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A Spotlight on Environmental Sustainability in View of the European Green Deal

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Abstract: This bibliometric study investigates the scientific landscape of environmental sustainability within the European Green Deal (EGD) framework. Utilizing data from the Scopus and Science Direct databases, the study aims to map research trends and frontiers, providing a comprehensive overview of the evolving discourse on sustainability. The EGD's ambitious goal to render the European Union climate-neutral by 2050 is highlighted, showcasing its significant impact across multiple sectors. The study reveals the integration of new methods and broadening research scopes by employing modern bibliometric techniques. Key thematic focuses include the transition to a circular economy and the emphasis on sustainable resource management, underpinning the EGD's comprehensive approach to combining economic growth with environmental protection. The analysis unveils the critical role of technological innovation and policy reforms in advancing toward a sustainable, competitive, and climate-neutral economy. The research demonstrates the pivotal role of empirical studies in guiding policy formulation and implementation, showing how targeted measures in resource and energy productivity, combined with a decisive shift towards renewable energy, are integral to fostering a sustainable, competitive, and climate-neutral economy. This convergence of findings reinforces the argument that a multifaceted approach, encompassing policy, technology, and innovation, is essential for navigating the challenges of environmental sustainability and climate change, aligning closely with the overarching aims of the EGD.

Keywords: environmental sustainability; Green Deal; climate change; European Union; bibliometric; R-bibliometrix

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1. Introduction

The European Green Deal is an inclusive policy initiative launched by the European Commission. It aims to achieve climate neutrality for the European Union (EU) by 2050. This ambition positions Europe as the world's first climate-neutral bloc, targeting significant impacts across numerous sectors such as construction, biodiversity, energy, transport, and food. A key component of this initiative is the transition to a circular economy, emphasizing the sustainability and efficiency of resources and energy (https://en.wikipedia.org/wiki/European_Green_Deal (accessed on 20 April 2024)) [1].

The European Green Deal (EGD) is a key initiative by the European Commission, targeting climate neutrality for the E.U. by 2050. It aims for a smooth transition, marrying environmental protection with economic growth through legal and financial measures across fundamental energy, agriculture, and transport sectors. The EGD emphasizes climate change mitigation, initiating transformative changes in major socio-technical systems to tackle carbon emissions and ecological challenges. This approach seeks to steer the EU

towards a sustainable, competitive economy, demonstrating a commitment to leading global environmental sustainability efforts [2].

Collaboration between academic research and urban policy implementation is pivotal for the success of the EGD. The insights derived from research offer a data-driven basis for policy formulation, while the initiatives undertaken by universities and cities provide actionable pathways for achieving the EGD's ambitious goals. Together, they highlight the necessity of a multidisciplinary approach that leverages academic research, technological innovation, and community-driven initiatives to foster a sustainable, inclusive, and climate-neutral future for Europe [3].

The Green Deal emerged as a response to escalating problems of climate change and environmental pollution, recognizing these issues as existential threats to Europe and the wider world. The Green Deal includes numerous actions and policy changes to transform the EU into a just and thriving society with a modern, competitive economy that no longer relies on resource exploitation. Some of the specific measures include the introduction of the "Fit for 55" package to reduce net greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, a new forest monitoring law to improve the resilience of European forests, and proposals for sustainable transport and energy efficiency [4].

A key area of action of the European Green Deal is its approach to sustainability reporting and regulation. The initiative has introduced several reporting regulations to monitor progress toward sustainability goals [1]. These regulations enhance transparency and accountability, encouraging organizations to disclose their environmental and climate-related data. For instance, the Ecodesign for Sustainable Products Regulation (ESPR) expands the scope of the Ecodesign directive to a broader range of goods, setting criteria for energy efficiency and eco-friendliness. The Sustainable Finance Disclosure Regulation (SFDR) dictates that financial market players to communicate how they mitigate sustainability risks and impacts on their products to prevent greenwashing. Additionally, the EU Taxonomy and the Corporate Sustainability Reporting Directive (CSRD) categorize economic activities based on their environmental sustainability, expanding reporting requirements on environmental impact, social policies, and governance matters [4]. These measures collectively seek to drive a positive change towards a sustainable, climate-neutral Europe by fostering collective efforts across sectors and among stakeholders.

The objective of this research is to perform a scientific mapping of environmental sustainability within the framework of the European Green Deal, utilizing data from the Scopus and Science Direct databases from their inception through the entire available period. This involves mapping research frontiers and trends in these topics using modern bibliometric methods. Furthermore, bibliometric indicators are used to illustrate the evolution of this scientific area over the years, its research extensions, and the development of new processes and protocols. This study marks one of the first reports analyzing environmental sustainability from this specific perspective through bibliometric analysis [5].

The text will explore the following research questions (R.Q.): R.Q. 1: What changes and updates have been made in the literature on environmental sustainability concerning the European Green Deal? R.Q. 2: What are the key topics and themes currently being explored in the research field of environmental sustainability and the European Green Deal? [5].

Our study contributes to the field of environmental sustainability by conducting an extensive bibliometric analysis over an extended period, capturing the evolution of research until March 2024. This long-term perspective provides a thorough understanding of how research trends have developed. Unlike previous studies that may have focused on environmental sustainability in general, our research aligns explicitly with the EGD's goals and frameworks. This alignment offers insights into how scientific research supports the EGD's objectives of achieving climate neutrality, economic growth, and environmental protection. Our study equips policymakers, researchers, and practitioners with a comprehensive overview of research trends. It identifies critical focus areas, enabling them to make informed decisions and collaborate more effectively to achieve the EGD's goals.

Our study employs two widely recognized tools for visualization and bibliographic mapping, VOSviewer and R-bibliometrix. This novel approach enables the creation of detailed networks that illustrate the relationships and thematic clusters within the scientific literature. This methodological innovation adds depth to the analysis and facilitates a better understanding of the research landscape, enhancing the credibility and trustworthiness of our research.

Insights from our co-occurrence analysis will directly inform policy formulation and research funding decisions. By aligning research efforts with the most pressing topics identified in the network, stakeholders will ensure that scientific advancements effectively support the goals of the European Green Deal. This practical application of our research empowers our audience to make informed decisions and drive meaningful change.

This study takes a comprehensive approach to contribute to the body of scientific literature by providing detailed bibliometric indexes that outline research production on the specified topic. The primary aim is to assess trends and identify research frontiers in critical hotspots of environmental sustainability using data from the Scopus and Science Direct databases and various bibliometric indicators. The study also seeks to visualize the relevant scientific literature. Another goal is to identify the disciplines involved in this research theme, examine emerging topics over time, and track their evolution. Additionally, the study aims to uncover primary research streams, current achievements, ongoing challenges, and trending issues through bibliometric tools [5].

2. Materials and Methods

The research involved conducting searches within the Scopus and Science Direct databases. Scopus is known for its extensive database, comprising over 1.7 billion cited references and covering around 2500 journal titles from nearly 7000 publishers—these span key disciplinary areas. Scopus is particularly noted for its broad scope, versatility in research areas, and enhanced document analysis tool. This tool utilizes Boolean Syntax, combining keywords with various Boolean operators for efficient document retrieval. The database is also esteemed for its capability to distribute numerous scientific journals through sophisticated indexing procedures [6–10].

After experimenting with different combinations, we chose "environmental sustainability" and "European Green Deal". The search was conducted within the time range from the initial date of the Scopus and Science Direct databases to 25 March 2024, with the language set to English: TITLE-ABS-KEY ("environmental sustainability" AND "European Green Deal") AND (LIMIT-TO (DOCTYPE, "ar")) OR LIMIT-TO (DOCTYPE, "re") (DOCTYPE, "mr") OR LIMIT-TO (DOCTYPE, "cp") AND (LIMIT-TO (LANGUAGE, "English")). The search included research documents, reviews, mini-reviews, and manuscripts from conference proceedings and reviews.

