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Bibliometric Studies on Renewable Energy—Poland Compared to Other EU Countries

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Abstract: The necessity to use renewable energy sources (RES), especially in EU countries, is becoming more and more urgent in the face of environmental degradation. It is reflected not only in technological solutions for obtaining energy from renewable sources, but also in scientific research supporting RES technology development. There are an increasing number of papers on renewable energy. The aim of the study was to compare research areas concerning renewable energy in Poland and other EU countries by analyzing scientific works. A selected collection of publications available in the Scopus scientific databases was selected as the subject of the study. After cleaning the data and elaborating the thesaurus, the analysis of the article content was conducted applying text processing methods. Conceptual maps of keywords and keyword co-occurrences were created, which enables arranging and classifying knowledge from the subject area. Research hotspots and the directions of science development in the field of renewable energy were identified. The computer program VOSviewer was used in the investigation. Lorenz curves and Gini coefficients were used to identify quite a strong concentration of RES articles in leading journals on the publication market.

Keywords: renewable energy; knowledge mapping; research trends; visual bibliometric analysis; VOSviewer

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1. Introduction

Renewable energy sources (RES) are currently one of the fastest growing economic sectors in the world. Their importance is related to the necessity of ensuring the continuity of energy supply, which should remain cheap and safe for consumers facing increased demand and consumption of electricity. Regardless of this fact, renewable energy sources are taking on a new fundamental dimension due to a rapid climate change, which seems to be heading for a climate catastrophe. Awareness of the problem is widespread around the world, but few regions take substantive actions and implement effective solutions to protect the climate and the environment, so that the needs of the present and future generations can be met [1]. An exception is the European Union (EU), which has put renewable energy (RE) at the heart of its future energy system and its climate agreement, being number one in the development and deployment of low-carbon energy technologies [2]. The EU sets the legislative framework and directions for technological development in the renewable energy sector. The European Green Deal Action Plan [3] was launched to strengthen the EU's position as a global climate leader. It proposes the modernization of existing legislation introduce transformational changes needed in the economy, society, and industry in order to achieve climate neutrality by 2050. The European Commission has launched the "Fit for 55" package, a set of new climate rules to amend the Renewable Energy Directive [4], as a part of the European Green Deal. The goal of the package is to implement a plan so as to reach at least 55% net greenhouse gas emission reductions by 2030.

The development of the renewable energy sector is not possible without the support of the scientific world. Research on renewable energy has attracted the interest of a multitude of scientists from various fields and is reflected in scientific publications, the number of

which increases each year. The scientific investigation trends in the RE field are most often identified using bibliometric methods, with the analyses relating mainly to selected types of renewable energy sources or selected regions of the world. However, to the best of the authors' knowledge, comparative bibliometric analysis concerning RES in Poland and in the European Union has not been undertaken.

The objective of the study was to identify the most popular research areas and influential journals on RE in Europe, namely for Poland and other EU countries. The differences and similarities between Poland and European Union countries, regarding research topics towards renewable energy, were diagnosed using mathematical and statistical tools, as well as the visualization of the renewable energy knowledge domain. In both cases, the publication market was characterized and its quantitative assessment was carried out.

1.1. Literature Review

Nowadays, a large number of scientific papers examine the feasibility of introducing renewable energy sources in the context of energy conservation and energy security of a country. There are some articles which deal with the issue in terms of bibliometry. Table 1 presents a short literature review regarding the most cited papers in which bibliometric analyses of the scientific publications on renewable energy were performed. In the works, the following methods of analysis were utilized: quantitative-based science mapping technique, co-citation, cooperation network, co-words and journal overlay analysis, frequency analysis, research trend analysis, hierarchical cluster analysis, and techniques or measures developed by the authors. The studies differ in the scope as well as in the subject of the investigation.

Table 1. The summary of the literature review.

Authors (Year); Number of Citations	Period Region	Database Software	Literature Research Subject and Main Findings
Wuni et al. (2019); 85	1992–2018 The whole world	Database: Scopus Software: VOSviewer	Subject. Green building. Findings. In the world, 44% of countries are involved in green building research; US, UK, China, Canada, and Hong Kong play the most important role. Some areas still require further research, i.e., green building policies and rating tools, application of complexity theory and system dynamics, best practice framework for green buildings implementation, and assessment of green building financing initiatives [5].
Shi et al. (2021); 67	1992–2019, the whole world	Database: WoS Software: CiteSpace	Subject. Carbon footprint. Findings. The theme of carbon footprint research has changed from ecology and botany (before 2008) to international trade and household behaviors (after 2008). The research has shown a significant trend of diversification and interdisciplinary development since 2008 [6].
He et al. (2019); 41	1990–2013, US	Database: WoS Software: CiteSpace	Subject. Agricultural waste management, agricultural greenhouse gas emission reduction. Findings. US has a leading position in research regarding institutions and scholars. Major topics in the field are as follows: the low-carbon and energy utilization of agricultural waste, the influence of agricultural waste emissions, the material flow and energy flow of agricultural waste, the prevention and control of agricultural waste pollution [7].

Table 1. *Cont.*

Authors (Year); Number of Citations	Period Region	Database Software	Literature Research Subject and Main Findings
Andreo-Martínez et al. (2020); 33	2001–2019, the whole world	Database: WoS Software: MS Excel, BibExcel, VOSviewer	Subject. Biodiesel production. Findings. The first rank in the field in terms of number of publications are: country—China, institution—Sila Science (Turkey), journal—Fuel. Regarding the author keywords, the transitions from the first to third generation biodiesel * as well as reaction optimization were indicated [8]. * *The article content indicates that the authors probably used the word biodiesel instead of biofuel incorrectly*.
Rosokhata et al. (2021); 24	1974–2020, the whole world	Database: WoS, Scopus Software: VOSviewer	Subject. Renewable energy. Findings. There is a lack of studies dedicated to less developed economies. The most popular research areas are: energy fuels, engineering, science technology, environmental sciences, ecology, and business economics. The majority of papers are published by scientists from US, China, and India. None of the G7 countries, except for US, is actively involved in the scientific development of renewable energy * [9]. * *The final conclusion is not consistent with the results presented in the article*.
Chanchetti (2020); 23	2000–2015, China, EU, US, Japan	Database: WoS Software: VantagePoint	Subject. Hydrogen storage materials. Findings. The main publishing countries are: China, EU countries, US, and Japan. There is a division between countries where the number of publications remained stable or slightly decreased after 2010 (European Union countries, USA and Japan), and countries where it grew (China and South Korea) [10].
Bortoluzzi et al. (2021); 14	1998–2019, the whole world	Database: WoS Software: VoSviewer, RStudio, NVivo QSR, SPSS	Subject. Renewable energy technology, sustainable development, multicriteria models. Findings. Renewable energy issues that are widely studied include: hydraulics, photovoltaics, biomass, wind, thermosolar, geothermal, hydrogen, waves, tides and waste. In recent years, there has been a significant growth in the use of Multicriteria Decision-Making/-Aiding methods for the development of renewable energy policies [11].
Ziabina et al. (2020); 12	1999–2019, UE	Database: Scopus. Sotware: MS Excel, VOSviewer	Subject. Renewable energy sources and energy conservation in the field of economics and social sciences. Findings. Six clusters that combine 131 terms were identified and labelled as follows: energy, energy conservation, sustainable development, renewable energy resources, and costs. The number of publications are expected to increase as a new cycle in developing a neutral carbon economy is about to begin [12].

Table 1. *Cont.*

Authors (Year); Number of Citations	Period Region	Database Software	Literature Research Subject and Main Findings
Reyes-Belmonte (2021); 12	1990–2020, the whole world	Database: WOS Software: VOSviewer	Subject. Solar energy. Findings: China, US, and India are the most productive countries in terms of solar energy research publications. The list of ten most productive countries accounted for 83% of total publications between 2019 and 2020. Main scientific thematic areas are divided into the following clusters: the first—devoted to chemical processes and materials science involving solar energy, the second—devoted to green energy generation technologies and simulation, and the third—devoted to heat and energy storage [13].

1.2. Research Framework

The bibliometric research undertaken in the study consists of several steps. They are organized as follows:

- Step 1. Downloading and consolidation of the Scopus bibliographic data.
- Step 2. Data preprocessing; data cleaning and development of the thesaurus.
- Step 3. Quantitative analysis; summary statistics, Lorenz curves, and Gini coefficients.
- Step 4. Identification of scientific research topics related to renewable energy in Poland and in other EU countries.

