



Article

Bibliographic Coupling Links: Alternative Approaches to Carrying Out Systematic Reviews about Renewable and Sustainable Energy

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Abstract: New technologies, specifically the internet, have over the last two decades increased the number of publications in the most diverse fields of science. Subjects related to renewable and sustainable energy are no exception. These frameworks have allowed the main insights produced by the scientific community through literature surveys to be highlighted. Nonetheless, considering the vast quantity of studies, systematic approaches have been proposed by the researchers to better organize and perform the literature review. Considering the subjectivity of some of these methodologies, the main objectives of this research are to conduct a systematic review about renewable and sustainable energy through more objective techniques, based on bibliometric analysis, to provide an alternative or to complement those already available within the literature. For this purpose, a “Biblio4Review” approach was proposed in order to perform systematic reviews about renewable and sustainable energy that may spread into other scientific fields. This methodology is based on bibliographic coupling links from the bibliometric analysis to identify the most relevant studies for the literature review. The results obtained highlight that with this approach it was possible to identify the studies with greater centrality in terms of references shared. In this way, they are among the most relevant documents for these topics. Specifically for the topic considered (renewable and sustainable energy) the main insights were referred to. In any case, the findings obtained show that there is a field for more interdisciplinary approaches.

Keywords: harmonic closeness centrality; PRISMA; energy sources; processes and technologies; methodologies of analysis



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1. Introduction

A preliminary survey of the literature shows that research on renewable and sustainable topics is often focused on energy dimensions, revealing that there is a field for interdisciplinary approaches. Indeed, interdisciplinary contributions allow making this topic broader where the environmental, social, and economic dimensions may be encompassed to give evidence for more sustainable development.

In addition, a search on the Web of Science Core Collection (WoS) [1] about the topics “renewable and sustainable energy” and “systematic review” shows a limited number of studies conducted on these subjects. The studies published on WoS focused on photovoltaic approaches [2], quality control [3], renewable energy and economic dynamics [4], renewable and sustainable energy in the Asian context [5], and heat waves [6].

This search on WoS also reveals that there is no document in which the topic “bibliometric” is added. This assessment highlights an interesting indication that supports the relevance of addressing the systematic reviews issue, based on bibliometric approaches on the topic of renewable and sustainable energy.

The consideration of the bibliometric analysis to conduct systematic reviews as a complement or alternative to the PRISMA [7] approach, for example, is not new. It was

considered for subjects related to food marketing [8], agri-food frameworks [9], circular economy [10], smart agriculture [11], and business contexts [12].

The novelty of the study provided is to propose a methodology based specifically on bibliographic coupling and centrality metrics to conduct systematic reviews concerning renewable and sustainable energy, which may be broadened into other fields.

Taking into account these findings, this research aims to highlight the main gaps in the literature about renewable and sustainable energy and to propose suggestions for more interdisciplinary approaches. It is intended to develop a proposal to conduct systematic reviews and then implement them based on bibliometric analysis, through bibliographic coupling links and centrality metrics. It is not easy to find a definition for systematic review; nonetheless, it may be considered as a review that considers the following [13]: research question, search sources, inclusion criteria, selection approaches, quality/risks analyses, transparency, and reproducibility. This definition was proposed by a study focused on the health care literature; however, the findings may be applied in other areas of science.

2. Literature Review

Bibliographic coupling links are similarity approaches used in the frameworks of science mapping [14], considered in the bibliometric analysis, and occur when different documents share the same references [15]. For bibliographic coupling, the relatedness of documents is relative to the number of references they share [16]. In other words, bibliographic coupling occurs when two documents have a third word as a reference [17].

Bibliographic coupling has been considered, in the literature, for analysis in several studies relating to the different fields of science, such as the following (sometimes combined with other approaches [18]): assessment of the risk culture in commercial enterprises [19]; interdisciplinary in health research [20]; industry 4.0 [21]; electrical and electronic waste [22]; social responsibility [23]; corporate social responsibility [24]; *Journal of Intellectual Capital* [25]; co-innovation [26]; business literature [27]; public relations theory [28]; distance learning [29]; search results [30]; big data and business strategy [31]; historiography dimensions [32]; Brazilian publications [33]; Iberoamerican scientific production [34]; *Journal of Marketing Education* [35]; *Journal of Marketing Theory and Practice* [36]; *Journal of Consumer Marketing* [37]; tourism sector [38]; sustainable operation [39]; classical music [40]; Chinese patent information [41]; Chinese-Latin American relations [42]; industry [43]; food sector [44]; Asian literature [45]; firm level analysis [46]; innovation management [47]; social capital [48]; and entrepreneurship [49].

