

## SUSTAINABLE ENERGY POLICY AND ENVIRONMENTAL RESPONSIBILITY: CLUSTERING OF KEY DEVELOPMENT PATTERNS

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<http://doi.org/10.46754/jssm.2024.08.010>

Received: 30 October 2023

Accepted: 13 May 2024

Published: 15 August 2024

**Abstract:** Implementation of SDG 2030 requires a systemic nature and the formation of an environmentally responsible attitude towards the environment and economic activity in society and the business sector. Considering this, studying the theoretical and applied conditions of the convergence of sustainable energy policy and environmental responsibility is essential. The bibliometric analysis was used using the VOSviewer software and the investigation period was 1990-2022. Applying the main keywords (“environmental responsibility” and “energy policy”), more than 63,214 scientific publications were found in the Scopus base. The results of the co-citation indicate a growing trend in publications devoted to environmental responsibility and energy policy, and seven clusters of scientific research areas were outlined over the selected period. The significant cluster (more than 17,000 categories) contains the conservation of natural sources, corporate social responsibility, and energy conservation categories. The co-occurrence analysis outlined the popular keywords: Environmental responsibility with 151 occurrences, 144 links strength and sustainable development with 89 occurrences and 50 links strength. Zhang C. is the author with China’s affiliation and the significant collaboration indicators, 122 citations. Countries with considerable citations represent the academic environment: China (2,051 citation), the USA (1,254), Great Britain (501), and Germany (506).

Keywords: Sustainable development, energy policy, energy efficiency, environmental responsibility, renewable energy.

### Introduction

The goals adopted by the world community as part of the landmark Paris Agreement—to limit global warming to well below 2°C and make every effort not to exceed 1.5°C—require a transition to renewable energy sources in a short period, namely over the next several decades. To protect the planet’s ecosystems and humans from climate change’s catastrophic consequences, humanity must eliminate greenhouse gas emissions from its activities and achieve a negative carbon balance already in the second half of the 21<sup>st</sup> century. By 2050, all economic sectors such as transport, energy, industry, agriculture, and private households must completely switch to alternative energy sources and renewables, leaving a significant part of the fossil fuel and non-renewable energy sources in the ground.

A whole range of research has proven that a complete transition to the latest sources of energy throughout the world is technically and economically possible. The first more detailed models and justifications were published by Greenpeace International in 2007 in the Energy Revolution Scenario report. The fifth edition of the Energy Revolution (Rodriguez, 2023), published in 2015, predicts that using renewable sources will ensure universal access to electricity and energy services for 100% of the population of all countries in the world by 2030. In 2050, we will meet humanity’s global energy needs at the expense of alternative energy.

According to the Energy Information Administration, despite the jump in investment in technologies needed for the energy transition,

investment in renewable energy sources, although at a record high level, still represents less than 40% of the average level of annual investment required to realise a scenario in which global warming may be limited to 1.5°C between 2021 and 2030 (Energy, 2023).

Despite a record \$1.3 trillion investment in the energy transition, the current pace of investment is insufficient to put the world on track to meet climate goals, according to the report (World, 2023). International Renewable Energy Agency (IRENA) said that annual investment is set to at least quadruple to about \$5.7 trillion on average between 2021 and 2030 and \$3.7 trillion between 2031 and 2050 (Renewable, 2023).

Implementing such ambitious tasks requires a systemic nature and the formation in society and the business sector of an environmentally responsible attitude towards the environment and the conduct of economic activity. Considering this, studying the theoretical and applied conditions of the convergence of sustainable energy policy and environmental responsibility is essential.

The main goal of the research is to investigate the scientific environment and form development patterns of sustainable energy policy nexus environmental responsibility theory. The key objectives of the paper are to explore the dynamics of scientific publications on the subject of sustainable energy policy and environmental responsibility, to analyse the formed scientific schools (dynamics of publications, affiliations, and geographical affiliation), to conduct a bibliometric analysis, and to determine subject clusters that define the structural and content environment of the studied subject. The scientific novelty of the study consists of identifying the main trends of scientific research in the field of sustainable energy policy and environmental responsibility, which differ from the existing systematic combination of trend (Scopus toolkit) and bibliometric (VOSviewer v.1.6.10) analyses. This made it possible to single out the main stages of scientific and public interest evolution

in sustainable energy policy and environmental responsibility, describe key subject areas, cluster international research networks, and substantiate the dominant patterns of cross-sector research.

The article is divided into five key parts. The first part introduces the research, which describes the background and main tasks of investigating environmental responsibility and sustainable energy sector policy. The second part outlines the theoretical basics and provides a literature review of the research. The third part highlights the methodology of the paper research and analysis of the information and describes the key aspects of the bibliometric study. The fourth section generalises the results of the investigation. The fifth part highlights the paper's main conclusions and emphasises the managerial and policy suggestions.

### Literature Review

The analysis of scientific publications on the topic of sustainable energy policy made it possible to single out some powerful research directions devoted to such problematic aspects as the implementation of sustainable development goals (Letunovska *et al.*, 2021; Kwilinski *et al.*, 2023a), the formation of sustainable development strategies of countries (Kwilinski *et al.*, 2022, 2023b; Chen *et al.*, 2023), integration of the principles of sustainable development into the state policy of energy sector management (Drago & Gatto, 2022; Ziabina *et al.*, 2023; Dzwigol *et al.*, 2023; Kwilinski *et al.*, 2023c) convergence of innovative economic management tools and tasks of environmentally oriented management in various sectors of the economy (Letunovska *et al.*, 2023; Chen *et al.*, 2023).

