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Review

A Sustainability Approach between the Water–Energy–Food Nexus and Clean Energy

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Abstract: The excessive use of energy from fossil fuels, which corresponds to population, industrialisation, and unsustainable economic growth, is the cause of carbon dioxide production and climate change. The Water–Energy–Food (WEF) nexus is an applicable conceptual framework that helps manage the balance between human development and natural resource constraints, and it becomes a valuable tool to address the challenges of resource depletion and clean energy. This article aims to analyse the relationship between the WEF nexus and clean energy through a statistical analysis and a systematic review of knowledge on energy sustainability. The methodology involves the selection of bibliographic information databases such as Scopus and Web of Science (WoS), a statistical analysis, specifically the Scientometrics applied to the information obtained, and the identification of 179 scientific publications related to the study variables through a screening process called Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The interaction of green energy and sustainability with the WEF nexus has been approached mainly by developed countries such as China (10%), the United States (9.49%), India (7.26%), and Brazil (5.02%). The review of 55 scientific papers identified strategies that balance economic growth and environmental impact, applying clean energy systems (e.g., solar and wind), and the importance of adaptation to the subsystems of the WEF nexus. This study also highlights adaptability to climate change in rural and urban communities. Therefore, it is consistent with the four pillars of sustainable development (Economic: 7 papers, Environmental: 22, Social: 18, and Cultural: 8). This study highlights the following: (a) the importance of the use of renewable energy either in mixed systems and consumption, energy storage, and seeking energy efficiency in systems adapted to diverse environments and (b) the relevance of community participation in the decision-making process for the use of clean energy, such as a strategy for climate change adaptation.

Keywords: renewable energy consumption; nexus; energy efficiency; sustainable development; decision making; scientometrics

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1. Introduction

Population, industrial, and economic development respond to the needs of contemporary society. However, human development becomes problematic due to the depletion of natural resources, environmental pollution, and economic growth [1–3]. Energy is the driving force behind economic and social development [4], yet fossil fuel-based energy is the primary cause of climate change [5]. Also, carbon dioxide (CO_2) emissions, industrialisation, overexploitation, and the consumption of fossil fuel-based products and services are the leading causes of climate change [6–9]. In 2022, global CO_2 emissions reached 37.15 billion tonnes, primarily due to the use of fossil fuels such as oil (31.57%), coal (26.73%), and gas (23.49%) as energy sources [10,11].

In 1987, the 'Our Common Future' report of the United Nations (UN) defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs [12]." However, sustainable development objectives could have been more precise due to the relationship between the environment (i.e., limited resources) and economic progress (i.e., exponential economic growth) [13,14]. The UN promotes the Sustainable Development Goals (SDGs) to address climate change through SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action). Moreover, in 2015, the UN proposed the Paris Agreement, which aims to secure countries' commitments to reducing CO_2 emissions and cooperating to adapt to the risks of climate change [15]. The UN highlights the development of innovative technologies and broad policy framework as a strategy that addresses the global natural resource crisis [16]. Therefore, the responsible use of natural resources and reducing CO_2 emissions are challenges for modern society, allowing the Water–Energy–Food (WEF) nexus to address these challenges.

The WEF nexus is a system that recognises water, energy, and food systems, as well as their operations and interactions, and focuses on synergies for the efficient use of resources [17–21]. The WEF nexus incorporates the term "energy" due to the scarcity of natural resources for energy generation [22,23]. The water subsystem is used for energy generation and food production [24]. The energy subsystem is used for water pumping and treatment and food production [25]. Water and energy are indispensable for food production: water for agricultural activities and energy for processing and cooking [26]. International meetings promote the WEF nexus as a global research agenda and an emerging paradigm for sustainable development [27]. Implementing the WEF nexus in development activities strengthens natural resource security and improves job opportunities, human quality of life, and regional integration [28]. However, there must be more policy responses and resource constraints to industrialisation, trade, consumption processes, planning, and decision-making frameworks [29,30].

The WEF nexus impacts a region's socioeconomic growth, becoming a topic discussed by the scientific, academic, and industrial communities in the energy and sustainable development framework [31,32]. For example, the WEF nexus needs to be improved in China, requiring a nexus policy coupling plan. Sun et al. [33] highlight that WEF nexus-oriented policies strengthen multi-sectoral contacts, departmental cooperation, and comprehensive policy development. Furthermore, when analysing the WEF nexus with CO_2 emissions, it is important to consider the contributions from the energy sector (i.e., primary sources and technologies) and the food sector (i.e., agriculture and livestock production) [34].

Energy is indispensable in the WEF nexus, which should seek to mitigate CO_2 emissions, following the SDGs and the Paris Agreement. In addition, the primary energy sources are fossil fuels and clean energy. Fossil fuel-based energy is the world's most widely used form of energy, but it is non-renewable and polluting [35]. On the other hand, clean energy sources are carbon neutral or do not emit carbon during energy generation [36]. According to Patil et al. [37], clean energy is "a type of energy that does not contribute to the pollution of our atmosphere." Clean energy comprises nuclear, hydrogen, and renewable energy sources such as solar, hydropower, bioenergy, wind, ocean, and geothermal [38,39]. Technologies for using clean energy were developed within the sustainability framework, considering socio-economic factors, strengthening environmental protection, and adapting the energy matrix (i.e., energy transition and energy efficiency) [40,41]. Figure 1 shows a theoretical basis of the interactions among the WEF nexus, clean energy, and sustainability.

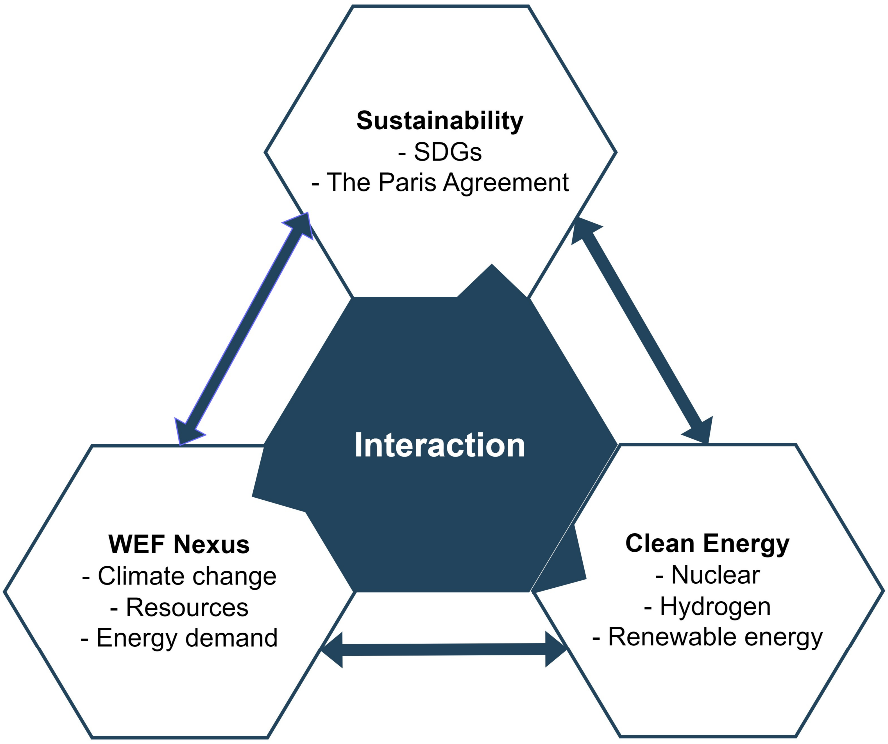

Figure 1. Theorical basis of the WEF nexus, clean energy, and sustainability interactions.

