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Mapping THE Knowledge Landscape OF Solar AND Renewable Energy Adoption: A Review OF Trends, Themes, AND Collaborations

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Abstract

This study presents a comprehensive approach to understanding the evolution and impact of research in a specific domain by quantitatively analysing publication patterns, citation networks, and collaboration trends. Bibliometric analysis can illuminate how these challenges are addressed in the literature, identifying dominant research themes, such as policy design, technological innovation, and social equity, and tracking their evolution over time. Consequently, this study employs bibliometric analysis to investigate the adoption of solar and renewable energy. In bibliometric analysis, VOSviewer 1.6.20.0 and Biblioshiny 4.0 are integral components of the R package, the most widely used software in this field. The primary information extracted from the Scopus database comprises 433 published documents from 135 sources, spanning the timeframe from 2015 to 2025. The present study provides a thorough analysis of articles published in the areas of solar and renewable energy adoption, government policies, and sustainability over the last decade. It will help researchers uncover the evolution and growth in this domain from different perspectives.

Keywords: *Solar, Renewable Energy, Bibliometric, Sustainability, Review, Adoption*

1. INTRODUCTION

The global transition to renewable energy sources, particularly solar energy, has emerged as a critical strategy to address climate change, enhance energy security, and promote sustainable development (R. Kumar et al., 2022; Vanegas Cantarero, 2020). Solar and renewable energy adoption has gained significant momentum, driven by technological advancements, declining costs, and supportive policy frameworks (Creutzig et al., 2017). The rapid growth of scholarly research in this domain reflects its importance, with a burgeoning literature exploring technological, economic, policy, and social dimensions of renewable energy deployment (Harichandan et al., 2022; Jaiswal et al., 2022; Luthra et al., 2015; Sovacool & Dworkin, 2015; R. Zhang et al., 2025).This research paper aims to systematically analyse the scholarly landscape of solar and renewable energy adoption worldwide over the past decade. By employing bibliometric methods, this study maps the intellectual structure, key themes, and research trends shaping this field, providing a foundation for future investigations.

This study presents a comprehensive approach to understanding the evolution and impact of research in a specific domain by quantitatively analysing publication patterns, citation networks, and collaboration trends (Mukherjee et al., 2022). In the context of solar and renewable energy adoption, bibliometric studies can reveal influential authors, institutions, and journals, as well as emerging research clusters and knowledge gaps. The present study represents the pinnacle of academic rigour in business and management disciplines, ensuring that this analysis captures high-impact research relevant to the socio-economic and policy aspects of renewable energy adoption. Additionally, government reports, such as those from the International Energy Agency (IEA, 2020), provide critical contextual data on global and regional adoption trends, enriching the research perspective.

Significant technological and economic developments have propelled the adoption of solar and

renewable energy. The cost of solar photovoltaic (PV) systems has declined by over 80% since 2010, making solar energy increasingly competitive with fossil fuels (P. Kumar et al., 2024). This cost reduction, coupled with advancements in energy storage and grid integration, has accelerated deployment across diverse sectors, from residential rooftops to large-scale solar farms (Griffith, 2021). According to IEA, 2021 report, renewables accounted for 29% of global electricity generation in 2020, with solar PV playing a pivotal role due to its scalability and adaptability. Scholarly research has extensively explored these trends, with studies such as those by (Victoria Agbakwuru et al., 2024). Emphasising the contribution of solar energy to achieving the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action).

Despite the progress, barriers to widespread adoption persist, including financial constraints, technological limitations, and policy uncertainties. Research by Sharma and Goel (2022) highlights the challenges of high upfront costs and inadequate infrastructure in developing economies, which hinder equitable access to renewable energy (Ansari et al., 2024; Maurya et al., 2024). Policy inconsistencies, such as fluctuating subsidies, further complicate adoption efforts, particularly in regions with entrenched fossil fuel industries (Zul Azlan et al., 2024). For instance, India, with its unique socio-economic and environmental context, faces distinct challenges and opportunities in its renewable energy journey. As the world's third-largest solar market, India has set an ambitious target to achieve 500 GW of renewable energy capacity by 2030, with solar energy serving as a cornerstone, as outlined in the National Solar Mission launched in 2010 (Energy, 2010). India's solar capacity reached 94.16 GW by November 2024, a 30-fold increase since 2014. Its total renewable energy capacity is expected to hit 170 GW by March 2025 (Energy, 2024). Iconic projects, such as the Bhadla Solar Park in Rajasthan—the world's largest solar facility with a capacity of 2,245 MW by 2023—demonstrate India's progress (Energy, 2024). Government policies, including waivers of Inter-State Transmission System (ISTS) charges for solar projects commissioned by June 2025 and Renewable Purchase Obligations (RPO) up to 2029–30, bolster this growth (Ministry of Power, 2024). Additionally, incentives like subsidies and tax exemptions have spurred rooftop solar installations in states like Gujarat, Rajasthan, and Maharashtra (Agency, 2025).

However, India's adoption of renewable energy is constrained by significant barriers. Geographical diversity and socio-economic disparities necessitate decentralised energy solutions, particularly for rural electrification. Inadequate grid infrastructure and high initial investment costs further hinder progress (Kazemzadeh et al., 2023). Unlike developed nations with mature energy systems, India's energy mix remains heavily reliant on fossil fuels, which account for over 70% of its energy consumption, contributing to substantial carbon emissions (CPCB Report, 2024). With a population exceeding 1.4 billion and rapid industrialisation, India's energy demand is projected to double by 2040, amplifying the urgency for sustainable energy solutions (NITI Aayog Policy Paper, 2023). Solar energy, abundant due to India's geographical location, offers a viable pathway; however, its scalability requires overcoming systemic challenges (Bansal et al., 2025; Bansal & Ansari, 2025; Maurya et al., 2025).

Bibliometric analysis can illuminate how these challenges are addressed in the literature, identifying dominant research themes, such as policy design, technological innovation, and social equity, and tracking their evolution over time (Kallawar et al., 2024). (Sovacool & Dworkin, 2015) underscores the growing focus on energy justice, highlighting the need for inclusive policies to ensure that marginalised communities benefit from the renewable energy transition.

The socio-economic implications of solar and renewable energy adoption are another critical area of research. (Sundaram et al., 2024) estimate that the renewable energy sector could generate over 40 million jobs globally by 2050, driven by solar and wind energy projects. Moreover, recent studies suggest that investors worldwide are increasingly drawn to making sustainable investment choices across various sectors (Bansal & Ansari, 2025). Government initiatives, such as the European Union's Green Deal Report (EU, 2020), further emphasise the potential for renewable energy to foster economic resilience and energy access in remote regions (Ansari et al., 2024; Ansari & Bansal, 2024; Gupta et al., 2024; Malik et al., 2024). Bibliometric studies can map the interdisciplinary nature of this research, revealing connections between management, economics, and environmental science, and identifying influential

works that shape policy and practice (Kumar et al., 2024).