Various studies contributed to the knowledge concerning the different dimensions associated with bibliographic coupling. Some support its introduction and dissemination in the literature [50]. Others consolidate its relevance [51] and pertinence for bibliometric analysis [52] by the scientific community and others to bring about improvements [53], insights [54], and overviews [55]. This approach has been frequently considered in the literature and used from diverse perspectives [56], including coupling assessment among social media network users [57]. It allows for the identification of networks and clusters between documents that share references [58]. Bibliographic coupling also considers documents as items [59], and this is an advantage compared to other links from the bibliometric analysis. In addition, this is a quantitative methodology having more objectivity in the outputs, which is an added asset relative to qualitative approaches [60]. Another advantage is that younger publications may cite older documents, giving an updated perspective on the topics [61] and changing the focus for current tendencies [62]. Citations shared by studies may prove to be an interesting indicator about their relationships [63] and interlinkages with the same topic [64]. In this way, bibliographic coupling is often considered as being more adjusted in identifying the most relevant research compared to other techniques [65].

Bibliometric analysis is a determinant tool in supporting researchers to overview the context of documents published about specific topics [66], namely when dealing with a large volume of information [67], with specific issues [68] or publications [69]. This analysis also allows for the identification of transformations in different scientific topics [70] as well

as current fields [71], emerging topics [72], trends [73], gaps in the literature [74], most relevant topics [75], themes [76], and similarities among items beyond documents [77]. The other items considered are, for example, the authors [78]. Nonetheless, it is not exempt from limitations and criticism [79], namely due to the different ways used by databases in writing the same information (references, for example) [80] and other sources of bias [81] and limitations [82], such as the potential great number of zeros in the similarity matrix [83].

3. Materials and Methods

To achieve the objectives proposed, 486 and 743 documents were obtained from the scientific databases WoS [1] and Scopus [84] during a search performed on 19 July 2021 for the topic “renewable and sustainable energy”. These documents were assessed through centrality metrics (harmonic closeness centrality), for bibliographic coupling links, with the Gephi software [85,86] to identify the most relevant document for the topic. The files for the Gephi software were prepared through the VOSviewer software [16,87]. The harmonic closeness centrality metric is the sum of the inverted distances between nodes, [88] in a not necessarily connected graph [89].

The bibliometric analysis was conducted separately for the two databases (WoS and Scopus). After identifying the most relevant studies for each database, the respective documents were added. Then the duplicate documents were removed, and a survey of the remaining studies was conducted to identify the most important insights.

The approach proposed may fill in the gaps the literature about systematic reviews in fields related to renewable and sustainable energy. It may include proposals to design alternative and more quantitative methodologies.

4. Data Analysis

Tables 1–4 show the most productive and networked authors, countries, organizations, and sources, for the topic “renewable and sustainable energy”. These top-20 items were obtained through the VOSviewer software [87], considering bibliographic data and bibliographic coupling links. These tables show the number of documents for each item (authors, countries, organizations, and sources) and for each database. The weight attributed to “Documents” corresponds to the number of documents published by each item [16].

Table 1. Top-20 networked authors from Scopus and WoS databases for bibliographic coupling links.

Scopus		WoS	
Authors	Documents	Authors	Documents
Hameiri Z.	20	Hosseini, Seyed Ehsan	9
Hosseini S.E.	9	Foley, Aoife	8
Li Y.	9	Wahid, Mazlan Abdul	7
liu J.	9	Duic, Neven	6
Foley A.	8	Markovska, Natasa	5
Li J.	7	Puksec, Tomislav	5
Liu Y.	7	Abdulkhani, Ali	2
Duić N.	6	Ajayan, J.	2
Pukšec T.	6	Alam, MD. MAHBUB	2
Wahid M.A.	6	Ali, Mumtaz	2
Zhang L.	6	Cao, Yijia	2
Zhang Y.	6	Chen, Wei	2
Zhou Y.	6	Daud, Wan Mohd Ashri Wan	2
Li S.	5	David, ghislain	2
Li X.	5	Dehghani-sanij, Alireza	2
Markovska N.	5	Demadis, Konstantinos d.	2
Wang H.	5	Dusseault, Maurice B.	2
Wang J.	5	Ewees, Ahmed A.	2
Wang S.	5	Fang, Baling	2
Wang Y.	5	Ganesh, Ibram	2

Table 2. Top-20 networked countries from Scopus and WoS databases for bibliographic coupling links.

Scopus		WoS	
Countries	Documents	Countries	Documents
China	140	Peoples R China	109
United States	108	USA	69
India	66	India	41
Malaysia	62	Malaysia	40
United Kingdom	53	England	26
Australia	42	Turkey	23
Italy	31	Italy	22
Turkey	27	South Korea	21
South Korea	25	Spain	20
Spain	25	Saudi Arabia	17
Saudi Arabia	24	Brazil	16
Germany	22	Germany	16
Iran	22	Australia	15
Canada	20	Iran	15
Brazil	17	Canada	13
Indonesia	15	The Netherlands	12
The Netherlands	15	France	11
France	14	Pakistan	10
South Africa	14	Scotland	10
Taiwan	14	South Africa	10

Table 3. Top-20 networked organizations from Scopus and WoS databases for bibliographic coupling links.