Thus, the authors, Zhao and Duan (2023) investigated the impact of financial indicators on energy efficiency as prerequisites for the energy transition of Asian countries. Using data envelopment analysis and Generalised Method of Moment analysis, the authors demonstrate the relevance of alternative energy as a determinant of electricity production optimisation in the Asian region. The authors analyse the impact of using green bonds in the green investment

system of renewable energy sources. The scientist (Kryk, 2019) assessing the level of environmental responsibility investigates the peculiarities of implementing the 7<sup>th</sup> goal of the 2030 agenda. The use of the Ward method and k-means made it possible to cluster the countries of the European Union according to the level of sustainable energy supply and to form prerequisites for making strategic and operational decisions. Another scholar (Fuchs *et al.*, 2023) investigated the level of environmental awareness of climate change issues and the environmental consequences of anthropogenic activities as factors that determine the environmentally oriented behaviour of the business sector. The least squares method and the probit regression model analysed motivational and limiting factors of influence on measures to prevent climate change and reduce greenhouse gas emissions. Among the factors contributing to positive changes and environmental behaviour, financial instruments of influence and ecological responsibility were singled out.

Khalid *et al.* (2023) investigate corporate environmental responsibility as a motivational component of supporting sustainable development by enterprises. The authors used a survey system for leading energy companies from various sectors of the economy to identify and analyse the level of environmental education and the degree of understanding of the importance of greening activities. The results showed that environmentally oriented corporate responsibility is key to promoting environmental policy and green investment in energy enterprises.

The research results by Fran Baum and others (2023) are interesting, who emphasise that green energy is the key to forming a healthy generation, and stable access to sustainable energy sources is a key component of national well-being. Using NVivo analysis to retrospectively analyse and forecast Australia's energy policy strategy for 2016-2030, the authors concluded that using fossil fuels in the energy sector creates risks and direct threats to the physical and psychological health of the population. Guven and Ermish

(2023) investigate the impact of sustainable energy development on socio-economic indicators of society's development. They emphasise developing comprehensive strategies for creating the energy sector, covering national and sectoral levels and individual households. Scientists (Batool *et al.*, 2023) note that ecologically oriented corporate strategies can fully resist the energy crisis.

Applying Partial Least Squares Structural Equation modelling, they use the influence of renewable energy sources, sustainable energy supply and sustainable energy development as latent variables. The study's results indicate that corporate responsibility is a driver of preventing and overcoming the environmental crisis. The conducted analysis confirmed the presence of a wide range of scientific publications devoted to the issue of sustainable transformation of the energy industry.

Simultaneously, the problems of interrelationship and mutual influence of environmental responsibility on greening the energy industry are insufficiently researched. First, the corresponding task can be solved by research utilising bibliometric analysis of scientific works on the relevant topic. The academic community apply a wide range of bibliometric analysis tools for an objective review and comprehensive study of the structural and content environment, the evolution of the development of a certain scientific field and key aspects of scientific research and their development trends.

In particular, Chinese scientists (Liu *et al.*, 2020) used the CiteSpace toolkit to research scientific medical publications. Rahman and others (2022) applied CitNetExplorer to review literature and scientific publications on sustainable development, fashion trends and consumption. To study the processes of convergence in industry and the development of innovative methods, the authors (Chen *et al.*, 2023) used the HistCite toolkit. The scholars (Beyene *et al.*, 2024) investigated the operational sustainability in dry ports by implementing the BibExcel toolkit. That study will combine trend

(Scopus toolkit) and bibliometric (VOSviewer) analyses to identify the main areas of scientific research in sustainable energy policy and environmental responsibility.

**Methods**

The development patterns of sustainable energy policy and environmental responsibility were studied using various methods and approaches. The use of appropriate techniques for clustering development trends has been proven by several authors (Rosokhata *et al.*, 2021; Owusu *et al.*, 2023). The analysis of trends in forming the concept of sustainable energy policy concerning the theory of environmental responsibility was carried out on two levels: The study of scientific publications using Scopus Analytics (analysing search results) and the VOSviewer

toolkit (scientific environment). The research methodology is represented in Figure 1.

The data from the Scopus scientific database was used in the next research stage. The search for scientific publications on the selected topic was carried out from the Scopus database, the world’s largest universal abstract database that tracks a wide range of scientific publications (articles, conference proceedings, serial book publications, etc.). It contains more than 94 million documents and involves approximately 19 million researchers worldwide. Utilising the paper data about publication activity from Scopus allows for a comprehensive assessment of the worldwide research output and implementation of a systematic overview of sustainable energy policy considering environmental responsibility. What is important is that Scopus can track scientific citations of publications