2. Data and Methodology

2.1. Collection of Scopus Bibliographic Data

Bibliographic data for the study were taken from the Scopus database, which is considered one of the largest repositories of this kind in the world. Scopus [14] is the Elsevier's abstract and citation database on scientific publications that cover a variety of subject fields, such as life sciences, social sciences, engineering sciences, physical sciences, and health sciences. Each record in the Scopus bibliographic resources is a publication description characterized by a set of bibliographic attributes, such as [15] authors' names, authors' affiliation, title, abstract, keywords defined by authors, name of a journal, conference, or publishing house. Apart from the above attributes, 80% of the publications in Scopus have an additional attribute that contains indexed keywords. These words are defined by experts and are based on specially developed thesauri owned or leased by Elsevier [16]. In the data acquisition process, selected attributes of the Scopus database were used to define the record search criterion.

The access to the Scopus data for the study was possible through the registered university network. The criterion in the search query was formulated for a selected topic—renewable energy sources in European Union (including Poland). The criteria for searching the bibliographic database are presented in Table 2. A logical conjunction operator connected them all.

When defining keywords for the search string, the following terms related to renewable energy were taken into account [17]: sun, wind, water, biomass, biogas, bioliquids, and biofuels, as well as heat sources from the ground (geothermal energy), air (aerothermal energy), and water (hydrothermal energy). When defining the final set of keywords, synonyms were also included so as to comprise vocabulary diversity. The analysis is focused on the following types of scientific publications: article, article review, and conference paper. The bibliographic resources were collected in such a way that the publications cover full years of the analyzed period. Thus, the year 2021 was the last year, and the first one was 2005, which is due to the fact that Poland became a member of UE in May 2004, although the first European Union directive on renewable energy appeared in 2001 [15,18].

The research took into account the languages of the countries that were EU members in 2005–2021, i.e., 25 languages. The data were acquired and downloaded on 12 November, 2021; the total number of records was 14,975.

Table 2. Search options for bibliographic records acquisition from the Scopus website.

Search Option [1]	Search Option Value [2]
String search for publication title, author keywords, indexed keywords, and abstract	"renewable energy" OR "green energy" OR "clean energy" OR "clear energy" OR "sustainable energy" OR "inexhaustible energy source" OR "solar energy" OR "photovoltaic" OR "solar power" OR "solar thermal" OR "wind energy" OR "shore wind" OR "water energy" OR "hydropower" OR "geothermal energy" OR "tide energy" OR "wave energy" OR "ocean energy" OR "biomass energy" OR "biogas" OR "biofuel" OR "bioenergy" OR "bioliquid" OR "aerothermal energy" OR ("municipal" AND "waste" AND "energy" AND "source"
String search for publication title, keywords, and abstract	"European Union" OR "Europe" OR "EU"
Document type	Article OR Review OR Conference paper
Language	"English" OR "German" OR "Polish" OR "French" OR "Czech" OR "Spanish" OR "Italian" OR "Finnish" OR "Croatian" OR "Lithuanian" OR "Portuguese" OR "Hungarian" OR "Slovak" OR "Slovenian" OR "Romanian" OR "Bulgarian" OR "Maltese" OR "Turkish" OR "Modern Greek" OR "Swedish" OR "Dutch" OR "Luxembourgish" OR "Estonian" OR "Danish" OR "Latvian"
Timespan	2005–2021

[1] plurals were also included in search string. [2] *shore wind* covers the terms: *on-shore wind*, *off-shore wind*.

2.2. Data Preprocessing/Preparation

The data obtained from the Scopus repository required cleaning [19]. In this aspect, the data transformation covered the following actions:

- incorrect records with truncated line endings were removed,
- entries [*No abstract available*] and [*No author name available*] were replaced with the *Null* value,
- square brackets and the text between them were deleted from the title field (these usually were the titles in authors' national languages),
- typographic (curly) apostrophe characters (' or ') were replaced by their straight equivalent (''),
- inverted comma characters ("", "", and"") were deleted from the title field,
- both the dash character (–) and the hyphen character (-) appeared in article titles. In order to unify the titles in this aspect, a dash appearing in a date range was replaced by a hyphen; for other cases a dash was replaced by a hyphen including spaces around it,
- the last character of the title was examined; dots and special characters were deleted where appropriate,
- all duplicated records were removed.

After data cleaning, as many as 547 records were excluded from the data set, which means that bibliographic information on 14,428 scientific publications on renewable energy constitutes the basis for further analysis.

The search string referred to titles, keyword lists, and abstracts, covering a wide range of topics. Even if some important words did not appear in the title or keywords of a publication, they should appear in its abstract. Thus, a fairly extensive set of unique

terms, keywords, used in scientific works related to the topic under consideration could be obtained. These were isolated by using the VOSviewer computer program. A thesaurus was developed to reduce redundant terms and to standardize them [20]. Online dictionaries and other materials presenting necessary definitions were utilized in this task. Using a thesaurus improves the quality of bibliometric and scientometric research.

The proposed RE thesaurus is a digital list of keywords in groups of synonyms and related concepts. The thesaurus contains the two original columns obtained from the VOSviewer program: *Keyword* and *Occurrences*. The third column, called *Synonym*, was specially prepared to cover the respective group of the *Keyword* phrases of the same or similar meaning, and it is the authors' proposition. This is a subjective proposition. Table 3 contains an example of the thesaurus concept. For the given example, the *electrical energy* phrase is the synonym term which represents six keyword values, also including the phrase itself, delivered by VOSviewer (*electric energies*, *electric energy*, . . . , and *electrical power*). Hence, the synonym frequency is equal to 6. The total occurrence of the synonym, being the sum of occurrences of its keywords, is equal to 125.

Table 3. The example contents of the RE thesaurus.

Keyword	Occurrences	Synonym
electric energies	26	electrical energy
electric energy	3	electrical energy
electric power	20	electrical energy
electrical energies	4	electrical energy
electrical energy	38	electrical energy
electrical power	34	electrical energy

Selected statistics calculated on the basis of the bibliographic records downloaded from Scopus are presented in Table 4. The content of the table is an approximate summary, because on the one hand it is the result of the subjective lexical vision of the authors, and on the other hand it reflects a snapshot-like bibliographic resource, the content of which may change over time (the download operation was performed in November 2021. There were 52,639 unique keywords identified by the VOSviewer program in the title, abstract, and both keyword lists (authors' and indexed) of the 14,428 bibliography items. After the thesaurus implementation, as many as 48,124 unique synonyms were obtained. Among them, there were 2425 *Synonym* phrases to which more than one *Keyword* field value was matched. In the thematic analysis of bibliographic resources, carried out further on, only those *Synonym* field values with more than the assumed number of the total occurrences were considered. They, in fact, create a reduced set of original keywords; therefore, the reference to them as keywords is kept further on. Among 14,428 publications, there were 630 papers that contained terms related to Poland (regarding the location according to political geography) in the title, abstract or both keyword lists (authors' and indexed), and 13,798 papers without such terms. These two sets of bibliographic resources constituted the datasets referred to as *Poland* and *other EU countries* later in the study.

Table 4. Selected statistics on RE scientific articles from the Scopus database.

Statistic Description	Totals
Number of records acquired from the Scopus bibliographic resources	14,428
Number of *Poland* documents; these are publications with the Poland related term in the Scopus database fields: *Title*, *Abstract*, *Author Keywords*, and *Indexed Keywords*	630
Number of *other EU countries* documents; these are publications without the Poland related term in the Scopus database fields: *Title*, *Abstract*, *Author Keywords*, and *Indexed Keywords*	13,798

Table 4. *Cont.*

Statistic Description	Totals
Number of distinct values in the *Keyword* field	52,639
Number of distinct values in the *Synonym* field	48,124
Number of distinct values in the *Synonym* field with the number of frequency greater than1 (number of synonyms matched to more than one keyword phrase	2425
Number of distinct values in the *Synonym* field for which the total *Occurrence* is greater than 10	2293
Number of distinct values in the *Synonym* field for which the total *Occurrence* is greater than 50	469

2.3. Methods

Two approaches were applied in the research, independently for *Poland*-related and *other EU countries*-related publications. The first one is related to the analysis of the publications concentration. The other, thematic analysis, is focused on the content of the articles; the conceptual maps of keywords and the keyword co-occurrences were created.

The most common statistical index employed for measuring the concentration degree of any random variable probability distribution is the Gini coefficient. In the literature, it is a well-known indicator of inequality in the distribution of income or wealth in a population [21]. The coefficient is calculated according to the following formula derived from a Lorenz curve $L(p)$:

$$G = 0.5 - \int_0^1 L(p)dp \quad (1)$$

In Formula (1) the Lorenz curve is defined as a continuous, piecewise linear function with vertices in the points:

$$p_i = \frac{\sum_{j=1}^{i} n_j}{n} \quad (2)$$

where:

n—total number of journals in the RE bibliographic data obtained from Scopus,
n_j—number of journals in j-th class,
x_j—number of articles published by journals of j-th class.

