiliation. Thanks to these results, we are able to identify which educational and scientific institutions significantly contribute to the development of research on renewable energy in social context.

Individual groups, marked with different colors, represent different research fields or thematic areas in which universities cooperate. The value of a node, expressed by its size, is related to the number of publications of a given university, which helps to identify institutions with a significant contribution to scientific research. Lines connecting different countries, marked in gray, reflect mutual citations between researchers from different regions. This is an important indicator of international cooperation and knowledge exchange.

Table 1 presents the 10 universities with the highest centrality index, which is a key aspect of the analysis. The centrality index allows for the identification of nodes that constitute key connections between different research groups. The node with the highest centrality index is usually an institution characterized by innovation and frequent citation by other scientists, which proves its importance in scientific research in a given area.

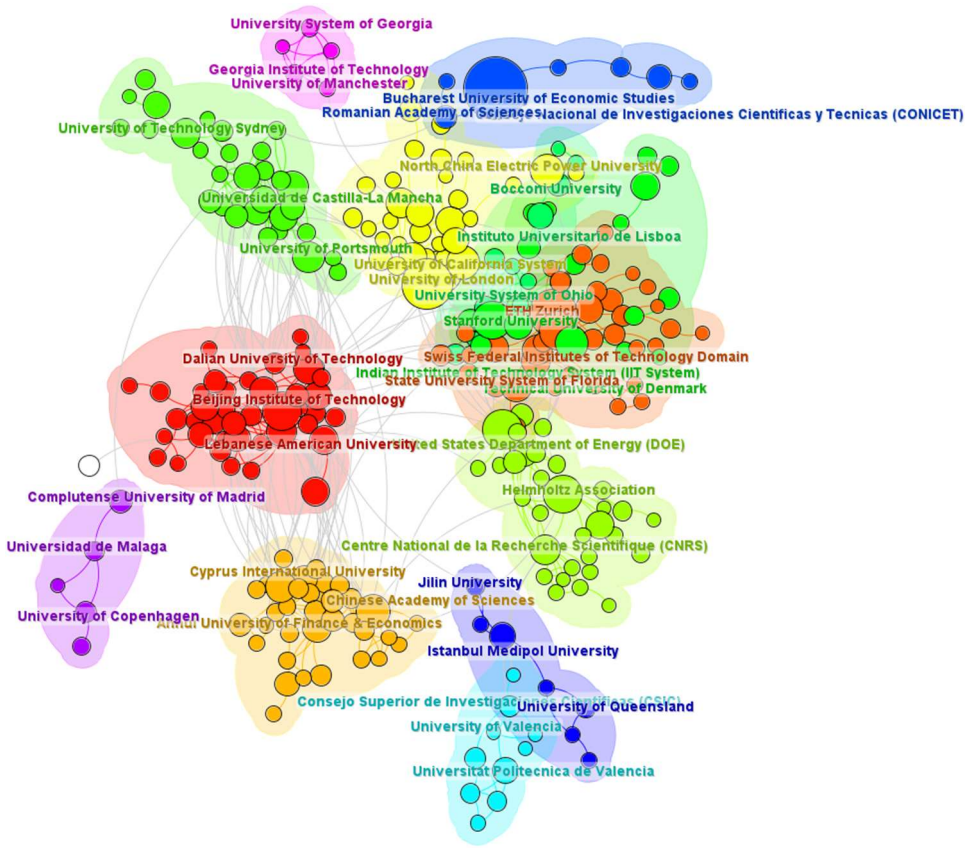

Figure 1. Cooperation between universities

Source: own development using the program CiteSpace 6.2.R6 Advanced.

Table 1. Top 10 institutions with highest centrality index

Institution	Number of publications	Centrality index
University of London	37	0.12
Swiss Federal Institutes of Technology Domain	32	0.07
United States Department of Energy	23	0.07
Centre National de la Recherche Scientifique	11	0.07
Nisantasi University	9	0.07
University of California	24	0.06
Helmholtz Association	21	0.06
Beijing Institute of Technology	21	0.06
Chinese Academy of Sciences	14	0.06
Technical University of Denmark	15	0.05

Source: own development using the program CiteSpace 6.2.R6 Advanced.

The analysis shows that the University of London play a key role in the field of renewable energy in social aspects research due to the high centrality index. This means that this institution are central player in the study of this topic and enjoy the highest respect in the scientific community. It follows that the works of scientists from this university are often cited in the scientific literature, which proves their importance in developing knowledge in the field of renewable energy sources. The number of publications does not always correlate with the level of citations. This suggests that there are certain factors, such as research quality and innovation, that influence whether research papers will be noticed and cited by other scientists. It is worth emphasizing that a high centrality index does not necessarily mean a large number of publications, but rather a significant impact on the development of knowledge in a given field.