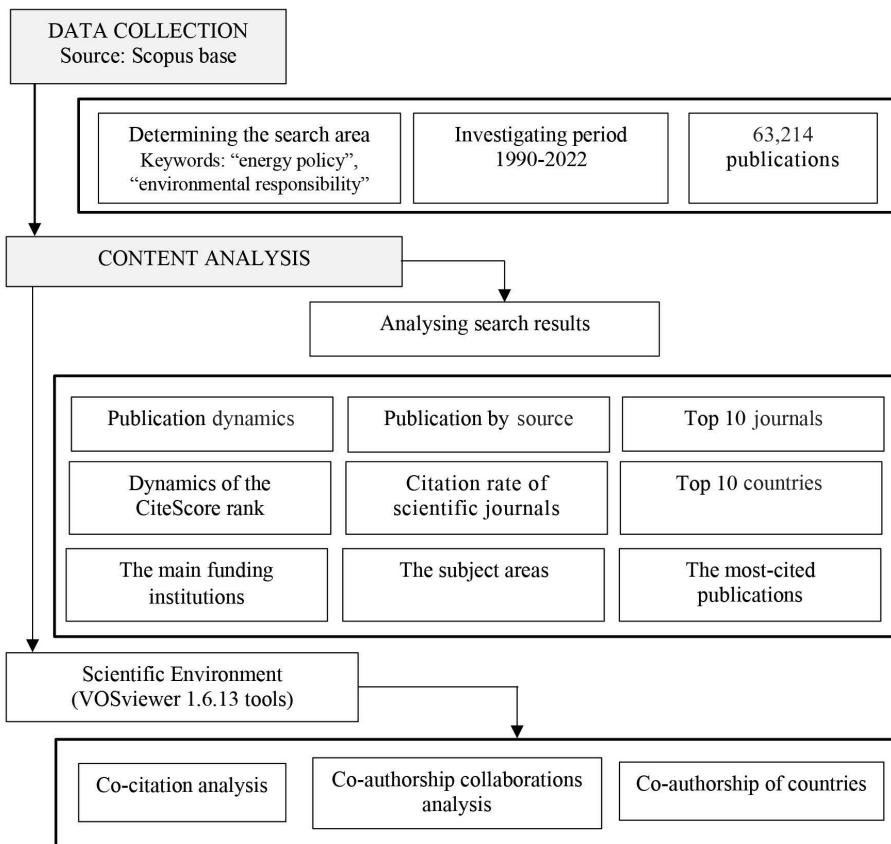


Figure 1: Research methodology  
Source: Developed by the authors

and individual scientists. The paper examined publications on sustainable energy policy and environmental responsibility from 1990 to 2022. Using the two main keywords (“environmental responsibility” or “energy policy”) were found more than 63,214 scientific publications: Articles (more than 41,000), conference papers (more than 14,000), reviews (more than 4,500), book chapters (more than 2,300), notes (more than 600), books (more than 580), short surveys (more than 300), and conference reviews (more than 100). As the main one, bibliometric analysis was used using the VOSviewer software, which allows the building and visualising bibliometric networks to analyse citations, bibliographic co-occurrence, co-citations, or co-authorship relationships. Terminology maps and citation maps were built using VOSviewer.

**Results**

The results of Scopus analytics are shown in Figure 2. This made it possible to form a definite basis for the analysis of crucial patterns of development of the concepts of “environmental responsibility” and “energy policy”. As a result, a sample of 63,214 scientific articles for 1990 to 2022 was formed in publications indexed by Scopus scientometric databases. The Scopus toolkit allows the analysis of the entire list of

publications by selected topic and keywords. This makes it possible to obtain a complex picture of the dynamics of scientific trends and ensures the completeness of the research.

The dynamics of the number of publications devoted to environmental responsibility and energy policy is characterised by a steadily growing trend, which indicates the growing relevance of developing the energy sector based on the principles of environmental responsibility, the introduction of alternative energy and increasing environmental awareness of society. The problems of sustainable energy, strategies for its development and environmental responsibility have become on the agenda of the scientific community. The dynamics of the growth of publishing activity testifies to this: 803 publications (2004), 2,151 publications (2008), and 3,684 publications (2018). Thus, the annual number of publications has increased significantly from 241 in 1990 to 5,284 in 2023. Corresponding growth primarily occurs due to the Conference in Rio de Janeiro in 1992 as part of adopting the “Agenda for the XXI Century”.

Figure 3 shows the dynamics of publications devoted to environmental responsibility and energy policy in leading academic journals. The presented dynamics characterise the annual growth of relevant scientific articles. Thus, in the

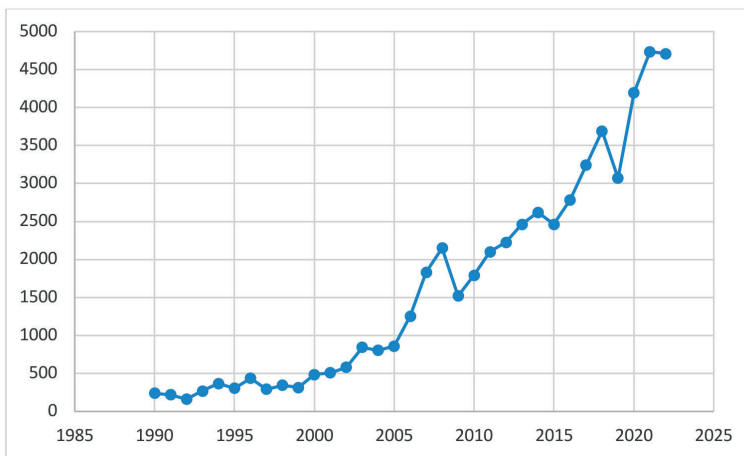


Figure 2: The dynamics of scientific publication on environmental responsibility and energy policy (1990-2022)

