Bibliometric analysis of the assessment of wind generation capacity

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Abstract. This study employs bibliometric analysis using Scopus data and tools like VOSviewer and Biblioshiny to map global research trends in wind energy generation capacity. Analyzing publications from 1975 to 2025, we identify key contributors, institutions, and evolving research themes through co-citation and keyword analysis. Results show a significant acceleration in research output post 2007, with China and the UK leading in productivity and influence. Emerging themes include offshore wind, grid integration, and AI applications. The findings highlight a shift from purely technical optimization towards policy, economics, and sustainability, offering strategic insights for researchers and policymakers to identify future collaboration and innovation avenues.

1 Introduction

Wind energy is pivotal in the global transition to sustainable energy. As installation costs decline and technology advances, wind power has become a cost-effective and eco-friendly alternative to fossil fuels. Assessing wind energy potential is crucial for effective resource planning and policymaking.

Bibliometric analysis offers a quantitative approach to understanding the landscape of this field, identifying major contributors, collaboration networks, and emerging trends. While renewable energy research is widespread [1-7], challenges such as resource limitations and emissions persist. Recent years have seen increased attention to the role of renewable energy across various disciplines [8-17], driven by sufficient funding and intellectual capital [18-23].

The global energy system is undergoing a financial transition [24-26]. According to the International Renewable Energy Agency (IRENA) [30], the installed wind power capacity worldwide increased from 743 GW in 2015 to 2020. Approximately 94 GW of new installations per year, equivalent to about 469 GW of new onshore and offshore wind power, were installed globally [31].

The digital environment [27-29] is often promoted as a viable means to reduce dependency on fossil fuels. Renewable energy sources, mainly hydropower, wind, and solar, are gaining recognition on a global scale as reliable and environmentally sustainable alternatives to conventional fossil fuels [36]. This change represents a significant step toward more sustainable and eco-friendly energy sources in the future. It reflects the global effort to mitigate the environmental impacts of energy production and use [37]. This aligns with European Union energy directives, which require member states to increase the share of renewable energy sources in their energy mix [38].

The European Union's commitment to promoting sustainable, environmentally friendly energy practices among its member states is demonstrated by this rule [39-41]. Germany and Poland, countries with comparable energy profiles, are actively contributing to the global shift toward renewable energy by increasing their investments in clean energy.

In addition to reflecting the rising global trend toward renewable energy, this collaborative project demonstrates its commitment to advancing sustainable growth [42,43]. Renewable energy is crucial to international cooperation and relations between countries, as global connections expand [44,45].

Renewable energy sources, including solar, wind, Hydropower, and bioenergy, are becoming increasingly significant in international commerce and diplomacy due to worldwide awareness of sustainable development [46]. The pressing need to combat climate change and reduce reliance on fossil fuels is the primary driver of this transition, which has led to significant investments in sustainable technology [47].

The broad adoption of renewable energy technology has been made possible by globalisation, which has enabled resource-rich nations to exchange knowledge and creative ideas across national boundaries [48-50]. This development has given the global economy a new dimension by linking environmental sustainability and energy security to national and international policy [51].

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Bibliometric studies have provided valuable insights into wind energy research. Lee et al [55] applied topic modelling to identify technological clusters in wind energy patents, revealing the dominance of grid integration and offshore technologies post-2005. Zhao et al. [56] mapped collaboration networks and knowledge domains through 2018, identifying a strong China-US-Germany partnership and core research themes.

However, these studies are limited by : (1) temporal coverage ending before the recent acceleration in AI applications for wind energy; (2) exclusive focus on either patents [55] or publications [56] without integrating both perspectives; and (3) limited attention to emerging economies beyond the traditional research powers.

The present study addresses these gaps by extending the analysis to 2025 to capture recent developments in AI and machine learning applications; providing a comprehensive publication-based analysis that complements patent studies; and explicitly examining the growing contribution of emerging economies such as India, Brazil, and South Africa. Furthermore, this study employs both VOSviewer and Biblioshiny to provide triangulated insights, combining network visualisation with advanced statistical analysis.