Energy development is constantly transforming socio-economic activities that integrate technologies for energy generation through clean energy sources. The constant focus on climate change adaptation forced transformations in the energy sector toward SDG fulfilment [42]. In recent years, there has been an increasing promotion of the use of clean energy with great attention from scientists, academia, and governments, including global energy policy, due to its fundamental role in sustainability [43]. However, the scientific community has indicated that the development is possible when the energy transition is economically feasible [44]. As a result, the relationship between the WEF nexus and clean energy has seen exponential growth in studies integrating sustainability-related concepts, mainly in energy management and multiple-water use [45,46]. Global organisations consider sustainable development as a way to conserve ecosystems without affecting the current economy. Furthermore, sustainable development links four main aspects: the social, cultural, economic, and environmental [47]. Sustainable energy development is the relationship between the evolution of the energy matrix and sustainability [48].

Scientific findings and publications on the relationship between the WEF nexus and energy development are necessary for resource management and decision making [49,50]. The thematic scope is related to energy security [51], energy access [52], energy efficiency [53], economic growth [54], renewable technologies [55], and greenhouse gas reduction [56]. Some reviews consider the WEF nexus and energy-related topics such as energy transition [57], bioenergy [45,58], hydropower [59], and energy modelling [60]. However, there is a need to review the scientific information about the information on the WEF nexus and clean energy, their interactions, and relations with a focus on sustainability. Therefore, the bibliometric analysis and systematic review allows us to know the development of a research field through qualitative and quantitative methods, deepening relevant knowledge gaps. The research question established for this study is the following: How does clean energy contribute to and evidence the Water–Energy–Food (WEF) nexus with sustainability? The objective of this study was to analyse the interaction between the WEF nexus and clean energy, considering alternative energy systems through a statistical analysis, the application of bibliometric software (i.e., VOSviewer v. 1.6.19 and Bibliometrix v. 4.1.2), and a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method for the knowledge and development of sustainability.

2. Materials and Methods

This study employed a methodological approach focusing on scientific publications in databases such as Scopus and Web of Sciences (WoS) with thematic criteria for the WEF nexus, clean energy, and sustainability [61]. The data were organised, sorted, and categorised utilising the Bibliometrix and VOSviewer software to visualise country trends, relationships between thematic areas, and the evolution of topics. The processing allowed for the extraction of significant contributions, including tools, techniques, and future lines of work in this area [62,63]. Using the PRISMA method criteria allowed for the analysis of papers presenting experiences, case studies, and reviews recognised by the scientific community. This analysis helped to extract trends in the relationship between the WEF nexus and clean energy. The study's methodological approach consisted of three phases (Figure 2): (i) a search of scientific information, which includes data processing using open tools such as software RStudio v. 4.2.2 [64,65], (ii) a statistical analysis using the processed data using Microsoft Excel v. 2401, and (iii) a systematic review for current knowledge of clean energy sources and the WEF nexus.

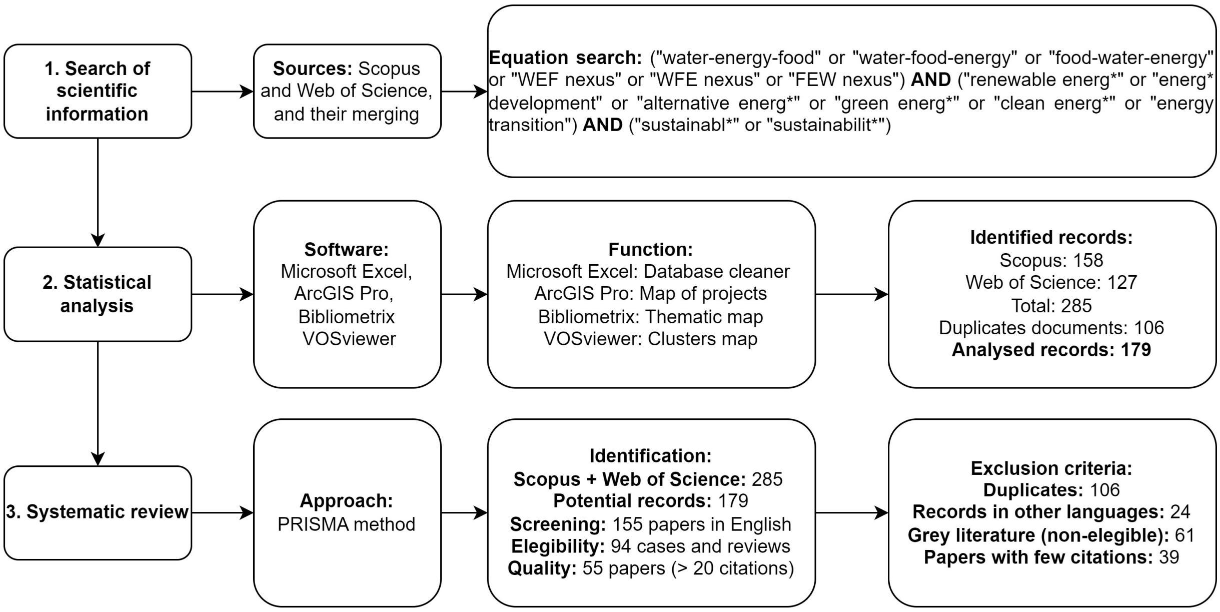

Figure 2. Outline of the methodology.