Source: Developed by the authors based on the Scopus database



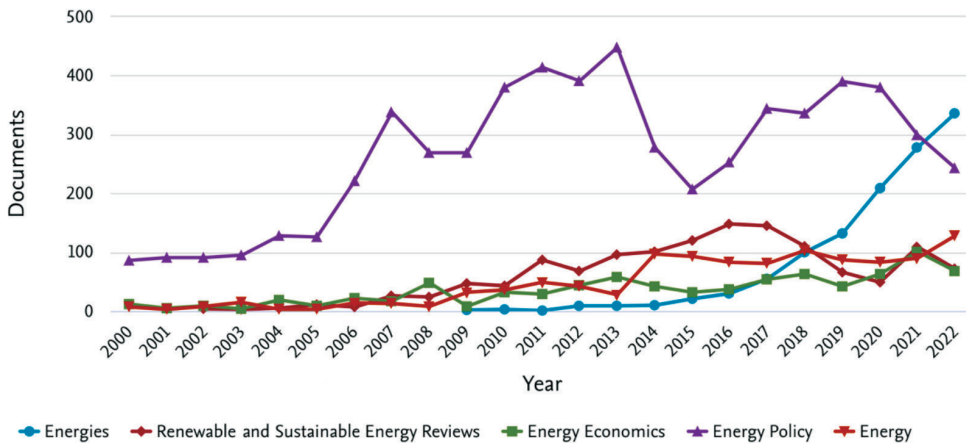


Figure 3: The dynamics of scientific publication on environmental responsibility and energy policy in scientific journals (1990-2022)

Source: Developed by the authors on the base of the Scopus database

scientific journal Energy Policy, the number of publications compared to 2000 (86 publications) increased to 243 in 2022. It is an international peer-reviewed journal and the key subjects are the economic, social, and ecological aspects and consequences of energy resource depletion at all levels (global, national, regional, and local). In the Energy Journal, scientific publications increased from 8 in 2009 to 336 in 2022.

The analysed journals have high indicators of CiteScore, Scientific Journal Rankings (SJR) and Source Normalised Impact per Paper (SNIP). CiteScore is one of the most important scientometric indicators of Scopus, which helps

to measure a journal’s impact. It is defined as dividing the number of citations by the number of documents published during the last three years.

Thus, for Renewable and Sustainable Energy Reviews Journal, CiteScore Rank - 26,3 (Table 1). The dynamics of the CiteScore indicator of the analysed scientific journals are presented in Figure 4. The dynamics of the CiteScore indicator of the analysed scientific journals are presented in Figure 4. It is characterised by gradual annual growth, which indicates the journals’ high scientific level and academic value.

Table 1: The top ten journals based on Scopus CiteScore 2022

Journal Title	CiteScore	SJR	SNIP
Renewable and Sustainable Energy Reviews	26,3	3,232	3,631
Applied Energy	21,1	2,907	2,758
Journal of Cleaner Production	18,5	1,981	2,379
Renewable Energy	16,1	1,815	2,146
Energy	14,9	1,989	2,132
Energy Economics	14,7	3,039	2,622
Sustainability	5,8	0,664	1,198
Energies	5,5	0,632	1,025
IOP Conference Series Earth and Environmental Science	0,8	0,197	0,255
Oil and Gas Journal	0,5	0,101	0,091

Source: Developed by the authors on the base of the Scopus database

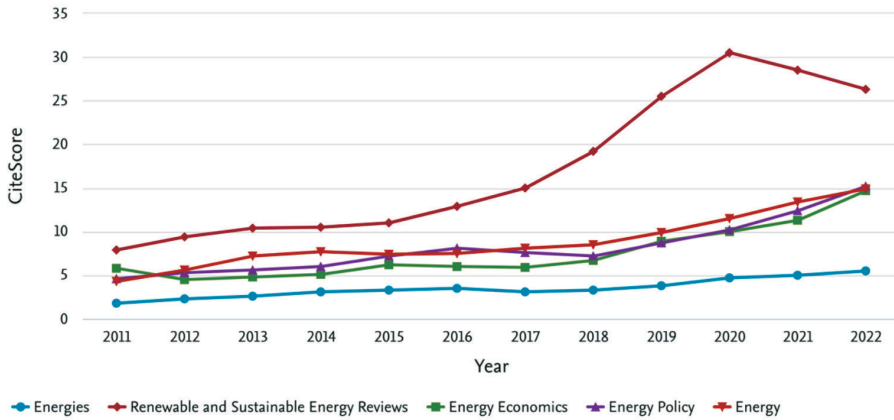


Figure 4: The dynamics of the CiteScore rank in scientific journals  
 Source: Developed by the authors on the base of the Scopus database

Figure 5 demonstrates a strong growth in the citation rate of scientific journals. Thus, the Energy Policy Journal’s annual citation increased from 9,011 in 2009 to 83,120 in 2022, for Renewable and Sustainable Energy Reviews Journal from 3,575 in 2009 to 206,364 in 2022, and for Applied Energy Journal from 3,166 in 2009 to 184,344.

Figure 6 shows the top ten countries with the most scientific publications on environmental responsibility and energy policy. Figure 6 shows China is the most active country, with more than 9,400 publications. Second is the United States of America, which has more than 9,000 scientific papers. By the end of 2022,

the number of publications from Great Britain is 4,558, Germany (2,955), India (2,718), Italy (1,902), Australia (1,806), Spain (1,633), Canada (1,542), and France (1,423).

The dates in Table 2 display the central funding institutions. The publications on environmental responsibility and energy policy were funded mainly by the National Natural Science Foundation of China (7% of publications), the leader in China’s competitive academic research.