This study contributes to the literature by providing a comprehensive analysis of research on the adoption of solar and renewable energy. It employs metrics such as publication and citation counts, co-authorship networks, and keyword co-occurrence to uncover the intellectual structure and emerging trends in this field. The study broadly addresses the following research questions: *Firstly,* what are the key publication trends and influential works in the adoption of solar and renewable energy? *Secondly,* how do research themes and collaborations evolve? *Thirdly,* what are the gaps and future directions for research in this domain?

The subsequent sections are structured as follows: *Section 2* outlines the theoretical background of renewable and solar energy adoption, *Section 3* includes the bibliometric methodology, *Section 4* presents the key findings and results of the analysis, *Section 5* focusses on the interpretation of results, and *Section 6* concludes with discussion, implications, limitations and recommendations for future studies. By synthesising high-quality academic research and government reports, this paper aims to provide a comprehensive understanding of the scholarly landscape of solar and renewable energy adoption, guiding researchers, policymakers, and practitioners toward a sustainable energy future.

1.1. Research Questions

RQ1. What is the volume and evolution of research on solar and renewable energy adoption?

RQ1.1 What are the current trends and thematic developments in solar and renewable energy adoption research?

RQ1.2 How have the core topics evolved in this field?

RQ1.3 Which journals, authors, and countries have contributed most significantly?

RQ2. What is the intellectual and collaborative research structure on solar energy adoption and sustainability?

RQ2.1 Which documents and authors are most influential based on co-citation networks?

RQ2.2 How are keywords, authors, and sources interlinked within the field?

RQ2.3 What patterns of national and international collaboration exist in solar energy research?

RQ3. What gaps exist in the existing literature, and what directions can future research take in the field of solar energy adoption and sustainability?

2. RESEARCH METHODOLOGY

2.1. Bibliometric Analysis

The bibliometric method provides a quantitative overview of existing literature, enabling researchers to identify trends, forecast future developments, assess scientific publications, and generate visual representations (Moosavi et al., 2021; Sharma et al., 2023). It helps to summarize a large number of publications, which is easier and more reliable; secondly, it helps to explore the relationship between articles, citations, authors' productivity, and emerging trends of keywords, which will indicate the research gaps in this domain through the visualization of networking mapping (Donthu et al., 2021; Mukherjee et al., 2022).The primary rationale for employing bibliometric approaches for analysis is that they can efficiently analyse extensive datasets over a defined timeframe. These approaches allow an extensive and subjective assessment of the current literature, thus establishing a robust theoretical foundation for the specific literature review study (Batistic and van der Laken, 2019; Huang et al., 2020; Sharma et al., 2022). Consequently, this study employs bibliometric analysis to investigate the adoption of solar and renewable energy. In bibliometric analysis, VOSviewer 1.6.20.0 and Biblioshiny 4.0 are integral components of the R package, the most widely used software in this field (Gupta and Siwal, 2022; Gyimah et al., 2023; Halepoto et al., 2022).

This study utilises the subsequent bibliometric analysis to achieve its objectives:

i. Co-citation: Co-citation refers to the occurrence of two documents being cited in tandem, which facilitates the analysis of the scientific structure based on historical publications (Small, 1973). When two documents are co-cited in subsequent literature, it implies a meaningful intellectual or thematic connection between them (Zupic & Čater, 2015). Co-citation analysis facilitates the systematic assessment of prior influential scholarly works and builds an empirical map of the intellectual landscape (Hota et al., 2020).

ii. Co-word analysis: Co-word analysis assesses the interaction among terms or the co-occurrence of keywords. Keywords are derived from the title, abstract, and keywords within the published works (Eck & Waltman,

2014). In an approach equivalent to co-citation analysis, co-word analysis posits that words that frequently co-occur share a thematic connection. The analysis can be employed to predict potential areas of investigation and avenues based on the significant terms derived from the analysis (Donthu et al., 2021).

iii. Three-Fold Plot or Sankey Diagram: Sankey diagrams illustrate the connections between sources, countries, affiliations, keywords, key authors, and cited sources. They also help visualize the flow of ideas and research contributions. Variables are represented by colours and height, with larger rectangles indicating more connections between components (Kumar et al., 2021; Riehmann et al., 2005).

iv. Thematic map of author keywords: The thematic map illustrates the most significant issues in the domain based on the author's keywords. Creating a thematic map aims to comprehend the current state and evaluate the prospective trajectory of research advancement within the domain (García-Lillo et al., 2023).

The thematic map is divided into four quadrants, providing a strategic representation of the intellectual framework of the research domain. This classification is based on two principal bibliometric indicators: *centrality* and *density*. *Centrality* refers to the degree to which a theme is interconnected with other themes, indicating its strategic significance and level of integration within the broader scientific discourse. A theme with high centrality generally has a pivotal place in the knowledge network, impacting and connecting several study domains. Conversely, *density* encapsulates a cluster's internal evolution, intellectual strength, and thematic sophistication. High-density themes are typically well-organised and self-contained, indicating a specialised and cohesive domain of investigation. The interaction between these two aspects facilitates the identification of foundational, emerging, niche, or pivotal themes, offering vital insights into the present condition and future direction of the area (Khaw et al., 2024).

2.2. Research design and article collection procedure

A structured search strategy was developed and executed on April 8th, 2025, using the Scopus database to ensure a comprehensive and targeted selection of scholarly literature. The advanced Boolean search string, as shown in Table 1, inclusion and exclusion illustrated in Table 2, was employed to retrieve relevant academic publications:

This search strategy was designed to capture articles that intersect at the nexus of solar and renewable energy adoption, government policy interventions, and sustainability. The initial search yielded 4728 documents.

To maintain high quality and academic rigour, grey literature, conference proceedings, editorials, and book chapters were intentionally excluded. This decision was made to prioritize peer-reviewed journal publications, which undergo rigorous editorial and review processes, thereby representing validated contributions to the area.