Traditionally, it is assumed that the Gini coefficient smaller than 0.25 indicates uniform distribution of the examined statistical feature, 0.25–0.5 is a medium degree of the feature concentration, and above 0.5 corresponds to severe inequality in the distribution [21].

The thematic analysis was carried out using the VOSviewer 1.6.7 networking software that enables scientific landscape mapping [22,23]. The map nodes (items) represent selected bibliographic attributes, such as scientific journals, researchers, research organizations, or keywords. Between any pair of items there can be a link illustrating a connection or a relation between them. Only items of one type are included in a map. The program can work with a file prepared by a user—a thesaurus, enabling the unification of keywords. Creating the thesaurus is necessary when analyzing terms (keywords, keyword phrases). This results in fewer nodes and fewer connections, and thus in a network that is clearer and easier to interpret.

In the study, a keyword co-occurrence network was investigated. The network focuses on the identification of knowledge structure of a certain scientific area by examining the association between keywords in the literature [24]. Each keyword is treated as a node (item) and each co-occurrence of a pair of words as a link between those two keywords. The link between two nodes i and j is characterized by the link strength LS_{ij} denoting the number of publications in which the corresponding keywords occurred together. In the

map, the thicker the link is, the greater the number of documents containing both keywords is. The map node i is characterized by the following statistics [22,23]:

- occurrence w_i (or weight), which is defined as the number of documents containing the corresponding keyword, thus indicating its relevance,
- links c_i, which denotes the total number of connections of the node, that is:

$$c_i = \sum_{j \neq i} c_{ij} \tag{3}$$

where c_{ij} takes a value of 1 if there is a link between node i and node j, otherwise it is equal to 0,

- total link strength TLS_i, which is the sum of the link strengths for all links (connections outgoing from the node):

$$TLS_i = \sum_{j \neq i} LS_{ij} \tag{4}$$

The larger the node is, the more often the keyword represented by that node in the map appears in the analyzed bibliographic resource.

The network generated by the VOSviewer program is illustrated in two-dimensional space. The authors of the software proposed a unified approach to mapping as well as a weighted and parameterized variant of modularity-based clustering [23]. The VOS mapping technique is related to the technique of multidimensional scaling. The modularity-based clustering algorithm of VOSviewer detects communities (clusters in a network), decomposing all keywords into meaningful modules. A cluster is a set of closely related nodes. Each node in the network is assigned to exactly one cluster.

In the study, based on the key terms found in the title, abstract, authors' keywords and indexed keywords for RE Scopus publications, the developed thesaurus related to RE topics, and after excluding irrelevant keywords, keywords ready for the analysis were obtained. These keywords and their co-occurrence were used to create a map and clusters within it, whereby research trends in renewable energy in *Poland* and *other EU countries* were investigated.

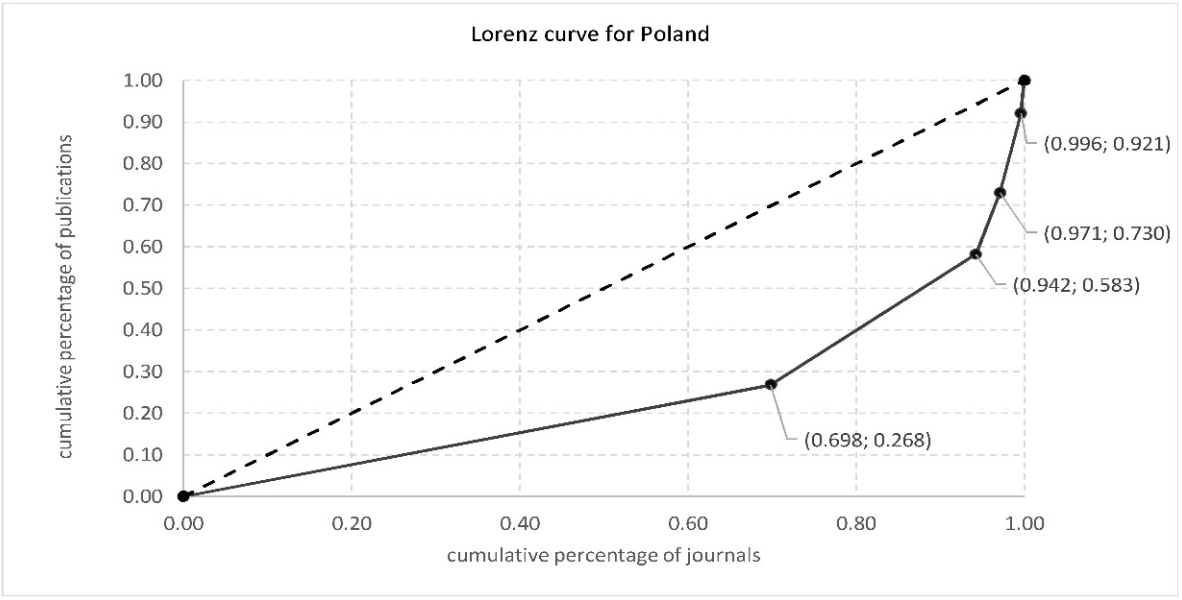
3. Results and Discussion

3.1. The Concentration of RE Publications

The classification shown in Table 5 was developed to measure the degree of inequality in the distribution of the number of publications across the journals in which they appeared. For each subset (*Poland* and *other EU countries*), class intervals were defined according to the number of published articles and on this basis the number of journals and articles in each interval was counted. For example, the first row informs that there were 169 and 1784 journals that in 2005–2021 published only one article on renewable energy in *Poland* and *other EU countries* respectively. According to the information in the second row, with relation to *Poland*, there were 59 journals that published more than 1 article, but less than 10 articles in the analyzed period, 198 articles in total. In relation to *other EU countries*, 1233 journals published between 2 and 17 articles, a total of 5299 articles. Based on the data contained in Table 5, the Lorenz curves presented in Figure 1 were created. The most popular journals regarding the publications on removable energy indentified in both *Poland* and *other EU countries* data sets are presented in Table 6.

Table 5. Journal and article classification for the concentration analysis.

Poland			Other EU Countries		
Number of Articles in Journals	**Number of Journals**	**Number of Articles**	**Number of Articles in Journals**	**Number of Journals**	**Number of Articles**
1	169	169	1	1784	1784
2–9	59	198	2–17	1233	5299
10–17	7	93	18–177	101	3781
18–26	6	120	178–337	6	1469
27–50	1	50	338–497	2	809
			498–656	1	656
Total	**242**	**630**	**Total**	**3127**	**13,798**



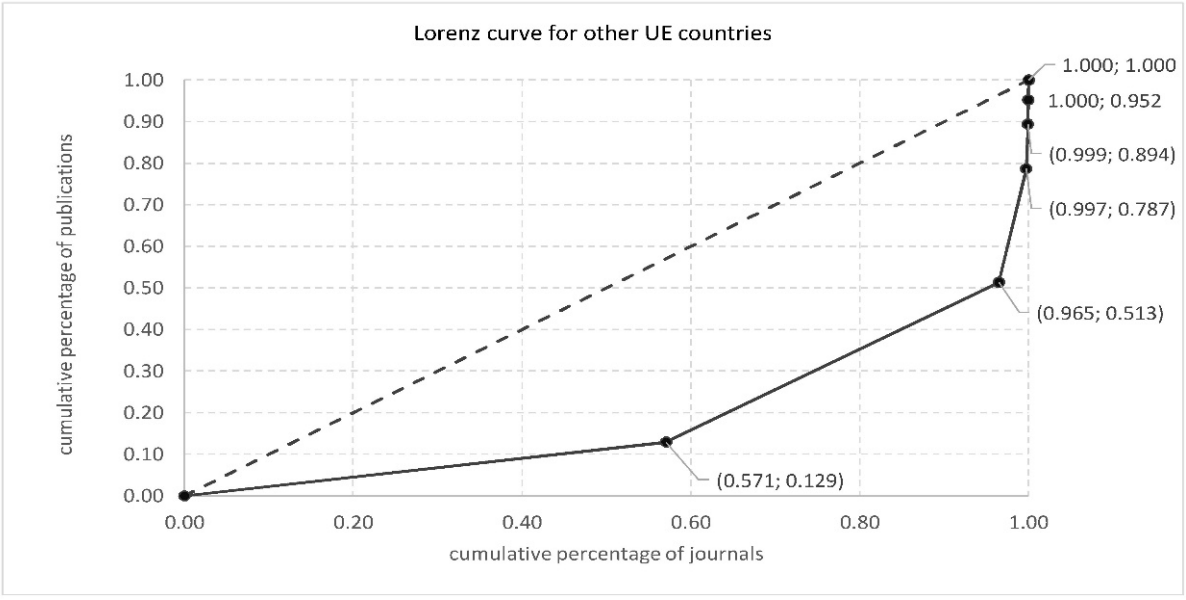


Figure 1. Lorenz curves—the illustration of the concentration degree of RE publications (Scopus, 2005–2021).