Scopus		WoS	
Organizations	Documents	Organizations	Documents
school of photovoltaic and renewable energy engineering, unsw australia, Sydney, NSW 2052, Australia	15	Chinese Acad Sci	14
school of mechanical & aerospace engineering, queen's university belfast, ashby building, stranmillis road, Belfast, BT9 5AH, United Kingdom	4	Univ Teknol Malaysia	14
department of energy, power engineering and environment, university of zagreb, faculty of mechanical engineering and naval architecture, ivana lučića 5, Zagreb, 10002, Croatia	3	Univ Malaya	10
high-speed reacting flow laboratory, faculty of mechanical engineering, universiti teknologi Malaysia, 81310 Utm Skudai, johor, Malaysia	3	Tsinghua Univ	9
institute for turbulence-noise-vibration interaction and control, shenzhen graduate school, harbin institute of technology, Shenzhen, 518055, China	3	Queens Univ Belfast	7
school of economics and management, north china electric power university, Beijing, 102206, China	3	Univ Zagreb	7
school of environmental science and engineering, shanghai jiao tong university, Shanghai, 200240, China	3	Aalto Univ	6
university of the west of scotland, school of engineering, high street, Paisley, PA1 2BE, United Kingdom	3	Univ Waterloo	6
aksaray university, industrial engineering department, Aksaray, Turkey	2	City Univ Hong Kong	5

Table 3. Cont.

Scopus		WoS	
Organizations	Documents	Organizations	Documents
center for engineering research, research institute, king fahd university of petroleum and minerals, Dhahran, 31261, Saudi Arabia	2	Harbin Inst Technol	5
college of electrical and information engineering, hunan university, Changsha, 410082, China	2	Hong Kong Polytech Univ	5
department of catalysis and chemical reaction engineering, national institute of chemistry, hajdrihova 19, Ljubljana, 1000, Slovenia	2	Hunan Univ	5
department of chemical engineering, universitas syiah kuala, Banda Aceh, 23111, Indonesia	2	King Saud Univ	5
department of earth and environmental sciences, university of waterloo, Waterloo, ON N2L 3G1, Canada	2	Univ Nottingham	5
department of industrial engineering and engineering management, national tsing hua university, Hsinchu, Taiwan	2	Univ Sao Paulo	5
department of mechanical engineering, universitas syiah kuala, Banda Aceh, 23111, Indonesia	2	Univ West Scotland	5
department of sustainable and renewable energy engineering, university of sharjah, United Arab Emirates	2	Georgia Inst Technol	4
department of wood and paper sciences and technology, faculty of natural resources, university of tehran, Karaj, 1417466191, Iran	2	Huazhong Univ Sci & Technol	4
e & m school, beihang university, Beijing, 100191, China	2	King Fahd Univ Petr & Minerals	4
faculty of management, universiti teknologi malaysia (utm), Skudai Johor, 81310, Malaysia	2	Univ Padua	4

Table 4. Top-20 networked sources from Scopus and WoS databases for bibliographic coupling links.

Scopus		WoS	
Sources	Documents	Sources	Documents
renewable and sustainable energy reviews	160	renewable & sustainable energy reviews	106
journal of renewable and sustainable energy	45	energies	11
progress in photovoltaics: research and applications	20	renewable energy	11
renewable energy	14	energy	10
energies	11	international journal of hydrogen energy	9
energy	9	energy conversion and management	8
energy conversion and management	8	journal of cleaner production	8
international journal of hydrogen energy	8	acs sustainable chemistry & engineering	6
journal of cleaner production	8	applied energy	6
applied energy	7	fuel	6
fuel	6	journal of renewable and sustainable energy	6
iop conference series: materials science and engineering	6	sustainability	6
sustainability (switzerland)	6	rsc advances	5
acs sustainable chemistry and engineering	5	electrochimica acta	4
energy storage materials	5	energy storage materials	4
green energy and technology	5	international journal of energy research	4
international journal of energy research	5	solar energy materials and solar cells	4
rsc advances	5	acs applied materials & interfaces	3
electrochimica acta	4	applied microbiology and biotechnology	3
energy policy	4	bioenergy research	3

The most productive and networked author considering the information obtained from the Scopus database is Hameiri, Z., with 20 documents. In second place is Hosseini, S.E.

who is also the most productive author for the WoS database (Table 1). Foley, A. and Duic, N. also appear among the authors having more documents in Scopus and WoS.