The Swiss Federal Institutes of Technology Domain, along with the United States Department of Energy, Centre National de la Recherche Scientifique, and Nisantasi University, all demonstrate substantial centrality indices, signifying their pivotal roles as influential nodes in the network of renewable energy research within social aspects. Despite differences in the number of publications, these institutions exhibit a remarkable level of interconnectedness and importance within the scholarly landscape. The University of California, Helmholtz Association, Beijing Institute of Technology, Chinese Academy of Sciences, and Technical University of Denmark also display noteworthy centrality indices, indicating their significant contributions to the scholarly discourse on renewable energy research. The collective impact of these institutions underscores the diverse and multidimensional nature of global engagement in advancing knowledge and understanding within the field of renewable energy from social perspectives.

Universities with high centrality index in the field of research on renewable energy in a social context have achieved this status due to several key factors. Their production of high-quality research, focused on the social aspects of renewable energy, contributes to the elevation of their centrality index. Active interdisciplinary collaboration, uniting various research groups, fosters a more integrated scholarly network, further enhancing their centrality. Extensive international collaboration attests to their integration into the global research community, elevating their significance internationally. The impact of their research, demonstrated through frequent citations in scientific literature, plays a pivotal role in enhancing their centrality indices. The reputation and prestige of these institutions within the academic community attract attention, significantly contributing to their high centrality. Moreover, their research, with practical implications influencing policy in the field of renewable energy and social aspects, further fortifies their centrality in the scholarly network. These factors collectively underscore their substantial impact and significance in the realm of research on renewable energy from a social perspective.

Figure 2 shows the analysis of publications in terms of the countries the scientists come from.

The analysis shows that England has the highest centrality index. China, Australia, USA, Germany, India and Turkey also have a centrality index above 0.1, which means that these countries are also important centers in research on renewable energy in social aspects.

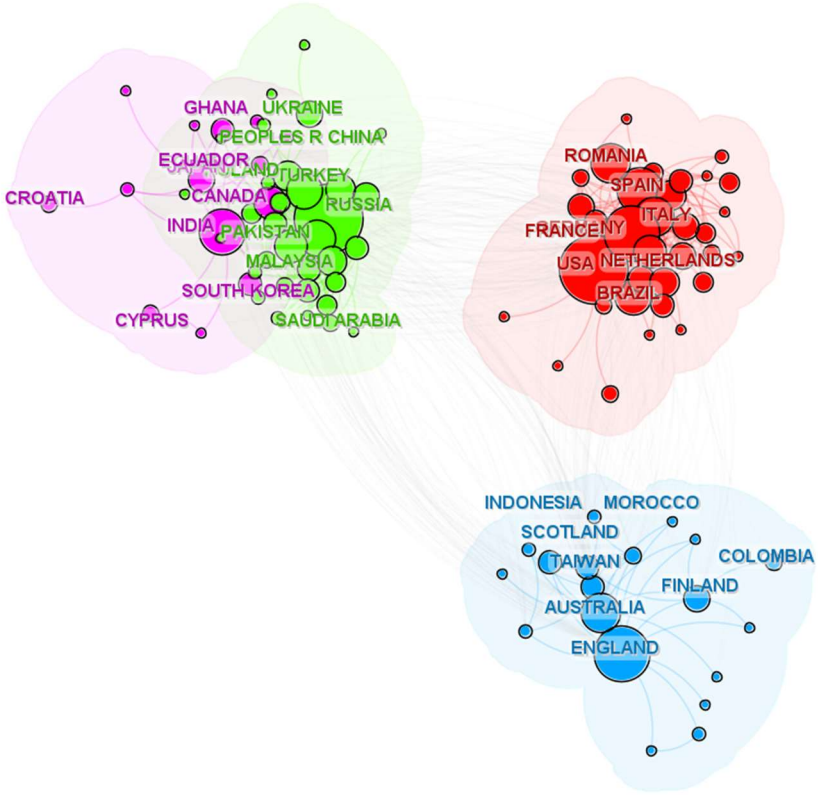

Figure 2. Cooperation between countries

Source: own development using the program CiteSpace 6.2.R6 Advanced.

Based on Figure 2, Table 2 was created, which presents the 10 countries with the highest centrality index.

Table 2. Top 10 countries with highest centrality index

Country	Number of publications	Centrality index
England	233	0.26
China	369	0.15
Australia	111	0.14
USA	391	0.13
Germany	237	0.11
India	148	0.11
Turkey	85	0.10
Spain	159	0.08
Italy	102	0.05
Japan	48	0.05

Source: own development using the program CiteSpace 6.2.R6 Advanced.

Figure 3 shows the citation analysis in the main areas of interest for researchers. Additionally, such analysis can help understand which research areas are particularly important or popular in a given field. This often reflects trends and priorities among scientists and indicates those issues that attract the most attention and interest in the scientific literature and, therefore, have the highest number of citations.