It should be noted that Chinese scientific institutions finance many publications. According to Statista (2023), by the end of 2022, China’s total expenditures on research and development

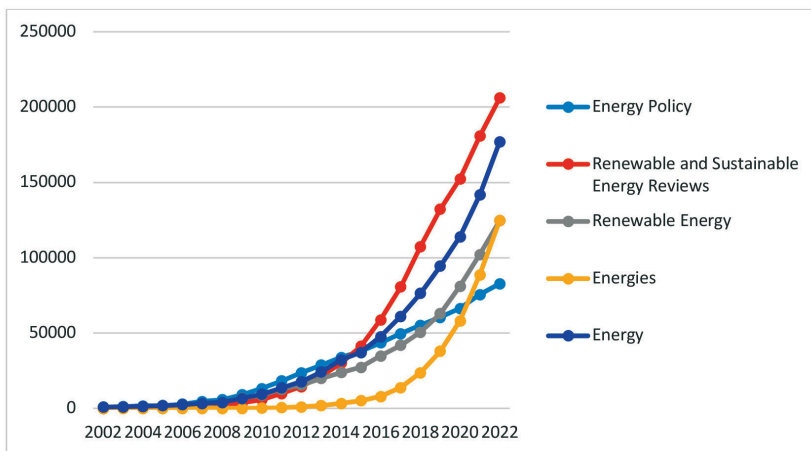


Figure 5: The dynamics of the citation by year in a scientific journal  
 Source: Developed by the authors on the base of the Scopus database

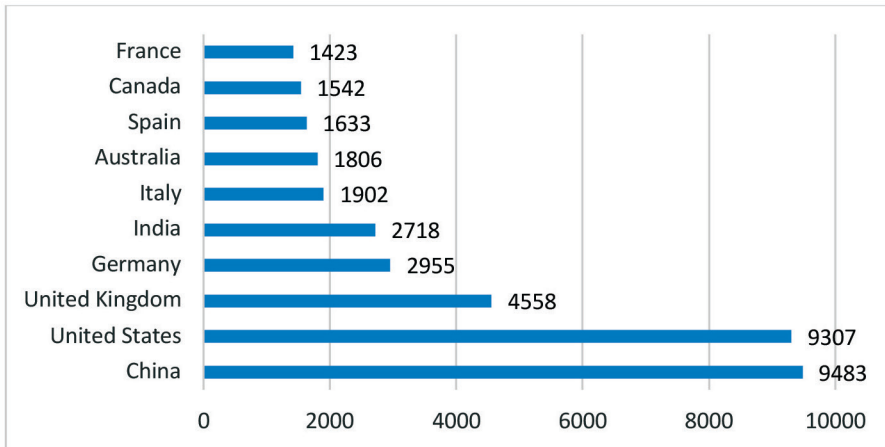


Figure 6: Number of publications on environmental responsibility and energy policy by country  
 Source: Developed by the authors based on the Scopus database

Table 2: The main funding institutions

Institution	Number of Papers
National Natural Science Foundation of China	3,483
European Commission	759
Fundamental Research Funds for the Central Universities, China	655
Engineering and Physical Sciences Research Council	604
National Key Research and Development Program of China	536
Horizon 2020 Framework Programme	508
U.S. Department of Energy	462
National Science Foundation, USA	441
Ministry of Education of the People’s Republic of China	315
European Regional Development Fund	282

Source: Developed by the authors on the base of the Scopus database

work exceeded \$418,2 billion. At the same time, the dynamic of science expenditures in the EU shows continued annual growth. The data for the last two years indicates that the EU spent more than €350 billion on research and development annually (Statista, 2023).

The results of the analysis of the subject areas of scientific publications devoted to environmental responsibility and energy policy are interesting. The diagram in Figure 7 indicates the presence of a wide range of industries, the scientific publications of which are related to the studied topic, which means the interdisciplinary

nature of research and as a result, a wide range of effects that arise from the implementation of environmentally oriented projects in the energy sector.

The Energy Science sector is the most significant (more than 26%) in this field of research. At the same time, the other scientific areas are also widely represented: Engineering (21,691 publications), Environmental Science (20,827 publications), Social Sciences (8,603 publications), Computer Science (6,034 publications), Business, Management and Accounting (4,726 publications), Mathematics



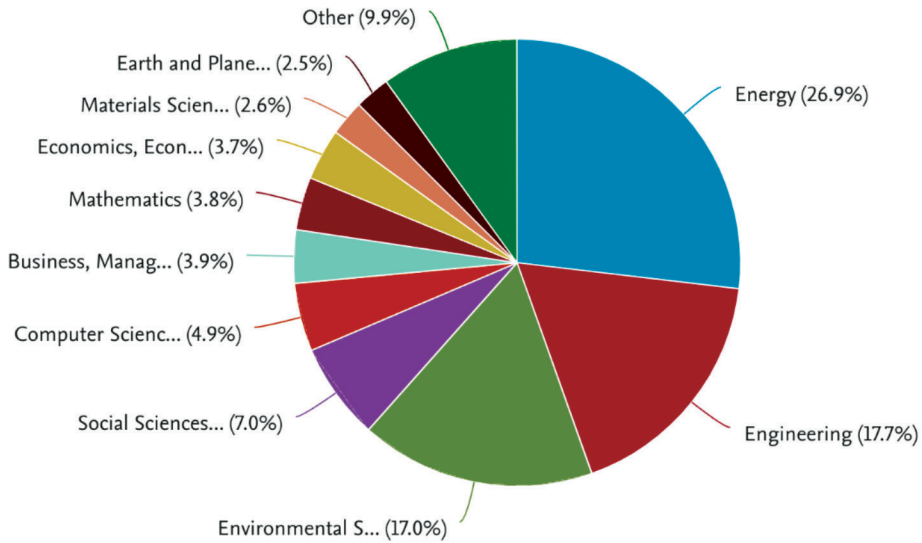


Figure 7: The subject areas of environmental responsibility and energy policy publications  
Source: Developed by the authors based on the Scopus database

(4,669 publications), Economics, Econometrics and Finance (4,558 publications), Materials Science (3,166 publications), and Earth and Planetary Sciences (3,121 publications).