Therefore, this study aims to : (1) document the growth trajectory of wind energy capacity research from 1975 to 2025; (2) identify the most productive authors; (3) map the intellectual structure of the field through co-citation and keyword co-occurrence analysis; (4) analyse international collaboration patterns; and (5) identify emerging research themes and future directions by achieving these objectives, this study provides researchers, policy makers, and industry stakeholders with a comprehensive understanding of the field's evolution and a roadmap for future investment and collaboration.

2 Techniques

2.1 Data sources and search strategy

Data was sourced from the Scopus database. As mentioned in [32], [33], the acquired data were then analysed using spreadsheet applications with data analysis features (such as Microsoft Excel with the necessary add-ins) or bibliometric analysis tools (like VOSviewer and Bibliometrix).

The study addressed key questions regarding publication trends, leading contributors (nations, organisations, authors), impactful works, thematic evolution, and collaboration patterns. Abstracts, citation counts, and keywords were exported for analysis.

2.2 Data analysis methods

The analysis combined quantitative and network- based approaches using VOSviewer (version 1.6.20) and Biblioshiny (the web interface for the Bibliometrix R package).

Software Parameters:
VOSviewer Settings:

- Co-authorship analysis: Minimum document threshold = 3 per author; minimum citations = 10; full counting method; normalization by association strength. Total link strength is calculated as the sum of co-authorship links for each author.
- Keyword co-occurrence analysis: Minimum occurrences = 5; binary counting (presence/absence only); normalization by association strength; clustering resolution = 1.0; minimum cluster size = 5.
- Keywords were standardised before analysis (plural/singular merging and synonym grouping).
- Citation analysis: Minimum citations per document = 10; full counting method.

Biblioshiny Settings:

- Publication trends: Annual scientific production calculated using Biblioshiny's built-in function.
- Bradford's Law: Automatic zone identification based on journal productivity ranking, with zones defined as approximately one-third of total publications each.
- Average citations: Mean total citations per article calculated across all years; mean citations per year calculated as total citations divided by citable years (2025 minus publication year).

Data Preparation:

- Before analysis, the exported Scopus data were cleaned:
- Author keywords standardised (e.g., "wind turbine" and "wind turbines" merged)
- Author names verified using Scopus Author ID where available
- Duplicate records identified by DOI and title matching (12 removed).

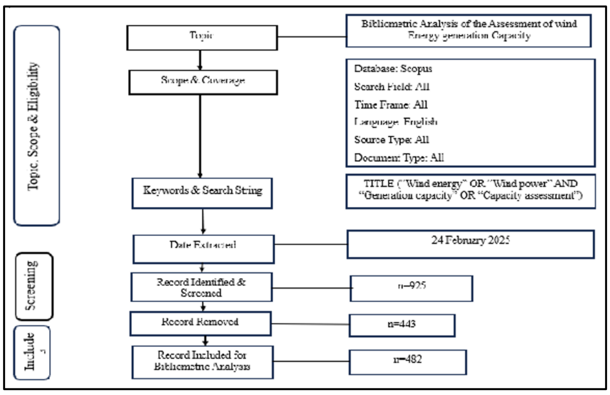

Fig. 1. Flowchart illustrating the search methodology.

3 Results and discussion

3.1 Dataset overview

The dataset spans 1975-2025, containing 925 publications from 482 sources (primarily journals). The annual growth rate is ~3.65%. Documents average 23.9 citations and are 8.66 years old. The publications involved 2,924 authors, with an average of 3.56 coauthors per document and 19.14% international co-authorships.

Table 1. Dataset Attributes.