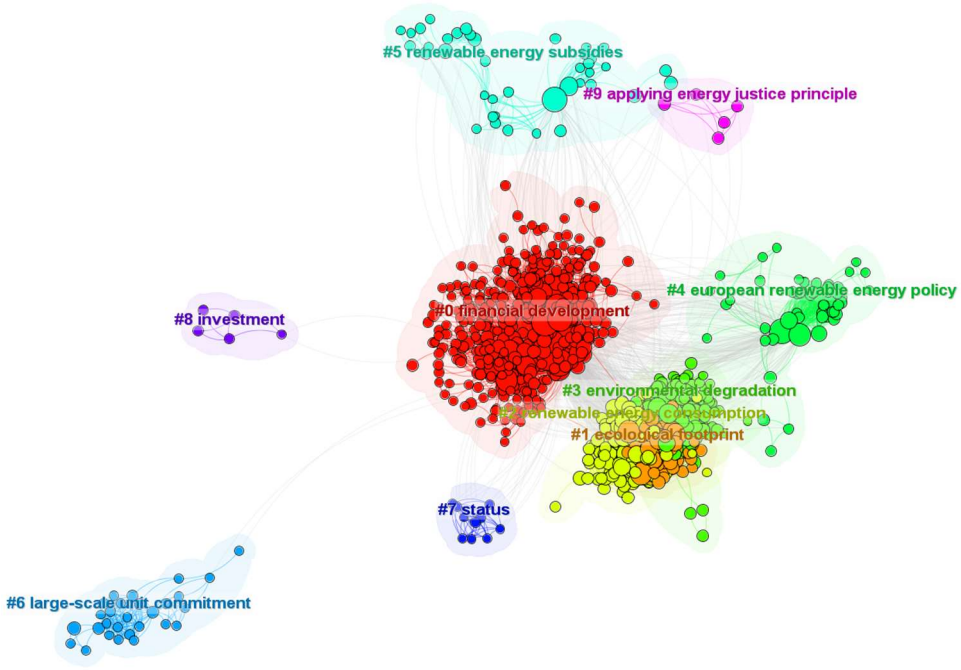

Figure 3. Major area of interest

Source: own development using the program CiteSpace 6.2.R6 Advanced.

Analyzing the graph, it can be concluded that the largest cluster is the cluster called "financial development". This cluster includes 468 nodes. The major citing article of this cluster is (Edmondson et al., 2019). This paper explores the role of policymaking processes in influencing the rate and direction of socio-technical change towards sustainability. It argues that policy mixes, rather than individual policy instruments, are more effective in driving transitions. The paper proposes a new conceptual framework for understanding the co-evolutionary dynamics of policy mixes and socio-technical systems. It highlights the importance of designing policy mixes that create incentives for beneficiaries and overcome challenges to political support. The paper concludes with research and policy implications for analyzing and designing dynamic policy mixes for sustainability transitions. The most cited article of this cluster is (Johnstone et al., 2010). This paper investigates how environmental policies influence technological advancements in the renewable energy sector. The study utilizes patent data from 25 countries spanning 1978–2003. Results indicate that public policies significantly impact patent applications. Different policy instruments are effective for distinct renewable energy sources. Broad-based policies like tradable energy certificates are more likely to stimulate innovation in technologies nearing

