Towards the Future: Global Research and Practice on Low-Carbon Economy and Carbon Neutrality

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Abstract. With the acceleration of urbanization and industrialization, international organizations have successively formulated and implemented policies to reduce carbon emissions. The importance of a low-carbon economy has gradually become prominent, stimulating researchers' continuous attention and exploration. Through scientific quantitative analysis methods and the Web of Science (WoS) database, research papers from 1900 to 2024 were systematically reviewed by us. From 268 papers, we analyzed and visualized them using the software. The research shows that in recent years, the research on carbon neutrality and low-carbon economy has become increasingly in-depth and active, and the fields have been expanding and showing a trend of diversification. The correlation network and development trend between keywords are displayed, which provides researchers with a reliable reference for the development direction.

Keywords: Low-carbon economy, carbon neutrality, climate change

1 Introduction

In the global response to climate change, carbon neutrality has become a key measure for governments, businesses, and individuals worldwide to address global warming[1]. For countries and enterprises,achieving emission reduction targets in the process of economic growth and decouplingcarbon emissions from economic growth is the best development path under a low-carbon economy[2].Climate change poses a significant threat to human welfare, making the development of a low-carbon economy a prevailing and unavoidable trend[3]. The European Green Deal set a 2050 net-zero emissions goal to tackle climate change[4]. China formally proposed the goal of reaching a carbon peak by 2030 and achieving carbon neutrality by 2060 in 2020[5]. The energy resources of economies are crucial in meeting the decarbonization targets for 2030 and 2050[6]. To achieve a net-zero and low-carbon economy and ensure sustainable energy, energy systems must be diversified by increasing the utilization of renewable and clean energy sources[7]. Illustrated within the context of a digital platform for carbon emissions information services is the value proposition of AI for the environment[8]. A critical imperative is achieving carbon peak and carbon neutrality, requiring a comprehensive

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transformation of economic and social systems. This transition involves moving from high energy consumption and pollution to emphasizing high-quality, sustainable development. By facilitating the shift to a green and low-carbon economy, lasting economic and social progress will be ultimately enabled[9].

2 Data and Methods

For obtaining literature on low-carbon economy and carbon-neutral technology, we utilize the following WoS advanced search query:

TS=(“Low-carbon economy”) and TS=("carbon neutrality" OR "carbon neutral*" OR "carbon-neutral*" OR "carbon positive*" OR "carbon-positive*" OR "carbon negative*" OR "carbon-negative*" OR "carbon accounting" OR "net-zero" OR "decarbonize? action")

On June 5, 2024, a total of 268 papers (including SCI extension and SS) were included. Analyze and visualize results using the Bibliometrix software.

3 Study Mapping Results

These findings offer data analysis and visualization to explore research on the low-carbon economy and carbon neutrality.

3.1 Annual Trend

According to Figure 1, from 2009 to 2020, the number of articles and references related to the low-carbon economy and carbon neutrality was relatively low but showed a slow but steady upward trend. However, from 2020 to 2024, this number increased rapidly and peaked in 2024.

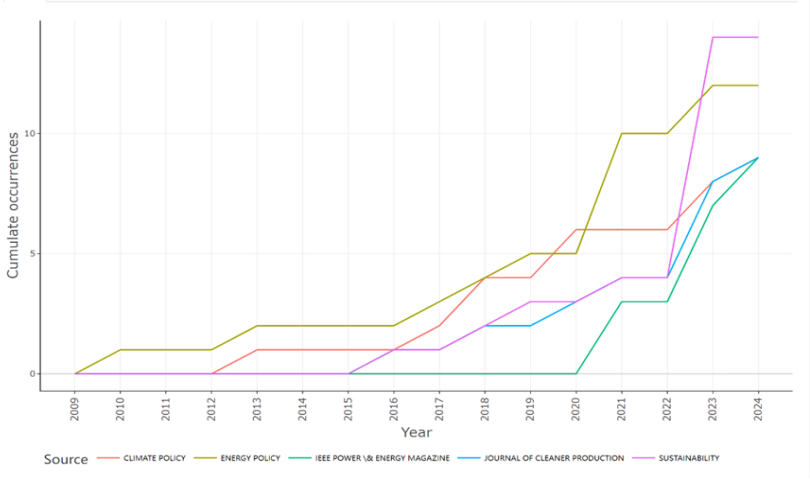

Fig. 1. Sources’ Production over Time.

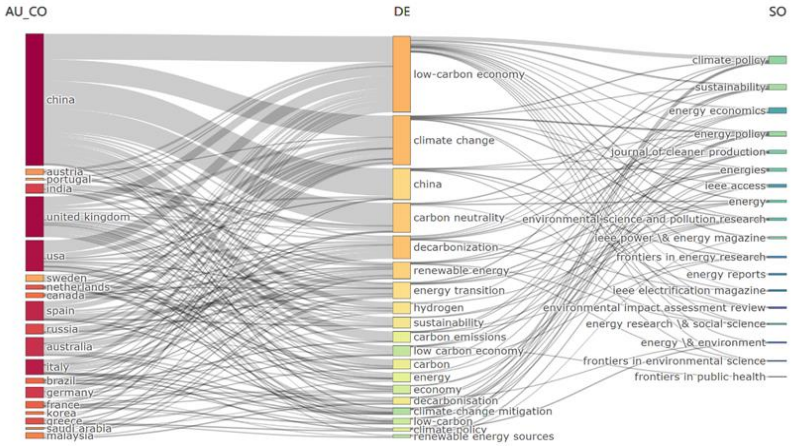

Fig. 2. Country, keywords, and source map.