Phase I (Search of scientific databases): The Scopus and WoS databases were selected because they contain peer-reviewed documents and index high-quantity records from academic journals [66]. This study conducted the topic search in November 2023, focusing on the link among the WEF nexus, clean energy, and sustainability, which attends to the research question established. The final search is the result of the intersection of three equations (Figure 3). (1) It focuses on the most commonly used terms from the WEF nexus ("water-energy-food" or "water-food-energy" or "food-water-energy" or "WEF nexus" or "WFE nexus" or "FEW nexus"). (2) It involves clean energy terms ("renewable energ*" or "energ* development" or "alternative energ*" or "green energ*" or "clean energ*" or "energy transition"). (3) It includes terms related to sustainability ("sustainabl*" or "sustainabilit*"). This phase considered all types of documents and languages in the search motors (i.e., Scopus and WoS). Additionally, the RStudio software (R v. 4.2.2) combined the databases with the function "MergeDbSources" (code from the Bibliometrix package) [67]. The combined file with 285 records (158 from Scopus, 127 from WoS) was exported to

Microsoft Excel to clean the data, eliminating 106 duplicate records. In addition, Microsoft Excel identified 179 publications corresponding to a study period between 2008 and 2023.

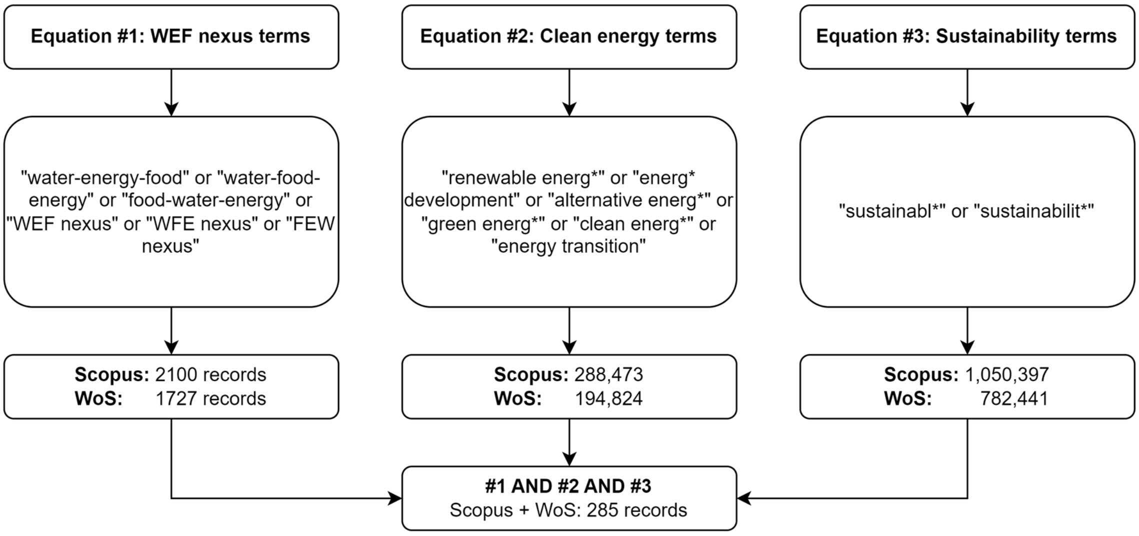

Figure 3. Selection of the topic search.

Phase II (statistical analyses, including quantitative data analysis): Bibliometrix-RStudio processed the data (i.e., 179 records) to recognise the evolution of the field of study and the contributions by countries and institutions [65]. Bibliometrix is an open software that processes bibliographical information considering published documents per year, journal, and keyword, i.e., it enables the export of the processed information to Excel [65,68]. VOSviewer generated the co-occurrence authors' keyword network by grouping them based on their frequency and relationship [69,70]. ArcGIS Pro v. 3.2.1 generated a map and a spatial representation, including the number of scientific papers per country and the types of clean energy implemented in the framework of the WEF nexus [71].

Phase III (systematic review): An eligibility analysis was conducted for selecting scientific publications, applying the PRISMA method. PRISMA is a replicable method that allows the definition of inclusion and exclusion criteria for identifying papers related to the topic of study. PRISMA allowed for the selection of relevant papers, including the following: (i) full-text papers written in English, (ii) cases of sustainability and reviews related to the WEF nexus in global energy development, and (iii) papers with more than 20 citations [72–74]. Therefore, the exclusion criteria were papers written in a language other than English, grey literature (e.g., conferences, book chapters), and papers with less than 20 citations, because they are quality metrics of papers [75] and have a relationship with the research variables. The PRISMA method, with the inclusion/exclusion criteria, identified 55 articles relevant to the relationship among the WEF nexus, clean energy, and sustainability.

3. Results

3.1. *Analysis of Intellectual Structure*

The scientific production about the interaction of the WEF nexus, clean energy and sustainability consisted of 179 records from 2008 to 2023, including the addressed energy systems and energy carriers. The research field's first contribution was on 2008, showing the relationship between the WEF nexus and sustainable energy, mainly hydropower. During 2009–2012, there were no records, and the publications start increasing steadily since 2013 (Figure 4). There is a remarkable output in 2018 due to the realisation of international conferences that promoted sustainable development in socio-economic activities, such as the "9th International Forum on Energy for Sustainable Development" [76]. The proposal of the SDGs and the Paris Agreement in 2015 made it possible to include various goals for strengthening studies that analyse energy and environmental issues. In 2020, production dropped due to the global COVID-19 pandemic and reduced progress toward energy access [77]. However, in 2021, there was an increase in publications proposing socio-economic and environmental development strategies due to the interest in reducing the effects of climate change while maintaining a balance with the global economy.