fossil fuel competitiveness. More targeted subsidies, such as feed-in tariffs, are essential to promote innovation in more expensive energy technologies like solar power. The second largest cluster is the "ecological footprint" with 167 nodes. Ecological footprint is an indicator that measures the amount of land required to sustain an individual or a population. It is calculated by comparing the amount of resources that a population consumes to the amount of resources that the planet can sustainably provide. The ecological footprint is expressed in global hectares, which is a unit of land area that can sustainably generate the resources needed for one person. The major citing article of this cluster is (Yasin et al., 2020). This study examined how urbanization, financial development, political institutions, trade openness, and energy consumption influence the ecological footprints of 110 countries from 1996 to 2016, using the Environmental Kuznets Curve (EKC) framework. Countries were categorized into developed and less-developed groups, and ecological footprint served as a proxy for environmental impact. The study found robust relationships between variables in both groups, confirming the EKC hypothesis of an inverted-U shape relationship between ecological footprints and per capita income. Results highlighted the negative impact of energy consumption and the composition effect on ecological footprints. Financial development was identified as detrimental to environmental quality in developed countries, while trade openness, urbanization, and political institutions were beneficial. The study recommended further exploration of factors like renewable energy consumption, innovation, and tourism. It emphasized the need for economic and social policies to reduce human impact on nature, suggesting the establishment of robust institutional structures and environmental guidelines for sustainable growth. The most cited article is (Ahmad et al., 2022). This study investigates the impact of financial development, human capital, and institutional quality on the ecological footprint (EF) in emerging countries. Using panel data from 1984 to 2017 and employing the cross-sectional autoregressive distributed lag (CS-ARDL) technique, the research reveals that financial development increases the EF, while human capital and institutional quality mitigate its negative impact. Furthermore, financial development contributes to environmental sustainability through the channel of human capital, and institutional quality helps counteract the adverse ecological effects of financial development. The causality analysis suggests that policies related to financial development, human capital, and institutional quality influence the EF but not vice versa. The findings underscore the importance of promoting environmental sustainability in emerging economies through the enhancement of human capital and the effective use of financial resources. Third largest cluster is "renewable energy consumption" with 155 nodes. The major citing article is (Zhao et al., 2021). This study empirically investigates the relationship between financial risk and global carbon emissions, utilizing a global balanced panel dataset spanning 62 countries from 2003 to 2018. The research explores the mediation effect of technological innovation on this nexus, considering potential regional heterogeneity and asymmetry. The results reveal a mediation effect between financial risk and carbon emissions, indicating that increased financial risk not only directly reduces global carbon emissions but also indirectly mitigates emissions by promoting technological innovation. The impact of financial risk and technological innovation on carbon emissions exhibits significant regional heterogeneity, and there is asymmetry across different quantiles, with inhibitory effects observed only in the 10th quantile while promoting carbon emissions in other quantiles. The most cited article is (Tiwari et al., 2022). This study investigates the transmission of return patterns between green bonds, carbon prices, and renewable energy stocks from January 4, 2015, to September 22, 2020. Utilizing daily data and employing

the TVP-VAR approach, various portfolio techniques, and a LASSO dynamic connectedness model, the research analyzes return spillovers and connectedness. The results reveal that dynamic total connectedness across assets is heterogeneous over time and event-dependent. Clean energy emerges as the main net transmitter of shocks, with Green Bonds and Solactive Global Wind being major recipients. Bivariate and multivariate portfolios effectively reduce investment risk, except for Green Bonds. The minimum connectedness portfolio demonstrates the highest Sharpe ratio, emphasizing the significance of information in the return transmission process for portfolio creation, a pattern observed even during the COVID-19 pandemic. These nodes also have the highest number of connections and mutual citations. Other areas of interest are shown in Figure 3.

Figure 4 shows the top five references with stronger citation burst. This metric is useful for identifying articles that have received a significant number of citations in a relatively short period of time. The continued citation sequence can be used to identify articles of significant scientific importance and those that have had a significant impact on a developing field.

References	Year	Strength	Begin	End	2013 - 2023
Wüstenhagen R, 2007, ENERG POLICY, V35, P2683, DOI 10.1016/j.enpol.2006.12.001, DOI	2007	**11.2**	2014	2019	
Flanagan K, 2011, RES POLICY, V40, P702, DOI 10.1016/j.respol.2011.02.005, DOI	2011	**8.22**	2016	2020	
Carley S, 2009, ENERG POLICY, V37, P3071, DOI 10.1016/j.enpol.2009.03.062, DOI	2009	**8.17**	2013	2019	
Bergek A, 2008, RES POLICY, V37, P407, DOI 10.1016/j.respol.2007.12.003, DOI	2008	**7.99**	2014	2019	
Unruh GC, 2000, ENERG POLICY, V28, P817, DOI 10.1016/S0301-4215(00)00070-7, DOI	2000	**7.94**	2013	2020	

Figure 4. Top five references with the strongest citation burst

Source: own development using the program CiteSpace 6.2.R6 Advanced.

First article with stronger citation burst is (Wüstenhagen et al., 2007). The article notes that despite ambitious government goals to increase the share of renewable energy, the article highlights the growing recognition that public acceptance may pose an obstacle to achieving these goals, particularly in the case of wind energy, sparking contentious debates due to its visual impact on landscapes. The article identifies three dimensions of social acceptance - socio-political, social and market acceptance – shedding light on the factors influencing public support and the challenges faced in implementing specific projects, calling for more research, especially from management researchers, in less examined dimension of market acceptance. The second article is (Flanagan et al., 2011). The article discusses the topic of "policy mix", borrowed from discussions on economic policy. Despite its ambiguity, the concept highlights the interactions and interdependencies between different policies that influence intended outcomes. The authors argue that the widespread use of 'policy mixes' in innovation policy research provides an opportunity to reassess underlying assumptions and address the complex, multi-level and multi-actor nature of the field. Drawing on a diverse literature, they propose a reconceptualization that defines tensions and interactions within the “policy mix” along different dimensions, with implications for the future direction of innovation policy studies, both normative and analytical. Third article is (Carley, 2009). In this article, the authors examined the effectiveness of state energy programs, with particular emphasis on renewable portfolio standards (RPS), a policy instrument aimed at increasing the share of renewable energy in the electricity market. Analysis using a fixed-effects vector decomposition model with