Description - main information about data	Results
Timespan	1975-2025
Sources (Journals, Books, etc)	482
Documents	925
Annual Growth Rate %	3,65
Document Average Age	8,66
Average citations per doc	23,9
References	25550
DOCUMENT CONTENTS	
Keywords Plus (ID)	5376
Author's Keywords (DE)	2411
AUTHORS	
Authors	2924
Authors of single-authored docs	78
AUTHORS COLLABORATION	
Single-authored docs	96
Co-Authors per Doc	3,56
International co-authorships %	19,14
DOCUMENT TYPES	
article	477
book	3
book chapter	34
conference paper	358
conference review	4
data paper	2
erratum	2
note	6
retracted	2
review	34
short survey	3

3.2 Publication trends and impact

Figure 2 illustrates a steady and notable increase in academic output, with a significant rise after 2007 and another noteworthy increase in 2011. Key growth years were 2013,2019, and 2023. This surge aligns with global policy shifts and technological advancements. Analysis of mean total citations per article shows a peak influence around 1998, followed by a decline in recent years due to the shorter time available for recent publications to accumulate citations.

Table 2 shows the mean total citations per article (Mean TC per Art) and the mean total citations per year (Mean TC per year) using the citable year parameter.

The annual publication trajectory (Figure 2) reveals three distinct phases in wind energy capacity research: Phase 1 (1975-2006): Incubation. Publications remained below 20 annually for three decades, reflecting wind energy as a niche research area with limited policy attention and technological maturity.

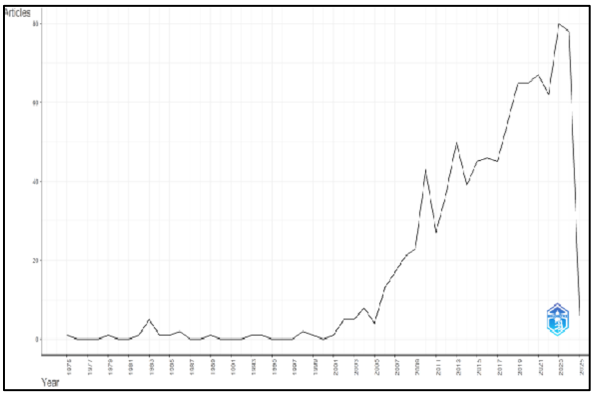

Fig. 2. Annual Scholarly Output (1975-2025).

Phase 2 (2007-2015): Acceleration. Output surged from 17 publications (2007) to 43 (2010)—a 153% increase in three years—coinciding with two critical drivers: the first EU Renewable Energy Directive (2009) mandating national targets, and global financial crisis stimulus packages that channelled billions into green energy infrastructure. The 2011 citation peak (66.04 per article) reflects research enabled by these investments reaching maturity in terms of publication and citations.

Phase 3 (2016-2025): Rapid Expansion. Annual output nearly doubled from 46 (2016) to 80 (2023), with step changes in 2019 (65 publications) and 2023 (80 publications). This acceleration aligns with the Paris Agreement (2015) implementation period and the maturation of offshore wind technology.

Table 2. Average citations per year eligible for citation.

Year	Mean TC per Art	N	Mean TC per Year	Citable Years
1975	1,00	1	0,02	51
1979	0,00	1	0,00	47
1982	0,00	1	0,00	44
1983	16,40	5	0,38	43
1984	18,00	1	0,43	42
1985	0,00	1	0,00	41
1986	0,00	2	0,00	40
1989	0,00	1	0,00	37
1993	0,00	1	0,00	33
1994	1,00	1	0,03	32
1998	278,50	2	9,95	28
1999	23,00	1	0,85	27
2001	0,00	1	0,00	25
2002	73,20	5	3,05	24
2003	0,80	5	0,03	23
2004	10,88	8	0,49	22