The collected manuscripts were organized in a Microsoft Excel sheet, categorizing them by publication year, subject area, document type, and the author's institutional affiliations. The visualization and bibliographic mapping of the results were conducted using the VOS Viewer version 1.6.20 (https://www.vosviewer.com/ (accessed on 15 April 2024)) and R-bibliometrix software (https://www.bibliometrix.org/home/index.php/download (accessed on 15 April 2024)). A co-authorship analysis was carried out using the full counting method, which treats each co-authorship equally. This method was also applied to examine the occurrence of keywords within the titles, abstracts, and texts of the manuscripts. The bibliometric analysis followed a structured approach, establishing research criteria and questions and selecting an analysis approach that included various parameters such as year, subject area, document type, and more. The process continued with the selection of bibliometric data and their analysis using bibliometric software, culminating in creating networks and visual figures and interpreting these outcomes [5,10] (Figure 1).

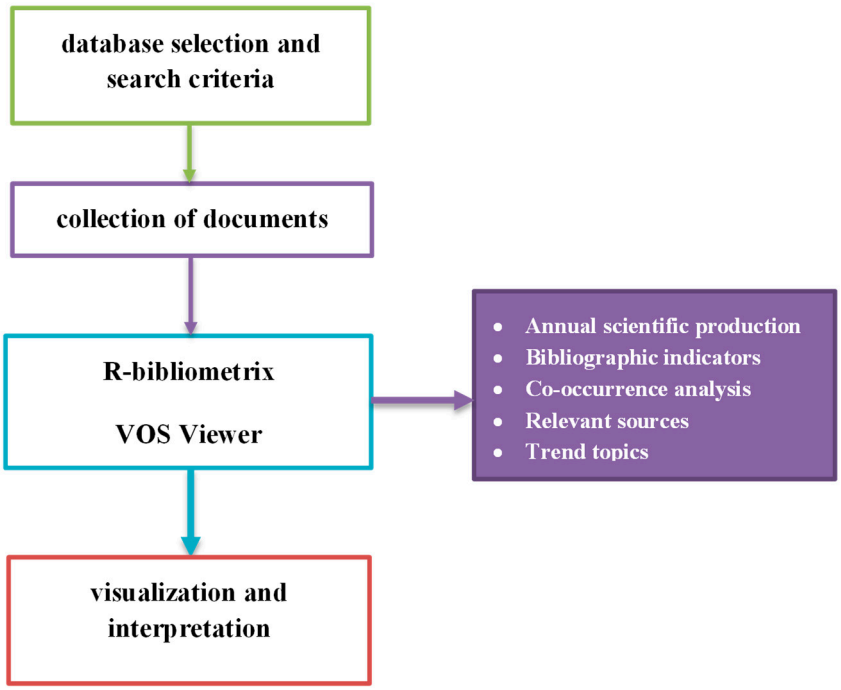

Figure 1. Research flow diagram.

3. Results

The document outlines a comprehensive overview of data from 1985 to 2020, sourced from 281 journals, books, and other mediums, totaling 898 documents (40 from Scopus = 858 from Science Direct). This body of work demonstrates an annual growth rate of 14.05%, with an average document age of 9.2 years. Notably, it averages 37.12 citations per document, contributing to a substantial reference pool of 43,935. The keywords section is detailed, with 1918 Keywords Plus (I.D.) and 2243 Author's Keywords (D.E.), suggesting a rich diversity of topics covered within these documents.

Regarding authorship, the data includes contributions from 2079 authors, with 112 identified as authors of single-authored documents. A modest number of single-authored papers totaled 121, indicating a trend towards collaborative efforts, underscoring an average of 2.96 co-authors per document and 36.41% of international co-authorships. The breakdown of document types includes 862 articles, a single article that is also a book chapter, nine early access articles, and 26 proceedings papers, highlighting the prevalent form of contributions to the scholarly discourse encapsulated within this dataset (Table 1).

Table 1. Basic bibliographic information.

Description	Result
Timespan	1985:2024
Sources (Journals, Books, etc.)	281
Documents	898
Annual Growth Rate	14.05%
Average citations per Document	37
References	43,935
Keywords Plus	1918
Author's Keywords	2243
Authors	2079
Co-Authors per Document	3
International co-authorships	36%
Research articles	862

The "Annual Scientific Production" line graph shows a trend in the number of articles produced over a specific period, with the years marked on the X-axis and the number of articles on the Y-axis. The Y-axis intervals are marked at 50, ranging from 0 to 250 articles, and the X-axis denotes the years from 2020 to 2024 (Figure 2).

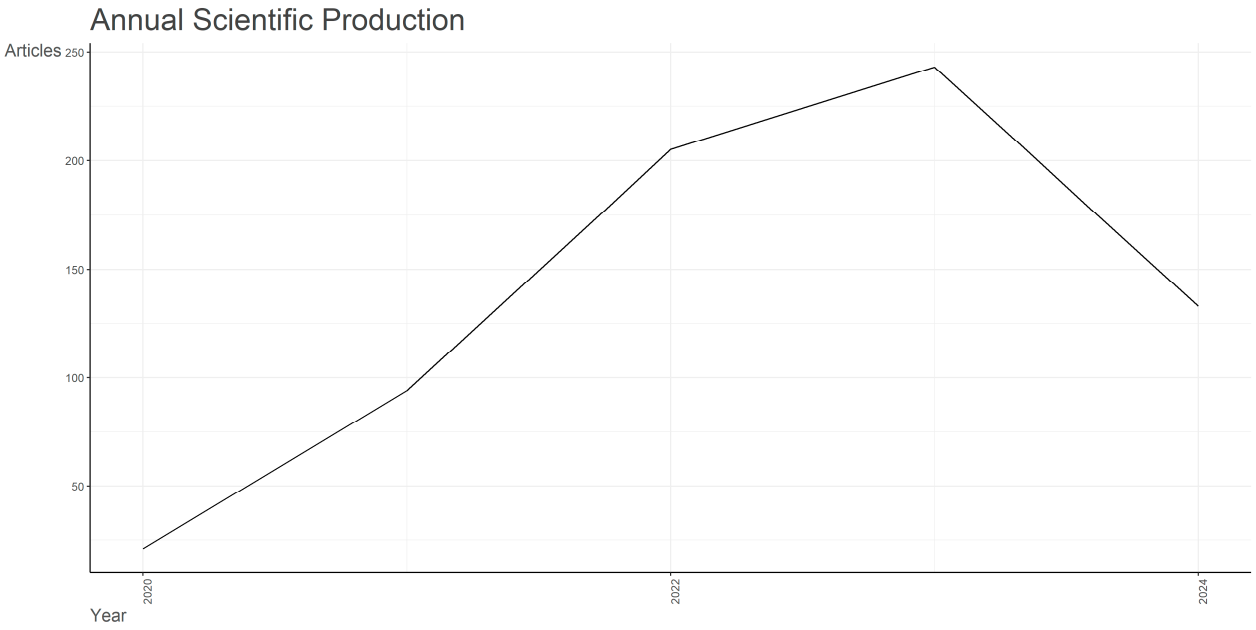

Figure 2. Annual scientific production.

As we look into the data, a promising trend emerges. At the onset of 2020, we witness a significant surge in article production, signaling heightened scientific output. To be precise, in 2020, we saw the publication of approximately 50 articles. This number doubled in 2021, reaching around 100, and continued to rise in 2022, hitting a significant milestone of about 150. This upward trajectory persisted until 2023, when scientific production peaked at just over 200 articles, painting a bright picture for the future of scientific research.

However, it is important to note that the decline in 2024, where the number of articles decreased to approximately 150, is not a straightforward reflection of decreased scientific productivity. This is due to the unique circumstances of 2024, which only includes three months of data, and the scientific production of manuscripts needs to be reflected in the extracted documents from the two databases. (Figure 2). What is particularly intriguing is that the number of articles detected in the first quarter of 2024 is equivalent to the total number of articles for the entire year 2022. This dynamic underscores the evolving nature of research in this field and the heightened interest of the scientific community in the context of objectives and policies referred to in the Green Deal.