state-level data from 1998 to 2006 suggests that although RPS implementation may not be a good predictor of the share of renewable energy in the total generation mix, states with RPS policies tend to increase the total amount of energy generated renewable over time. The study also identified various factors, including political institutions, natural resources, deregulation, economic indicators and regional RPS policies, significantly influencing the use of renewable energy. Fourth article is (Bergek et al., 2008). This paper addresses the challenge of translating empirical studies on innovation systems into actionable guidelines for policymakers. Building on a functional approach to analyzing innovation system dynamics, the authors provide a practical scheme for policymakers. The scheme draws from existing literature and the authors' own expertise, offering a tool to identify key policy issues and establish effective policy goals in the realm of innovation systems. The last article is (Unruh, 2000). This paper contends that industrial economies are entrenched in fossil fuel-based energy systems due to the co-evolution of technology and institutions, resulting in carbon lock-in. The concept of a Techno-Institutional Complex is introduced to emphasize the interconnectedness of technological systems and governing institutions in this lock-in process. While carbon lock-in poses challenges for the diffusion of carbon-saving technologies, the paper raises questions about traditional economic models that overlook the evolution of technology and institutions. The possibility of escaping carbon lock-in is deferred for future exploration.

Figure 5 shows the five largest clusters of scientists' interests in specific years. Thanks to this analysis, it is possible to observe which research topics are current and which were popular in previous years.

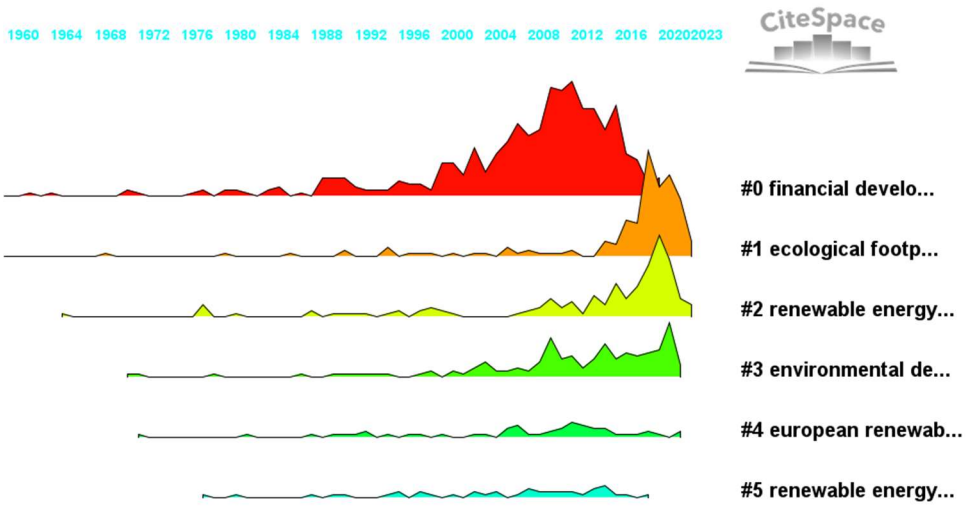

Figure 5. Timeline view of the 5 largest clusters

Source: own development using the program CiteSpace 6.2.R6 Advanced.

Analyzing the above figure, it can be seen that the current main research topics in the analyzed group of publications are “ecological footprint”, “renewable energy consumption” and “environmental degradation”.

The current main research topics within the analyzed group of publications, namely "ecological footprint", "renewable energy consumption" and "environmental degradation", represent critical areas of inquiry due to their significant impact on global sustainability and environmental stewardship. The focus on ecological footprint reflects a growing concern regarding the ecological resources consumed by human activities and their long-term implications for the biosphere. Additionally, the prominence of research on renewable energy consumption underscores the imperative to transition towards sustainable energy sources in the face of climate change and finite fossil fuel reserves. Furthermore, the emphasis on environmental degradation aligns with the pressing need to understand, mitigate, and reverse the detrimental effects of human-induced activities on the natural environment. These research topics have emerged as central areas of investigation due to their fundamental relevance to the preservation of planetary ecosystems and the well-being of present and future generations.

4. CONCLUSIONS AND PERSPECTIVES

The article provides an in-depth analysis of the impact of renewable energy on the scientific community, with a particular focus on social and economic perspectives. The results presented in the article show that RE not only plays a crucial role in the energy revolution but also shapes society and the economy on multiple fronts.

The evolution toward an RES-based economy has significant economic consequences. Investments in the RES sector not only drive economic growth but also shape new employment aspects and generate financial benefits. The introduction of new RE technologies becomes a source of economic innovation, creating new markets and jobs in the research and development sector.