2005	25,50	4	1,21	21
2006	18,85	13	0,94	20
2007	65,47	17	3,45	19
2008	98,86	21	5,49	18
2009	16,52	23	0,97	17
2010	33,88	43	2,12	16
2011	66,04	27	4,40	15
2012	23,76	37	1,70	14
2013	37,56	50	2,89	13
2014	11,77	39	0,98	12
2015	45,60	45	4,15	11
2016	32,67	46	3,27	10
2017	24,42	45	2,71	9
2018	14,25	55	1,78	8
2019	26,72	65	3,82	7
2020	21,52	65	3,59	6
2021	11,64	67	2,33	5
2022	10,82	62	2,70	4
2023	5,19	80	1,73	3
2024	1,95	78	0,98	2
2025	0,17	6	0,17	1

The 1998 citation peak (278.5 average) is attributable to two seminal works that established foundational methodologies for wind energy assessment. Petersen et al.'s two-part series on wind power meteorology provided both the theoretical framework (Part I: wind profiles, turbulence, extreme winds) and applied methodologies (Part II: numerical modelling, terrain analysis, siting optimisation) that underpinned subsequent research for two decades.

Concurrently, Schwartz and George introduced the use of global climatic reanalysis data for wind resource mapping at the National Renewable Energy Laboratory (NREL). This methodology became the international standard for regional wind prospecting and continues to inform contemporary AI-enhanced assessment studies. These papers' exceptional citation longevity reflects their role in establishing the analytical approaches that the field still builds upon today.

3.3 Core Sources and Bradford's Law

Bradford's Law analysis confirms a concentration of literature in a core set of journals. Zone 1, which contains the most productive sources, includes high-impact journals such as Energies, Renewable and Sustainable Energy Reviews, and Energy Policy. This concentration underscores their central role in the field, while Zones 2 and 3 show a wider dispersion of lower-output journals.

According to this theory, there will be a concentration of highly productive journals at the top, followed by a decline in productivity when examining journals with lower rankings [34]. Figure 3 illustrates Bradford's Law in wind energy research: a multidisciplinary core of three journals accounts for 41% of the literature. In comparison, a long tail of 479 journals shows the field's permeation into adjacent disciplines.

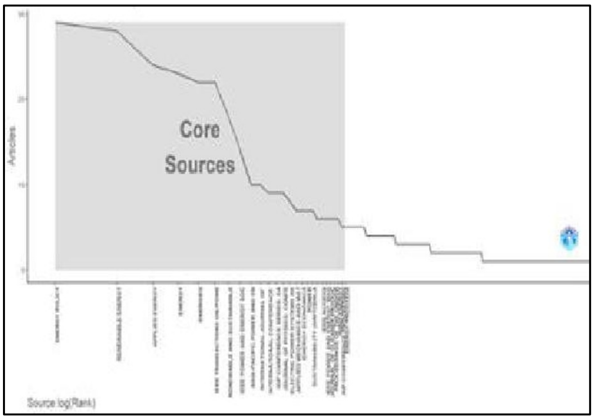

Fig. 3. Distribution of Core Journals According to Bradford's Law.

Details on Bradford's Law and important periodicals are provided in Table 3. Table 3 reveals a concentrated core of three multidisciplinary journals publishing 41% of the literature—Renewable and Sustainable Energy Reviews (synthesis), Energy Policy (social science), and Energies (applied engineering)—with a long tail of 479 journals indicating widespread disciplinary permeation.

Table 3. Prominent Journals According to Bradford's Law.

Bradford Zone	Journal Name	Publications	Impact Factor
Zone 1 (Core Journals)	Renewable and Sustainable Energy Reviews	150	14.98
	Energy Policy	120	6.82
	Energies	110	3.96
Zone 2 (Moderate Productivity)	Applied Energy	75	8.86
	Journal of Renewable Energy	65	4.12
Zone 3 (Low Productivity)	Miscellaneous Journals	< 50 each	-

3.4 Geographic Distribution of Research

A global map of publications output(Figure 4) reveals concentrated research activity in Europe, North America, and Asia. China, the US, Germany, and India are the top contributors, reflecting their substantial investments in renewable energy and robust research capabilities. The US leads in total citations (7,739), indicating high- impact research, while China leads in publication volume, demonstrating a massive research output.