Table 2 reveals that the most productive countries for the two databases are China, the United States, India, Malaysia, and the United Kingdom/England. For the European Union member-states, Italy, Spain, Germany, the Netherlands, and France are the countries with more publications for the topic.

These findings highlight the importance given by countries, such as China and the United States, to the fields related to renewable and sustainable energy. This is a concern for several countries, including Saudi Arabia and Iran.

The results provided in Table 3 are consistent with the findings described for Tables 1 and 2 relative to the top authors and countries of affiliation. In fact, the most productive organizations are from Australia, China, the United Kingdom, Croatia, and Malaysia. The United States is in second place as an affiliated country, but does not appear among the most productive organizations, showing that the network is weaker for these organizations.

The most productive sources are the following (Table 4): Renewable and Sustainable Energy Reviews; Energies; Renewable Energy; and Energy. In addition, a relevant part of the top-20 sources are publications associated with the topics related to energy, with the exception for journals, such as *Journal of Cleaner Production and Sustainability*.

5. Identifying the Most Relevant Documents for Systematic Review

The information displayed in Tables 5–7 was obtained through the Gephi software [85,86], considering files prepared with the VOSviewer software [16,87] for bibliographic data and bibliographic coupling links. The advantages of the bibliographic coupling links to identify the most relevant documents for systematic review were highlighted in the literature review section. Some of these advantages are relative to the specificities of the nodes that are documents and, in this way, do not change over time [59]. Another advantage is that more recent publications may refer back to older documents and give an updated view of the topics analyzed [61].

Table 5. Top-20 documents with higher harmonic closeness centrality from Scopus database for bibliographic coupling links.

Documents	DOI	Harmonic Closeness Centrality
Rajeswari G. (2021)	https://doi.org/10.1186/s12934-021-01597-0	0.876078
Ghalandari T. (2021)	https://doi.org/10.1016/j.renene.2021.06.010	0.702586
Ali M. (2021)	https://doi.org/10.1016/j.renene.2021.06.052	0.598779
Shahabuddin M. (2021)	https://doi.org/10.1016/j.seta.2021.101434	0.561782
Ibram G. (2015)	https://doi.org/10.1016/j.rser.2015.01.019	0.556753
Joshi G. (2017)	https://doi.org/10.1016/j.rser.2017.05.185	0.554957
Baños R. (2011)	https://doi.org/10.1016/j.rser.2010.12.008	0.535201
Hosseini S.E. (2016)	https://doi.org/10.1016/j.rser.2015.12.112	0.534842
Raheem A. (2015)	https://doi.org/10.1016/j.rser.2015.04.186	0.533764
Pandiyani K. (2019)	https://doi.org/10.1016/j.renene.2018.08.049	0.530891
Abomohra A.E.-F. (2019)	https://doi.org/10.1007/978-981-13-2264-8_13	0.530532
Liew W.H. (2014)	https://doi.org/10.1016/j.jclepro.2014.01.006	0.525144
Hosseini S.E. (2014)	https://doi.org/10.1002/er.3190	0.523707
Rehman M.S.U. (2013)	https://doi.org/10.1016/j.rser.2012.10.019	0.520833
Rostami R. (2017)	https://doi.org/10.1016/j.rser.2016.11.172	0.520474
Long F. (2021)	https://doi.org/10.1016/j.rser.2021.111269	0.519756
Hani M.R. (2020)	https://doi.org/10.37934/arfmts.74.2.85119	0.518319
Zadeh Z.E. (2020)	https://doi.org/10.3390/pr8070799	0.517601
Hosseini S.E. (2015)	https://doi.org/10.1016/j.enconman.2015.02.012	0.515086
Wu Y. (2020)	https://doi.org/10.1007/978-3-030-27161-9_18	0.514727

Table 6. Top-20 documents with higher harmonic closeness centrality from WoS database for bibliographic coupling links.

Documents	DOI	Harmonic Closeness Centrality
Aydin (2021)	https://doi.org/10.1016/j.energy.2021.120891	0.893978
Kawale (2021)	https://doi.org/10.1016/j.renene.2021.03.139	0.702714
Liu (2021)	https://doi.org/10.1016/j.colsurfa.2021.126582	0.587362
Li (2021)	https://doi.org/10.1016/j.ccr.2021.213946	0.570823
Ganesh (2015)	https://doi.org/10.1016/j.rser.2015.01.019	0.567006
Joshi (2017)	https://doi.org/10.1016/j.rser.2017.05.185	0.557252
Rostami (2017)	https://doi.org/10.1016/j.rser.2016.11.172	0.552587
Hosseini (2016)	https://doi.org/10.1016/j.rser.2015.12.112	0.547074
Banos (2011)	https://doi.org/10.1016/j.rser.2010.12.008	0.546226
Amran (2020)	https://doi.org/10.1016/j.jclepro.2019.119602	0.537744
Raheem (2015)	https://doi.org/10.1016/j.rser.2015.04.186	0.53732
Liew (2014)	https://doi.org/10.1016/j.jclepro.2014.01.006	0.53732
Hosseini (2014)	https://doi.org/10.1002/er.3190	0.536472
Hasan (2012)	https://doi.org/10.1016/j.rser.2011.12.007	0.536472
Pandiyani (2019)	https://doi.org/10.1016/j.renene.2018.08.049	0.535199
Lah (2021)	https://doi.org/10.1016/j.rser.2021.111103	0.530534
Rehman (2013)	https://doi.org/10.1016/j.rser.2012.10.019	0.528838
Hosseini (2015)	https://doi.org/10.1016/j.enconman.2015.02.012	0.528414
Strantzali (2016)	https://doi.org/10.1016/j.rser.2015.11.021	0.527566
Kumar (2018)	https://doi.org/10.1016/j.rser.2018.03.049	0.527142