Bibliometric analysis, conducted using the CiteSpace tool, allowed for the systematization and understanding of research areas related to RES from a social perspective. The identification of dominant trends and central themes contributes significantly to the development of this social science field. Such an approach to the analysis of scientific literature can serve as a valuable starting point for further research, helping researchers better understand the changing social and economic landscapes associated with RES. The bibliometric analysis uncovered influential publications, key authors, and collaborative networks, thereby providing a comprehensive overview of knowledge dissemination and scholarly communication in the domain of renewable energy.

Bibliometric analysis also facilitates the identification of institutions and countries that play a crucial role in RES research. Understanding the structure of international collaboration and knowledge exchange becomes possible. The article demonstrates that the University of London plays a pivotal role in social-context RES research, reflected in its high centrality index. Similarly, the country analysis shows that England has the highest centrality index, indicating its significant role in RES research.

Research on the analysis of citation networks in sustainable development has focused on identifying key thematic clusters and their interrelations. The largest cluster, "financial development", primarily encompasses studies on the impact of policy on socio-technical changes toward sustainable development. A pivotal article in this area is authored by Edmondson et al. (2019). These studies emphasize the role of policy mixes in accelerating transitions and the necessity of designing mixes that consider incentives for beneficiaries while overcoming challenges related to political support. Significant attention is given to

analyzing the interactions of various policy instruments on the development of sustainable technologies.

Another crucial area is the "ecological footprint", covering research on the influence of urbanization, financial development, political institutions, trade openness, and energy consumption on the ecological footprint of 110 countries. Studies such as Yasin et al. (2020) confirm the Environmental Kuznets Curve hypothesis, indicating a U-shaped relationship between ecological footprints and per capita income. Moreover, the results point to the negative impact of energy consumption and compositional effects on the ecological footprint, while financial development may have detrimental effects on environmental quality in developed countries. These studies suggest the need to consider multiple factors in sustainable development policy analyses.

In the "renewable energy consumption" domain, the focus is on the relationship between financial risk and greenhouse gas emissions. Analyses, such as those by J. Zhao et al. (2021), indicate the mediating effect of technological innovation between financial risk and emissions. The results also highlight regional heterogeneity and asymmetry in the relationships between these variables. In the context of investment portfolios, the research demonstrates the effectiveness of bivariate and multivariate portfolios in reducing investment risk, although Green Bonds appear to be an exception. The significance of information in the return transmission process is emphasized by the lowest degree of connections and mutual citations in this cluster.

Conclusions from these studies suggest that the development of sustainable technologies, analyzed in the context of socio-technical changes, requires a holistic approach considering diverse policy aspects. Understanding the impact of policy mixes on the development of innovative technologies and identifying factors influencing ecological footprints and greenhouse gas emissions are crucial. These studies also yield practical insights, suggesting that sustainable development policy should address both financial and social aspects and engage various stakeholders. Ultimately, the research emphasizes the importance of a comprehensive and integrated approach to sustainable development policy.

In practical terms, bibliometric analysis becomes a supporting tool for decision-makers, researchers, and institutions in formulating energy policy and making decisions at the intersection of science, business, and public policy. It provides the opportunity to identify areas that require further investigation, helping to direct resources to the most critical aspects related to the development of RES. In this way, bibliometric analysis serves not only as a research tool but also as a practical instrument supporting decision-making in the field of sustainable development based on renewable energy.

The future work in the field of "Renewable Energy Sources in the Socio-Economic Context: Prospects for the Transformation of the Global Energy Landscape" could encompass several crucial perspectives. Firstly, the exploration of emerging renewable energy technologies and their integration into socio-economic frameworks will be essential. This could involve investigating the economic viability, social acceptance, and policy implications of transitioning towards renewable energy sources on a global scale. Additionally, further research into the environmental and socio-economic impacts of large-scale renewable energy deployment will be critical for understanding the broader implications of such transformations. Moreover, the analysis of global trends and regional disparities in renewable energy adoption within socio-economic contexts can provide valuable insights into the challenges and opportunities associated with transitioning to a more sustainable energy landscape. Furthermore, interdisciplinary studies that consider the intersection of renewable energy with fields such as economics, sociology, and public

policy could offer novel perspectives for advancing the understanding of the socio--economic dynamics underlying the global energy transition. Overall, future work in this area should aim to elucidate the multifaceted interactions between renewable energy deployment and socio-economic systems, thereby informing informed decision-making and policy development in the pursuit of a more sustainable global energy landscape.

REFERENCES

Ahmad, M., Ahmed, Z., Yang, X., Hussain, N., Sinha, A. (2022). *Financial development and environmental degradation: Do human capital and institutional quality make a difference? "Gondwana Research"*, 105. DOI: 10.1016/j.gr.2021.09.012.