Subsequently, a multi-stage filtration process was applied:

1. **Initial screening by metadata filters**: Articles were selected according to specific inclusion and exclusion criteria concerning the time frame (2015–2025), language (English), document type (Articles only), publication stage (Final stage), source type (Journal), and subject areas encompassing Energy (ENER), Economics (ECON), Social Sciences (SOCI), Environmental Science (ENVI), and Business (BUSI), as detailed in Table 2. This diminished the collection to 2,170 documents.
2. **Manual screening:** A manual screening process was undertaken following the initial filtering based on predefined inclusion and exclusion criteria. During this phase, the **titles and abstracts** of the remaining documents were thoroughly reviewed to assess their thematic alignment with the research objectives. Articles that did not address the core focus areas — namely solar energy adoption, government interventions, sustainability, or related behavioral and policy factors — were excluded. As a result, **1727 documents (including 12 duplicates)** were deemed irrelevant and removed, narrowing the dataset to **443 articles**.
3. **Metadata validation:** The final step involved validating the completeness of each article's bibliographic information. Articles lacking critical metadata such as title, author name(s), or DOI, were considered unsuitable for analysis due to insufficient traceability and citation information. Consequently, **8 articles** were excluded at this stage, resulting in a final dataset of **433 high-quality peer-reviewed journal articles**, which formed the basis for the subsequent bibliometric analysis. After implementing all inclusion criteria and eliminating irrelevant, duplicate, or incomplete entries, 433 documents were selected for detailed bibliometric analysis. This rigorous selection approach ensured the reliability, accuracy, and thematic consistency of the dataset used in the study.

Table 1. Search string applied in Scopus database

No	Keywords	Justification
1	"solar energy" OR "renewable energy" OR "clean energy" OR "green energy" OR "solar photovoltaics" OR "solar PV" OR "solar rooftop" OR "photovoltaics"	To retrieve literature widely associated with solar energy technologies and systems, encompassing solar photovoltaics, rooftop systems, solar power, and other related solar-based energy solutions. The focus is on solar energy within the broader framework of renewable energy.
2	"adoption" OR "adopt" OR "purchase" OR "uptake" OR "willingness" OR "intent" OR "intention to use" OR "install" OR "installation" OR "awareness" OR "awareness to use"	To retrieve literature discussing consumers' behavioural intentions and actions toward adopting solar or renewable energy technologies.
3	"deployment" OR "investment" OR "install" OR "installation"	To identify literature related to the broader scale deployment of solar technologies, including financial and infrastructural aspects.
4	"government" OR "government policies" OR "government subsidy" OR "policy" OR "intervention"	To focus on literature that discusses the role of government, policies, and interventions that influence or facilitate solar energy adoption.
5	"sustainability" OR "sustainable development goals"	To ensure relevance to literature aligned with sustainability goals, especially regarding renewable energy adoption.

Table 2. General information about the Inclusion and exclusion criteria of Documents

Description	Results
Domain	Solar and Renewable Energy
Timespan	2015:2025
Source	Journals
Publication Stage	Final
Document Type	Peer-Reviewed articles
Language	English
Subject area	Energy, Economics, Social Sciences, Environmental Science, Business Management

4. RESULTS AND DISCUSSION

The primary information extracted from the Scopus database is presented in Table 3, highlighting 433 published documents from 135 sources within the timeframe of 2015–2025. The annual growth rate is 16.77% per year during this period. The average number of citations per document is 23.45. The retrieved articles comprise over 25,000 references and more than 2,000 keywords.

It can be inferred that multiple-author contributions have been made, as only 25 documents out of 433 are single-authored. This also emphasises a highly collaborative environment in the research theme, with a collaboration index of 3.8. In the case of international co-authorship, it can be observed that authors from different countries write 38.11% of research articles. This shows that the research topic is broad and important internationally.

Table 3: Overview of extracted records from the Scopus database

Description	Results
Main information about the data	
Timespan	2015:2025

Sources (Journals, Books, etc)	135
Documents	433
Annual Growth Rate %	16.77
Document Average Age	3.25
Average citations per doc	23.45
References	25889
Document contents:	
Keywords Plus (ID)	2757
Author's Keywords (DE)	1462
Authors	
Authors	1479
Authors of single-authored docs	25
Authors Collaboration	
Single-authored docs	25
Co-Authors per Doc	3.8
International co-authorships %	38.11
Document Types	
Article	433

Number of Citations and publications in the timespan 2015-2025

Figure 1 presents the number of articles published and the number of citations received based on the keywords applied in the database. The figure shows an increase in the number of publications year by year. In 2024, 87 documents were published, and 33 were published in 2025. It should be noted that the 2025 data was collected only up to April, so the final number is expected to be higher. At the same time, the number of citations reached its highest point in 2020, with 2,961 citations, followed by a noticeable decline in subsequent years. This suggests that individual papers receive fewer citations as more research is being produced.

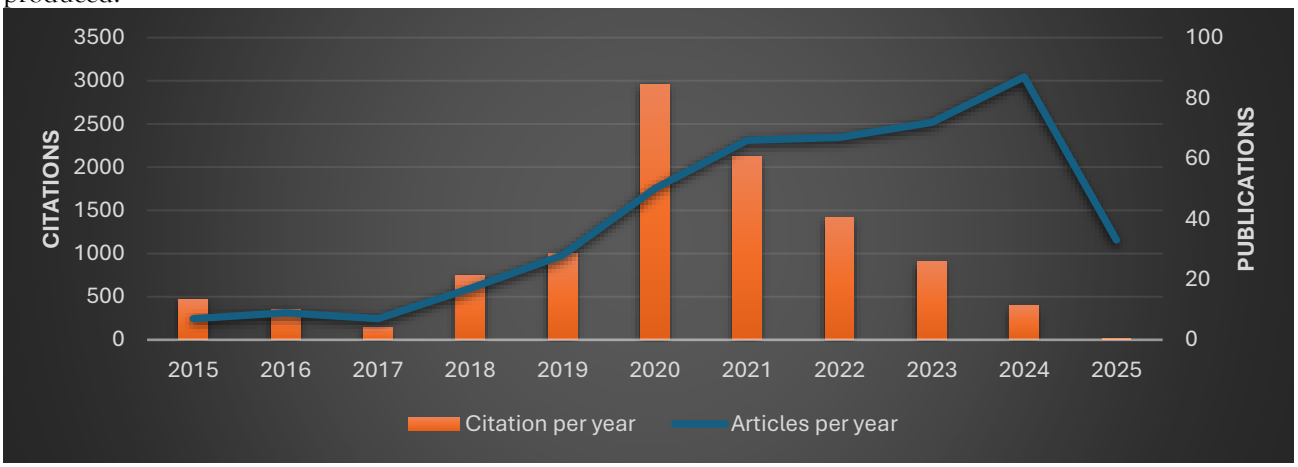

Figure 1. Number of Publications and Citations on Solar, Renewable and Clean Energy

Co-citations analysis by authors

The co-citation analysis of authors highlights their contributions to research on solar or renewable energy adoption. *Figure 2.* presents the network map created using VOSviewer. This analysis identified 201 authors with at least one article with a minimum of 20 or more citations. The network map represents four clusters, each coloured red, green, blue, and yellow, respectively.