Table 7. Top documents with higher harmonic closeness centrality from Scopus and WoS top-20 documents, after removing duplicates, for bibliographic coupling links.

Documents	DOI	Harmonic Closeness Centrality
Aydin (2021)	https://doi.org/10.1016/j.energy.2021.120891	0.893978
Rajeswari (2021)	https://doi.org/10.1186/s12934-021-01597-0	0.876078
Kawale (2021)	https://doi.org/10.1016/j.renene.2021.03.139	0.702714
Ghalandari (2021)	https://doi.org/10.1016/j.renene.2021.06.010	0.702586
Ali (2021)	https://doi.org/10.1016/j.renene.2021.06.052	0.598779
Liu (2021)	https://doi.org/10.1016/j.colsurfa.2021.126582	0.587362
Li (2021)	https://doi.org/10.1016/j.ccr.2021.213946	0.570823
Ganesh (2015)	https://doi.org/10.1016/j.rser.2015.01.019	0.567006
Shahabuddin (2021)	https://doi.org/10.1016/j.seta.2021.101434	0.561782
Joshi (2017)	https://doi.org/10.1016/j.rser.2017.05.185	0.557252
Rostami (2017)	https://doi.org/10.1016/j.rser.2016.11.172	0.552587
Hosseini (2016)	https://doi.org/10.1016/j.rser.2015.12.112	0.547074
Banos (2011)	https://doi.org/10.1016/j.rser.2010.12.008	0.546226
Amran (2020)	https://doi.org/10.1016/j.jclepro.2019.119602	0.537744
Liew (2014)	https://doi.org/10.1016/j.jclepro.2014.01.006	0.53732
Raheem (2015)	https://doi.org/10.1016/j.rser.2015.04.186	0.53732
Hasan (2012)	https://doi.org/10.1016/j.rser.2011.12.007	0.536472
Hosseini (2014)	https://doi.org/10.1002/er.3190	0.536472
Pandiyani (2019)	https://doi.org/10.1016/j.renene.2018.08.049	0.535199
Lah (2021)	https://doi.org/10.1016/j.rser.2021.111103	0.530534
Abomohra (2019)	https://doi.org/10.1007/978-981-13-2264-8_13	0.530532
Rehman (2013)	https://doi.org/10.1016/j.rser.2012.10.019	0.528838
Hosseini (2015)	https://doi.org/10.1016/j.enconman.2015.02.012	0.528414
Strantzali (2016)	https://doi.org/10.1016/j.rser.2015.11.021	0.527566
Kumar (2018)	https://doi.org/10.1016/j.rser.2018.03.049	0.527142
Long (2021)	https://doi.org/10.1016/j.rser.2021.111269	0.519756
Hani (2020)	https://doi.org/10.37934/arfmts.74.2.85119	0.518319
Zadeh (2020)	https://doi.org/10.3390/pr8070799	0.517601
Wu (2020)	https://doi.org/10.1007/978-3-030-27161-9_18	0.514727

In addition, the harmonic closeness centrality metric was considered as an indicator to order the documents. This metric gives evidence concerning the distance of each node/label to the others [85,86]. Considering that bibliographic data were considered for bibliographic coupling links, shorter distances among documents means that they share more references. From this perspective, the harmonic closeness centrality is an appropriate indicator for the objectives proposed in this research.

With the information presented in Tables 5 and 6, (after removing the duplicates) the results shown in Table 7 were obtained. These documents will be considered for systematic review. The approach that was considered since the beginning of this study, and referred to as "Biblio4Review", to achieve the documents shown in Table 7, is summarized in Figure 1.