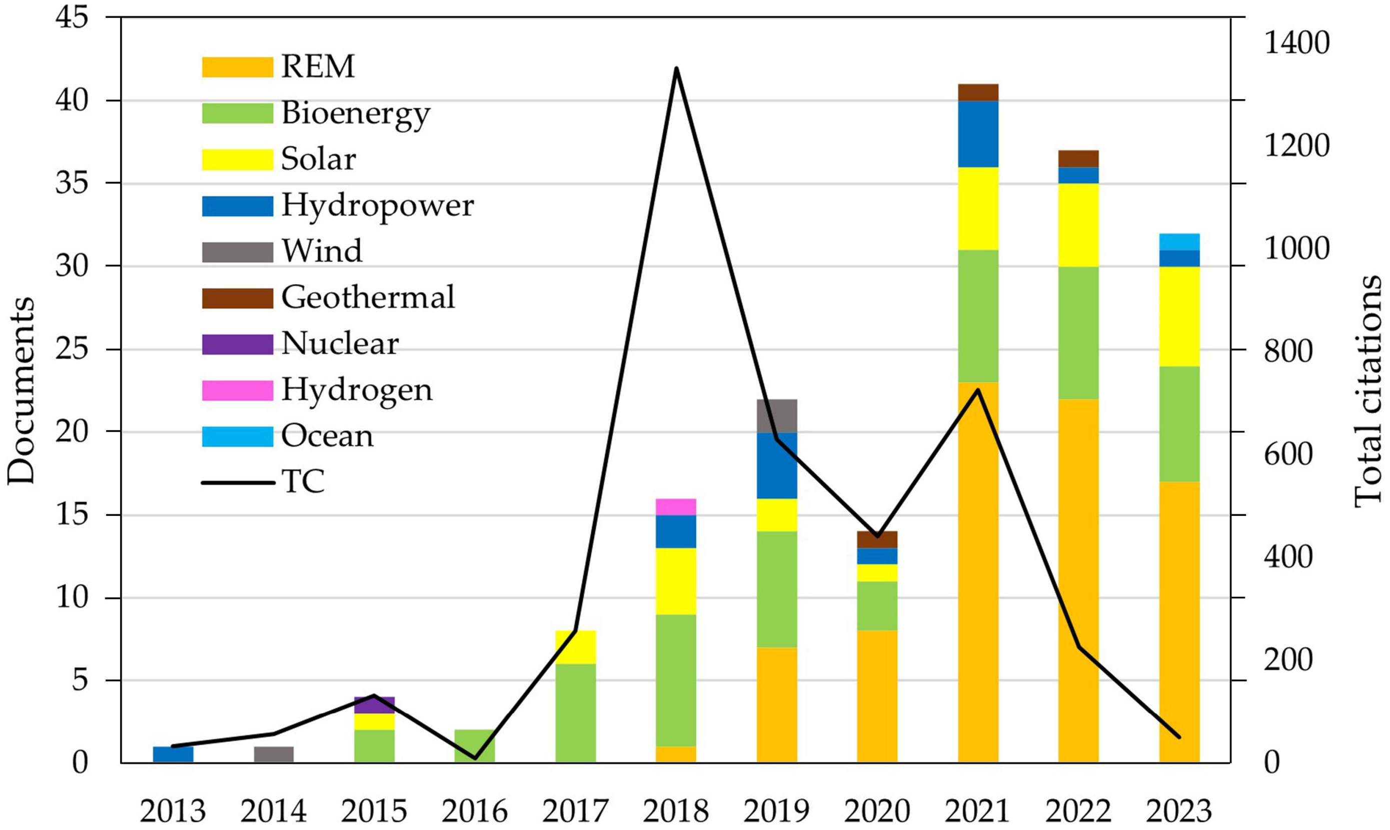

Figure 4. Scientific productions on clean energy applied to the WEF nexus and sustainability, according to annual publications and citations. Note: REM: Renewable Energy Mix. TC: Total Citations.

This analysis shows the countries that have studied and developed energy projects in the framework of the WEF nexus, considering local energy resources. Also, it reflects the use of Renewable Energy Mix (REM), mainly in developed countries such as China (10%), United States (9.49%), India (7.26%), Brazil (5.02%), and South Africa (5.02%) (Figure 5). Africa developed REM projects, mainly solar and wind. In South America, the focus is on the potential of bioenergy. In the Caribbean, the implementation of REM stands out. On the other hand, Europe shows the most significant use of REM, bioenergy, and hydropower. Finally, in Asia, the WEF nexus is related to hydropower, REM, and bioenergy. A more detailed version of the countries, documents, and projects is in Supplementary Material Table S1.

Bibliometric Networks

Overall, implementing the WEF nexus includes resource security, reducing the carbon footprint, and demand for water and energy. The WEF nexus also promotes sustainability and clean energy sources. The authors' keyword network of the WEF nexus with energy-sustainable development shows a link to five thematic clusters (Figure 6). VOSviewer clustered groups of authors' keywords into similar themes based on frequency (co-occurrence) and similarity.

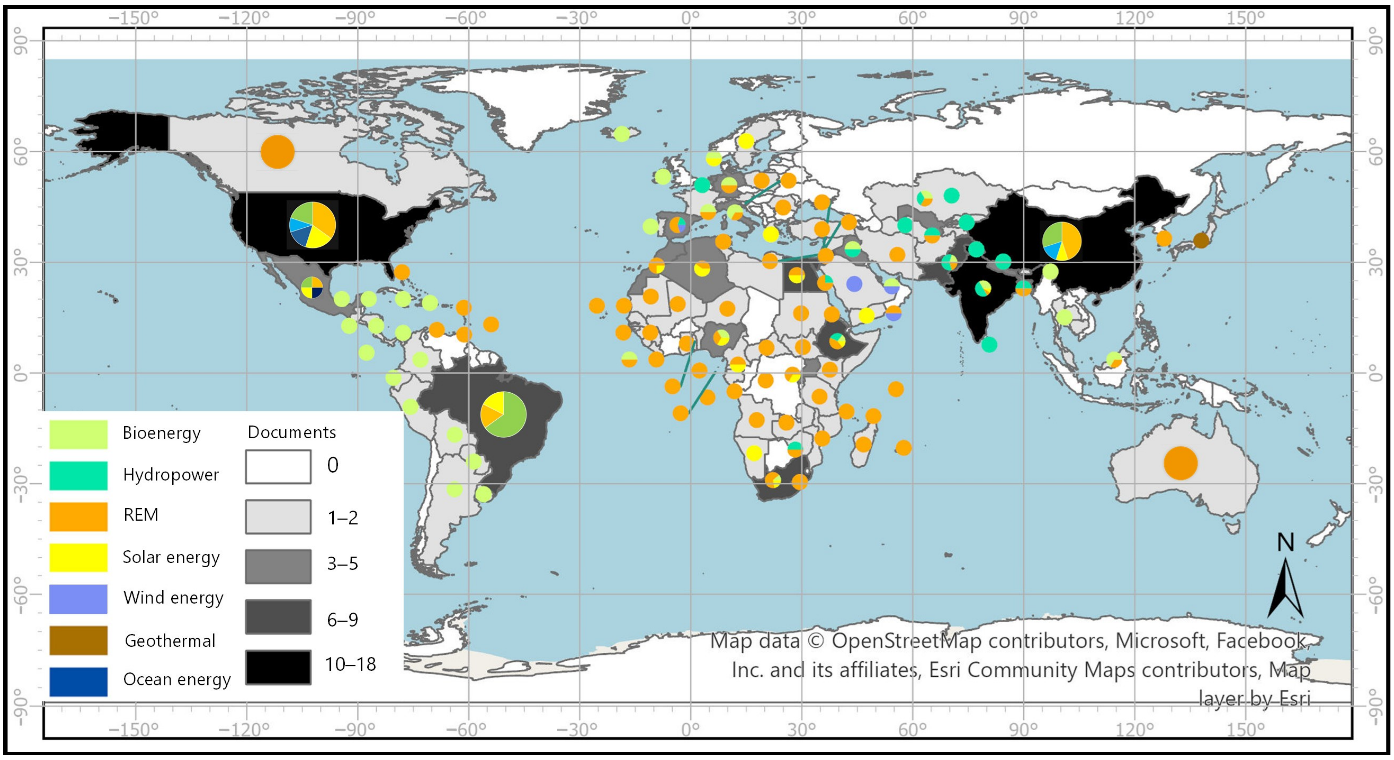

Figure 5. Documents on the WEF nexus and alternative energy systems by country. Note: REM: Renewable Energy Mix.