The analysis of the most cited papers shows the relevance of this topic and the high interest of the scientific community in the study of sustainable transformation of the energy sector and environmental responsibility as a driver of sustainable, responsible behaviour of various groups of stakeholders (Table 3). Thus, the scholars (Pérez-Lombard *et al.*, 2008) analysed the world contribution of some economic sectors toward energy consumption and proposed to create the information basis for decision-making in the energy-intensive sectors in the frame of environmental management and audit systems. At the same time, the authors (Orlitzky *et al.*, 2003), in the meta-analysis framework, proved that a high level of corporate integrity, environmental responsibility, and sustainable reputation and image significantly correlate with operational indicators of business activity.

Using the tools of VOSviewer 1.6.13, a citation analysis of the most significant clusters and research collaborations that have the greatest importance in the theory of evolution

and development of sustainable transformation of the energy sector and environmental responsibility was carried out (Figure 8).

The data presented on the Figure 8 co-citation map showed that most publications are devoted to sustainable, responsible practices, energy efficiency, environmental protection, renewable energy, and environmental regulation. Simultaneously, some publications dealt with corporate environmental management and responsibility, green innovation, environmental regulation, environmental education, and the attractiveness of alternative energy. The co-citation analyses outline the most authoritative academic groups that determined the content of the theories of environmental responsibility in the energy sector.

The most significant blue cluster contained the categories connected with the conservation of natural sources, corporate social responsibility, energy conservation, environmental policy, environmental management, waste management, etc. The next big cluster includes the categories that describe natural resource conservation approaches: Alternative energy, cost-effectiveness, renewable energy, power generation, climate change, etc. The third big

Table 3: The most-cited publications

Title	Author (s)	Journal Title	Year of Publication	Number of Citations
A review on buildings energy consumption information	Pérez-Lombard, L., Ortiz, J., Pout, C.	Energy and Buildings	2008	4,641
Corporate social and financial performance: A meta-analysis	Orlitzky, M., Schmidt, F.L., Rynes, S.L.	Organisation Studies	2003	4,385
Alternative energy technologies	Dresselhaus, M.S., Thomas, I.L.	Nature	2001	3,682
Highly efficient visible-light-driven photocatalytic hydrogen production of CDs-cluster-decorated graphene nanosheets	Li, Q., Guo, B., Yu, J., ...Yan, H., Gong, J.R.	Journal of the American Chemical Society	2011	2,218
The role of renewable energy in the global energy transformation	Gielen, D., Boshell, F., Saygin, D., ...Wagner, N., Gorini, R.	Energy Strategy Reviews	2019	1,989
Understanding carbon lock-in	Unruh, G.C.	Energy Policy	2000	1,766
Social acceptance of renewable energy innovation: An introduction to the concept	Wüstenhagen, R., Wolsink, M., Bürer, M.J.	Energy Policy	2007	1,745
Decomposition analysis for policymaking in energy: Which is the preferred method?	Ang, B.W.	Energy Policy	2004	1,567
Application of multi-criteria decision-making to sustainable energy planning - A review	Pohekar, S.D., Ramachandran, M.	Renewable and Sustainable Energy Reviews	2004	1,410
Energy justice: A conceptual review	Jenkins, K., McCauley, D., Heffron, R., Stephan, H., Rehner, R.	Energy Research and Social Science	2016	843

Source: Developed by the authors on the base of the Scopus database

cluster characterises the scientific publication devoted to economic and social categories: Investments, economic and social effects, sustainable development, laws, legislation, etc.

Checking the selected keywords allows us to determine the occurrences and strength of the relationships between the categories. The most popular keywords are environmental

responsibility (151 occurrences, 144 total link strength), sustainable development (89 occurrences, 50 total link strength), energy efficiency (72 occurrences, 68 total link strength), environmental impact (47 occurrences, 42 total link strength), energy utilisation (41 occurrences, 41 total link strength), environmental protection (40 occurrences, 39

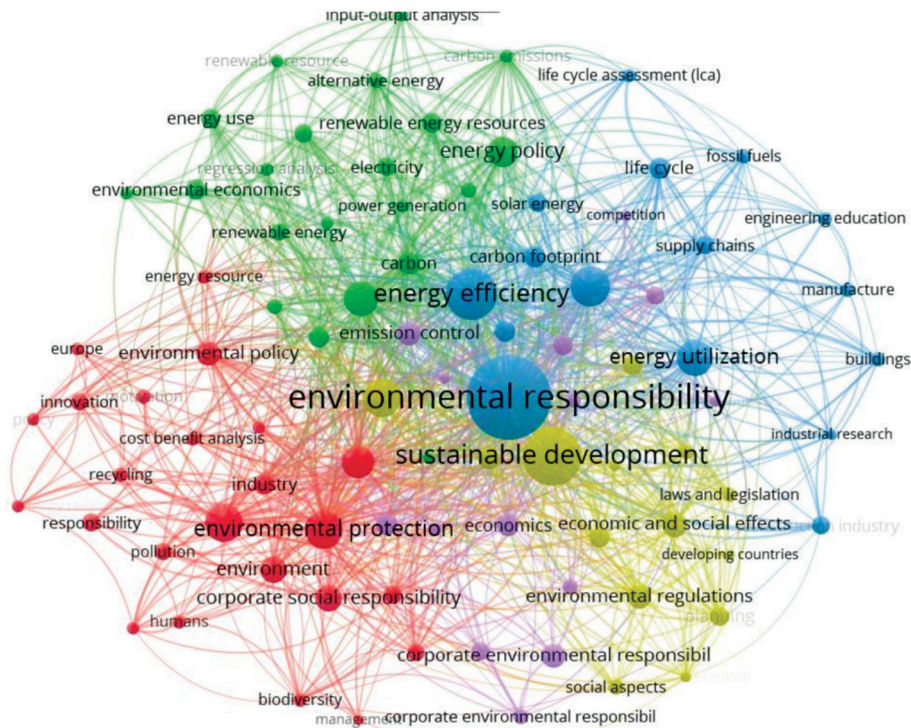


Figure 8: The results of the co-citation analysis of environmental responsibility and energy policy publications