3.5 Collaboration Networks

Co-authorship analysis extends beyond simple citation counts to reveal the social structure of scientific research [35]. Using VOSviewer (minimum document threshold 3 per author; complete counting method; association strength normalization), we constructed the co-authorship network shown in Figure 6, where node size represents total publications, node color indicates cluster membership, and link thickness represents collaboration strength (total co-authored documents). Table 4 complements this visualization by ranking top authors by citations and total link strength.

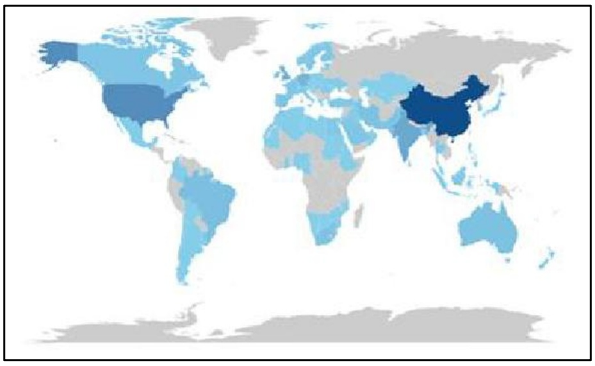

Fig. 4. Global Distribution of Articles on Wind Energy.

Table 4 reveals three distinct research strategies: high- impact collaborators (O'Malley et al.) who achieve influence through focused group work, high-impact isolates (Breyer, Pinson) whose conceptual contributions propagate through citation alone, and low-impact isolates (Park, Bell) whose work lacks the collaborative amplification or conceptual distinctiveness to achieve broad recognition.

Table 4. The top nine authors were identified through citation metrics and network affiliations.

Id	Author	Documents	Citations	Total link strength
262	Bell, K.R.W.	5	41	0
342	Breyer, Christian	6	405	0
924	Harrison, Gareth P.	6	949	4
989	Holttinen, Hannele	5	462	2
1840	O'malley, Mark	7	1159	2
1844	Ochoa, Luis F.	5	883	4
1905	Park, G.L.	5	59	0
1906	Park, Heejung	5	180	0
1968	Pinson, Pierre	5	371	0

3.6 Thematic evolution

Keyword co-occurrence analysis (Figure 5) reveals the evolution of research themes. Key clusters include:

- Offshore Wind Energy: Focus on technology and environmental challenges.
- Grid integration: Concerns stability, power quality, and smart grids.
- AI and Machine Learning: Applications in wind prediction, turbine optimisation, and predictive maintenance.

The field has evolved from a primary focus on technical turbine optimisation in the 2000s to a broader emphasis on policy, economics, and sustainability in the 2020s.

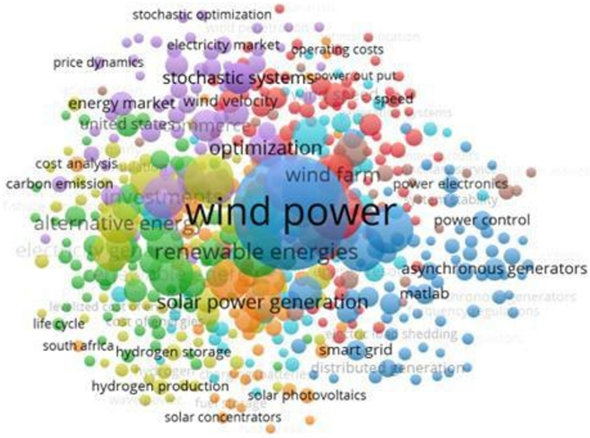

Fig. 5. Keyword Co-Occurrence Network (Emerging research Topics).

The network highlights emerging research fields, including offshore wind energy, grid integration, and artificial intelligence applications. Additionally, it identifies correlations between terms that appear together, revealing connections between different topics.