The provided scatter plot, labeled "Most Relevant Sources", illustrates the distribution of documents across various scientific sources and depicts which journals are the most prolific or influential within a specific research domain or time frame. The Y-axis lists the names of the sources, while the X-axis quantifies the number of documents published. The "Journal of Cleaner Production" markedly dominates, with a significantly higher number of records (77) than other sources, indicating its prominence and possible influence in the field. Other sources, such as "Science of the Total Environment" and "Renewable and Sustainable Energy Reviews", also contribute notable numbers, with 45 and 18 documents, respectively. The size of the markers correlates with the volume of documents, highlighting the relative contribution of each source to the overall body of work (Figure 3).

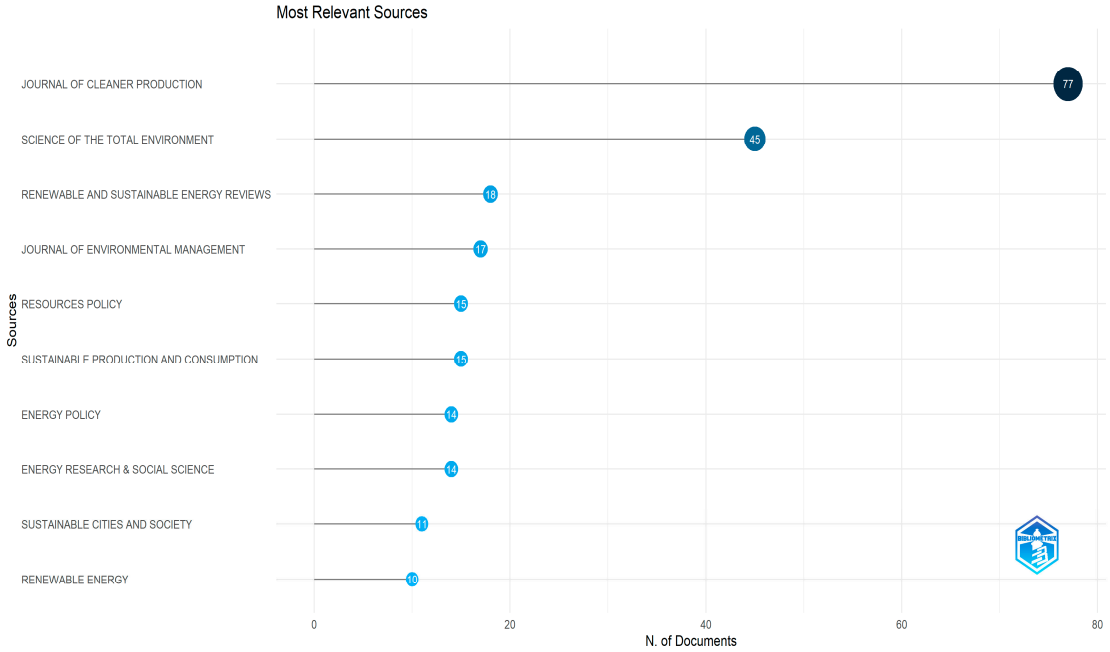

Figure 3. Most relevant sources.

The graph "Words' Frequency over Time" traces the cumulative occurrences of selected terms in the two databases from 2020 to 2024. This visualization can help understand the shifts in thematic emphasis in the research or the publication space over the given period. The terms, representing authors' keywords from a collection of documents, exhibit various trends in their usage frequency. Notably, "Sustainability" shows a dominant increasing trend, suggesting it is consistently a focal point of discussion. "Circular economy" and "Climate change" also show significant steady increases in frequency, indicating growing research interest or concern in these areas. The graph provides insights into the evolving landscape of topics within the dataset, with keywords such as "Innovation" and "Life cycle assessment" gaining momentum over the years (Figure 4).

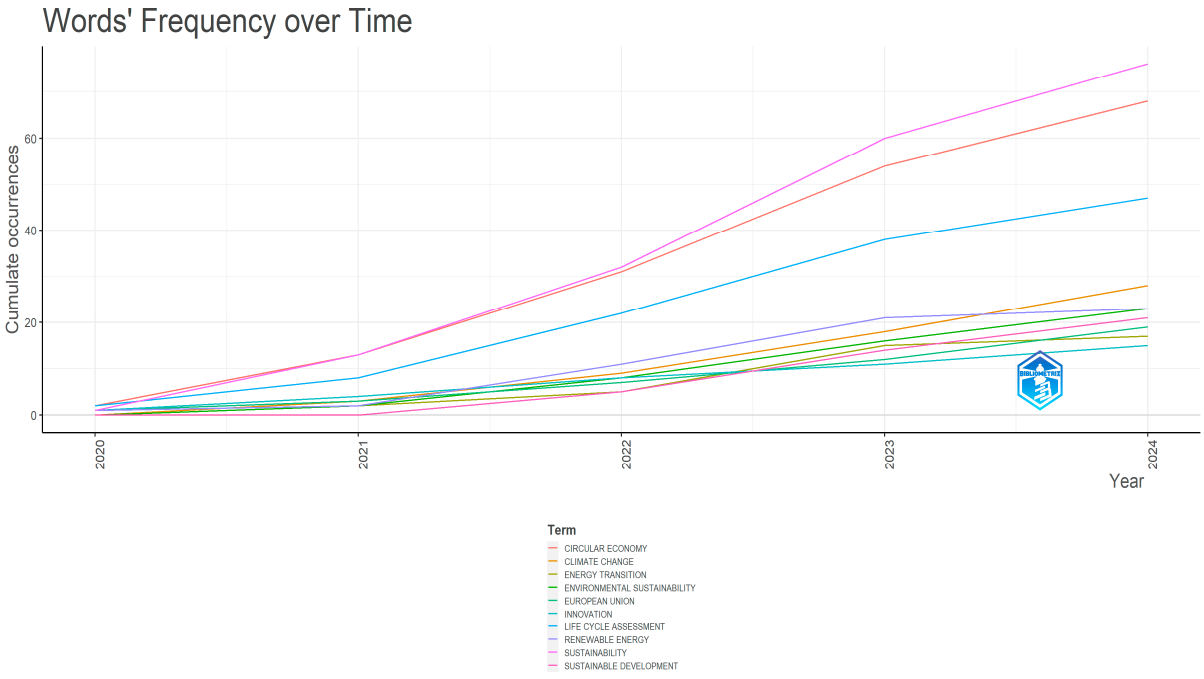

Figure 4. Word's frequency over time.

The treemap presented is a visual representation of the frequency of keywords within a given dataset (Figure 5). This type of visualization helps quickly identify which concepts are most commonly associated with the dataset and potentially the relative importance or focus areas of the research or publications analyzed. Each block's size corresponds to the term's frequency, with larger blocks indicating more occurrences. The term "sustainability" has the largest block, showing 76 occurrences, constituting 11% of the total, making it the most prominent term in the dataset. "Circular economy" follows closely with 68 mentions, accounting for 10%. Other terms with a significant presence include "life cycle assessment", "climate change", and "environmental sustainability", indicating these are critical topics within the scope of the data. More minor terms, while less frequent, still show diversity in the dataset, with topics ranging from "digitalization" to "energy efficiency" and "waste management".

Figure 6 communicates the dynamic nature of topic popularity and can be instrumental in understanding trends and shifts in research focus over time. The "Trend Topics" visualization displays a range of terms along the Y-axis, each associated with a horizontal timeline reflecting their prominence over a specified period. The size of the circles on the timelines indicates term frequency, with larger circles representing a higher number of occurrences. The visualization suggests that topics such as "sustainability", "circular economy", and "life cycle assessment" have maintained a relatively consistent and significant presence over the timeline. In contrast, terms like "decarbonization" and "bioeconomy" appear to have emerged more prominently only in more recent years, as indicated by the commencement of their timelines and the size of the circles towards the present year. This pattern may reflect evolving priorities and innovations in environmental and sustainability discourse.

Figure 7 is a network visualization from a bibliometric analysis generated by VOSviewer, a software tool for constructing and visualizing bibliometric networks. These networks may include networks of journals, researchers, or individual publications and can represent various relationships such as citation, co-citation, bibliographic coupling, co-authorship, and co-occurrence of terms.