Source: Developed by the authors using tools of VOSviewer 1.6.13 tools

total link strength), energy conservation (39 occurrences, 39 total link strength), climate change (37 occurrences, 36 total link strength), sustainability (41 occurrences, 33 total link strength), environmental management (32 occurrences, 31 total link strength), energy policy (27 occurrences, 27 total link strength), corporate social responsibility (23 occurrences, 22 total link strength), environmental regulation (21 occurrences, 21 total link strength), (72 occurrences, 68 total link strength), emission control (20 occurrences, 20 total link strength), economic and social effects (19 occurrences, 19 total link strength), and environmental policy (19 occurrences, 19 total link strength).

The top ten keywords show that the formation of environmental responsibility in the context of the green transformation of the energy industry will be ensured by implementing principles and mechanisms of sustainable

development, energy efficiency, assessment of the impact of environmental quality, energy use, and prevention of climate change. Figure 9 represents the scientists who collaborated with other authors in the frame of study of environmental responsibility and energy sector policy.

Figure 9 represents the scientists who collaborated with other authors in the frame of study of environmental responsibility and energy sector policy. The author with the biggest collaboration indicators is Zhang Ciu (citations 122, 3 links), who devoted their publications to corporate environmental responsibility and political determinants (Zhang, 2017). A powerful scientific pool (citations 161, 3 links) is represented by scientists from the Collaborative Innovation Center of Resource-conserving and Environment-friendly Society and Ecological Civilisation, School of Business, Central South

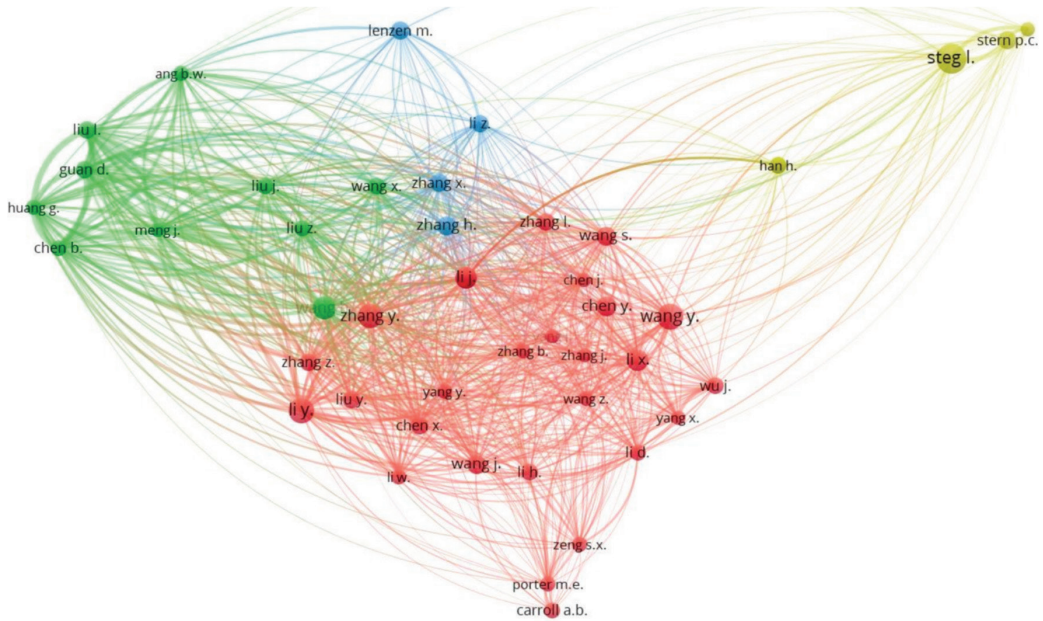


Figure 9: The results of the co-authorship collaborations  
 Source: Developed by the authors using tools of VOSviewer 1.6.13 tools

University and Hunan University of Commerce (China). They investigate the moderating role of government regulation and the effects of corporate environmental responsibility on financial performance (Li *et al.*, 2017).

Figure 10 shows the extent of scientific cooperation between countries, which illustrates the strength of the research network ties of the network of countries.

The research results indicate a strong cooperation in China, with a citation level of 2051. At the same time, the set of countries illustrates high indicators of citations: The United Kingdom (501 citations), the United States (1,254 citations), Canada (240 citations), India (124 citations), Taiwan (214 citations), Australia (804 citations), Germany (506 citations), Netherlands (723 citations), Sweden (521 citations), Finland (482 citations), Spain