Cluster 1, Water–Energy–Food system (Red): It groups the main subsystems of the nexus, their interactions with CO_2 emissions, system dynamics, and circular economy because it proposes economic development through reusing resources, such as, in this case, water [78]. Furthermore, the cluster shows the relevance of stakeholders and governance to socio-ecological systems.

Cluster 2, Renewable energy and SDGs (Green): It includes topics related to renewable energies (i.e., solar energy) and their applications in sustainable agriculture (i.e., energy for irrigation activities), energy efficiency, and land use [79]. This cluster shows the importance of renewable energy in decentralised energy systems for agricultural activities and the relevance of energy efficiency.

Cluster 3, WEF nexus and Bioenergy (Blue): It considers biomass and biofuels as resources for energy generation and their contribution to the WEF nexus [80]. This cluster highlights water and carbon footprint issues with life cycle assessments (LCAs).

Cluster 4, Sustainability, Climate Change, and Hydropower (Yellow): It links security, environment, and biodiversity, highlights the importance of hydropower in sustainability [81], and uses artificial intelligence in such systems.

Cluster 5, FEW Nexus (Purple): It involves the importance of the FEW nexus in affordable resource management for energy, food, and water security and its interaction with livelihoods. Also, it links the importance of clean energy and synergy with the FEW nexus, improving the security of the systems [82].

Figure 7 shows nodes grouping themes and arranges them in quadrants (motor, niche, emerging/declining, basic). The motor theme shows the relationship of governance to socio-ecological systems. The niche themes (highly developed) reveal the importance of the life cycle with a focus on the carbon and water footprints. In addition, resource management is indispensable for livelihoods and implementing artificial intelligence (AI) in the WEF nexus. The basic themes highlight the relationship between the WEF nexus, sustainability, renewable energy, and solar energy in urban environments. Finally, the emerging theme features the WEF nexus around the application of clean energy and its focus on resource management technologies.

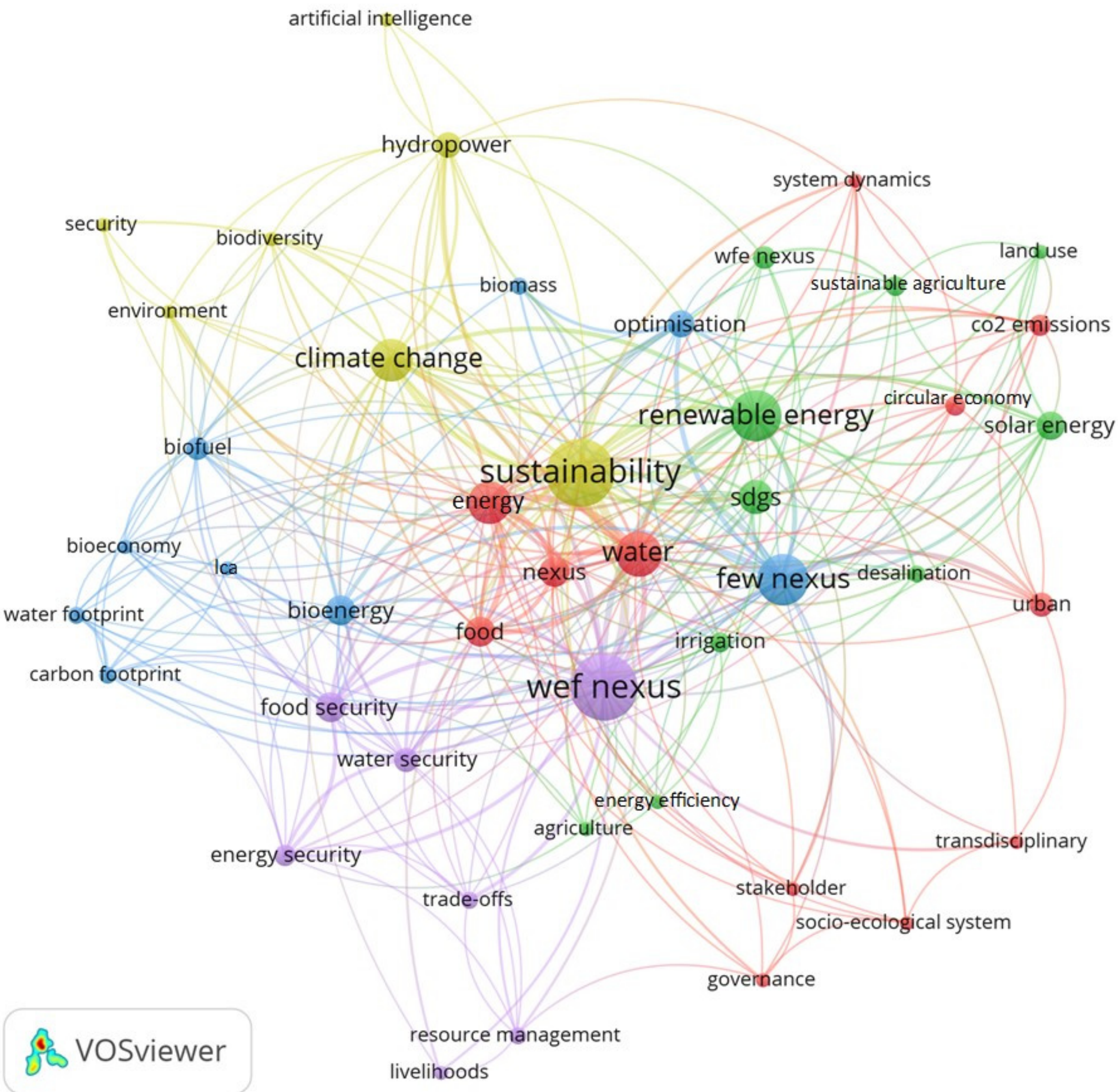

Figure 6. Clustering of authors' keyword network.

3.2. *Systematic Review of WEF Nexus, Clean Energy, and Sustainability*

Table 1 shows the integral involvement of the WEF nexus with sustainable and clean energy systems that allow for the sustainability management of WEF resources. Several authors have conducted studies on decision making and using clean energy sources considering the WEF nexus and sustainability. The review identified few contributions in wind, hydrogen, nuclear, geothermal, and ocean energy since these topics are relatively new, including the interactions with the WEF nexus and sustainability.