Each cluster of terms is color-coded, suggesting they are thematically related based on the data's underlying structure. Typically, these clusters are formed by terms frequently appearing together within the same documents (Table 2). The outcome was derived from 2056 terms extracted from the manuscripts' titles, keywords, and abstracts. By establishing the minimum number of keyword occurrences to 7, only 34 terms met the threshold. These terms were then categorized into two significant groups depicted by different colors on the map.

This visualization can be used to identify which topics are most prevalent in a field and how they relate to each other:

Red Cluster: This could represent energy-related topics, including renewable energy, energy policy, and energy transition, often linked with discussions on sustainable development and economic growth.

Green Cluster: This cluster might focus on bioeconomy and policy, including terms like "innovation" and "circular bioeconomy", emphasizing the integration of biological processes in economic systems and innovation policy.

Blue Cluster: This may cover themes around European Union policies and their impact, with terms like "European Union", "common agricultural policy", and "European green deal", suggesting a focus on the EU's regulatory and policy frameworks.

Yellow Cluster: Appears to concentrate on sustainability and its assessment, with central terms like "sustainability", "circular economy", and "life cycle assessment", indicative of the methodological approaches to evaluate sustainability.

Purple cluster: The purple cluster in the network discloses the crossroads of advanced technologies and environmental management. The keywords associated with this cluster are: "artificial intelligence (AI), blockchain, carbon footprint, digitalization, and waste management".

Figure 5. Tree map.

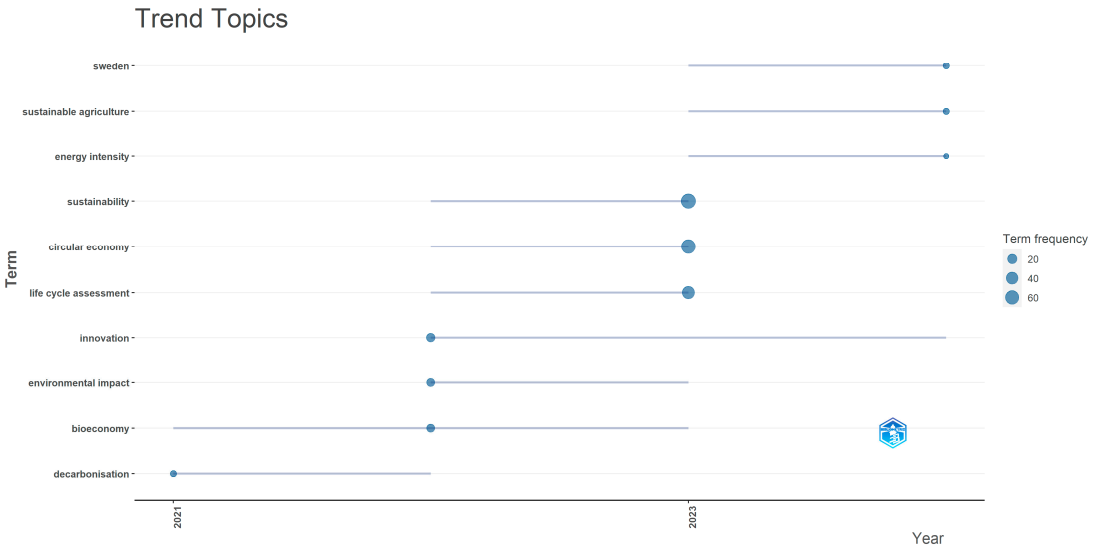

Figure 6. Trend topics.

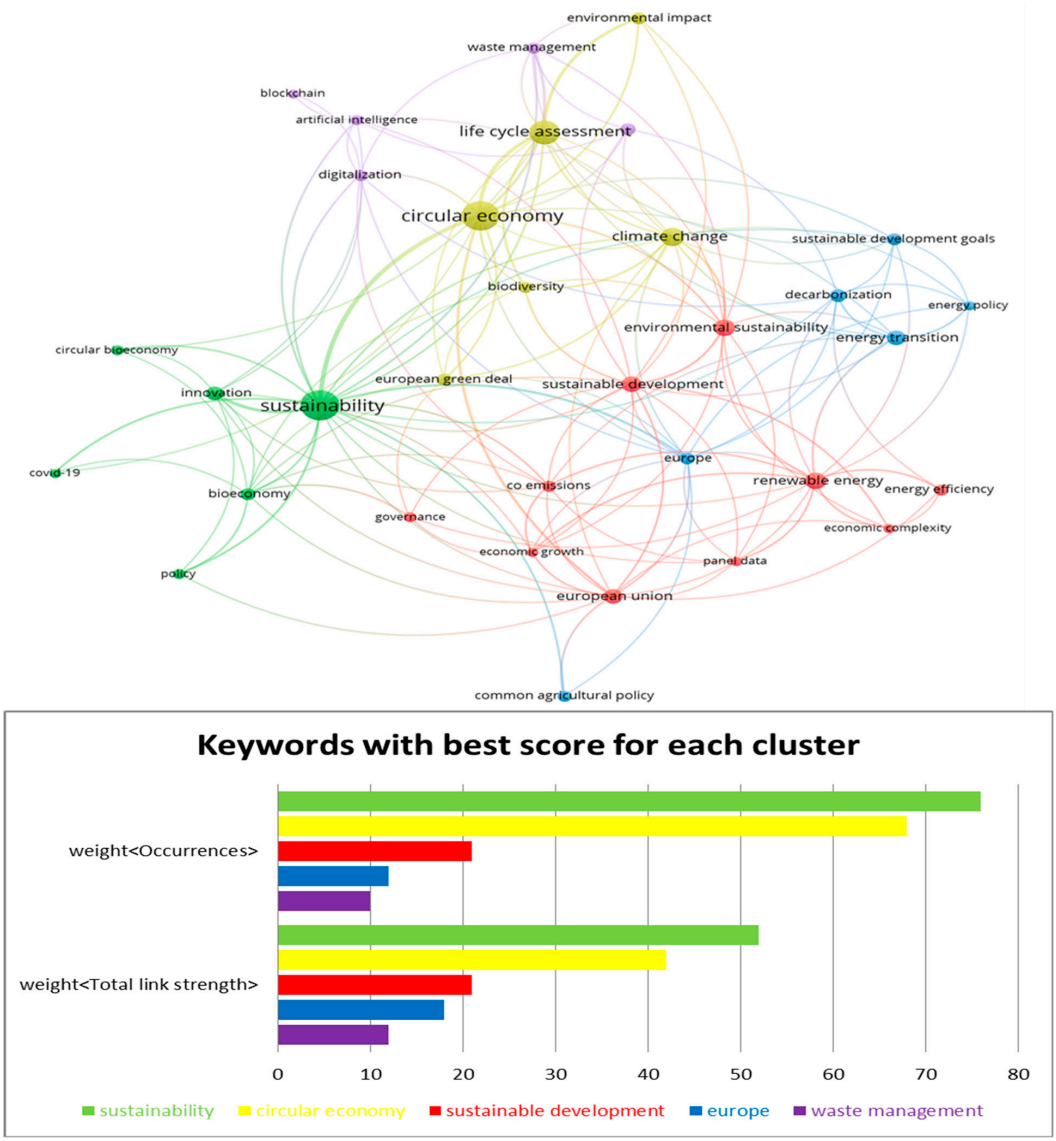

Figure 7. Co-occurrence analysis of keywords and bibliographic network.

Table 2. VOSviewer clusters "environmental sustainability and European Green Deal".

Cluster Identification	Keywords
Red	CO emissions economic complexity economic growth energy efficiency environmental sustainability European Union governance panel data renewable energy sustainable development
Green	bioeconomy circular bioeconomy COVID-19 innovation policy sustainability
Blue	common agricultural policy decarbonization energy policy energy transition Europe sustainable development goals
Yellow	biodiversity circular economy climate change environmental impact European green Deal life cycle assessment
Purple	artificial intelligence blockchain carbon footprint digitalization waste management

The visualization indicates how different themes are interrelated within the scope of sustainability and associated fields, which can be essential for understanding the multidimensional nature of research in this area. It also shows which terms are central to the discourse (central, larger nodes) and which are more peripheral or emerging (smaller, outer nodes).