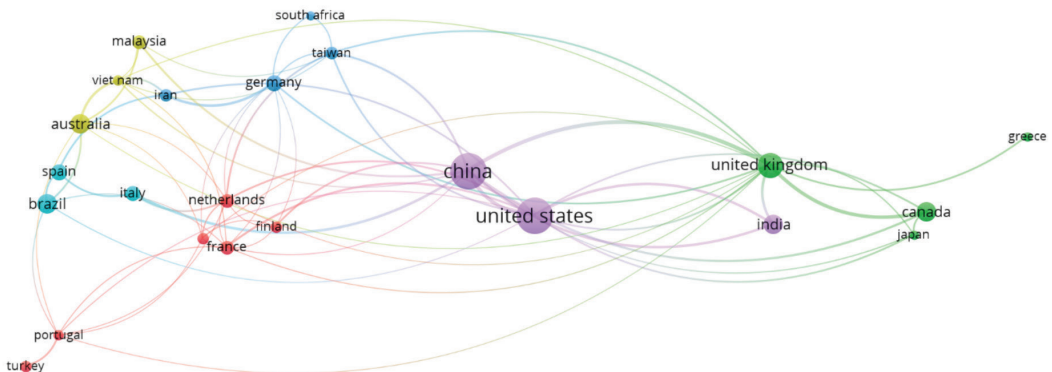


Figure 10: The results of the co-authorship of countries  
 Source: Developed by the authors using tools of VOSviewer 1.6.13 tools



(227 citations), Portugal (169 citations), Malaysia (501 citations), and Italy (101 citations). It is important to note that most countries are developed or actively developing. The corresponding testifies to the multi-vector connection of the transformation processes of national economies, greening the energy industry, and promoting ideas and principles of sustainable development.

### Discussion and Implications

The conclusions obtained in the study do not contradict similar scientific studies. Thus, utilising CiteSpace and VOSviewer software to study trends in the development of global research in the field of green energy allowed authors (Tao & Chao, 2023) to conclude the current state and meaningful dynamics of the development of scientific research considering green energy topics. To study the relationship between environmental responsibility and strategic planning, the authors (Gandrita *et al.*, 2023) used the Web of Science and ScienceDirect, which made it possible to conclude the value of implementing environmental principles in management processes and the relationship between environmental and social responsibility.

The formation and development of an environmentally responsible energy sector is impossible without the implementation of several operational steps: Appointment of a responsible, competent body in the management structure, whose obligations should be to assess ecological and economic damage, establish causal relationships, determine the responsible operator, determine liquidation measures, approve a plan of preventive actions, etc.; introduction at the legislative level of fiscal guaranteed instruments to stimulate ecologically responsible transformational processes in the energy sector; provide economic substantiation of the cost of environmental and economic losses from the operation of energy enterprises.

It should be noted that the existing administrative structure and resources in the

country, the available practical experience, and the relevant relationships between state bodies, interested persons and practitioners influence the implementation of these conditions. An important prerequisite for the effective development of an environmentally responsible energy sector is a clear awareness of the socio-economic and environmental benefits that such activities provide to energy companies, especially within the scope of using renewable technologies, recycling, and developing circular economy principles. At the same time, for the formation and promotion of a culture of environmental responsibility, an important incentive is the understanding that because of the implementation of the strategy of sustainable development, significant benefits are received not only by the enterprises of the industry, but also by the entire society, which makes its environment safer, preserves the natural potential of the planet, and prevents climate change.

The success of the development of the environmentally responsible energy sector largely depends on the systematicity and complexity of the implemented measures, their improvement based on the constant monitoring of the environmental results of the companies' activities, the development of an effective methodology of which is an important direction of further scientific research. The seriousness and acuteness of the problems of environmental pollution, climate change, and energy security, as well as the numerous advantages of modern alternative energy technologies, justify the feasibility of global transformation of the energy sector.

Summarising the study results, it is possible to suggest directions for forming and strengthening environmental responsibility in the energy sector. In particular, the introduction of the environmental management system is not only based on national environmental standards, but also takes into account the accepted international standards and directives, development of "circular production" programs and reuse of used resources, which involves

reducing the amount of waste and using it as a resource for the next production cycle, use of renewable energy sources, formation of environmental awareness of employees and environmental culture of the population, development of environmental education, and involvement of employees in companies' environmental initiatives.

### Conclusions

The article conducted a bibliometric analysis of scientific publications on energy policy and sustainable responsibility. The source of data on available scientific publications was the Scopus database. The key categories of the study were "energy policy" and "sustainable responsibility". More than 64,000 scientific publications from the Scopus database from 1990 to 2022 were analysed for the selected topic. The analysis of the dynamics of publications showed a more than 20-fold increase in publication activity. The analysis of publications by country showed that scientists published a significant part of the research devoted to environmental responsibility, sustainable development, energy efficiency, environmental impact strength, energy utilisation, and environmental protection. Applying VOSviewer allowed us to provide a citation analysis and detect the most significant clusters and research collaborations connected with environmental responsibility, sustainable development, and energy efficiency. The countries with the most significant co-authorship are China, the USA, Great Britain, India, Germany, and Italy. The most-cited publication is devoted to principles of energy consumption and mechanisms in buildings. The study results allowed us to emphasise the main stages of scientific and public interest evolution in sustainable energy policy and environmental responsibility, describe key subject areas, cluster international research networks, and substantiate the dominant patterns of cross-sector research.

### Limitations

The presented study inevitably has some limitations that should be considered for

future research. At first, the Scopus database was utilised as a source of information for the study, which may have led to the use of an incomplete volume of scientific publications. Google Scholar and Web of Science were not used in the research. Secondly, the article used the VOSviewer software to analyse and map the collected and received data. In turn, future research can use other modern tools and software products (for example, the package SciVal).

### Acknowledgements

This research was funded by grants from the Ministry of Education and Science of Ukraine: Innovative energy transformations for sustainable development and national security: Smart technologies and environmental responsibility (grant number: 0122U000788), Economic-mathematical modelling and Technologies of cross-border energy security management in the conditions of military actions and post-war reconstruction (grant number: 0123U101920).

### Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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