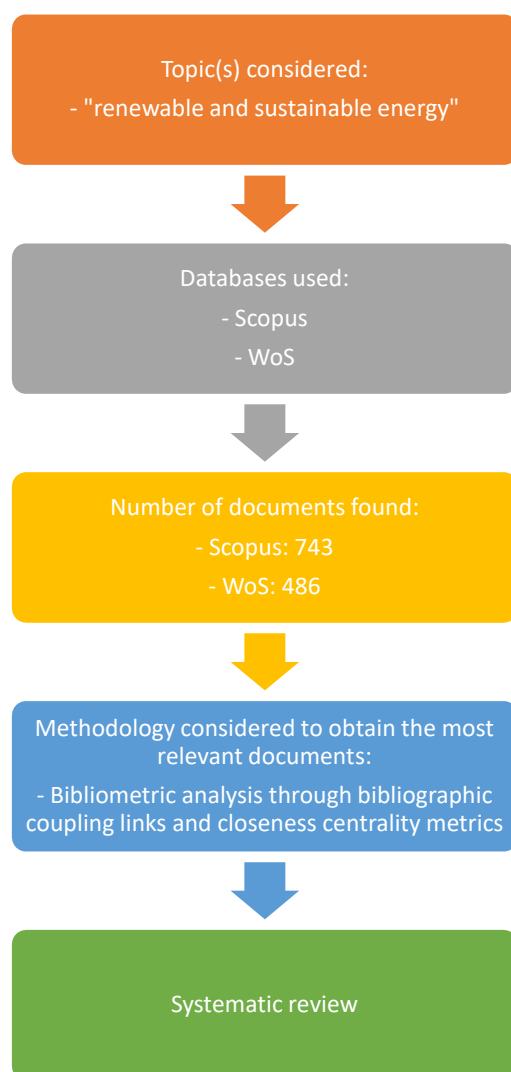


Figure 1. Steps to find the most relevant documents for systematic review, considering the proposed Biblio4Review approach.

6. Systematic Review

The systematic review conducted with the documents shown in Table 7 are summarized in Table 8. In general, these documents are focused on specific issues or specific countries.

The specific countries addressed by these studies were Australia, Saudi Arabia, Turkey, Indonesia, Malaysia, India, Pakistan, and Afghanistan. Some of them are petroleum export countries. The particular issues focused on were those related to energy sources (biomass, late transition metals, and solar power), processes and technologies (hydronic asphalt

pavement, polygeneration, and bioconversion), methodologies (extreme learning machines, deep learning models, and computational optimization approaches), hydrogen, biofuel, and solar energy production.

In terms of biomass sources, this systematic review highlighted the importance of microalgae to produce biodiesel [90], palm oil solid waste [91], *Delonix Regia* [92], cereal crop residues [93], and *Cannabis sativa* [94]. Microalgae biomass may become an important alternative, because it is more efficient in terms of carbon sequestration and has a higher level of carbohydrates. The palm oil waste can support 40% of the energy demand in Malaysia through thermochemical processes. *Delonix Regia* has a higher H/C ratio relative to pinewood sawdust and coal.

With regard to the processes and technologies, it is worth noting that the hydronic asphalt pavement approach [95] may reduce carbon dioxide emissions by 8–100%. Bioconversion with insect and ruminant host symbionts for recycling of lignocellulosic carbon [96]. Additionally, the pre-treatment to use cereal crop residues [93] and for pyrolysis processes [97] have also been concerns for researchers.

Extreme learning machines, deep learning models [98], and computational optimization approaches [99] are methodologies emphasized by the literature. The production of hydrogen has motivated the scientific community [100]. The supercritical water gasification of biomass seems to be the more profitable thermochemical system in producing hydrogen.

Finally, the concerns of petroleum export countries, such as Saudi Arabia [101] and Indonesia [102], for more environmentally friendly energy production and use are good news in achieving global goals for more renewable and sustainable sources of energy.

Figure 2 summarizes the main topics and sub-topics related to renewable and sustainable energy dimensions. It highlights the main potentialities for interdisciplinary approaches.