As stated above, Figure 7 presents a network visualization from a bibliometric analysis generated using VOSviewer, a software tool designed to construct and visualize bibliometric networks. This figure provides insights into the relationships between different keywords extracted from the titles, abstracts, and keywords of the manuscripts retrieved from the Scopus and Science Direct databases. The extraction process involved a comprehensive search for relevant terms related to environmental sustainability and the European Green Deal, ensuring the inclusion of all pertinent keywords. The visualization helps identify prominent themes and their interconnections within the environmental sustainability field, particularly in the framework of the European Green Deal (EGD).

The nodes in the network represent keywords from the analyzed documents. The size of each node reflects the frequency of the keyword's occurrence, with larger nodes indicating more frequently occurring keywords, highlighting their significance in the research field. The lines connecting the nodes, or edges, represent the strength of the relationship or association between keywords. The closer and thicker the line, the stronger the association between keywords, indicating that the connected keywords frequently appear together in the same documents.

The network is color-coded to differentiate clusters of related keywords. These clusters are formed based on the co-occurrence of keywords, with terms frequently appearing together and being grouped into the same cluster. Each color represents a different thematic area within the broader scope of environmental sustainability and the EGD, providing a clear and comprehensive overview of the research landscape.

The red cluster focuses on energy and sustainability. Keywords such as CO emissions, economic complexity, economic growth, energy efficiency, environmental sustainability, European Union, governance, panel data, renewable energy, and sustainable development are central to this cluster. It emphasizes the relationship between economic activities and their environmental impact, focusing on energy efficiency, renewable energy, and sustainable development within the European Union's regulatory framework. This cluster highlights how policies and governance are critical in driving sustainable energy use and economic growth practices.

The green cluster addresses bioeconomy and innovation, incorporating keywords like bioeconomy, circular bioeconomy, COVID-19, innovation, policy, and sustainability. This cluster highlights the integration of biological processes into economic systems and innovation policies. The inclusion of COVID-19 emphasizes the pandemic's significant impact on these areas, emphasizing the urgent need for innovative and sustainable solutions to address both economic and environmental challenges brought about by global disruptions.

The blue cluster relates to European policies and sustainable goals, featuring keywords such as common agricultural policy, decarbonization, energy policy, energy transition, Europe, and sustainable development goals. This cluster covers themes around European Union policies and their impact on sustainability. It includes discussions on the common agricultural policy, decarbonization efforts, energy transition, and how these policies align with sustainable development goals. It underlines the importance of cohesive policy frameworks in achieving broad sustainability targets.

The yellow cluster is focused on sustainability assessment and the circular economy, with key terms including biodiversity, circular economy, climate change, environmental impact, European Green Deal, and life cycle assessment. This cluster concentrates on methodologies for evaluating sustainability, mainly through life cycle assessments. It includes key themes of the European Green Deal, such as biodiversity and the circular economy, reflecting the EGD's comprehensive approach to sustainability. This cluster illustrates the detailed assessments needed to understand and mitigate the environmental impacts of various practices and policies.

The purple cluster highlights technological innovations and waste management, featuring keywords such as artificial intelligence, blockchain, carbon footprint, digitalization, and waste management. This cluster points out the role of technological innovations in advancing environmental sustainability. It includes emerging technologies like artificial intelligence and blockchain and their applications in waste management and carbon footprint reduction. This focus on technology highlights the potential for innovative tools and systems to enhance sustainable practices and efficiency significantly.

4. Discussion

The European Green Deal sets a directional path for policy and environmental initiatives and profoundly influences the landscape of sustainable investments. The alignment of investment strategies with the Deal's sustainability criteria necessitates a robust regulatory framework, transparency, and enhanced investor literacy to mitigate risks and maximize the financial sector's contributions towards achieving a sustainable future. Therefore, the interplay between policy initiatives and sustainable investment practices emerges as a critical junction for promoting the goals of the EGD, underscoring the need for an integrated approach that harmonizes environmental ambitions with financial market dynamics [11–13]. Economic growth, economic complexity, innovation, sustainable development goals, circular economy, and digitalization are terms highlighted in this bibliometric analysis and

illustrate the dynamic of environmental sustainability and the vision of the European Green Deal [13,14].

The European Green Deal (EGD) and the Bio-Based Industries Joint Undertaking (BBI JU) represent complementary forces propelling Europe towards a sustainable and climate-neutral future. The European Green Deal presents an ambitious blueprint for transforming the EU into a modern, resource-efficient economy by 2050. It underscores the necessity for comprehensive changes across various sectors to combat climate change and bolster environmental sustainability. A vital element of this vision is the shift to a circular economy, the enhancement of biodiversity, and the introduction of sustainable agricultural practices through initiatives like the Farm to Fork strategy [15]. As outlined above, terms like bioeconomy, circular economy, and circular economy have emerged in the bibliographic network of keywords, underlining the importance of environmental sustainability in the concept of the EGD.

A recently published bibliometric analysis of circular economy (CE) research within the European Union (EU) revealed a growing body of work aligned with the EU's sustainability strategies. This collaborative research, as evidenced by a bibliometric analysis, combines life cycle assessment principles, carbon emissions reduction, and renewable energy management. These findings, which are also reflected in the keywords detected in the yellow and blue clusters in our bibliometric analysis, underline various stakeholder unity achievements in advancing the EU's circular economy [16].

The topics unearthed in the present bibliographic analysis illustrate circular economy and bioeconomy. In line with the above, the term bioeconomy also reflects the fact that it directly or indirectly extends to all the objectives of the EGD. From food production to climate change and the value of biodiversity, the bioeconomy axis is driving a host of sustainability policies in Europe [17].

The interconnection between environmental sustainability, inclusive growth, and the essential role of Small and Medium Enterprises (SMEs) within the European Union (EU) framework is a critical area of inquiry that draws from another study [18]. This study collectively underlined the EU's strategic focus on fostering a sustainable and inclusive economy, with SMEs identified as crucial conduits for achieving these objectives. Integrating insights from these outcomes elucidates the complex but synergistic relationship between environmental policies, economic strategies, and the financing of SMEs within the EU. It spotlights the crucial role of small and medium-sized enterprises (SMEs) in leading the progress to an economy with sustainable direction, which aligns with the demanding goals of the European Green Deal. Digitization and technological transition go hand in hand and are equally of utmost importance as sustainability actions, as confirmed by other research [18–20].

While the Green Deal provides a macro-policy framework to propel the EU towards a sustainable future, digitalization offers the micro-tools necessary for organizations to navigate and contribute effectively to these broader goals. The convergence of digital accounting practices with sustainability goals reinforces the essential role of technological innovation in achieving environmental objectives [21]. The relevant keywords in the network clusters depicted by the bibliometric analysis demonstrate the significance of digitalization and innovation, artificial intelligence, and energy efficiency in the research.

The transition to green energy requires more than technology and efficiency. As presented in another study, more dimensions need to be considered, which justifies the presence of different terms related to energy issues in various clusters of our bibliographic network [22]. In environmental sustainability, the intersection of environmental policies and technological innovations with energy resource management forms a critical nexus for advancing sustainable development goals (SDGs). An additional study brought to the fore the pivotal role of environmental taxes, technological advancements, and the strategic utilization of energy resources in driving down consumption-based carbon emissions. This research aligns with and amplifies the current research findings, highlighting the

essentiality of integrating environmental policies and innovations with renewable energy adoption to accomplish sustainability and a climate-neutral future [23].