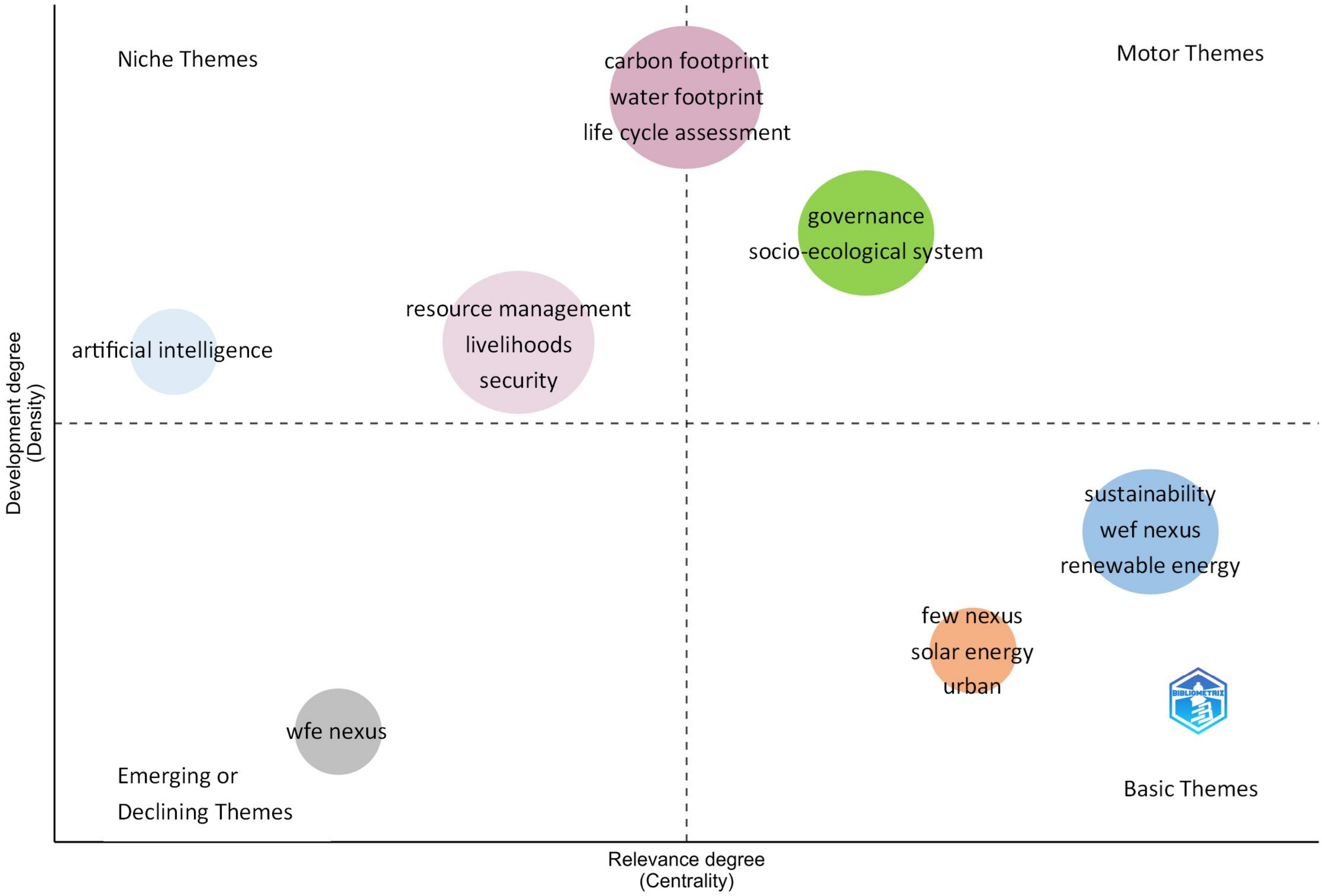

Figure 7. Thematic map of the relationships among the WEF nexus, clean energy, and sustainability.

Table 1. Systematic review oriented toward the interaction among the WEF nexus, clean energy, and sustainability, based on 55 documents.

Clean Energy	Main Contributions	SDGs	References
WEF nexus/renewable energy mix	• The renewable energy mix contributes to energy generation (i.e., electricity, power, heating, cooling), carbon footprint reduction, and energy security with energy storage technologies. • Decentralised energy solutions used in rural areas, such as photovoltaic, wind, and hydropower technologies, generate social benefits; however, problems in maintenance, operation, and management costs must be considered. • Decision making should consider strengthening infrastructure construction in comprehensive renewable energy development, with financial support and international collaboration. • Technological innovation, renewable energy mix, certification, and strict environmental regulations can achieve the environmental sustainability agenda. • The sustainable political management of natural and territorial resources makes it possible to strengthen food and energy security in sectors with depletion problems.	2; 7; 11; 13	[34,83–87]

Table 1. *Cont.*

Clean Energy	Main Contributions	SDGs	References
WEF nexus/solar energy	• Concentrated Solar Power (CSP) and photovoltaics reduce the use of fossil fuels for power generation. • Solar photovoltaic energy is decentralised, relatively inexpensive, and supports sustainable agriculture and aquaculture activities. • Photovoltaic cell technology allows energy to be generated from sunlight to displace water for livestock activities, and the shade from the cells improves livestock production.	7; 2	[88–90]
WEF nexus/bioenergy	• Waste management and recovery for the production of biofuels contribute to reducing greenhouse gas emissions through anaerobic digestion. Biofuels are a sustainable option considering emissions in the transport sector. • Bioenergy based on sugar cane requires large amounts of water during the process. Irrigation and recycling help reduce water consumption. • Energy crops can contribute to decarbonisation by mitigating climate change and are used as biofuels for the energy generation and transport sector. • Understanding the WEF nexus strengthens the promotion of the SDGs, and coppice willow can substitute for fuel, reducing the negative impact of climate change.	7; 11	[91–95]
WEF nexus/ hydropower	• Hydropower is central to the WEF nexus, because it supports WEF systems (water, energy, food). Water storage is also used in irrigation, industrial, and domestic activities. • The effluent water from the desalination plants is used to augment the water and energy in the hydropower system. • Multi-sectoral water allocation optimises water sourcing to support hydropower production, which benefits the WEF nexus on the water scarcity index.	7; 6; 2	[59,96,97]
WEF nexus/wind energy	• Wind energy is combined with water desalination technologies contributing to the production of water for agricultural activities; these systems combined with wind energy are widely used in arid areas.	7; 6; 2	[98]
WEF nexus/ hydrogen	• The plants generate clean energy to produce freshwater (i.e., used for agriculture and industry) and hydrogen (i.e., as an energy carrier for a CSP plant).	7; 6	[99]

Figure 8 reveals a complete conceptual framework of the WEF nexus with sustainability and clean energy, where the WEF nexus mainly considers climate change, food security, resources, water scarcity, and energy demand. Sustainability involves governance by addressing technological implementation to meet the SDGs. Clean energy consists mainly of renewable energy, hydrogen and nuclear. The 55 papers in the systematic review were classified according to the four pillars of sustainability. The environmental and social aspects reached 22 and 18 scientific publications, respectively. Finally, the cultural and social pillars require the most research, with eight and seven papers, respectively.