For the *Poland* set of bibliographic resources, the Gini coefficient equal to 0.518 proves a highly concentrated distribution of publications in relation to journals. Of the journals, 69.8% published only 1 article on renewable energy topics during the analyzed period (2005–2021); these journals published a total of 26.8% of all articles. Of all articles, 58.3% were in journals that on average published no more than 1 article in a two-year period on RE (rows: first and second in the table). These journals represent 94.2% of all the journals in the *Poland* set. Of the journals, 99.6% did not publish more than 2 articles per year (all rows but the last one in the table). Of all articles, 92.1% under consideration in the study were published in these journals. Only one journal, *Energies*, published on average 3 articles on renewable energy a year; 7.9% of all the articles were published in this journal, totaling 50 articles during the analyzed period, with the first, and only, publication appearing in 2017. In 2020, there were 13 articles, and in 2021, there were 36.

For the *other EU countries* set of bibliographic resources, the Gini coefficient equal to 0.626 proves a highly concentrated distribution of publications in relation to journals, which is higher than in the *Poland* case. In the studied period, 57.1% of the journals published only one article on RE related topics, representing 12.9% of all the articles. On average, no more than one article per year was published by 96.5% of the journals under consideration (rows: first and second in the table). The number of articles published by them represents 51.3% of all the articles. Merely 110 journals (3.5%) publish more than 10 articles on renewable energy a year (three last rows in the table). *Energy Policy* is the journal with the largest number of publications related to renewable energy. This journal published 4.8% of all such articles; 656 in total during the analyzed period, with the first publications appearing in 2005 (there were 15 articles). Most publications (69) appeared in 2008 and in 2021, and there were 28 articles. The second journal by popularity was *Renewable and Sustainable Energy Reviews*. The journal published two articles in 2005, most of them in 2017—54 publications, and in 2021—36 publications.

Table 6. Statistics of publications in the top five journals in 2005–2021 (Scopus, 2005–2021).

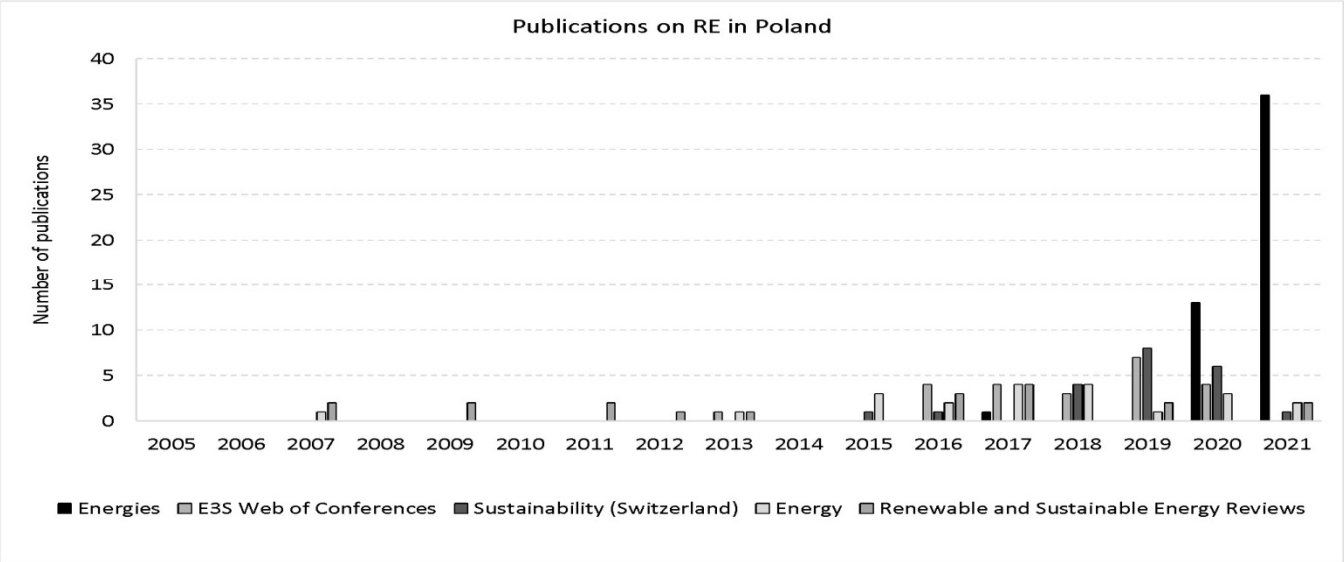
Poland			Other EU Countries		
Journals	**Number of Publications**	**Percentage of Total Publications**	**Journals**	**Number of Publications**	**Percentage of Total Publications**
Energies	50	7.9%	Energy Policy	656	4.8%
E3S Web of Conferences	23	3.7%	Renewable and Sustainable Energy Reviews	443	3.2%
Sustainability (Switzerland)	21	3.3%	Renewable Energy	366	2.7%
Energy	21	3.3%	Energies	318	2.3%
Renewable and Sustainable Energy Reviews	19	3.0%	Energy	278	2.0%

Figure 2 shows the dynamics of changes in the popularity of journals, listed in Table 6 by the number of RE publications.

In 2005–2015, in each year, the total number of publications related to *Poland* in all the journals in Table 6 did not exceed four. An increase of researchers' interest in RE topics has been observed since 2015. In terms of the number of published articles, *Energies* stands out significantly from the five journals. It is an open access peer-reviewed journal, distinguished by its frequent editions (biweekly), which makes it popular and attractive on the publication market.

In case of publications related to *other EU countries*, the *Energy Policy* journal played a leading role between 2005 and 2013, while the popularity of *Energies* has clearly increased

since 2012, dominating the market with publications on renewable energy in the last three years of the studied time period. An astonishing drop in the publication activity in 2010 was observed in all the indicated journals. During the analyzed period, the annual number of publications in the *Renewable Energy* journal remained relatively constant—22 articles per year, with a coefficient of variation equal to 29%, while for the other journals the coefficient value ranges from 44% to 159%.



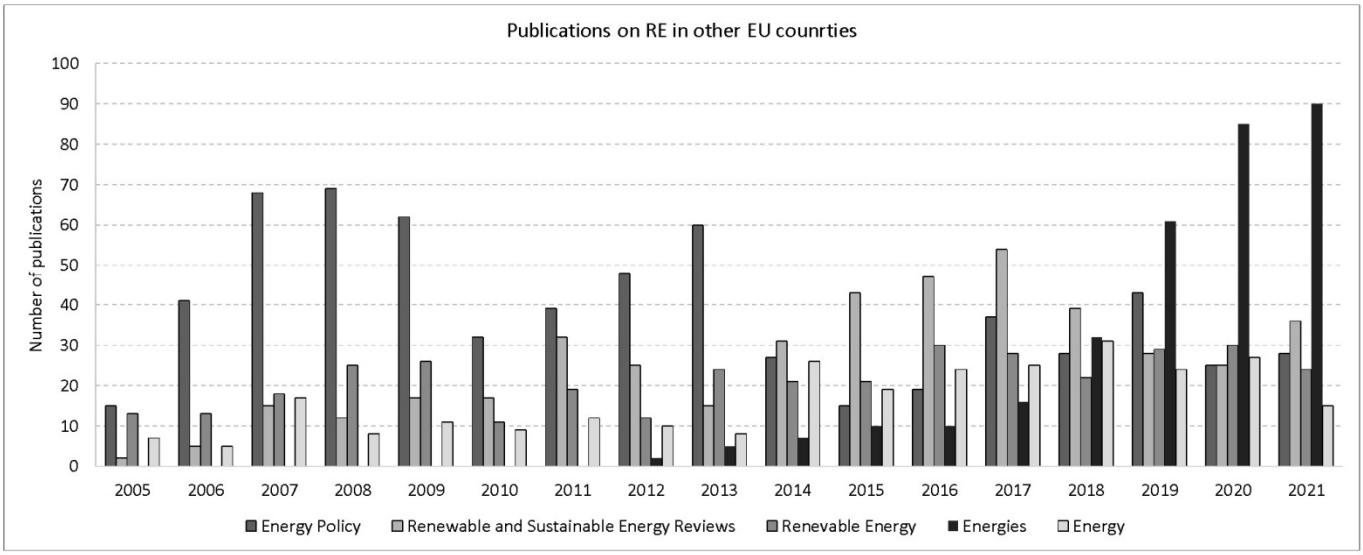


Figure 2. Publications on RE in the top five journals in 2005–2021 (Scopus, 2005–2021).