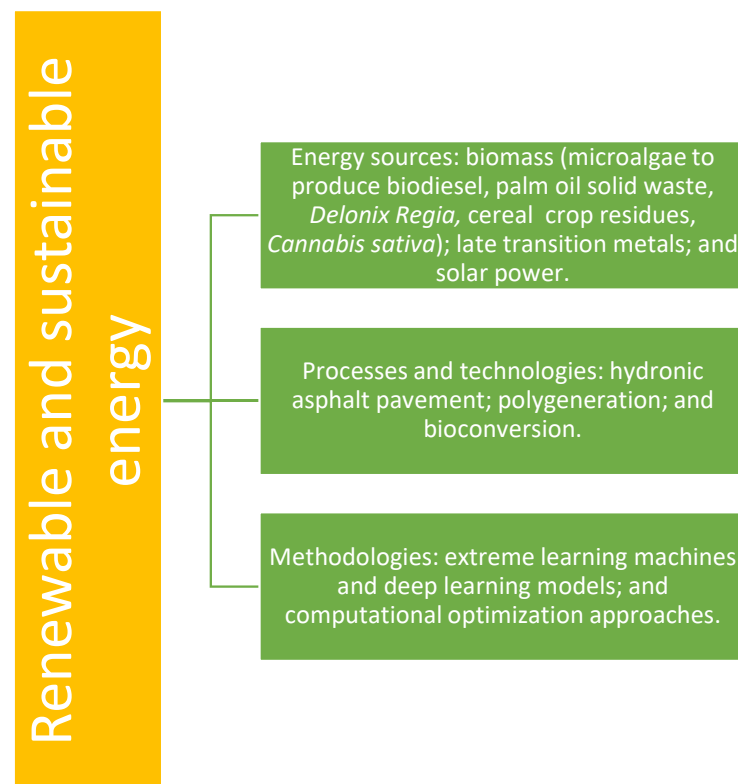


Figure 2. Topics and sub-topics related to renewable and sustainable dimensions.

Table 8. Main findings from systematic review.

Document	Objectives/Methodologies	Main Insights
[90]	Review about microalgae to produce biodiesel and butanol	Algae as a source of biofuels have several advantages, such as they grow faster; are more efficient at carbon sequestration; and are high in oil and carbohydrates.
[98]	Predict the highest wave energy period in Australia with extreme learning machines and deep learning models	In terms of forecasting, extreme learning machines produce better results than deep learning models.
[101]	Review the context about renewable and sustainable energy technologies in the Kingdom of Saudi Arabia, considering Saudi Vision 2030	Fossil fuel is presently used to produce about 80% of the energy needs in the Kingdom of Saudi Arabia. This country prepared a plan to increase renewable and sustainable energy technologies for power generation to achieve 50% by 2050.
[103]	Design and simulation of an electrical submersible pump system in geothermal conditions of Turkey	The electrical submersible pump design has an impact on the production rate.
[99]	Review about computational optimization methods in the fields of the renewable and sustainable energy	The main optimization approaches found in the literature were: mixed-integer and interval linear-programming; Lagrangian relaxation; quadratic programming; Nelder–Mead Simplex search; heuristic optimization approaches; and Pareto-optimization methods.
[104]	Review the late transition metal nanocomplexes as a source in renewable energy	The types of catalytic reactions and types of energy storage were highlighted.
[105]	Review about solar fuels and solar energy generation	Solar fuels may be an interesting alternative to produce sustainable energy and mitigate the dioxide carbon impacts.
[95]	Review about hydronic asphalt pavement approaches	Pavement solar collector approaches may reduce carbon dioxide emissions by 8–100%.
[106]	Review about polygeneration	Polygeneration is a sustainable approach that may be improved with the design of prototypes with intelligent control and monitoring structures.
[102]	Review about the sustainable energy context in Indonesia	The utilization of renewable energy in power generation in Indonesia is only around 3%.
[107]	Review about renewable and sustainable energy in Malaysia	Malaysia has conditions to increase power generation through biomass and biogas utilization, solar power generation, and Hydropower.
[100]	Overview about hydrogen production	Supercritical water gasification of biomass is the more economical and thermochemical system to produce hydrogen.
[91]	Review about hydrogen production from oil palm solid waste in Malaysia	Forty percent of the energy needs of Malaysia may be supplied by a thermochemical process of palm solid residues.

Table 8. Cont.

Document	Objectives/Methodologies	Main Insights
[108]	Review about utilization of biofuels in India	More research about these fields and adjusted strategies to increase the availability of biofuel feedstock were suggested, as were a revision of the related fiscal system and promotion of public-private partnerships.
[92]	<i>Delonix Regia</i> as a source of biomass	<i>Delonix Regia</i> has an H/C ratio of 1.56 which is higher than pinewood sawdust (1.43) and of coal (1–1.4).
[93]	Review about Indian cereal crop residues to produce biogas	Chemical pretreatment in cereal crop residues use for bioenergy generation by unmasking lignin.
[109]	Review about hollow heterostructures derived from metal-organic-framework for electrocatalysis	The use of hollow heterostructures as electrode materials for oxygen- and hydrogen-involved energy conversion strategies and rechargeable batteries were emphasized.
[110]	Review about biofuel production	The principal barriers of biofuel markets are related to total capital cost, feedstock cost, process yield, and fossil oil price.
[111]	Synthesis of WO _{3-x} /MoO _{3-x} heterojunction	CO performance is 40.2 μmol·g ⁻¹ ·h ⁻¹ , which is 9.5 times greater than that of the pristine MoO _{3-x} nanosheet.
[112]	Review about biofuel generation from triglycerides	Biomass availability and composition, conversion technologies, and characteristics of biofuel were highlighted.
[113]	Review about crop residues and weedy biomass for bio-ethanol generation	Pretreatment technologies, enzyme cocktails for saccharification, and fermentation strategies were discussed.
[114]	Discussion about microalgal biomass for biofuel generation	Thermochemical conversion of microalgal biomass has relevant advantages, namely due to its simplicity, shorter conversion time, and higher productivity.
[96]	Review about insect and ruminant host symbionts for recycling of lignocellulosic carbon	The xylophagous insects and herbivores animals are interesting sources for lignocellulosic biomass bioconversion.
[94]	Review about bioenergy generation from <i>Cannabis sativa</i> in Pakistan	This biomass feedstock will allow savings of U.S. \$200–400 million and will supply 4000 MW of energy.
[115]	Review about tendencies in Afghanistan for more renewable and sustainable energies sources	The power sector is one of the main constraints for development in Afghanistan where renewable and sustainable sources of energy may bring relevant opportunities.