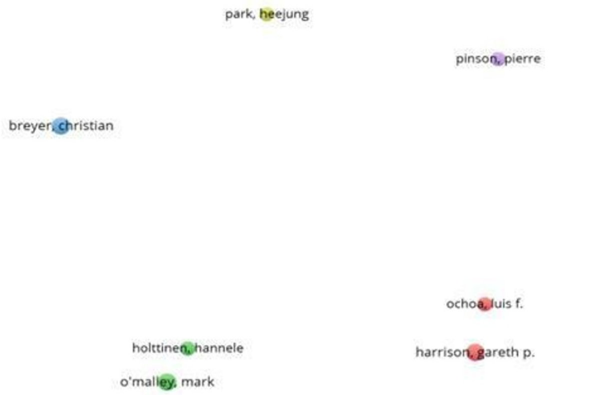

Fig. 6. Examination of Co-Authorship Network.

This network visualisation, which was produced using VOSviewer, shows author collaborations. Nodes represent individual writers, while the links indicate interaction between co-authors. It highlights key areas of study. Research affiliations can be classified as strong or weak based on the thickness of the linkage.

4 Conclusion and prospective

4.1 Conclusion

This bibliometric analysis set out to map the global research landscape of wind energy generation capacity from 1975 to 2025, addressing five specific objectives:

- (1) document publication trends;
- (2) identify core journals and their disciplinary orientations;

- (3) map geographic distribution and leadership patterns;
- (4) characterize collaboration networks and strategies; and
- (5) trace thematic evolution and identify emerging frontiers.

Using Scopus data and complementary bibliometric tools (VOSviewer, Biblioshiny), we analysed 925 publications to generate insights that extend beyond description to provide strategic guidance for researchers, policymakers, and industry stakeholders. This section synthesises the key findings, acknowledges limitations, and proposes evidence-based priorities for future research.

4.2 Outlook

Despite progress, critical research gaps remain in offshore wind cost-reduction, small-scale systems for rural electrification, and seamless smart grid integration. Future research should prioritize:

- Multidisciplinary Cooperation: Fostering collaboration between engineering, environmental science, and economics.
- AI and ML integration: Leveraging these technologies for forecasting, efficiency optimisation, and maintenance.
- Policy and investment Assessment: Evaluating regulatory frameworks and economic instruments for long-term sustainability.
- Focus on Emerging Economies: Developing low- cost, small-scale solutions and addressing adoption barriers.

By focusing on these avenues, wind energy research can make a significant contribution to global renewable energy targets, enhance energy security, and mitigate climate change.