There are 5 leading journals on the market. Three out of them, i.e., *Energies*, *Renewable and Sustainable Energy Reviews*, and *Energy*, are identical for publications concerning *Poland* and *other EU countries*. Articles published in them represent about 14.1% and 7.5% of all the publications respectively. The results show that renewable energy researchers submit their publications mainly to the above mentioned journals. The authors collected some information on the journals [25–29], presented in Table 7, so as to explain this phenomenon. There are only two journal publishers in the table: Elsevier and Multidisciplinary Digital Publishing Institute (MDPI), which offer an attractive average number of weeks from submission to publication, 12 and 11 weeks respectively [27,30,31]. The short waiting time for the publication of research results is crucial for scientific development, enabling

rapid exchange of information. It can be assumed that the *Energies* journal has been a leader in recent years due to the high number of issues per year (24), the relatively high citation index (H index = 111), the relatively low cost of publication (2100 EUR), and the open access publishing mode, which provides the general public with free access to scientific information.

Table 7. Characteristics of journals.

Journals	Issues Per Year	H Index	Article Publishing Charges (EUR)	Business Model	Publisher
Energy Policy	12	234	2840	Hybrid	Elsevier
Renewable and Sustainable Energy Reviews	21	337	2100	Open access	Elsevier
Renewable energy	15	210	3060	Hybrid	Elsevier
Energies	24	111	2100	Open access	MDPI
Energy	11	212	3250	Hybrid	Elsevier
Sustainability (Switzerland)	24	109	1910	Open access	MDPI
E3S Web of Conferences	na	28	na	na	Web of Conferences (EDP Sciences)

It should be noted that the presented results are consistent with the ones obtained by Rosokhata et al. [9]. Among the five most cited journals on renewable energy (on the basis of data from Web of Science, worldwide), i.e., *Renewable and Sustainable Energy Reviews*, *Energy Policy*, *Renewable Energy*, *Energy*, and *Applied Energy*, four of them were identified in the study as the most attractive.

3.2. Thematic Analysis—Knowledge Maps of Bibliographic Data

At the stage of preprocessing data, some keywords were excluded from the analysis due to their inadequacy, i.e., single letters, unclear abbreviations, single word fragments, locations according to political geography (for example, names of the countries), and the phrases *article* and *literature review*. For both analyzed sets of the publications, keyword phrases were selected to create a lexical map as follows:

- for 630 publications concerning *Poland*, the minimum number of occurrence was fixed to 10, which resulted in 88 phrases out of 3723,
- for 13,798 publications concerning *other EU countries*, the minimum number of occurrence was fixed to 50, which resulted in 411 phrases out of 46,755.

Figure 3 shows the knowledge maps, along with identified clusters within the maps, for the most common keywords on the RE related research in a lexical aspect. All the map nodes (bubbles) have links, but 200 most important connections are presented for map clarity.

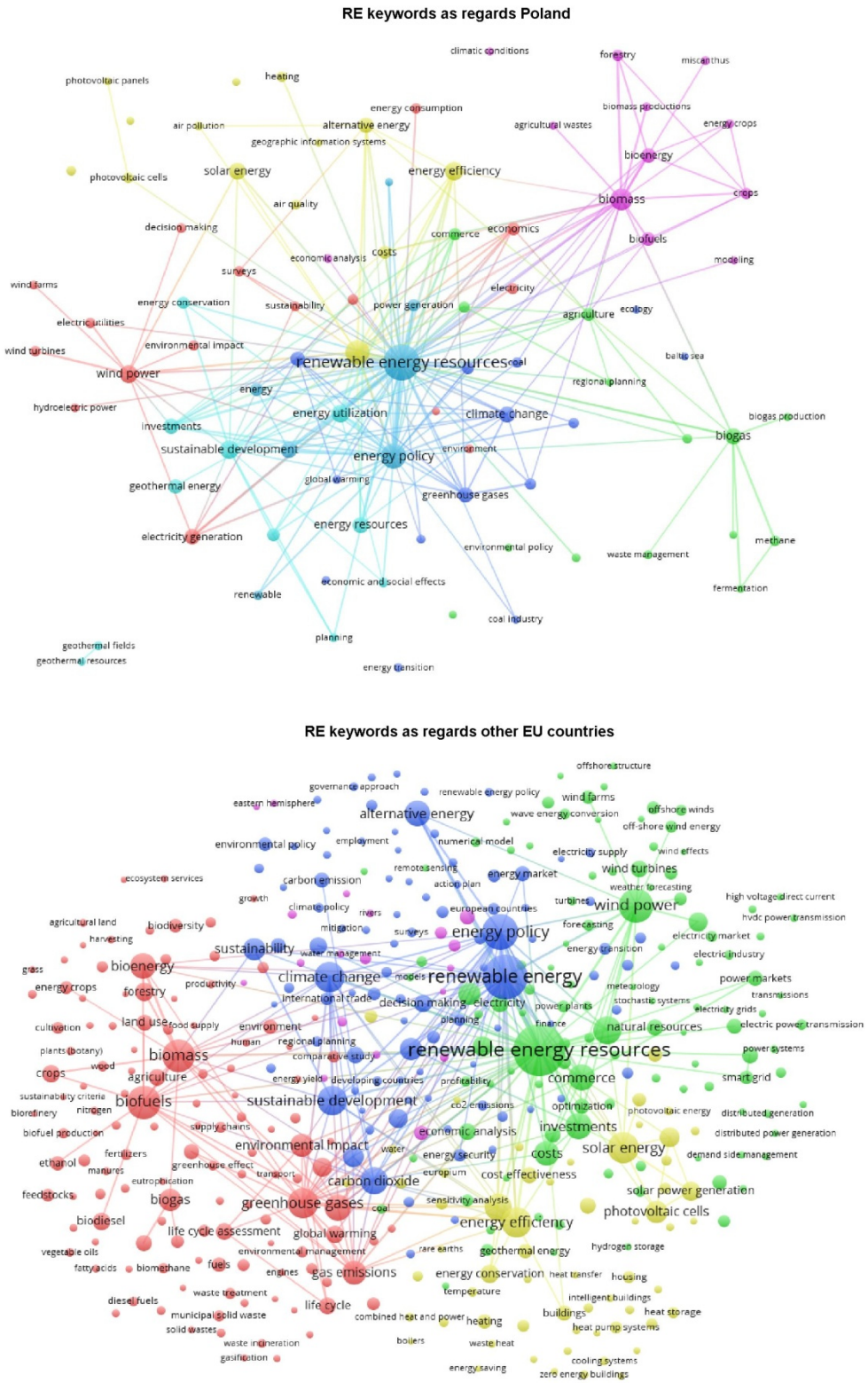


Figure 3. Keywords and keywords co-occurrence mapping for publications on RE research.

VOSviewer classified publications from recent 17 years into seven and five clusters for *Poland* and *other EU countries* respectively, reflecting groups of emerging research topics in renewable energy research. Table 8 shows five most co-occurring keywords. The number of all phrases in a given cluster that meet the map construction criteria (minimum number of occurrences) is given in brackets, next to the cluster identifier. For each keyword phrase, the numbers that speak for its relevance are as follows: *occurrence-links-total link strength*.

The remaining keywords were also taken into account while profiling the cluster content. There are seven clusters for *Poland* and five for *other EU countries*. The content of clusters and the knowledge map images allow deriving the patterns on renewable energy research in 2005–2021.

Table 8. The most common keywords from RE research (Scopus, 2005–2021).