Table 8. Cont.

Document	Objectives/Methodologies	Main Insights
[116]	Review about solar power technologies	The cost for concentrated solar power with storage is about 9.0 ¢/kWh and is expected to drop at ~5.0 ¢/kWh by 2030. Nonetheless, this technology needs further development and cost reductions.
[117]	Review about renewable energy investments	The methods used for energy planning are often from multicriteria decision analysis. LCA and CBA are more used for energy policy and management and environmental impact analysis.
[118]	Summary about interfacial chemical particularity of the Platinum-based catalysts for controlling alkaline hydrogen evolution reaction	The alkaline electrolyzed water hydrogen output approach is relevant to generate sustainable and alternative energy.
[97]	Review about lignocellulosic biomass pyrolysis	One of the main challenges are in the pretreatment approaches.

7. Discussion and Conclusions

The main objectives of this study were to highlight the main insights from the literature, about the topic of renewable and sustainable energy through a systematic review supported by a more objective approach based on bibliometric analysis. For this purpose, an alternative methodology was proposed, which has been referred to in this study as “Biblio4Research”. This approach is based on bibliographic data and bibliographic coupling links so as to identify the most relevant documents for the topic addressed. The Biblio4Research methodology was implemented for the topic of renewable and sustainable energy, and may be easily applied in other fields.

The bibliographic coupling links have been considered by the literature for assessments in several fields of science. They are the most appropriate to achieve the objectives proposed by this research because of the following advantages: they consider the documents as items; the number of documents is considered as nodes in a more stable context over time; more recent publications cite older ones giving an updated framework about the issues analyzed; and the citations shared by documents are indicators of their interrelationships covering the same subject.

The data analysis has shown that the most productive authors are the following: Hameiri, Z.; Hosseini, S.E.; Foley, A.; and Duic, N. The most productive affiliation countries are China, the United States, India, Malaysia, and the United Kingdom/England. Italy, Spain, Germany, the Netherlands, and France are the countries that possess more publications about renewable and sustainable energy from the European Union. The organizations with a greater number of documents are those from Australia, China, the United Kingdom, Croatia, and Malaysia. Renewable and Sustainable Energy Reviews, Energies, Renewable Energy, and Energy are the top sources. From these findings, it is worth mentioning that the network of countries and organizations does not follow the performance of some affiliated authors. Conversely, the European Union could promote more networks about these issues among their researchers. In addition, the documents about these topics are generally published in sources focused on the field of energy production.

The systematic reviews show that the documents analyzed are focused mainly on specific subjects (biomass, late transition metals, solar power, hydronic asphalt pavement, polygeneration, bioconversion, extreme learning machines and deep learning models, computational optimization approaches, hydrogen production, and biofuel generation). They are focused on specific countries, including Australia, Saudi Arabia, Turkey, Indonesia, Malaysia, India, Pakistan, and Afghanistan. It seems that the large number of documents available on the scientific platforms (Scopus and WoS) hampers the consideration for interdisciplinary topics. The approach that has been proposed may provide an interesting suggestion to overcoming these constraints. In any case, there is a field for some topics to become more interdisciplinary. In fact, the topics related to renewable and sustainable energy are transversal to several areas of science, where the environmental dimension is a concern. The use of biomass as a source of energy is an example where the interdisciplinary field may bring interesting insights; namely, to solve associated problems [119], to recover nutrients for a more circular economy [120], and to control the quality of solid fuels [121].

In terms of practical implications, it is recommended that researchers conduct more studies considering broader topics with findings that may favor more stakeholders. It could be important to create the right environment for increasing the network among researchers worldwide, particularly in the European Union. Concerning policy recommendations, it could be important that governments worldwide, including the European Union institutions, create policies and plans to increase research and the network for renewable and sustainable energy frameworks. For future research, the application of the approach in this study is recommended for even broader topics related to renewable and sustainable energy.

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