The intricate relationship between environmental sustainability, particularly within the agricultural sector, and overarching policy frameworks such as the European Green Deal (EGD) presents a complex yet indispensable area of analysis for ensuring the future well-being of our planet. Research through the ecological footprint methodology offered a localized, quantifiable examination of sustainability within agricultural practices, underscoring the importance of evaluating and managing the environmental balance between biocapacity and the ecological footprint of agricultural activities [24]. This approach aligns with and significantly contributes to the broader objectives outlined in the European Green Deal, particularly in its efforts to promote sustainable agriculture, reduce greenhouse gas emissions, and enhance biodiversity. The presence of terms such as carbon footprint, common agricultural policy, sustainability, and climate change justified the need for a multi-scaled approach encompassing overarching policy frameworks and localized, sector-specific assessments. This localized assessment complements the broader, policy-driven ambitions of the European Green Deal, demonstrating how detailed environmental analyses can inform and enhance policy initiatives to promote sustainability across various sectors, including agriculture [25,26]. The European Green Deal (EGD) will significantly change the agri-food sector. Agricultural production and food systems will be critical indicators in reducing GHG emissions and pave the way for the future establishment of the carbon credit market. The Common Agricultural Policy (CAP) is central to the Green Deal, and its inclusion in the blue cluster, along with terms related to decarbonization, highlights its potential importance [27–30].

Integrating green innovation strategies within the framework of environmental sustainability initiatives, particularly in European Union countries, presents a critical pathway towards achieving the ambitious goals the European Green Deal set forth. A study in 2023 shed light on the significant impact of renewable energy consumption, energy R&D investments, and green patents and outlined the significance of reducing the ecological footprint, which aligned closely with the objectives of the Green Deal framework for a climate-neutral Europe by 2050 [31]. The research highlighted the varied effects of green innovation components across different EU countries, illustrating the complex interplay between economic growth, innovation, and environmental sustainability. Taking into account various terms of the clusters of the visualization network, it becomes evident that achieving ecological sustainability and adhering to the ambitious targets of the European Green Deal requires a concerted effort that spans policy reforms, technological innovation, and strategic investments in green technologies [32]. Elevating sustainability levels is usually achieved using less energy or technological means with a lower energy footprint. The presence of the terms in the red cluster confirms this fact even more emphatically [32,33].

Moreover, additional research analyzed the expansive and multifaceted nature of Green Deal Strategies (GDS) at global, European, and national levels, highlighting the pivotal role these strategies play in fostering sustainable development and stressing the problems of climate change and environmental pollution [34]. This comprehensive examination accentuates the urgency and complexity of implementing green deal concepts worldwide, especially after the COVID-19 pandemic, emphasizing the need for a holistic and concerted approach to ensure a green and resilient recovery across various regions. This global perspective on the Green Deal illuminates the diverse methodologies and ambitions driving the transition towards a more sustainable and equitable world, highlighting the significance of such initiatives in shaping post-COVID recovery plans and fostering a sustainable future [34–36]. In the current bibliometric research, the keyword COVID-19 appears in the green cluster, along with other keywords like bioeconomy, circular bioeconomy, innovation, policy, and sustainability.

In the same cluster, there is also the term policy, which is geared towards achieving the goals within the framework of the EGD. One such paradigm that illuminates this term

detected in the green group, among others, is the policies that inspire EU citizens towards sustainability and the need to diffuse these policies locally [37].

Another study conducted an in-depth analysis of how resource productivity, energy efficiency, and renewable energy utilization affect environmental quality within the European Union, underlining the critical role these factors play in enhancing environmental sustainability. The research provides valuable insights into how productivity in resource and energy use, combined with integrating renewable energy sources, can significantly reduce environmental degradation. The output emphasized the necessity of transitioning towards more sustainable energy systems and resource utilization strategies to achieve environmental quality and sustainability goals [38,39].

As the results of the cluster analysis, the word's frequency over time, and the trend topics illustrated, synergies between policy initiatives, technological advancements, and sustainable practices are central to achieving the EGD's objectives. It highlights the importance of empirical research in guiding policy formulation and implementation, demonstrating how targeted measures in resource and energy productivity, along with a decisive shift towards renewable energy, are integral to fostering a sustainable, competitive, and climate-neutral economy. This convergence of findings reinforces the argument that a multifaceted approach, encompassing policy, technology, and innovation, is essential for navigating the challenges of environmental sustainability and climate change, aligning closely with the overarching aims of the European Green Deal [40,41].

Moreover, two studies on the convergence of economic, environmental, and energy equity across Europe examined the complexities of achieving a balanced transition towards a climate-neutral continent by 2050 [42,43]. These analyses align with the thematic concerns addressed in our bibliometric study on the European Green Deal (EGD), particularly in terms of integrating economic development with environmental sustainability, energy equity, and the usage of renewable energy sources, as described by the terms that emerged in the red and blue clusters. Their investigation into the heterogeneity of European countries' progress towards these goals emphasized the multifaceted challenges of navigating the trade-offs between economic progress, environmental protection, and equitable energy access [42,43].

The comprehensive assessment of the European Green Deal's (EGD) performance across E.U. member states is pointed out by another research that provided a pivotal analysis of the variability of Green transformation progress among EU countries [38]. This study's use of a multi-criteria decision-making approach to evaluate the performance of EU member states across various dimensions integral to the EGD aligned with the overarching goals of enhancing environmental sustainability within the EU.

By identifying critical criteria such as primary energy consumption and transport freight transport mode as significant for EGD compliance, these studies echo the complex and multifaceted nature of achieving environmental sustainability and climate neutrality, as confirmed in our bibliometric study on the European Green Deal [43,44]. While our study provides a scientific mapping of ecological sustainability within the context of the EGD, highlighting the evolution of research trends and methodologies, the studies mentioned above offer a practical examination of how these ambitions translate into tangible performance metrics across EU nations [44–46].

The necessity of intertwining environmental sustainability with economic and innovation policies, advocating for a systemic approach that fosters a green transition of existing financial structures, is underlined by another research manuscript. The evolution of smart specialization, from a concept aiming to leverage regional strengths for innovation to a pivotal E.U. instrument addressing cohesion and innovation, mirrors the EGD's comprehensive approach to sustainability. This synthesis illustrates the mutual reinforcement between smart specialization and the EGD, where regional innovation strategies inherently align with the broader objectives of environmental sustainability, climate change mitigation, and economic transformation [47].

Our bibliometric analysis observed a complementary narrative emerging within the scientific community. Our study maps the evolution and trends in research on environmental sustainability under the EGD, revealing an expanding academic focus on the themes of circular economy, sustainable resource management, and technological innovation for sustainability. Insights from another research spotlighted the academic community's engagement with the EGD's objectives, reflecting a broader acknowledgment of the need for transformative approaches to address climate change and environmental sustainability [47]. Together, these perspectives draw attention to the symbiotic relationship between policy discourse and scientific research in shaping the trajectory of the E.U.'s environmental policies. Examining the EGD as a paradigm shift in policy discourse and our bibliometric overview of the scientific landscape illustrates a significant realignment of priorities within the E.U., moving towards a holistic approach that integrates environmental sustainability with economic and social policies [48,49].

The critical discourse analysis conducted by another research team on the European Green Deal (EGD) provided a vital perspective on the policy's environmental sustainability ambitions and potential flaws [49]. Their work suggested that, despite the EGD's transformative intentions towards a sustainable European Union (EU), it may only partially achieve its objectives due to an underlying emphasis on economic growth that could overshadow environmental considerations. This analysis raises important questions about the depth and effectiveness of the EGD's approach to sustainability, echoing concerns that it might repeat the shortcomings of previous EU efforts in sustainable planning [50].

By connecting these insights with our bibliometric study on the EGD, we engage in a dynamic dialogue between critical policy analysis and scientific research on environmental sustainability. While the specific research scrutinized the EGD's policy discourse and its alignment with sustainable development principles, our bibliometric study maps the evolving scientific discourse around the EGD, highlighting key thematic focuses and the integration of new methodologies in research [51,52]. These perspectives reinforce the complex challenges and opportunities of realizing the EGD's vision for a climate-neutral Europe by 2050, emphasizing the collective effort in understanding and shaping the EGD.