				Poland			
	ClusterPL-1 (16)	**ClusterPL-2 (14)**	**ClusterPL-3 (14)**	**ClusterPL-4 (14)**	**ClusterPL-5 (12)**	**ClusterPL-6 (11)**	**ClusterPL-7 (7)**
Rank	**Red**	**Green**	**Blue**	**Yellow**	**Pink**	**Turquoise**	**Light Brown**
1	wind power 46-55-191	biogas 40-57-167	climate change 40-65-197	renewable energy 89-79-388	biomass 71-68-307	sustainable development 53-67-233	renewable energy resources 195-85-769
2	electricity generation 35-58-175	agriculture 26-59-133	greenhouse gases 34-64-191	energy efficiency 53-64-197	bioenergy 31-50-139	energy utilizatio 47-70-253	energy policy 91-80-460
3	economics 27-55-158	commerce 23-54-124	carbon dioxide 31-63-168	solar energy 42-55-151	biofuels 30-52-110	energy resources 39-58-152	natural resources 39-66-215
4	electricity 20-42-75	rural areas 20-51-103	fossil fuels 23-57-119	alternative energy 36-57-149	forestry 20-37-97	investments 36-63-189	energy 26-57-123
5	energy consumption 18-32-57	methane 17-25-53	gas emissions 20-54-119	costs 25-57-111	crops 19-34-86	geothermal energy 31-43-73	power generation 22-55-125
				Other EU countries			
Rank	**ClusterEU-1 (126)**	**ClusterEU-2 (112)**	**ClusterEU-3 (94)**	**ClusterEU-4 (60)**	**ClusterEU-5 (19)**		
	Red	**Green**	**Blue**	**Yellow**	**Pink**		
1	biofuels 1183-335-6468	renewable energy resources 2835-410-16,660	renewable energy 2125-409-11,642	solar energy 1026-370-5175	hydroelectric power 250-255-1313		
2	biomass 1150-383-7422	wind power 1234-370-6456	energy policy 1354-400-9195	energy efficiency 973-388-6462	laws and legislation 229-302-1504		
3	greenhouse gases 989-401-8445	electricity generation 819-393-5403	climate change 1001-404-6697	energy utilization 773-384-5606	hydropower 156-214-812		
4	fossil fuels 726-397-5860	investments 756-394-5397	sustainable development 911-395-6136	photovoltaic cells 541-294-2854	hydroelectric power plants 155-196-698		
5	bioenergy 695-320-4445	commerce 743-380-5090	carbon dioxide 805-391-6318	photovoltaics 438-290-2331	risk assessment 149-269-883		

In the case of research relating to *Poland*, *ClusterPL*-1 (red) is devoted to wind power and electricity generation from wind. It is the largest cluster, which, to some extent, indicates the fact that onshore wind farms have the largest share in the production of electricity from renewable sources in *Poland* [32]. The counterpart of this cluster is *ClusterEU*-2 (green) in the case of studies relating to other EU countries. Cost issues appear in both clusters (*Poland*: *economics*, *other EU countries*: *investments*, *costs*, *economics analysis*, *costs benefit analysis*, *costs reduction*), but this topic is much more visible in *ClusterEU*-2. According to *ClusterEU*-2, there are quite a number of scientific investigations on offshore wind energy in Europe.

The counterpart of *ClusterPL*-2 (green) and *ClusterPL*-5 (pink) regarding *Poland* is *ClusterEU*-1 (red), the most numerous, regarding *other EU countries*. The profile of these clusters indicates that research interests are focused on bio-energy (appearing in both *Poland* and *other EU countries*: *biogas*, *biomass*, *bioenergy*, *biofuels*, *crops*, *agriculture*).

Both *ClusterPL*-3 (blue) and *ClusterEU*-3 (blue) refer to the environmental protection issues in the context of climate change (1st position in *ClusterPL*-3 and 3rd position in *ClusterEU*-3) and greenhouse gas emissions (*Poland*: *greenhouse gases*, *carbon dioxide*, *gas emissions*; *other EU countries*: *carbon dioxide*, *emission control*, *carbon emission*).

ClusterPL-4 (green) and *ClusterEU*-4 (green) present a profile of solar energy research in general (3rd position in *ClusterPL*-4 and 1st position in *ClusterEU*-4), in this context mainly photovoltaic energy (key phrases common for both clusters: *photovoltaic cells*, *photovoltaics*, *photovoltaic system*, *photovoltaic panels*; additionally in *ClusterEU*-4: *photovoltaic effects*, *photovoltaic energy*). There is also another common topic—the one related to heat energy (*heating* in *ClusterPL*-4 and *heating*, *heat pumps*, *geothermal energy*, *thermal energy* in *ClusterEU*-4).

ClusterPL-6 (turquoise) is heterogeneous. It contains keywords from different areas connected with solar energy, which do not indicate a clearly defined predominant topic.

ClusterPL-7 (light brown) can be seen as concerning energy transition. *Renewable energy resources* (195 occurrences) is the most important key phrase not only in the cluster, but also in the entire *Poland* data set. The phrase is also the most important one (2835 occurrences) in the *other EU countries* data set, but it belongs to *ClusterEU*-2.

ClusterEU-5 is devoted to hydropower. The number of scientific studies focusing on the topic is the lowest. It could result from the fact that in order to produce energy in hydroelectric plants, differences in elevation and significant rainfall are necessary, and few countries in Europe meet these requirements. Additionally, in relation to *Poland*, renewable energy from water sources is a less popular topic; with the assumed criteria for the map creation, such a cluster was not identified.

The knowledge maps for the most common keywords on the RE-related research in temporal aspect are presented in Figure 4. The temporal network illustrates the dynamics of the research development. This is the same map as in Figure 3, but its coloring indicates the average publication year (*APY*) of the documents in which a particular keyword or term occurs.

The earliest publications on RE in *Poland* referred to obtaining energy from biomass, which is indicated by the keywords: *energy corps* (*APY* = 2013), *bioenergy* (2014), *biomass* (2015), *forestry* (2015), *miscanthus* (2014), and *agricultural waste* (2015). The period 2016–2017 is the timespan in which the development of issues related to energy policy in the context of environmental protection can be noticed, as shown by, for example, *ecology* (2016), *renewable energy resources* (2017), *energy policy* (2017), *energy efficiency* (2017), *energy utilization* (2017), and *sustainable development* (2017). Since 2018, terms related to various renewable energy technologies (presumably increasingly cost-effective) have appeared in the keyword set more and more often. Rapid environmental degradation and climate change have also become hot topics in recent years. Regarding technology, the following phrases stand out: *wind power* (2018), *photovoltaic panels* (2019), *photovoltaic cells* (2019), *energy transition* (2020), *geothermal fields* (2019), and *agricultural robots* (2020). Regarding the hot topics, the following phrases stand out: *climate change* (2018), *coal industry* (2019), *carbon* (2019), *air pollution* (2019), and *air quality* (2019).

The visualization of the dynamic change in research topics regarding *other EU countries* shows the following transitions in the subjects of scientific publications:

- bioenergy power generation: power plants (2012), biomass power (2012), crop production (2012), energy crops (2012), biomass (2013), biofuels (2013), forestry (2013), harvesting (2013), forest management (2013), biofuel production (2013),
- clean energy issue, climate topics, economic aspects: renewable energy resources (2014), biogas (2014), renewable energy (2015), solar energy (2015), photovoltaic cells (2016), alternative energy (2016), climate change (2015), global warming (2015), greenhouse gasses (2015), costs (2015), economics (2015), sustainable development (2015), commerce (2016), investments (2016),
- renewable energy storage technologies and areas related to energy transformation: solar power generation (2017), electric energy storage (2017), heat storage (2017),

electric batteries (2017), electric vehicles (2017), renewable energy consumption (2018), energy transition (2019).