Cluster 1 (Red): In Cluster 1, two prominent authors, Kumar A. and Zhang Q. Kumar A, have 80 citations, a Total Link Strength (TLS) of 1836, and 194 connections with other authors, indicating their moderate

influence in the co-citation network. Although Zhang Q. has 70 citations, his TLS of 2531 and 192 connections are far higher. That means Zhang Q. is more central and influential in this cluster's study.

Cluster 2 (Green): In Cluster 2, Wang Y. stands out as a major contributor. He has received 135 citations and shows a strong Total Link Strength (TLS) of 4261, with 199 connections to other authors. These figures suggest that Wang Y. holds a solid position within this cluster.

Cluster 3 (Blue): In Cluster 3, Ozturk I. emerges as a key voice in the network. With 115 citations and a TLS of 5487, he maintains 184 active links with other authors. This combination of citation count and network connections indicates his significant role in shaping the academic discourse in this area. Ozturk I.'s influence is well-placed, showing both reach and relevance in the cluster's research context.

Cluster 4 (Yellow): In Cluster 4, Irfan M. possesses the highest citation count among all detected writers, totalling 139 citations. His Total Link Strength (TLS) is 8443, the greatest among all clusters, with 184 linkages to other authors. This makes him the most referenced author across all clusters.

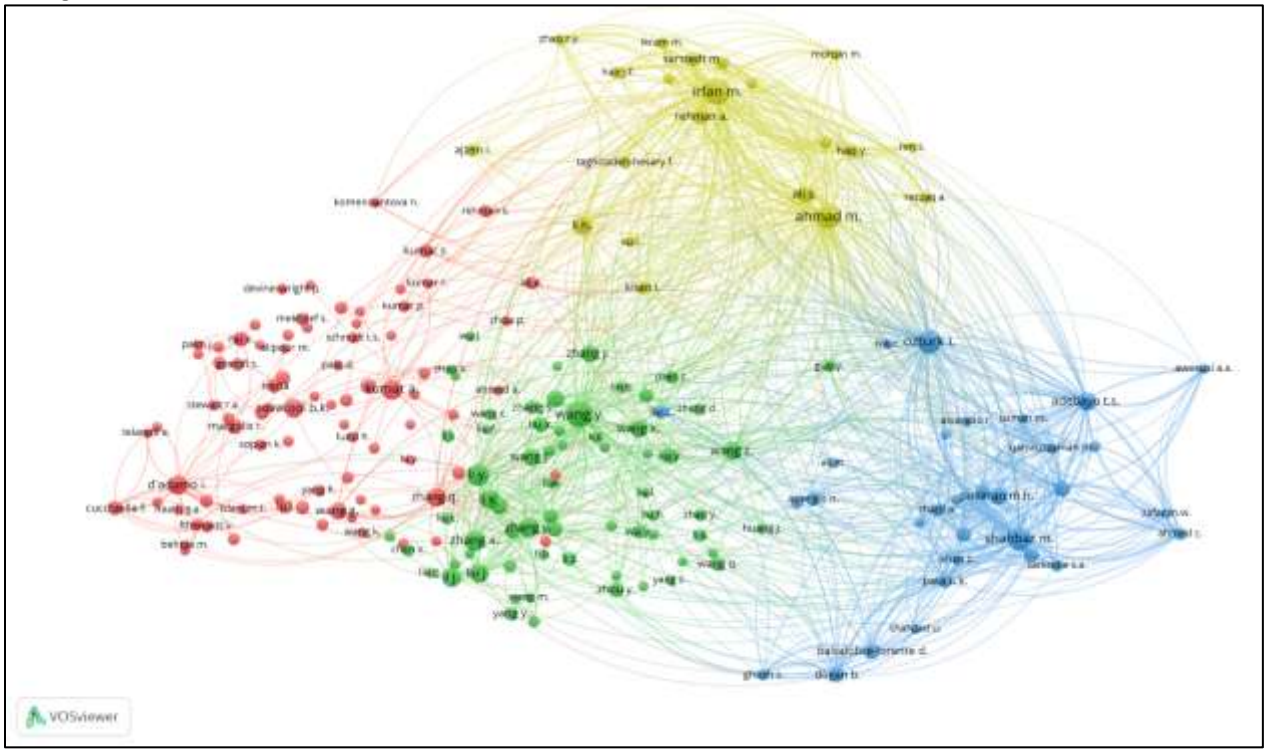

Figure 2. Co-citations analysis by authors

Table 4. Top 10 authors by Citations, Total Link Strength, and Network Connections

S. No.	Author	Citations	Total link strength	Links	Cluster
1	Irfan M.	139	8443	184	*Yellow*
2	Wang Y.	135	4261	199	*Green*
3	Ahmad M.	117	7275	185	*Yellow*
4	Ozturk I.	115	5487	184	*Blue*
5	Shahbaz M.	107	5461	185	*Yellow*
6	Li Y.	100	3248	196	*Green*
7	Zhang X.	82	2326	197	*Green*
8	Kumar A.	80	1836	194	*Red*
9	Zhang Y.	79	2343	193	*Green*
10	Li. H.	78	3638	190	*Yellow*

Co-word analysis of the author's keywords

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This section examines the author's keywords from 433 published documents between 2015 and 2025. The analysis used the complete counting method in VOS viewer, with a minimum threshold of four keyword occurrences. Based on this criterion, 1,462 keywords were identified, and 50 met the threshold for inclusion in the map. The Lin Log layout method was used to visualise the data, as it helps to separate clusters and improve interpretation. ***Figure 3.*** presents the network map of frequently used author keywords in studies on solar and renewable energy adoption. Each cluster is shown in a different colour, highlighting related themes. The size of each node reflects the frequency of that keyword, while the lines between nodes represent their co-occurrence links. This observation is complemented by density visualisation in Figure 4. The brighter and more densely packed keywords represent greater occurrences of the topic in the field (e.g., renewable energy, sustainability, and solar energy).

The results found that the keywords were divided into three major clusters. The first cluster (Red) contains eighteen author keywords: photovoltaics, environmental impact, sustainability, techno-economic analysis, solar PV, sustainable development goals, solar energy, energy access, clean energy, energy transition, rural electrification, globalization, photovoltaic system, renewable energy sources, PV, China, energy storage, and optimization. The second cluster (Green) also contains eighteen author keywords: renewable energy, solar panels, life cycle assessment, circular economy, solar photovoltaics, solar photovoltaic, barriers, India, environmental sustainability, climate change, sustainable energy, Sub-Saharan Africa, energy policy, energy efficiency, co_2 emissions, Vietnam, biomass, and sustainable development. The third and final cluster (Blue) comprises fourteen keywords: energy sector, renewable energies, Iran, CO_2 emissions, photovoltaics, policy, distributed generation, economic analysis, PV systems, scenario analysis, net metering, energy, solar, and system dynamics. This analysis is complemented by **Table 5, which presents the above information in a tabular** format.