3.2 Main Countries, Keywords, and Publication Sources

The correlation between major countries, keywords, and publication sources is clearly depicted in Figure 2. There is active cooperation and research between authors from various countries, especially Chinese authors, who account for the largest proportion. In addition to China, authors from Italy, the United Kingdom, Spain, Germany, France, and other countries are also actively involved, and the United Kingdom has research in areas such as nuclear energy technology budgeting, decarbonization technologies, and electric vehicle batteries. Italy, Spain, Germany, and France have studied measures to reduce CO2 emissions. Climate policy makes up a significant proportion of publication sources, covering topics such as sustainability, energy economy, energy policy, and clean energy. Among the keywords, low-carbon economy dominates, followed by climate change, carbon neutrality, decarbonization, renewable energy, etc.

3.3 Factor Analysis

A conceptual structure diagram (Fig. 3) was created using the MCA method for multi-factor analysis, with the significance indicated by the size of the cluster diagram.

The Blue Cluster's largest clusters include the low-carbon economy, climate change, sustainable development, renewable energy, consumption, technology, and growth. Closest to the central point among them is climate change, indicating that the climate issue is a crucial key influencing carbon neutrality. The second is the red cluster, which includes carbon dioxide emissions, reduction, energy growth, energy consumption, urbanization, and the environmental Kuznets curve. Within the Green Cluster lies the third cluster containing Challenges, Capture, Optimization, Modeling, Carbon Emissions, Environment, and Industry. Finally, there is trade openness and financial development in the purple cluster.

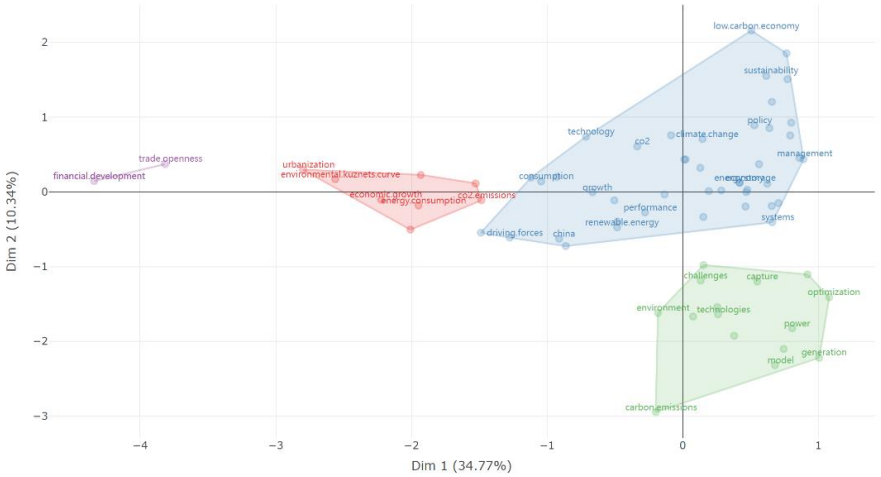

Fig. 3. Structure concept diagram.

4 Conclusion

In the context of global warming, low-carbon economy has attracted more and more countries' attention[10]. Analyzing the literature on low-carbon economy and carbon neutrality reveals China's more prominent research results, showcasing the country's active investment in and significant emphasis on low-carbon economy and carbon neutrality. Many countries have set the goal for reducing energy consuming for green development[11]. For example, the United Kingdom, Italy, Spain, Germany, France, and other countries have also carried out research in this area. The interdisciplinary nature of research is reflected in the participation of scholars in the fields of economics, environmental science, energy science, etc., to provide theoretical support and practical guidance for achieving a low-carbon economy and carbon neutrality. Low-carbon economy, climate change, sustainable development, renewable energy, and other issues have attracted much attention, showing global joint efforts and important concerns.

In addition, the scholars also focus on carbon emissions, urban economic transformation, decarbonization technologies, and more. Moving towards a low-carbon economy will imply a considerable 15 increase in the deployment of green technologies[12]. For example, oil refineries will have to embrace decarbonization technologies like advanced biofuels, green hydrogen, and carbon capture and storage (CCS) to facilitate the shift towards a low-carbon economy[13], carbon capture technologies will play a crucial role in the decarbonization of fossil-based industrial processes[14]and so on. This shift entails transitioning from high energy consumption and pollution to focusing on high-quality development, thereby facilitating the transition to a green and low-carbon economy and ultimately realizing sustainable economic and social progress[15]. In today's global context, experts and scholars from various countries are increasingly focusing on research related to the low-carbon economy and carbon neutrality.

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