5. Conclusions

By mapping research trends and frontiers in environmental sustainability within the context of the EGD, the study delivers a bibliographic overview of the scientific discourse and its evolution. This bibliometric analysis helps identify critical areas of focus, gaps, and emerging topics crucial for policy formulation and implementation under the EGD framework. The research presented here is closely connected to the European Green Deal (EGD) framework through its focus on environmental sustainability, a core objective of the EGD. The EGD aims to render the European Union climate-neutral by 2050 by promoting policies and initiatives across various sectors, including energy, transport, agriculture, and construction, to achieve this goal.

Essential Connections to the EGD Framework:

Transition to a Circular Economy:

The research highlights the importance of transitioning to a circular economy, a central EGD component. This transition aims to enhance the sustainability and efficiency of resources and energy use, reducing waste and promoting recycling and reuse of materials.

Sustainable Resource Management:

Emphasizing sustainable resource management aligns with the EGD's goals of reducing the ecological footprint and promoting the sustainable use of natural resources. This includes the integration of green technologies and practices to improve environmental outcomes.

Technological Innovation:

The paper underlines the critical role of technological innovation in advancing environmental sustainability. Innovations in renewable energy, energy efficiency, and digitalization are vital for achieving the EGD's targets.

Policy Reforms:

The research discusses the need for policy reforms that align with the EGD's objectives. Effective governance and regulatory frameworks are necessary to implement the EGD successfully and ensure that economic growth is decoupled from resource exploitation and environmental degradation.

Empirical Research and Data-Driven Policy:

As highlighted in the paper, the insights derived from empirical research are essential for guiding policy formulation and implementation. Data-driven approaches ensure that the policies and measures adopted are effective and targeted toward achieving the EGD's ambitious goals.

Overall, the study's findings contribute to a deeper understanding of the mechanisms through which the EGD's objectives can be achieved. The research supports the EGD's overarching aims to foster a sustainable, competitive, and climate-neutral economy by integrating technological innovations, sustainable practices, and policy reforms.

Our future research initiatives will focus on monitoring the research projects developed within the framework of the Green Deal through the tools of the European Union. In addition, research efforts within the Horizon program (mission, pillars, actions) of the following years in all thematic sections will lead to a better understanding and research evaluation of the entire framework of action, its mechanisms and success, its weaknesses and the diffusion of the results of the Green Deal in Europe.

As the EU continues to navigate the challenges of climate change and environmental degradation, scientific research's contributions to the discourse on environmental sustainability and the European Green Deal will remain indispensable in shaping a resilient, inclusive, and sustainable Europe.

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References

1. Zuazua Ruiz, A.; Martín Martín, J.M.; Prados-Castillo, J.F. The European Union facing climate change: A window of opportunity for technological development and entrepreneurship. *Sustain. Technol. Entrep.* **2023**, *2*, 100035. [CrossRef]
2. Molek-Kozakowska, K. The hybrid discourse of the 'European Green Deal': Road-mapping economic transition to environmental sustainability (almost) seamlessly. *Crit. Discourse Stud.* **2024**, *21*, 182–199. [CrossRef]
3. Cerutti, S.; Boccaleri, E. The role universities and cities can play in the E.U.'s Green Deal. *J. Urban Regen. Renew.* **2021**, *15*, 141–154.
4. The European Green Deal—European Commission. Available online: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en (accessed on 30 March 2024).
5. Stefanis, C.; Stavropoulou, E.; Giorgi, E.; Voidarou, C.; Constantinidis, T.C.; Vrioni, G.; Tsakris, A. Honey's Antioxidant and Antimicrobial Properties: A Bibliometric Study. *Antioxidants* **2023**, *12*, 414. [CrossRef] [PubMed]
6. Falagas, M.E.; Pitsouni, E.I.; Malietzis, G.; Pappas, G. Comparison of PubMed, Scopus, Web of Science, and Google Scholar: Strengths and weaknesses. *FASEB J.* **2007**, *22*, 338–342. [CrossRef] [PubMed]
7. Yataganbaba, A.; Kurtbaş, I. A scientific approach with bibliometric analysis related to brick and tile drying: A review. *Renew. Sustain. Energy Rev.* **2016**, *59*, 206–224. [CrossRef]
8. Martín-Martín, A.; Orduna-Malea, E.; Thelwall, M.; Delgado López-Cózar, E. Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *J. Informetr.* **2018**, *12*, 1160–1177. [CrossRef]