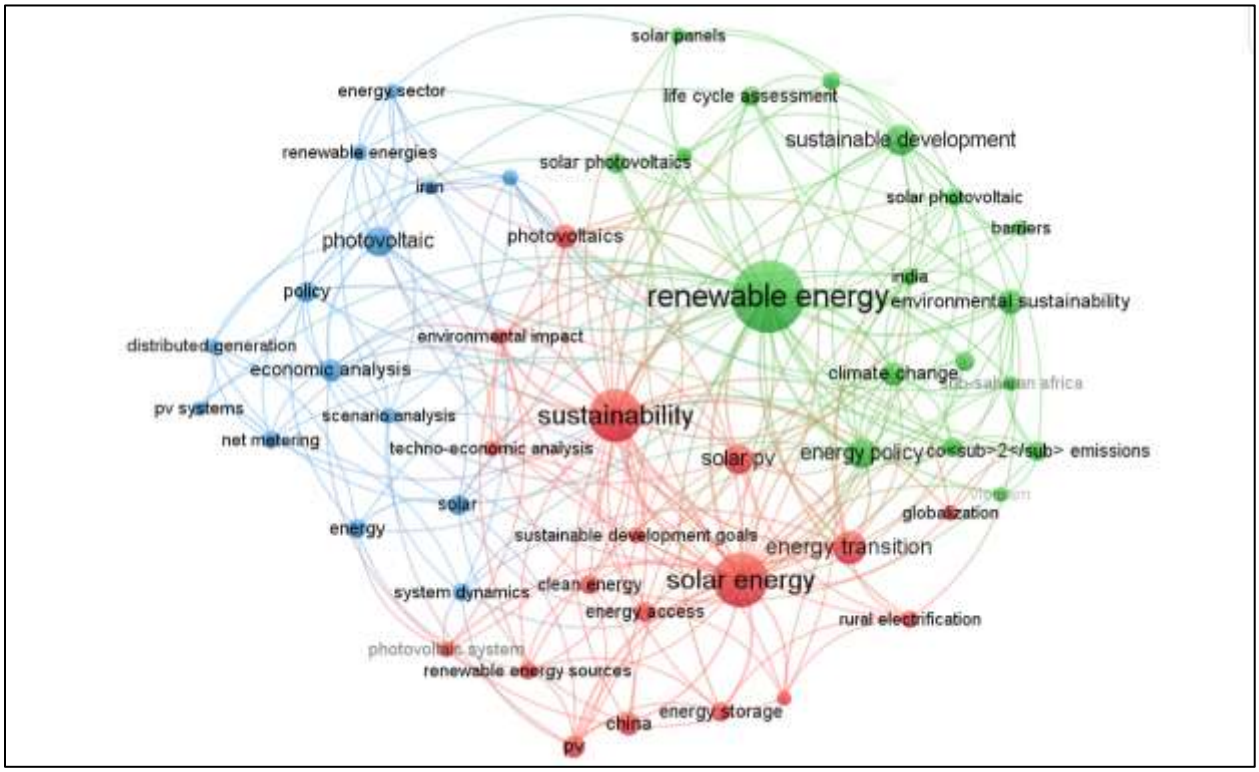

Figure 3: Co-occurrence visualization of author keywords

Table 5: Keywords co-occurrence network summary

Cluster 1 (red): Focused on sustainability and solar energy transition.	Cluster 2 (green): Focused on renewable energy for climate action and sustainable development.	Cluster 3 (blue): Focused on photovoltaic technology and economic analysis

Keyword	Occurrences	Link strength	Keyword	Occurrences	Link strength	Keyword	Occurrences	Link strength
Solar energy	55	62	Renewable energy	95	97	Photovoltaic	16	17
Sustainability	52	67	Sustainable development	17	19	Economic analysis	9	17
Energy transition	21	26	Energy policy	16	27	Policy	8	14
Solar PV	16	14	Environmental sustainability	12	17	Solar	8	13
Photovoltaics	10	15	Climate change	11	20	Energy	7	8
China	10	8	Solar photovoltaics	8	7	Net metering	6	10
PV	9	14	Life cycle assessment	7	13	System dynamics	6	8
Energy access	7	8	Sustainable energy	7	9	Renewable energies	5	8
Clean energy	7	9	Energy efficiency	7	13	CO_2 emission	5	11
Energy storage	7	9	CO_2 emissions	7	11	Scenario analysis	5	9
Rural electrification	6	8	Circular economy	6	8	Energy sector	4	10
Renewable energy sources	6	10	Solar photovoltaic	6	10	Iran	4	5
Environmental impact	5	15	India	6	15	Distributed generation	4	8
Techno-economic analysis	5	7	Solar panels	5	6	PV systems	4	6
Sustainable development goals	5	8	Barriers	5	6			
Photovoltaic system	5	9	Sub-Saharan Africa	4	8			
Globalization	4	6	Vietnam	4	4			
Optimization	4	8	Biomass	4	9			