References

1. A. El Amri, R. Boutti, S. Oulfarsi, F. Rodhain, B. Bouzahir, Financial Markets, Institutions and Risks **4**, 31–44 (2020)
2. A. El Amri, R. Boutti, F. Rodhain, Financial Markets, Institutions and Risks **4**, 52–64 (2020)
3. M. Smith, SocioEconomic Challenges **2**(1), 21–34 (2018)
4. D. Bhowmik, Socioeconomic Challenges **3 (2)**, 15–30 (2019)
5. O. Lyulyov, T. Pimonenko, A. Kwilinski, H. Dzwigol, M. Dzwigol-Barosz, V. Pavlyk, P. Barosz. Energies **14 (2)**, 373 (2021)
6. D.T.A. Marcel, Socioeconomic Challenges **3**(2), 63–69 (2019)
7. I. Didenko, K. Volik, T. Vasylieva, S. Lyeonov, N. Antoniuk, E3S Web Conf. **202** (2020)
8. Y. Samusevych, A. Vysochyna, T. Vasylieva, S. Lyeonov, S. Pokhylko, E3S Web Conf. 234 (2021)
9. S. Furmaniak, P.A. Gauden, A. Patrykiejew, R. Miśkiewicz, P. Kowalczyk, Sci. Rep. 15407 (2018)
10. S. He, Business Ethics Leadership **3**(4), 43–48 (2019)
11. V. Pavlyk, SocioEconomic Challenges **4 (1)**, 122–128 (2020)
12. V. Panchenko, Yu. Harust, Ya. Us, O. Korobets, V. Pavlyk, Mark. Manag. Innov. **1**, 256–264 (2020)
13. Ya. Us, T. Pimonenko, T. Tambovceva, J.-P. Segers, Health Econ. Manag. Rev. **1 (1)**, 48–59 (2020)
14. R. Miskiewicz, Energies **13 (22)**, 6106 (2020)
15. R. Miskiewicz, Polityka Energetyczna **21 (2)**, 49–62 (2018)
16. Y. Kharazishvili, A. Kwilinski, O. Grishnova, H. Dzwigol, Sustainability **12 (21)**, 8953 (2020)
17. H. Dzwigol, M. Dzwigol-Barosz, Z. Zhyvko, R. Miskiewicz, H. Pushak, J. Secur. Sustain. Issues **8 (3)**, 307–317 (2019)
18. O.Y. Halan, Mark. Manag. Innov. **1**, 196–206 (2018)
19. I. Sotnyk, I. Shvets, L. Momotiuk, Y. Chortok, Mark. Manag. Innov. **4**, 150–160 (2018)
20. R. Vanickova, Mark. Manag. Innov. **2**, 56–67 (2020)
21. H. Dkhili, L.B. Dhiab, Mark. Manag. Innov. **4**, 252–268 (2019)
22. V. Pavlyk, Financial Markets, Institutions and Risks **4(1)**, 117–123 (2020)
23. L. Starchenko, S. Lyeonov, T. Vasylieva, T. Pimonenko, O. Lyulyov, E3S Web Conf. 234, 00015 (2021)
24. O. Chygryn, A. Rosokhata, O. Rybina, N. Stoyanets, E3S Web Conf. 234, 00004 (2021)
25. I. Vakulenko, L. Saher, L. Syhyda, S. Kolosok, A. Yevdokymova, E3S Web Conf. 234, 00020 (2021)
26. Ye. Ziabina, T. Pimonenko, L. Starchenko, Socioeconomic Challenges **4 (4)**, 160–174 (2020)
27. H.S. Andrade, G. Loureiro, Business Ethics Leadership **4 (2)**, 86–95 (2020)
28. A. Rosokhata, O. Rybina, A. Derykolenko, V. Makerska, Res. World Econ. **11 (4)**, 42–52 (2020)
29. H. Dzwigol, M. Dzwigol-Barosz, Acad. Strateg. Manag. J. **19 (5)**, 1–7 (2020)
30. Technologies. Available online: https://www.irena.org/statistics/view-data-by-topic/capacity-and-generation/technologies (accessed May 2022)
31. Global Wind Energy Council, GWEC Global Wind Report 2021 (GWEC, Brussels, 2021)
32. J.A. Moral-Muñoz, J. Herrera-Viedma, M. Santisteban-Espejo, E. Cobo, Software tools for conducting bibliometric analysis in science: An