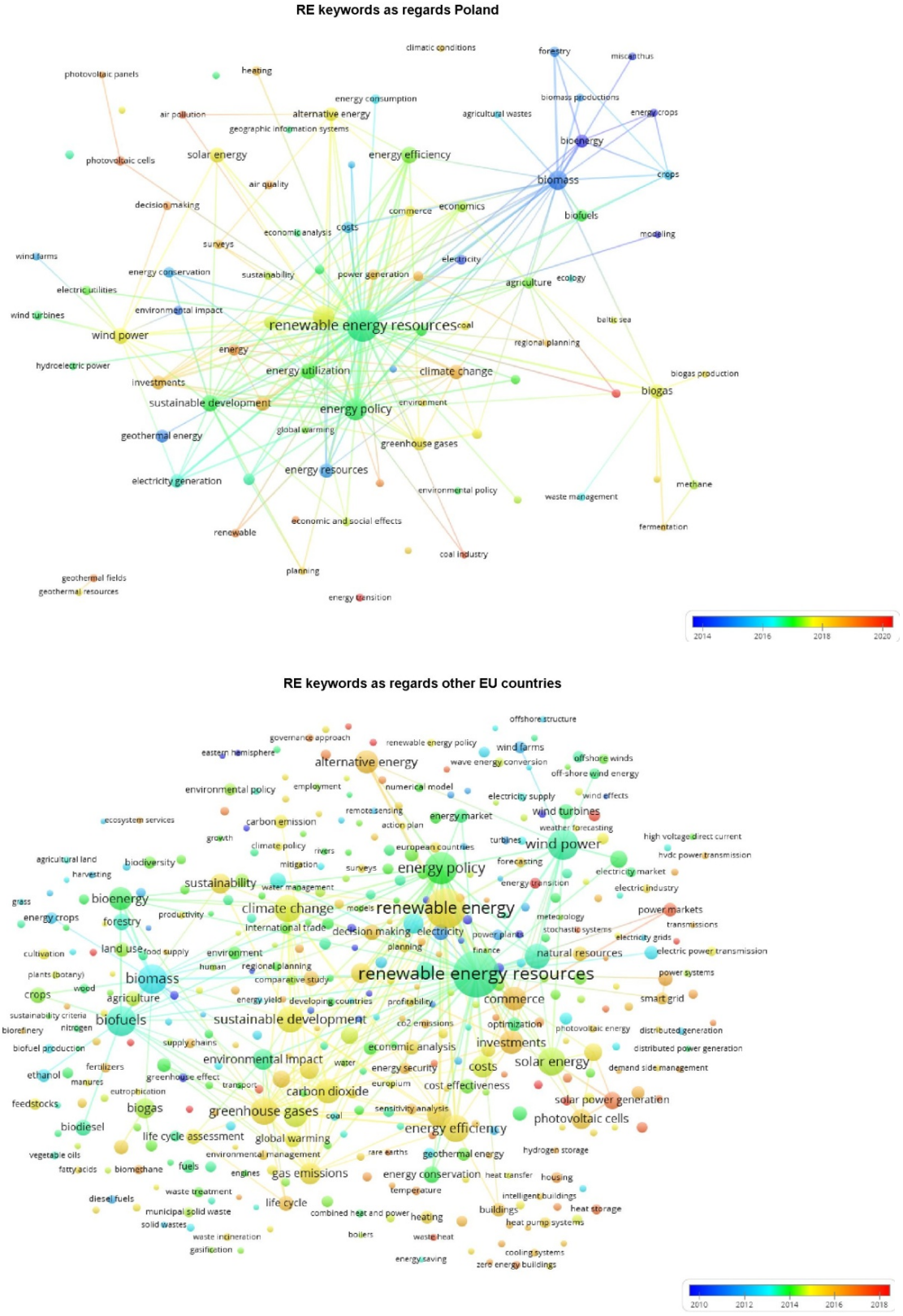


Figure 4. Keywords and keywords co-occurrence mapping for publications on RE research in a temporal aspect.

The question worth asking is whether the indicated research trends are consistent with the thematic areas of the EU framework related to the energy transformation process. According to the European Green Deal assumptions [33], the framework should foster the use of innovative technologies and infrastructures. It involves solutions which can result in the commercial application of breakthrough technologies in key industry sectors. Table 9 presents the keywords formulated on the basis of the document content as relevant to the above-mentioned European Green Deal strategy elements. The *Year* column refers to the first publication containing a specific keyword. However, due to the fact that the studied period covers the years after Poland's accession to the European Union, the keywords identified as the ones appearing for the first time in 2005 may have already been in use earlier. The number of articles in the table (the *Articles* column) was calculated directly from the records retrieved from the Scopus database; therefore, they may not correspond to the respective *Occurrence* values in Table 8 determined in VOSviewer. The *Occurrence* values (and other statistics) for the keywords are implied by the criterion of the total strength of co-occurrence links with other keywords. In spite of certain limitations (single bibliography database and limited time period), one can assume that Table 9 presents the general trend for research works.

The research on energy generation from biomass, conducted both in *Poland* and *other EU countries* for many years, is still up to date. It seems that scientists should continue the research on new more efficient technologies, taking into account low production costs.

Similar conclusions can be drawn regarding the keywords related to environmental protection (*carbon capture*, *carbon emission*, *emission control*, and *emission reduction*). In this respect, Poland (as a member of the EU) is slightly behind other EU countries. Taking into consideration conducted (broad) debates, not only in the field of science, it can be expected that the research topics in this area will be mainly related to the development of effective methods of environmental protection and the reversal of the existing environmental degradation effects.

The general term *alternative fuels* was relatively rare in the publications related to *Poland* and *other EU countries*, which can be caused either by the use of more specific vocabulary regarding the keyword or by no combination of the keyword with the terms specified in the search string (Table 1).

As far as both *Poland* and *other EU countries* are concerned, there are not many publications on the use of hydrogen in terms of renewable energy, which shows the need for European research to expand in this field and for its greater participation in worldwide research. Nowadays, great hopes are connected with this aspect in the power industry. The European Commission [33,34] and the Polish Hydrogen Strategy [35] assume that hydrogen will be one of the leading technologies of green transformation in Europe.

Researchers' attention should also be given to new technologies related to energy storage and distribution as well as to communication between energy market participants (*energy storage*, *fuel cells*, *smart grids*).

Table 9. The Green Deal keywords regarding innovative technologies and infrastructure (numerical values on the basis of Scopus database, 2005–2021).

Keywords Terms	Poland		Other EU Countries	
	First Publication	Articles	First Publication	Articles
alternative fuels	2008	11	2005	193
Biodiesel [1]	2006	10	2005	560
Biofuel [2]	2006	64	2005	2145
Biomass [3]	2005	140	2005	2182
carbon capture [4]	2007	6	2005	149
carbon emission	2005	77	2005	428
clean hydrogen	-	0	2011	3

Table 9. *Cont.*

Keywords Terms	Poland		Other EU Countries	
	First Publication	Articles	First Publication	Articles
emission control	2009	17	2005	457
emission reduction	2005	16	2005	342
energy storage [5]	2008	19	2005	514
fuel cells	2014	4	2005	200
green hydrogen	2020	4	2006	22
hydrogen	2007	8	2005	274
hydrogen fuel	2019	3	2005	59
hydrogen networks	-	0	2021	1
hydrogen production	2017	4	2005	106
hydrogen storage	2017	5	2005	65
smart grids	2014	7	2007	247

[1] covers: biodiesel, biodiesel production. [2] covers: biofuels, biofuel production. [3] covers: biomass, biomass power, biomass productions, lignocellulosic biomass. [4] covers: carbon capture, carbon capture and storage, carbon capture and utilization. [5] covers: energy storage, electric energy storage.

The obtained results may imply that some authors treat the task of formulating keywords in their works in a careless way, without realizing how important this element is in automatic searching for subject matter publications. Because of such an approach, some valuable works may be overlooked, and consequently not quoted or analyzed (this can be the case of hydrogen, the connection of which with renewable energy was comparatively weak, especially regarding *Poland*). The keyword list should contain general terms so as to assign the work to the research area easily, as well as precise terms for the subject of the analysis, thus making it easier to identify the specificity of the research.

4. Conclusions

Access to scientific articles is now greatly facilitated by online electronic databases of scientific journals and advanced publication search options offered by the platforms providing these databases.

The search is carried out according to selected fields, e.g., author, publication title, and journal title. Information about publications indexed in bibliographic databases can be a source of synthetic knowledge on a selected field of scientific research.

In the work, bibliographic data on articles related to renewable energy were collected from the Scopus database, and quantitative and qualitative analyses of the main directions of scientific research were carried out on their basis. Comments and conclusions that arose during the implementation of the task relate to various stages of its implementation.

VOSwiever, the information visualization software, was used to identify the research hotspots and the directions of science development in the field of renewable energy, as well as to diagnose the differences and similarities in the topic between *Poland* and *other EU countries*. Taking into consideration 630 and 13,798 articles for both of the regions respectively, the following main conclusions were obtained.

(1) The selected time period of 17 years showed the relevance of RE topic in the last 4 years. A deeper insight into the statistics shows that there were 52% of the scientific publications on renewable energy regarding *Poland* and 33% referring to *other EU countries*.
(2) Using the bibliometric analysis made it possible to identify leading journals on the publication market. The strong concentration of published articles around these journals is confirmed by the values of the Gini coefficient (greater than 0.5 for publications relating to both regions). The *Energies* journal was identified as the leader of recent years (2019–2021).
(3) The obtained results revealed the researchers' interest in similar topics in the last seventeen years (from 2005 to 2021) regarding both *Poland* and *other EU countries*, i.e., *wind power* and *electricity generation from wind*, *bio-energy*, *environmental protection*, *climate change*, *solar energy* in general, and *energy transition*. It is worth noting that the

studies on *hydropower*, which are undertaken relatively often in *other EU countries*, are not very popular in works concerning *Poland*.