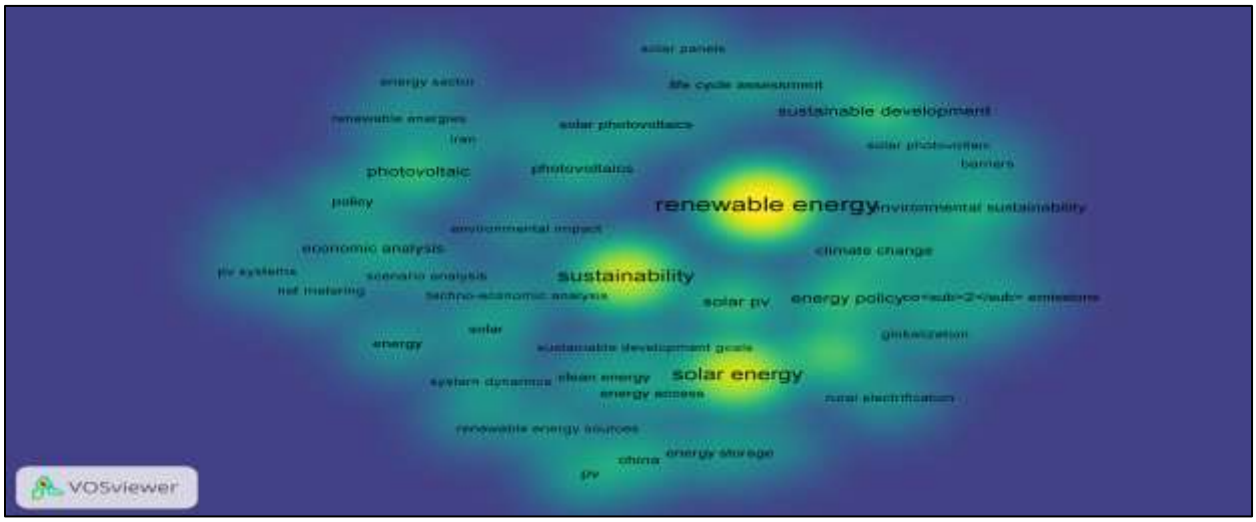

Figure 4. Density visualization of authors' keywords

Visualization of Author Keyword source relationships using Sankey diagrams

A Threefold or Sankey diagram depicts the relationships between variables using a three-dimensional flowchart of rectangular shapes and multiple colours. Using Biblioshiny 4.0, three-field plots were constructed to examine the relationships and contributions among authors, keywords, and sources. **Figure 5** illustrates the top 20 authors, journal sources, and keywords in research on solar and renewable energy adoption. The keywords are Renewable energy, solar energy, sustainability, photovoltaics, economic analysis, energy transition, energy policy, solar PV, sustainable development, environmental sustainability, photovoltaics, PV, solar photovoltaics, CO_2 emissions, policy, climate change, clean energy, China, energy, and solar. The leading journals publishing research in this area include "Sustainability (Switzerland)", "Energies", "Energy Policy", "Renewable Energy", "Journal of Cleaner Production", "Energy for Sustainable Development", "Renewable and Sustainable Energy Reviews", "Energy Reports", "Environmental Science and Pollution Research" and "Sustainable Energy Technologies and Assessments" etc. The most prominent authors include D'Adamo and Idiano, Irfan Muhammad, Gastaldi and Massimo, Asif Muhammad, Huang and Fubin, and Shuai, among others.

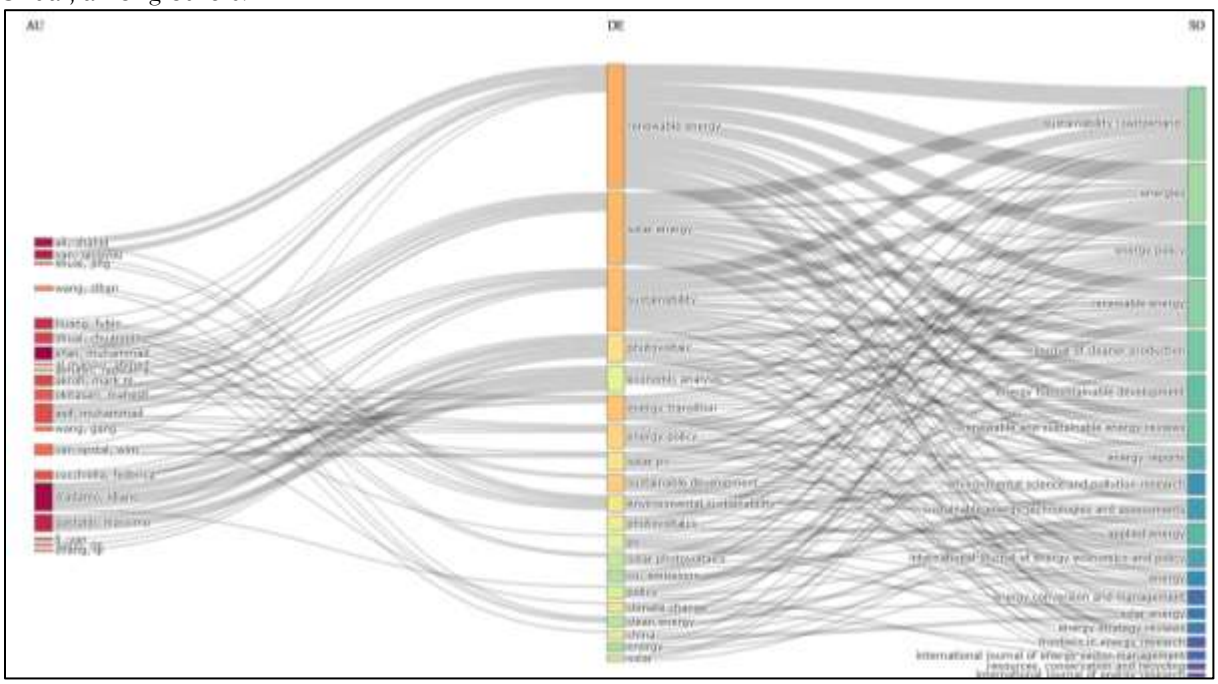

Figure 5. Threefold plot or Sankey diagram created using Biblioshiny

Thematic map

As shown in **Figure 6,** a thematic map was created using Biblioshiny, anchoring upon the author's keywords. It illustrates the most prominent issues in the domain using four quadrants, each representing the status of a specific research theme.

The upper right quadrant, the Motor Theme, is well-developed and central to the overall structure. It highlights areas that greatly influence research in solar and renewable energy. Keywords such as solar photovoltaics, CO_2 emissions, biomass, solar PV, rural electrification, and techno-economic analysis fall into this category. These terms have consistently drawn researchers' attention due to their strong relevance to solar or renewable energy and sustainability studies. Interestingly, themes such as solar energy, sustainability, and energy transition appear to be situated near the boundary between Foundational and Motor themes. This suggests that while they provide a base, they become more prominent. Furthermore, keywords like CO_2 emissions, renewable energies, and scenario analysis are positioned just above the line between Motor and Niche themes. Although well-developed, their gradual shift toward the centre reflects their growing integration of technical, environmental, and policy perspectives.

The niche theme, or the upper-left quadrant, consists of keywords such as energy access, Africa, business model innovation, rooftop photovoltaic, theory of planned behaviour, and structural equation modelling. These terms represent well-developed and specialised research areas. Most studies in this cluster focus on the behavioural dimensions of solar and renewable energy adoption and regional access issues, particularly in specific geographic contexts. Keywords such as photovoltaics, clean energy, and energy security, positioned near the density line, demonstrate evolving potential but lack a direct connection with the solar energy discourse. However, these themes are directly beneficial due to their stronger linkage to policy and core sustainability-related research.

The emerging theme in the bottom-left quadrant has low density and centrality, indicating either nascent areas or areas that are losing relevance. Keywords such as foreign direct investment, renewable energy consumption, globalization, ASEAN, solar power, and development analysis fall into this category. The bottom-right quadrant (Basic or Fundamental Themes) has high centrality and low density, indicating that these themes are the field's cornerstone but not yet fully developed. Keywords related to this theme include renewable energy, sustainable development, energy policy, photovoltaics, economic analysis, and policy. These topics require greater attention in the future to strengthen their academic maturity.