9. Zyoud, S.H.; Fuchs-Hanusch, D. Mapping of climate change research in the Arab world: A bibliometric analysis. *Environ. Sci. Pollut. Res.* **2019**, *27*, 3523–3540. [CrossRef] [PubMed]
10. Stefanis, C.; Giorgi, E.; Kalentzis, K.; Tselemponis, A.; Tsigalou, C.; Nena, E.; Kontogiorgis, C.; Kourkoutas, Y.; Voidarou, C.; Chatzaki, E.; et al. Assessing Worldwide Research Activity on ICT in Climate Change Using Scopus Database: A Bibliometric Analysis. *Front. Environ. Sci.* **2022**, *10*, 868197. [CrossRef]
11. Horn, M. The European Green Deal, retail investors, and sustainable investments: A perspective article covering economic, behavioral, and regulatory insights. *Curr. Res. Environ. Sustain.* **2023**, *7*, 100241. [CrossRef]
12. Vela Almeida, D.; Kolinjivadi, V.; Ferrando, T.; Roy, B.; Herrera, H.; Vecchione Gonçalves, M.; Van Hecken, G. The "Greening" of Empire: The European Green Deal as the E.U.'s first agenda. *Polit. Geogr.* **2023**, *105*, 102925. [CrossRef]
13. Hodžić, S.; Šikić, T.F.; Dogan, E. Green environment in the E.U. countries: The role of financial inclusion, natural resources, and energy intensity. *Resour. Policy* **2023**, *82*, 103476. [CrossRef]
14. Gomes, S.; Pinho, M. Can we count on the commitment of European SMEs to achieve SGD12? An exploratory study of business sustainability. *J. Clean. Prod.* **2023**, *42*, 139016. [CrossRef]
15. Johnson, C.; Ruiz Sierra, A.; Dettmer, J.; Sidiropoulou, K.; Zicmane, E.; Canalis, A.; Llorente, P.; Paiano, P.; Mengal, P.; Puzzolo, V. The Bio-Based Industries Joint Undertaking as a catalyst for a green transition in Europe under the European Green Deal. *EFB Bioeconomy J.* **2021**, *1*, 100014. [CrossRef]
16. Dragomir, V.D.; Dumitru, M. The state of the research on circular economy in the European Union: A bibliometric review. *Clean. Waste Syst.* **2024**, *7*, 100127. [CrossRef]
17. Prasad, M.N.V. Bioremediation, bioeconomy, circular economy, and circular bioeconomy—Strategies for sustainability. In *Bioremediation and Bioeconomy*; Elsevier: Amsterdam, The Netherlands, 2024; pp. 3–32. [CrossRef]
18. Okolo, V.O.; Ohanagorom, M.I.; Okocha, E.R.; Muoneke, O.B.; Okere, K.I. Does financing SMEs guarantee inclusive growth and environmental sustainability in the European Union? *Heliyon* **2023**, *9*, e15095. [CrossRef] [PubMed]
19. Burinskienė, A.; Nalivaikė, J. Digital and Sustainable (Twin) Transformations: A Case of SMEs in the European Union. *Sustainability* **2024**, *16*, 1533. [CrossRef]
20. Truong, T.C. The Impact of Digital Transformation on Environmental Sustainability. *Adv. Multimed.* **2022**, *2022*, 6324325. [CrossRef]
21. Antonini, C. Accounting digitalization in the quest for environmental sustainability. *Curr. Opin. Environ. Sustain.* **2024**, *66*, 101399. [CrossRef]
22. Kumar, S.; Darshna, A.; Ranjan, D. A review of literature on the integration of green energy and circular economy. *Heliyon* **2023**, *9*, e21091. [CrossRef] [PubMed]
23. Ali, K.; Jianguo, D.; Kirikkaleli, D.; Oláh, J.; Bakhsh, S. Do environmental taxes, environmental innovation, and energy resources matter for environmental sustainability: Evidence of five sustainable economies. *Heliyon* **2023**, *9*, e21577. [CrossRef] [PubMed]
24. Franco, S. Assessing the environmental sustainability of local agricultural systems: How and why. *Curr. Res. Environ. Sustain.* **2020**, *3*, 100028. [CrossRef]
25. Hassoun, A.; Prieto, M.A.; Carpena, M.; Bouzembrak, Y.; Marvin, H.J.P.; Pallarés, N.; Barba, F.J.; Bangar, S.P.; Chaudhary, V.; Ibrahim, S.; et al. Exploring the role of green and Industry 4.0 technologies in achieving sustainable development goals in food sectors. *Food Res. Int.* **2022**, *162*, 112068. [CrossRef] [PubMed]
26. Ravani, M.; Georgiou, K.; Tselempi, S.; Monokrousos, N.; Ntinas, G.K. Carbon Footprint of Greenhouse Production in EU—How Close Are We to Green Deal Goals? *Sustainability* **2024**, *16*, 191. [CrossRef]
27. Opryshko, O.; Pasichnyk, N.; Kiktev, N.; Dudnyk, A.; Hutsol, T.; Mudryk, K.; Herbut, P.; Łyszczarz, P.; Kukharets, V. European Green Deal: Satellite Monitoring in the Implementation of the Concept of Agricultural Development in an Urbanized Environment. *Sustainability* **2024**, *16*, 2649. [CrossRef]
28. Popova, O.; Koval, V.; Vdovenko, N.; Sedikova, I.; Nesenenko, P.; Mikhno, I. Environmental footprinting of agri-food products traded in the European market. *Front. Environ. Sci.* **2022**, *10*, 1036970. [CrossRef]
29. Marchewka-Bartkowiak, K. The European Union Emission Trading System and its role for green budgeting development—The case of EU member states. *Curr. Opin. Environ. Sustain.* **2023**, *65*, 101390. [CrossRef]
30. Tsironi, T.; Koutinas, A.; Mandala, I.; Stoforos, N.G. Current and new Green Deal solutions for sustainable food processing. *Curr. Opin. Environ. Sci. Health* **2021**, *21*, 100244. [CrossRef]
31. Aydin, M.; Degirmenci, T.; Gurdal, T.; Yavuz, H. The role of green innovation in achieving environmental sustainability in European Union countries: Testing the environmental Kuznets curve hypothesis. *Gondwana Res.* **2023**, *118*, 105–116. [CrossRef]
32. Samoichuk, K.; Fuchadzhy, N.; Verkholantseva, V.; Horetska, I.; Hutsol, T.; Prylipko, T.; Glowacki, S.; Nurek, T.; Sorokin, D. The European Green Deal: Determination of the Energy Parameters of the String Husking Device in Buckwheat Processing. *Sustainability* **2024**, *16*, 940. [CrossRef]
33. Nußholz, J.; Çetin, S.; Eberhardt, L.; De Wolf, C.; Bocken, N. From circular strategies to actions: 65 European circular building cases and their decarbonisation potential. *Resour. Conserv. Recycl. Adv.* **2023**, *17*, 200130. [CrossRef] [PubMed]
34. Smol, M. Is the Green Deal a global strategy? Revision of the Green Deal definitions, strategies and importance in post-COVID recovery plans in various regions of the world. *Energy Policy* **2022**, *169*, 113152. [CrossRef]
35. Rowan, N.J.; Galanakis, C.M. Unlocking challenges and opportunities presented by COVID-19 pandemic for cross-cutting disruption in agri-food and green deal innovations: Quo Vadis? *Sci. Total Environ.* **2020**, *748*, 141362. [CrossRef] [PubMed]

36. Rowan, N.J.; Casey, O. Empower Eco multiactor HUB: A triple helix 'academia-industry-authority' approach to creating and sharing potentially disruptive tools for addressing novel and emerging new Green Deal opportunities under a United Nations Sustainable Development Goals framework. *Curr. Opin. Environ. Sci. Health* **2021**, *21*, 100254. [CrossRef]
37. Pascale, A.; Di Vita, G.; Giannetto, C.; Ioppolo, G.; Lanfranchi, M.; Limosani, M.; Szopik-Depczyńska, K. The circular economy implementation at the European Union level. Past, present and future. *J. Clean. Prod.* **2023**, *423*, 138658. [CrossRef]
38. Aydin, M.; Erdem, A. Analyzing the impact of resource productivity, energy productivity, and renewable energy consumption on environmental quality in E.U. countries: The moderating role of productivity. *Resour. Policy* **2024**, *89*, 104613. [CrossRef]
39. Aydin, M.; Sogut, Y.; Altundemir, M.E. Moving toward the sustainable environment of European Union countries: Investigating the effect of natural resources and green budgeting on environmental quality. *Resour. Policy* **2023**, *83*, 103737. [CrossRef]
40. Litră, A.V.; Nichifor, E.; Chițu, I.B.; Zamfirache, A.; Brătucu, G. The Dilemma of the European Integration Principle—Ensuring Energy Independence of the European Union. *Sustainability* **2023**, *15*, 15560. [CrossRef]
41. Zabel, A.; Häusler, M.M. Policy instruments for green infrastructure. *Landsc. Urban Plan.* **2024**, *242*, 104929. [CrossRef]
42. Llorca, M.; Rodriguez-Alvarez, A. Economic, environmental, and energy equity convergence: Evidence of a multi-speed Europe? *Ecol. Econ.* **2024**, *219*, 108133. [CrossRef]
43. Mogoș, R.I.; Petrescu, I.; Chiotan, R.A.; Crețu, R.C.; Troacă, V.A.; Mogoș, P.L. Greenhouse gas emissions and Green Deal in the European Union. *Front. Environ. Sci.* **2023**, *11*, 1141473. [CrossRef]
44. Ozdemir, S.; Demirel, N.; Zaralı, F.; Çelik, T. Multi-criteria assessment framework for evaluation of Green Deal performance. *Environ. Sci. Pollut. Res.* **2024**, *31*, 4686–4704. [CrossRef] [PubMed]
45. Noussan, N.; Tagliapietra, S. The effect of digitalization in the energy consumption of passenger transport: An analysis of future scenarios for Europe. *J. Clean. Prod.* **2020**, *258*, 120926. [CrossRef]
46. Vukovic, M.; Miskic, M.; Kastelan, I.; Lale, S.; Forcan, M.; Vukovic, G.; Ikic, M. Renewable Energy-Powered Traffic Signalization as a Step to Carbon-Neutral Cities (The Case of Western Balkans). *Sustainability* **2023**, *15*, 6164. [CrossRef]
47. Young, J.; Macura, A. Forging Local Energy Transition in the Most Carbon-Intensive European Region of the Western Balkans. *Energies* **2023**, *16*, 2077. [CrossRef]
48. Kruse, M. On sustainability in regional innovation studies and smart specialization. *Innov. Eur. J. Soc. Sci. Res.* **2023**, 1–22. [CrossRef]
49. Schunz, S. The 'European Green Deal'—A paradigm shift? Transformations in the European Union's sustainability meta-discourse. *Polit. Res. Exch.* **2022**, *4*, 2085121. [CrossRef]
50. Paleari, S. The Role of Strategic Autonomy in the EU Green Transition. *Sustainability* **2024**, *16*, 2597. [CrossRef]
51. Hereu-Morales, J.; Segarra, A.; Valderrama, C. The European (Green?) Deal: A systematic analysis of environmental sustainability. *Sustain. Dev.* **2024**, *32*, 647–661. [CrossRef]
52. Popielak, P.; Majchrzak-Kucęba, I.; Wawrzyńczak, D. Climate change mitigation with CCUS—A case study with benchmarking for selected countries in adapting the European Union's Green Deal. *Int. J. Greenh. Gas Control* **2024**, *132*, 104057. [CrossRef]