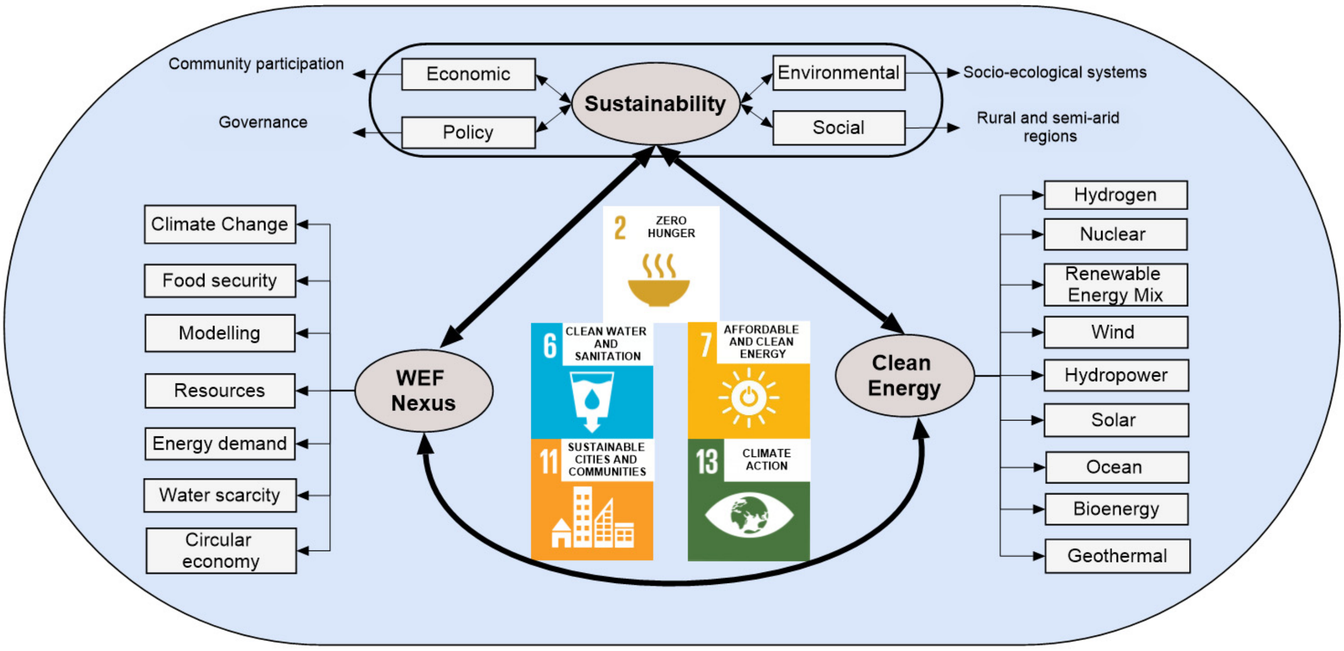

Figure 8. Conceptual matrix of the WEF nexus, sustainability, and clean energy.

4. Discussion

This study highlights that it is essential to consider clean energy in a holistic framework ranging from energy policies to strategies applicable to rural and urban communities focusing on the sustainable use of WEF nexus systems. The study showed that sustainability initiatives in recent years (2015–2023) enabled the integration of WEF nexus initiatives into energy development. The WEF nexus is a topic of recent scientific interest that helps manage sustainability strategies related to energy development, considering environmental issues (e.g., resource scarcity and climate change). The main results of this study are the analysis of the intellectual structure, which includes the scientific production with its relation to sustainability and the WEF nexus (Figure 4), as well as the global distribution of energy projects using clean energy (Figure 5). This study used the bibliometric networks by research area (Figure 6) and the evolution of the themes (Figure 7) to analyse the conceptual structure. Finally, the systematic review allowed us to identify the main contributions and a conceptual framework of the interactions among the WEF nexus, clean energy, and sustainability (Figure 8).

The analysis of the topics that relate the WEF nexus with clean energy by country (Figure 4) evidenced that there are countries where scientific production does not reflect the reality of the most used clean energy (e.g., Ecuador, Brazil, and Egypt) where the most used energy generation is hydropower and bioenergy [100,101]. Table 2 compares the data found in the review and the data on the clean energy used in 2022 [101]; it also considers the countries' income levels and the low percentage of clean energy use. The review highlights the importance of considering energy storage due to the intermittent of renewable energy (e.g., solar and wind). Additionally, a diversified energy matrix is essential because if only conventional renewable energy (i.e., hydropower) is available, energy insecurity may arise due to climate change and water scarcity [59,102].

The thematic map identified the following motor themes: resources, food security, and optimisation, which are the most relevant in this domain (i.e., the WEF nexus and clean energy). The basic themes in this field are climate change, sustainability, and water security, which are relevant in different areas. The emerging/declining themes are renewable energy, artificial intelligence, sustainable agriculture, and SDGs; the resulting niche themes are circular economy, urban sustainability, LCA, and carbon footprint, which are developed but marginal to these domains. This indicates that the increasing utilisation and development of renewable energy in sustainable agriculture and the circular economy (i.e., Waste-to-Energy technologies) applications are ways to achieve urban sustainability. Resource management is intrinsically related to food security and the influence of climate change on water security. The clustering-by-keyword analysis revealed the importance of WEF, FEW, and Water–Food–Energy (WFE) linkages to manage resources and meet sustainability indicators.

Table 2. Comparison between the use of clean energy sources and that found in the review by country.