(4) There are the following six hotspots (keywords with the highest occurrence and total link) in *Poland* articles: *renewable energy resources* (195; 769); *energy policy* (91; 460), *renewable energy* (89; 388), *biomass* (71; 307), *sustainable development* (53; 233), *energy efficiency* (53; 197), and the following six hotspots in *other UE countries: renewable energy resources* (2835; 16,660), *renewable energy* (2125; 11,642), *energy policy* (1354; 9195), *wind power* (1234; 6456), *biofuels* (1183; 6468); *biomass* (1150; 7422). The four terms in common confirm that the research course on RE in Europe is consistent.

(5) The development history of the RE scientific research is divided into three phases. In *Poland*, the initial phase (till 2015) refers to biomass; the stable growth phase (2016–2018) refers to renewable energy resources and energy policy; the rapid development phase (2019–2021) refers to climate change and selected solar technologies. In *other EU countries:* the initial phase (until 2013) refers to biomass (during this period, most publications appeared in the *Energy Policy* journal); the slowdown growth phase (2014–2017) refers to subjects that seem to be in line with the EU Renewable Energy Directive (2009/28/EC) main resolutions (*Renewable and Sustainable Energy Reviews* is a dominant journal); rapid development phase (since 2018) refers to renewable energy storage technologies (*Energies* as a leading journal).

(6) Interestingly, the result of the study shows a delay in the publication on RE topics for *Poland* in relation to *other EU countries*.

(7) Research on renewable energy in *Poland* is relatively new; the first three articles registered in the Scopus database appeared in 2007, while in relation to *other EU countries* in 2005, there were 37 of them.

(8) The analysis results show new scientific horizons of renewable energy in Europe but also the necessity to continue research on certain existing topics.

The results can help scientists interested in renewable energy identify important and current research areas and the most popular journals in the field.

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References

1. Agenda na Rzecz Zrównoważonego Rozwoju 2030 i Cele Zrównoważonego Rozwoju, Addis Ababa Action Agenda (AAAA). Available online: http://www.un.org.pl/files/170/Agenda2030PL_pl-5.pdf (accessed on 2 May 2022).
2. The European Union Leading in Renewables, European Comission, RE-Energising the Future COP21. Available online: https://ec.europa.eu/energy/sites/ener/files/documents/cop21-brochure-web.pdf (accessed on 16 May 2022).
3. Communication from the Commission to European Parliament, The European Council, The Council, The European Economic and Social Committee and the Committee of the Regions the European Green Deal, Brussels, 2019 COM (2019) 640. Available online: https://ec.europa.eu/info/sites/default/files/european-green-deal-communication_en.pdf (accessed on 16 February 2022).
4. Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the Promotion of the Use of Energy from Renewable Sources (Recast) (Text with EEA Relevance). Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018L2001&from=pl (accessed on 16 February 2022).
5. Wuni, I.Y.; Shen, G.Q.P.; Osei-Kyei, R. Scientometric review of global research trends on green buildings in construction journals from 1992 to 2018. *Energy Build.* **2019**, *190*, 69–85. [CrossRef]
6. Shi, S.; Yin, J. Global research on carbon footprint: A scientometric review. *Environ. Impact Assess. Rev.* **2021**, *89*, 106571. [CrossRef]
7. He, K.; Zhang, J.; Zeng, Y. Knowledge domain and emerging trends of agricultural waste management in the field of social science: A scientometric review. *Sci. Total Environ.* **2019**, *670*, 236–244. [CrossRef] [PubMed]

8. Andreo-Martínez, P.; Ortiz-Martínez, V.M.; García-Martínez, N.; Pérez de los Ríos, A.; Hernández-Fernándeza, F.J.; Quesada-Medina, J. Production of biodiesel under supercritical conditions: State of the art and bibliometric analysis. *Appl. Energy* **2020**, *264*, 114753. [CrossRef]
9. Rosokhata, A.; Minchenko, M.; Khomenko, L.; Chygryn, O. Renewable energy: A bibliometric analysis. *E3S Web Conf.* **2021**, *250*, 03002. [CrossRef]
10. Chanchetti, L.F.; Leiva, D.R.; Lopes de Faria, L.I.; Ishikawa, T.T. A scientometric review of research in hydrogen storage materials. *Int. J. Hydrog. Energy* **2020**, *45*, 5356–5366. [CrossRef]
11. Bortoluzzi, M.; Correia de Souza, C.; Furlan, M. Bibliometric analysis of renewable energy types using key performance indicators and multicriteria decision models. *Renew. Sustain. Energy Rev.* **2021**, *143*, 110958. [CrossRef]
12. Ziabina, Y.; Pimonenko, T. The Green Deal Policy for Renewable Energy: A Bibliometric Analysis. *Virtual Econ.* **2020**, *3*, 147–168. [CrossRef]
13. Reyes-Belmonte, M.A. Quo Vadis Solar Energy Research? *Appl. Sci.* **2021**, *11*, 3015. [CrossRef]
14. Scopus®. Available online: https://www.elsevier.com/solutions/scopus (accessed on 10 November 2021).
15. Scopus. Quick Reference Guide. Available online: https://www.elsevier.com/__data/assets/pdf_file/0005/79196/scopus-quick-reference-guide.pdf (accessed on 10 November 2021).
16. Salmerón-Manzano, E.; Manzano-Agugliaro, F. Worldwide Scientific Production Indexed by Scopus on Labour Relations. *Publications* **2017**, *5*, 25. [CrossRef]
17. Renewable Energy Glossary. Available online: https://enerdynamics.com/cbtms/Glossaries_PDF/Renewable%20Energy%20Glossary.pdf (accessed on 11 November 2021).
18. Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the Promotion of Electricity Produced from Renewable Energy Sources in the Internal Electricity Market, Official Journal of the European Communities 2001. Available online: https://archive.epa.gov/epawaste/nonhaz/municipal/web/pdf/euridirectives.pdf (accessed on 25 March 2021).
19. Osborne, J.W. *Best Practices in Data Cleaning*; Sage: London, UK, 2013.
20. The Meaning of "Term" and "Terminology Standardization". Available online: https://gov.wales/bydtermcymru/how-to-use/meaning-term-and-terminology-standardization (accessed on 11 November 2021).
21. Gastwirth, J.L. The Estimation of the Lorenz Curve and Gini Index. *Rev. Econ. Stat.* **1972**, *54*, 306–316. Available online: https://www.researchgate.net/publication/24093177 (accessed on 5 March 2022). [CrossRef]
22. Van Eck, N.J.; Waltman, L. *VOSviewer Manual. Manual for VOSviewer Version 1.6.7*; Universiteit Leiden: Leiden, The Netherlands, 2018.
23. Waltman, L.; Van Eck, N.J.; Noyons, E.C.M. A unified approach to mapping and clustering of bibliometric networks. *J. Informetr.* **2010**, *4*, 629–635. [CrossRef]
24. Radhakrishnan, S.; Erbis, S.; Isaacs, J.A.; Kamarthi, S. Novel keyword co-occurrence network-based methods to foster systematic reviews of scientific literature. *PLoS ONE* **2017**, *12*, e0172778. [CrossRef]
25. Scimago Journal & Country Rank. Available online: https://www.scimagojr.com/journalrank.php?type=j&year=2021 (accessed on 12 June 2022).
26. ELSEVIER. Pricing. Available online: https://www.elsevier.com/about/policies/pricing (accessed on 12 June 2022).
27. Web of Science Group. Available online: https://mjl.clarivate.com/manuscript-matcher (accessed on 12 June 2022).
28. MDPI. Open Access and Article Processing Charge (APC). Available online: https://www.mdpi.com/journal/sustainability/apc (accessed on 12 June 2022).
29. MDPI. Open Access and Article Processing Charge (APC). Available online: https://www.mdpi.com/journal/energies/apc (accessed on 12 June 2022).
30. ELSEVIER. Review Speed. Available online: https://journalinsights.elsevier.com/journals/0360-5442/review_speed (accessed on 12 June 2022).
31. ELSEVIER. Online Article Publication Time. Available online: https://journalinsights.elsevier.com/journals/0360-5442/oapt (accessed on 12 June 2022).
32. Energy Transition in Poland, 2021 Edition. Available online: https://www.forum-energii.eu/en/analizy/transformacja-2021 (accessed on 5 May 2022).
33. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. The European Green Deal. Brussels, 11.12.2019. Available online: https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF (accessed on 12 June 2022).
34. A European Strategy for Energy System Integration. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021IP0240 (accessed on 12 June 2022).
35. POLSKA STRATEGIA WODOROWA DO ROKU 2030 Z PERSPEKTYW DO ROKU 2040. Available online: https://www.gov.pl/attachment/4c261e63-f57d-48e3-b451-10b235aa2de8 (accessed on 12 June 2022).