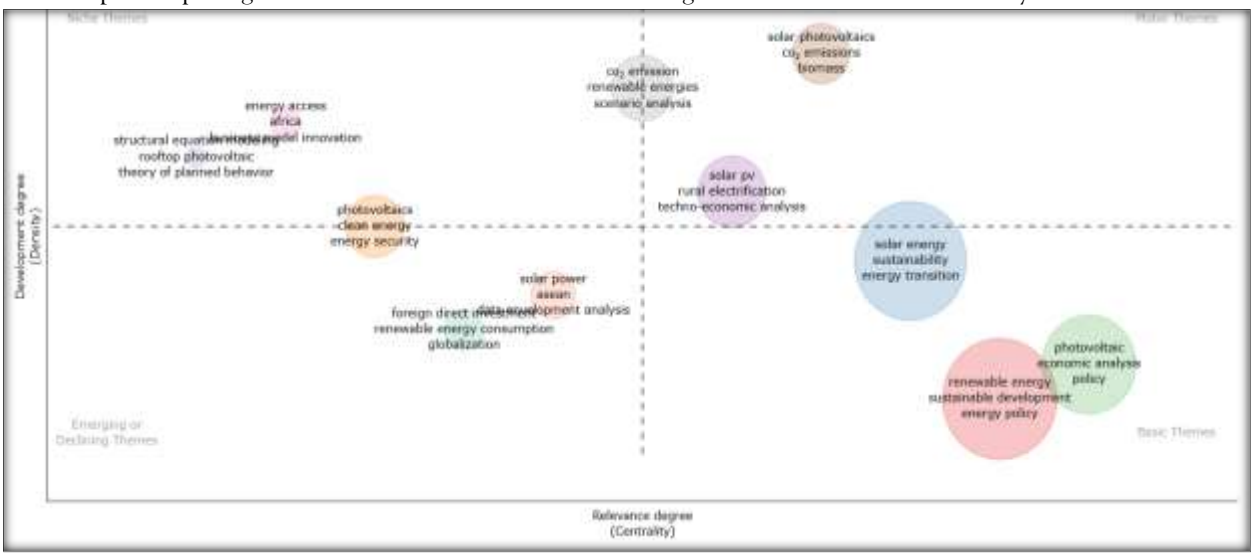

Figure 6: Thematic map created using Biblioshiny

Geographic Distribution of Corresponding Authors and International Collaboration Patterns

Figure 7 and the accompanying Table 6 illustrate the contributions of Multiple and Single Country Publications (MCP and SCP) per total number of articles, country-wise. China ranks first in the total number of articles published, with 76 articles, SCP 40, and MCP 36. India ranks second, with 26 articles published, an SCP of 21 and an MCP of 5. The United Kingdom ranks third, with 23 articles published, including SCP

13 and MCP 10. The United States of America ranks fourth, with 20 articles published, an SCP of 16, and an MCP of 4. These figures highlight China's high output and strong international collaboration environment, while India relies more on a domestic research orientation. At the same time, the United Kingdom and the United States are showing moderate levels of international collaboration in research.

Table 4: Summary of corresponding authors' countries

Country	Articles	Articles %	SCP	MCP	MCP%
China	76	17.6	40	36	47.4
India	26	6	21	5	19.2
United Kingdom	23	5.3	13	10	43.5
USA	20	4.6	16	4	20
Bangladesh	14	3.2	9	5	35.7
Italy	14	3.2	10	4	28.6
Spain	14	3.2	7	7	50
Saudi Arabia	13	3	6	7	53.8
Australia	12	2.8	7	5	41.7
Japan	11	2.5	7	4	36.4

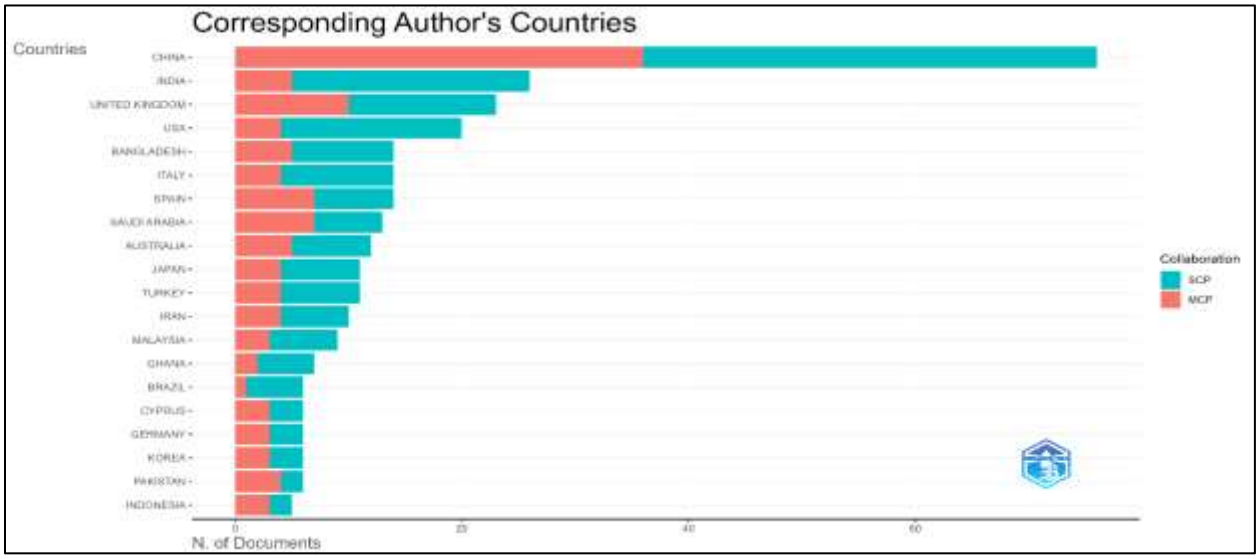

Figure 7: Visualization of corresponding author countries created using Biblioshiny analysis of author keywords using a word cloud

Figure 8. presents a word cloud created using Biblioshiny, anchored upon the author keywords extracted from the selected articles. The visualisation highlights the most frequently used keywords, where the size of each word corresponds to its frequency and centrality in the dataset. Terms like sustainable development, solar energy, solar power, photovoltaic system, solar power generation, alternative energy, and energy policy appear prominently, highlighting the primary focus of researchers within the domain. This distribution highlights the growing attention toward clean energy transitions and sustainability-driven research.