Income Level	Country	H (%)	B (%)	REM (%)	S (%)	W (%)	T (%)
High	China	(✓) (7.67)	(✓) (0.06)	(✓) (1.27)	(✓) (2.51)	(X) (4.49)	16.00
	United States	(✓) (2.53)	(✓) (1.62)	(✓) (0.84)	(✓) (2.01)	(✓) (4.29)	11.29
	Spain	(✓) (2.97)	(X) (0.97)	(✓) (1.36)	(X) (5.50)	(✓) (10.22)	21.02
Upper middle	Brazil	(X) (29.89)	(✓) (6.49)	(✓) (4.52)	(✓) (2.11)	(X) (5.71)	48.72
	South Africa	(X) (0.60)	(✓) (0.07)	(✓) (0.10)	(✓) (1.20)	(X) (1.89)	3.86
	Ecuador	(X) (29.36)	(✓) (0.08)	(X) (0.56)	(X) (0.04)	(X) (0.07)	30.11
Low middle	Egypt	(X) (3.25)	-	(X) (0.00)	(✓) (1.18)	(X) (1.21)	5.64
	Pakistan	(✓) (9.13)	(X) (0.00)	(✓) (0.28)	(X) (0.23)	(X) (1.21)	10.85
	Algeria	(X) (0.02)	-	(X)	(✓) (0.26)	(X) (0.004)	0.284

Note: ✓, match between information founded in the review and the real energy consumption; X, mismatch of the energy sources used. H (hydropower), B (bioenergy), REM (renewable energy mix), S (solar), W (wind). % (clean energy consumption as a percentage of the total energy consumption, % (TWh/TWh)). T (total, the sum of sustainable clean energies). - There is no record of this type of energy in official data.

The systematic review identified 55 relevant articles to sustainable and energy development strategies. These articles show strong links between the WEF nexus and the SDGs, mainly with SDG 7, "Affordable and Clean Energy"; due to technological advances in harnessing renewable energy sources, it is possible to interconnect water and food systems, reducing greenhouse gases and contributing to other SDGs (6. Clean Water and Sanitation; 11. Sustainable Cities and Communities; 13. Climate Action). The WEF nexus with aspects of energy sustainability focuses on SDG 7 and is also related to SGDs 1, 2, 5, 6, 11, and 13, always with the vision of sustainable communities, addressing the issue of water and food. On the other hand, according to Andrade Guerra et al. [103], promoting this scientific field requires a governmental and educational contribution and intersectoral and multilevel cooperation between the WEF nexus involved and interested in socio-economic, technological, and scientific activity. Despite organisations, governments, and scientists of several nations such as the United States, China, the United Kingdom, Germany, and others of lower production levels promoting sustainability, further development of public policies for adapting clean energy sources in the industry is crucial. Also, it is essential to implement strategies for using clean energy in developing countries (e.g., strategic partnerships exist between Europe and Africa for clean energy generation in both regions [104]).

Currently, governmental linkage efforts show interest in integrating sustainability in urban and industrial areas through food–water security and strengthening the circular economy to reduce the carbon footprint [105]. Studies indicate that the WEF nexus in the energy sector is an effective tool that assesses and understands the resources used in socio-economic activities. Cansino-Loeza et al. [106] indicated that the WEF nexus can be included in decision making to study the current state of integral sectors and subsequently implement policies in future scenarios. This criterion includes the levels of legislation, rule linking, the elaboration of shared principles, knowledge, and experience, and the exchange of views [107]. However, the present study found several strategies that the scientific community considers relevant in the WEF nexus processes with energy-sustainable progress: (i) agricultural intensification, (ii) governance approach, (iii) linking WEF nexus groups, (iv) cross-sectoral coordination, (v) the LCA method, (vi) technological innovation, (vii) the use of different renewable energy sources, (viii) environmental regulations,

(ix) collaboration/economic support, (x) social participation, and (xi) the promotion of irrigation/recycling in bioenergy production.

The WEF nexus generally assesses the political, social, economic, and environmental aspects of energy activities linked to the demand for food and water. Moreover, the WEF nexus is based on sustainability activities, which facilitates the possibility of strategically promoting energy development. Therefore, part of the challenges in the decision making of the WEF nexus is characterising socio-economic legislation to understand the importance of sustainability in education and industrial development programmes. The WEF nexus generates innovations supported through different measures, such as awareness-raising for water, energy, and food resources.

This study recognised that no studies in the PRISMA review focused on nuclear and geothermal energy connected to the WEF nexus and sustainability. It is a conceptual limitation; nuclear energy is unsustainable due to accidents (e.g., the Chernobyl disaster) and nuclear waste management [108,109]. On the other hand, there is minor evidence of geothermal studies because of the high investment cost [110]. However, nuclear (i.e., using molten salt reactors) and geothermal energy (i.e., high-enthalpy systems) could produce promising clean and sustainable energy and could be considered in future studies [111,112].

5. Conclusions

The link between the WEF nexus, clean energy, and sustainability is reflected in 30% of the 179 scientific publications, showing the importance of finding an alternative energy source and promoting strategies that consider the renewable energy mix, i.e., a diversified energy matrix.

Twenty-seven publications reflected the reality of countries regarding their energy matrix; these studies looked for alternative energy sources to adapt to the energy matrix, for instance, in developing countries that depend on traditional energy sources such as hydropower. However, most scientific publications focused on other sources (i.e., REM and bioenergy). At the same time, the WEF nexus needs to be integrated into regions with low industrial activity in the use of clean energy (e.g., some Latin American and African countries). Due to limited natural resource management, these regions need international cooperation to promote effective adaptation plans and projects, mainly in marginal and neglected areas such as rural and semi-arid zones.

The origin topics of the scientific publications related to the articulation of clean energy, the WEF nexus, and sustainability are governance and sustainability policies, which are critical for interacting with socio-ecological systems and issues such as climate change and water scarcity. The review highlights sustainable strategies that promote governance, identifying the interrelationship between the resources and subsystems of the WEF nexus. These contributions focus on strengthening cross-sectoral linkages, academic and scientific knowledge, organisational contributions, legal frameworks, and their relationship with the SDGs. There is a significant relation with SDG 7, referring to clean energy that promotes governmental, educational, and social support for sustainable practices.

The WEF nexus and clean energy must involve CO_2 mitigation, energy access, energy efficiency, and sustainable energy. Therefore, the results of the systematic review identified the following future research topics: (i) the articulation framework between the WEF nexus, sustainability, climate change, energy efficiency, bioenergy, and hydrogen as viable alternatives for the energy transition and (ii) the promotion of current technologies such as artificial intelligence (AI) and the Internet of Things (IoT) for monitoring, energy system planning, energy storage, energy efficiency, and energy security is recommended.

The challenge is the integration of all the possibilities of clean energy sources in a territorial system to create sustainability models where the WEF nexus is the axis of decision making and planning. This study identified as a limitation that it should have considered economic factors, denoted in some studies as critical variables in the systematic review, to understand applicable clean energy projects globally and regionally. The data analysis showed that geothermal, ocean, and nuclear energies are also relevant, but few studies have considered these energies, the WEF nexus, or sustainability. Therefore, decision makers should promote the designation of funds for this type of research.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/w16071017/s1, Table S1. The top 20 countries are researching the relationship among the WEF nexus, clean energy, and sustainability of the 179 analysed documents.

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