up-to-date review. El Prof. Inf. **29 (4)**, e290407 (2020). https://doi.org/10.3145/epi.2020.jul.07
33. N.J. Van Eck, L. Waltman, Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics **84 (2)**, 523–538 (2010). https://doi.org/10.1007/s11192-009-0146-3
34. J. Nicolaisen, K.H. Hjørland, F.B. Frandsen, Structured abstracts in library and information science journals. J. Doc. **63 (4)**, 591–603 (2007)
35. M. Velden, K. Haque, J. Lagoze, A new approach to analysing collaboration patterns in co-authorship networks, in Proceedings of the IEEE International Conference on Science and Technology Indicators (2010)
36. E.D.R. Santibanez Gonzalez, V. Kandpal, M. Machado, M.L. Martens, S. Majumdar, A bibliometric analysis of circular economies through sustainable smart cities. Sustainability **15**, 15892 (2023)
37. D. Gielen, F. Boshell, D. Saygin, M.D. Bazilian, N. Wagner, R. Gorini, The role of renewable energy in the global energy transformation. Energy Strategy Rev. **24**, 38–50 (2019)
38. A. Jachura, R. Sekret, Life cycle assessment of the use of phase change material in an evacuated solar tube collector. Energies **14**, 4146 (2021)
39. D.S. Armeanu, G. Vintila, S.C. Gherghina, Does renewable energy drive sustainable economic growth? Multivariate panel data evidence for EU-28 countries. Energies **10**, 381 (2017)
40. L. Ollier, F. Metz, A. Nuñez-Jimenez, L. Späth, J. Lilliestam, The European 2030 climate and energy package: Do domestic strategy adaptations precede EU policy change? Policy Sci. **55**, 161–184 (2022)
41. D. Pekanov, I. Fosic, I. Jadresic, EU energy policy: Implications for renewable energy investments, in New Perspectives and Paradigms in Applied Economics and Business (Springer, Cham, 2023), 207–218
42. R. Slosarski, Clean energy in the European Union: Transition or evolution? Energy Environ. **34**, 2163–2185 (2023)
43. I. Potapenko, V. Kukartsev, V. Tynchenko, A. Mikhalev, E. Ershova, Analysis of the structure of Germany's energy sector with self-organising Kohonen maps, in Business Information Systems Workshops (Springer, Cham, 2022), 5–13
44. K. Hansen, B.V. Mathiesen, I.R. Skov, Full energy system transition towards 100% renewable energy in Germany in 2050. Renew. Sustain. Energy Rev. **102**, 1–13 (2019)
45. K. Cheba, I. Bąk, M.B. Pietrzak, Conditions of the green transformation: The case of the European Union. Technol. Econ. Dev. Econ. **29**, 438–467 (2022)
46. E. Kochanek, Evaluation of energy transition scenarios in Poland. Energies **14**, 6058 (2021)
47. D. Morea, M. El Mehtedi, P. Buonadonna, Energy context: Analysis of selected studies and future research developments. Energies **16**, 1423 (2023)
48. T.R. Fetter, Energy transitions and technology change: "Leapfrogging" reconsidered. Resour. Energy Econ. **70**, 101327 (2022)
49. H.I. Hussain, K. Szczepańska-Woszczyna, F. Kamarudin, N.A.M. Anwar, M.H.M. Saudi, Unboxing the black box on the dimensions of social globalisation and the efficiency of microfinance institutions in Asia. Oeconomia Copernic. **12**, 557–592 (2021)
50. P. Dvořák, S. Martinát, D.V. der Horst, B. Frantál, K. Turečková, Renewable energy investment and job creation: A cross-sectoral assessment for the Czech Republic concerning EU benchmarks. Renew. Sustain. Energy Rev. **69**, 360–368 (2017)
51. J. Liu, Y. Zheng, X. Hu, S. Yu, Assessing renewable energy efficiency to identify improvement strategies: A network data envelopment analysis approach. Energy Sustain. Dev. **76**, 101308 (2023)
52. R. Tsay, Bibliometric analysis of the Journal of Documentation. J. Doc. 64, 123–139 (2008)
53. M. Wallin, Bibliometric methods: Pitfalls and possibilities. Basic Clin. Pharmacol. Toxicol. **97**, 261–275 (2005)
54. D. Bouyssou, T. Marchant, Bibliometric rankings of journals based on impact factors: An axiomatic approach. J. Informetr. **5**, 165–177 (2011)
55. H. Lee, J. Yoon, Y. Park, Trend analysis of research on wind energy technology using topic modelling. Renew. Sustain. Energy Rev. **79**, 1303–1312 (2017)
56. Y. Zhao, Y. Zhang, C. Lei, Mapping knowledge domain of wind energy research: A bibliometric and visualisation analysis. Energy Rep. **6**, 1559–1574 (2020)