Ahn, K., Chu, Z., Lee, D. (2021). *Effects of renewable energy use in the energy mix on social welfare. "Energy Economics"*, 96. DOI: 10.1016/j.eneco.2021.105174.

Akella, A.K., Saini, R.P., Sharma, M.P. (2009). *Social, economical and environmental impacts of renewable energy systems. "Renewable Energy"*, 34(2). DOI: 10.1016/j.renene. 2008.05.002.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., Rickne, A. (2008). *Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. "Research Policy"*, 37(3). DOI: 10.1016/j.respol.2007.12.003.

Boubaker, S., Omri, A. (2022). *How does renewable energy contribute to the growth versus environment debate? "Resources Policy"*, 79. DOI: 10.1016/j.resourpol.2022.103045.

Carley, S. (2009). *State renewable energy electricity policies: An empirical evaluation of effectiveness. "Energy Policy"*, 37(8). DOI: 10.1016/j.enpol.2009.03.062.

Chen, C. (2018). *Visualizing and Exploring Scientific Literature with CiteSpace: An Introduction*. Proceedings of the 2018 Conference on Human Information Interaction& Retrieval – CHIIR'18. DOI: 10.1145/3176349.3176897.

Chou, C.-H., Ngo, S.L., Tran, P.P. (2023). *Renewable Energy Integration for Sustainable Economic Growth: Insights and Challenges via Bibliometric Analysis*. *"Sustainability"*, 15(20). Article 20. DOI: 10.3390/su152015030.

Ding, X., Yang, Z. (2022). *Knowledge mapping of platform research: A visual analysis using VOSviewer and CiteSpace. "Electronic Commerce Research"*, 22(3). DOI: 10.1007/ s10660-020-09410-7

Eagle, L., Osmond, A., McCarthy, B., Low, D., Lesbirel, H. (2017). *Social Marketing Strategies for Renewable Energy Transitions. "Australasian Marketing Journal"*, 25(2). DOI: 10.1016/j.ausmj.2017.04.006.

Edmondson, D.L., Kern, F., Rogge, K.S. (2019). *The co-evolution of policy mixes and socio--technical systems: Towards a conceptual framework of policy mix feedback in sustainability transitions. "Research Policy"*, 48(10). DOI: 10.1016/j.respol.2018.03.010.

Flanagan, K., Uyarra, E., Laranja, M. (2011). *Reconceptualising the 'policy mix' for innovation. "Research Policy"*, 40(5). DOI: 10.1016/j.respol.2011.02.005.

Fraser, T., Chapman, A.J., Shigetomi, Y. (2023). *Leapfrogging or lagging? Drivers of social equity from renewable energy transitions globally. "Energy Research & Social Science"*, 986. DOI: 10.1016/j.erss.2023.103006.

Gagnon, J.P. (2013). *Development by synergising renewable energy with social services. "International Journal of Innovation and Sustainable Development"*, 7(4). DOI: 10.1504/IJISD.2013.057039.

García-Lillo, F., Sánchez-García, E., Marco-Lajara, B., Seva-Larrosa, P. (2023). *Renewable Energies and Sustainable Development: A Bibliometric Overview. "Energies"*, 16(3). Article 3. DOI: 10.3390/en16031211.

Gozgor, G., Mahalik, M.K., Demir, E., Padhan, H. (2020). *The impact of economic globalization on renewable energy in the OECD countries. "Energy Policy"*, 139. DOI: 10.1016/j.enpol.2020.111365.

Hossain, M.S., Madlool, N.A., Rahim, N.A., Selvaraj, J., Pandey, A.K., Khan, A.F. (2016). *Role of smart grid in renewable energy: An overview. "Renewable and Sustainable Energy Reviews"*, 60. DOI: 10.1016/j.rser.2015.09.098.

Jenniches, S. (2018). *Assessing the regional economic impacts of renewable energy sources – A literature review. "Renewable and Sustainable Energy Reviews"*, 93. DOI: 10.1016/j.rser.2018.05.008.

Johnstone, N., Haščič, I., Popp, D. (2010). *Renewable Energy Policies and Technological Innovation: Evidence Based on Patent Counts. "Environmental and Resource Economics"*, 45(1). DOI: 10.1007/s10640-009-9309-1.

Kaygusuz, A., Keles, C., Alagoz, B.B., Karabiber, A. (2013). *Renewable energy integration for smart sites. "Energy and Buildings"*, 64. DOI: 10.1016/j.enbuild.2013.05.031.

Kerr, S., Watts, L., Colton, J., Conway, F., Hull, A., Johnson, K., Jude, S., Kannen, A., MacDougall, S., McLachlan, C., Potts, T., Vergunst, J. (2014). *Establishing an agenda for social studies research in marine renewable energy. "Energy Policy"*, 67. DOI: 10.1016/j.enpol.2013.11.063.