Figure 8: Visualization of a word cloud of author keywords created using Biblioshiny

DISCUSSION

A lot of emphasis is being placed on renewable energy due to environmental concerns, and solar energy is a green energy source that brings a range of benefits to the climate, water, scarce resources, and the environment. We present the existing knowledge in academia on solar and renewable energy adoption, covering the period from 2015 to 2025. The present study focuses on the scholarly discourse on solar and renewable energy adoption, as well as government policy, that contributes to sustainability. Figure 1 shows the number of articles and citations of the articles. The number of articles has shown an increasing trend over the last two years, as the selection criteria were applied until April 2025. A plausible reason for this is the change in tax bills in the USA and unclear policies around the globe, including those in India. Topics such as wind, electric vehicles, and hydropower are also gaining attention. As the number of articles has increased, this has led to a decrease in citations as citations were spread over a greater number of articles. Our results align with those of Obaideen et al. (2023), who reported an increasing trend in articles in this domain. Co-citation of authors is presented in Figure 2, where the results are clustered into four distinct colours, indicating the important authors based on the TLS and co-citation analysis in these four different clusters. If the circle is large, it implies a publication has been cited more, while a proximity between two publications implies a close relation and higher similarity. Although there are four clusters, a convergence is seen among them, and no single cluster stands alone, implying the interconnectedness among the clusters.

We used co-word analysis of the author keywords, and the results are presented in Figure 3 and 4. These keywords are grouped under three distinct clusters. The size of the circle represents the most frequently used words, and the link among those keywords shows how frequently words are used in tandem. Renewable Energy, Solar energy, and sustainability are highly dense keywords, implying a greater focus on these topics within this domain.

We used a Sankey diagram to show authors, keywords, and the journal in a single figure 5, highlighting which authors use which keywords and publish in which journal. This also shows that Renewable Energy, Solar energy, and sustainability are important keywords, with renewable energy being mostly published in the "Sustainability" journal, followed by "Solar Energy" in the "Energies" and "Energy Policy" journals. Our results corroborate with those of L. Zhang et al. (2022), who reported that renewable energy was the most cited term. Contrary to our results, they found that "Energies" was the most productive journal, whereas our analysis indicates that "Sustainability" is the most productive journal. This divergence is because their bibliometric analysis focused on artificial intelligence in renewable energy, whereas our study focuses on solar and renewable energy, as well as government policy interventions.

We also used a thematic map, using the author keywords as shown in Figure 6, to illustrate the development and relevance of these topics in the literature by dividing them into four quadrants: motor, niche, emerging/declining, and basic themes. It clearly shows "Solar Power", "Asean", "Development Analysis", "FDI", etc. are the emerging themes based on the relevance and give direction to future researchers to focus on these topics. Figure 7 illustrates a country analysis, highlighting which countries contribute more to the scholarly articles in this domain. The leading countries are China, with 76 articles, and India, with 26 articles.

Several other authors (Obaideen et al., 2023; L. Zhang et al., 2022) have also documented China's leading position as a contributor to this domain.
This also provides motivation for other countries to contribute to the body of knowledge by highlighting the solar and renewable energy resources in their respective countries, as well as connecting these topics to broader sustainability goals. It also signals that there is either a lack of funding or capacity to support research in other countries, thus providing evidence to regulators to support this research. This will not only help in amassing knowledge but also provide the impetus for solar energy providers, customers, the environment, and society to achieve the goal of a sustainable environment.

CONCLUSION

We aimed to analyse the volume and evolution of solar and renewable energy adoption, along with the intellectual and collaborative research, using bibliometric analysis of scholarly articles published in Scopus from 2015 to April 2025. Using the multi-stage filtration 433 peer-reviewed articles were analysed. We used performance analysis to present the growth in the number of articles and citation over the study period. There has been an increasing trend in the number of articles due to the growing importance of solar and renewable energy. We performed co-citation analysis to identify articles that are being cited together, and the results show four clusters of articles that are frequently cited together. The leading authors in each cluster are. We also performed co-word analysis, and the results show that "Renewable Energy," "Solar energy," and "sustainability" are the highly used keywords, represented by three different clusters, by the authors in these articles. This was followed by Sankey diagram to show the relationship between authors, keywords and the journal. The results show that most of the articles are published in “Sustainability” followed by “Energies” and “Energy Policy”. The topic is related to sustainability; these articles are well-positioned in journals that welcome publications concerning sustainability and renewable energy. The next analysis was a thematic map that categorised the topics into four distinct categories, highlighting that foreign direct investment, renewable energy consumption, globalisation, ASEAN, solar power, and development analysis are topics that are either in the nascent stage or fading from researchers’ attention. We also show that China, followed by India, has the maximum number of articles published during this time period, highlighting the need for other countries to contribute to the growing body of knowledge. The word cloud also shows the most frequently used author keywords are “Sustainable Development”, “Solar Energy”, “Solar Power”, “Alternative Energy”, and “Photovoltaic Systems” among others.
The present study provides a thorough analysis of articles published in the areas of solar and renewable energy adoption, government policies, and sustainability over the last decade. It will help researchers uncover the evolution and growth in this domain from different perspectives.

Implication

Adoption of solar energy is prominent in the reduction of carbon emissions to net zero by 2050, directly supporting SDG 7 (Affordable and Clean Energy), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action) by promoting clean energy access, reducing urban environmental impact and supporting environmental and climate change concerns in communities. Needless to say, the energy sector has the biggest carbon footprint, contributing to the majority of global greenhouse emissions. Globally, the adoption of solar and renewable energy is a prominent concern, as energy is a significant issue in all aspects of development. It is the most affordable and sustainable energy option for communities, residents, and industries to bridge the energy access divide(Sovacool et al., 2022). In a developing country like India, where conventional energy sources primarily meet energy demands, greenhouse gas emissions pose a significant challenge. As of 2023, more than 70 per cent of the power came from fossil fuels, with coal accounting for approximately 55 per cent of that. This energy mix puts pressure on the environment and the national grid. Shifting towards solar energy can ease that pressure by reducing emissions and balancing demand, especially during peak usage. With the cost of solar energy decreasing and more government support in place, it makes sense for developing countries to focus on solar as a cleaner and more dependable energy source.

Limitations and future research directions

This study is limited to published articles extracted from the Scopus database, excluding grey literature, such as book chapters, conference proceedings and editorials. The logic behind this exclusion is that we decided to include only peer-reviewed articles to determine the quality of the analysis. This exclusion may have missed significant studies that aligned with our research questions. Secondly, we only included the Scopus database for retrieving articles; future studies are advised to include the Web of Science to make the analysis more comprehensive. The environmental impact of solar energy systems during manufacturing should not be ignored regardless of whether solar energy is a clean and sustainable energy source. Its production involves hazardous contaminants, which can pollute water resources, so all these aspects must be considered to ensure that the overall circular economy is sustained (Tawalbeh et al., 2021).

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