Knuth, S., Behrsin, I., Levenda, A., McCarthy, J. (2022). *New political ecologies of renewable energy. "Environment and Planning E: Nature and Space"*, 5(3). DOI: 10.1177/25148486221108164.

Kut, P., Pietrucha-Urbanik, K. (2022). *Most Searched Topics in the Scientific Literature on Failures in Photovoltaic Installations. "Energies"*, 15(21). DOI: 10.3390/en15218108.

Lee, T. (2021). *Financial investment for the development of renewable energy capacity. "Energy & Environment"*, 32(6). DOI: 10.1177/0958305X19882403.

Liu, W., Shen, Y., Razzaq, A. (2023). *How renewable energy investment, environmental regulations, and financial development derive renewable energy transition: Evidence from G7 countries. "Renewable Energy"*, 206. DOI: 10.1016/j.renene.2023.02.017.

Mathews, A.P. (2014). *Renewable Energy Technologies: Panacea for World Energy Security and Climate Change? "Procedia Computer Science"*, 32. DOI: 10.1016/j.procs.2014.05.483.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G. & PRISMA Group (2009). *Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. "BMJ (Clinical Research Ed.)"*, 339. DOI: 10.1136/bmj.b2535.

Sengupta, S., Sahay, A., Hisrich, R.D. (2020). *The social – market convergence in a renewable energy social enterprise. "Journal of Cleaner Production"*, 270. DOI: 10.1016/j.jclepro.2020.122516.

Su, C.-W., Khan, K., Umar, M., Chang, T. (2022). *Renewable energy in prism of technological innovation and economic uncertainty. "Renewable Energy"*, 189. DOI: 10.1016/j.renene.2022.02.110.

Tan, K.M., Babu, T.S., Ramachandaramurthy, V.K., Kasinathan, P., Solanki, S.G., Raveendran, S.K. (2021). *Empowering smart grid: A comprehensive review of energy storage technology and application with renewable energy integration*. *"Journal of Energy Storage"*, 39. DOI: 10.1016/j.est.2021.102591.

Tiwari, A.K., Aikins Abakah, E.J., Gabauer, D., Dwumfour, R.A. (2022). *Dynamic spillover effects among green bond, renewable energy stocks and carbon markets during COVID-19 pandemic: Implications for hedging and investments strategies. "Global Finance Journal"*, 51. DOI: 10.1016/j.gfj.2021.100692.

Unruh, G.C. (2000). *Understanding carbon lock-in. "Energy Policy"*, 28(12). DOI: 10.1016/S0301-4215(00)00070-7.

Uzar, U. (2020). Political economy of renewable energy: Does institutional quality make a difference in renewable energy consumption? *"Renewable Energy"*, 155. DOI: 10.1016/j.renene.2020.03.172.

Wan, B., Wan, W., Hanif, N., Ahmed, Z. (2022). *Logistics performance and environmental sustainability: Do green innovation, renewable energy, and economic globalization matter? "Frontiers in Environmental Science"*, 10. DOI: 10.3389/fenvs.2022.996341.

Wang, W., Melnyk, L., Kubatko, O., Kovalov, B., Hens, L. (2023). *Economic and Technological Efficiency of Renewable Energy Technologies Implementation. "Sustainability"*, 15(11), Article 11. DOI: 10.3390/su15118802.

Wüstenhagen, R., Wolsink, M., Bürer, M.J. (2007). *Social acceptance of renewable energy innovation: An introduction to the concept. "Energy Policy"*, 35(5). DOI: 10.1016/j.enpol.2006.12.001.

Yasin, I., Ahmad, N., Chaudhary, M.A. (2020). *Catechizing the Environmental-Impression of Urbanization, Financial Development, and Political Institutions: A Circumstance of Ecological Footprints in 110 Developed and Less-Developed Countries. "Social Indicators Research"*, 147(2). DOI: 10.1007/s11205-019-02163-3.

Zafirakis, D.P. (2010). *Overview of energy storage technologies for renewable energy systems* [In:] *Stand-Alone and Hybrid Wind Energy Systems* (p. 29–80). Elsevier. DOI: 10.1533/9781845699628.1.29.

Zhao, J., Shahbaz, M., Dong, X., Dong, K. (2021). *How does financial risk affect global CO2 emissions? The role of technological innovation. "Technological Forecasting and Social Change"*, 168. DOI: 10.1016/j.techfore.2021.120751.

Zhao, X., Zhao, J. (2023). *Digital finance and inequality in renewable energy technology innovation. "Energy & Environment"*, 0958305X231171352. DOI: 10.1177/0958305X231171352.