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Article

Green economy and energy: Green labor market elements identification

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Abstract: With the advancement of the green economy, the labor market is experiencing the emergence of new employment forms, positions, and competencies. This arises from the special relationship between the green job market and the transforming energy sector. On the other hand, the energy sector's influence on the green labor market and the creation of green jobs is particularly significant. It is because, the energy sector is one of the fundamental foundations of any country's economy and impacts its other sectors. Key components of this influence include green employment and green self-employment. The purpose of this study is to identify elements of the green labor market within the context of the green economy and the energy sector. The methodology employs a hybrid literature review, combining a systematic literature review facilitated by the use of VOSviewer software. Exploring the Scopus database enabled the identification of keywords directly related to the green economy and the energy sector. Within these identified keywords, elements of the green labor market were searched. The main result is the empirical identification of the crucial term 'green skills,' which links elements of the green labor market, as presented in bibliometric maps. The research results indicate a gap in the form of insufficient discussion on green self-employment within the energy sector. Aspects of green jobs and elements of the green labor market are prominently featured in current research. However, there is a notable gap in the literature regarding green self-employment, presenting promising avenues for further research.

Keywords: energy; green jobs; green self-employment; green labor market; sustainable development

1. Introduction

The decarbonization of economic and social processes is one of the most important contemporary challenges addressed by researchers on various perspectives of local (Gajdzik et al., 2024; Gaman et al., 2022; Janikowska and Kulczycka, 2021), regional (Kryk and Skubiak, 2015; Weller, 2012; Xin et al., 2024; Zhou et al., 2024), national (Hasan et al., 2020; Koval et al., 2022), and international development (Guo et al., 2023; Hu et al., 2024). Activities aimed at decarbonization contribute to the green transformation of the economy. However, in order for this to be possible, the various sectors of the economy, as well as the activities of the various players in the market, must be greened (Kasztelan and Sulich, 2023). In practice, this process is complex, as it requires not only often quite significant financial investments directed at the development and implementation of new less carbon-intensive technologies (Lin et al., 2023; Liu and Wang, 2023), or the adoption and implementation of appropriate strategies aimed at this goal (Kaleta et al., 2018; Lundmark et al., 2024; Pearse, 2021; Terzi, 2020). The process of greening is primarily dependent on access to a workforce characterized by appropriate competencies, referred to in the literature as green

competencies (Kozar and Sulich, 2023c; Mehrajunnisa et al., 2023). Only workers with the appropriate green profile can meet the challenging expectations faced by organizations. Therefore, the greening of the economy and green economic transformation requires not only green competencies, but also appropriate mindset, behavior, and green skills (Kozar and Sulich, 2023c). This is the primary reason for the importance of research in identifying elements of the green job market.

Thus, the process of green transformation is taking place gradually and, at the same time, it is impossible to indicate when it will end. In addition, scholarly considerations point out that the greatest challenge of this process is that it occurs without sacrificing economic progress and guarantees equity and inclusiveness (Llorca and Rodriguez-Alvarez, 2024). Hence, it can be pointed out that rather than a fully formed green economy, a brown economy is still being dealt with today, along with elements of an emerging green economy. Such elements indicating that a greening of the economy is taking place include green jobs (Consoli et al., 2016; de la Vega et al., 2024; Kozar and Sulich, 2023b), or green self-employment (Chakrabarty et al., 2013; Kozar, 2023a), which are among the key pillars of the green labor market (Kozar and Sulich, 2023a; Larrea Basterra and Fernández Gómez, 2023; Scully-Russ, 2013). At this point, it should be emphasized that the issue of greening individual processes and economic areas is not only a challenge for practitioners, but also an important element of contemporary economic discourse (Buseth and Bergius, 2019; Khan et al., 2021; Montesano et al., 2024). Therefore, investigating the practical and theoretical implications provides further justification for the importance of research in identifying elements of the green job market.

One of the most important economic sectors in which the green transformation process is taking place is the energy sector (Kryk, 2019a; Lema et al., 2021; Pegels et al., 2018). This sector affects other areas of socio-economic life, as it is strategic in nature (Chwiłkowska-Kubala et al., 2023; Sołoducho-Pelc, 2016). It should be noted, for example, that the ways of obtaining energy affect their price, and this is reflected in the prices of goods and services in the economy. Increasingly, researchers are addressing the issue of energy poverty (Belaïd, 2022; Hussain et al., 2023; Popescu et al., 2024), among other issues. In addition, changes in energy prices can affect the wage expectations of workers throughout the economy. The green transformation of the energy sector itself, due to costs, the availability of appropriately skilled workers and regulations in this area, is occurring at different rates taking into account individual countries (Niemczyk et al., 2022). A common feature, however, is the increase in the sourcing of energy from renewable sources and, at the same time, the gradual shift away from non-renewable sources as sources of energy generation (Rokicki and Perkowska, 2020).

The motivation for taking up the subject of identifying elements of the green labor market in the field of green economy and energy is the relevance of this sector in socio-economic life and the totality of the changes currently taking place in it. The lack of studies identifying the elements of the green labor market in a comprehensive manner is also in favor of taking up this topic (Napathorn, 2022). The studies to date generally address only the issue of green jobs. These are studies with different understandings of green jobs and their role and importance in the context of the energy sector (Betini, 2013; Sharma and Banerjee, 2021; Yi, 2013). Some such analyses are quantitative in

nature (Kozar et al., 2022; Tănasie et al., 2022), while others focus on qualitative issues of green jobs (Jung, 2015). However, the authors of this article recognize a research gap in the form of insufficient discussion in the context of green self-employment in the energy sector. Moreover, it should be noted that researchers are increasingly addressing the energy issue through the lens of green economics. Hence the urgent need to implement research in the form of a systematic literature review that will present the elements of the green labor market.

The aim of the study is to identify elements of the green labor market in the context of the green economy and the energy sector. The purpose of the paper formulated in this way is accompanied by a research question expressed in the form of a query to the Scopus database. This article is an original study using the methodology of a hybrid literature review. The introduction, discussion and conclusion use a classical critical literature review, which is characterized by the author's selection of scientific sources that argue the adopted mode of narrative and scientific discourse. The classical literature review is complemented by a systematic, structured bibliometric literature review, conducted transparently according to the established research area, defined by the selected keywords used in the query to the selected bibliometric database. In this way, the procedure of the systematic literature review and its results are presented in the sections describing the materials and methods in turn, followed by the results. The aim of the literature review procedure used was the same as that of the article. The research procedure of the bibliometric literature review was similar to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) scheme. Therefore, the research methodology in this article is derived from the PRISMA procedure. The results of the analyses were presented by bibliometric maps generated with the help of the VOSviewer software (version 1.6.20). The entire procedures of classical and systematic literature review resulted in a comprehensive hybrid literature review.

This article consists of the following parts. After presenting the justification for the research approach in the introduction, the next section details the research materials and methods. A detailed description of the second part serves the reproducibility of the results. This section includes the limitations of using the adopted research methods and the rationale for choosing the Scopus database. The third section presents the results obtained, which are discussed in the fourth section. Part four also presents a discussion of the results, which relates the obtained results to the research conducted to date in this area. The article concludes with the main insights from the research, theoretical and practical implications, and future promising research directions.

2. Materials and methods

The study used structured literature review research procedure presented in **Figure 1**. This is a popular procedure for conducting research for systematic literature reviews. The scheme is divided into columns: time and stages are indicated on the left, while key research activities are listed on the right. The research commenced with a literature review, as outlined in the previous section of this article, utilizing sources from the Web of Science, Scopus, and Google Scholar. This step led to the

identification of the research gap.

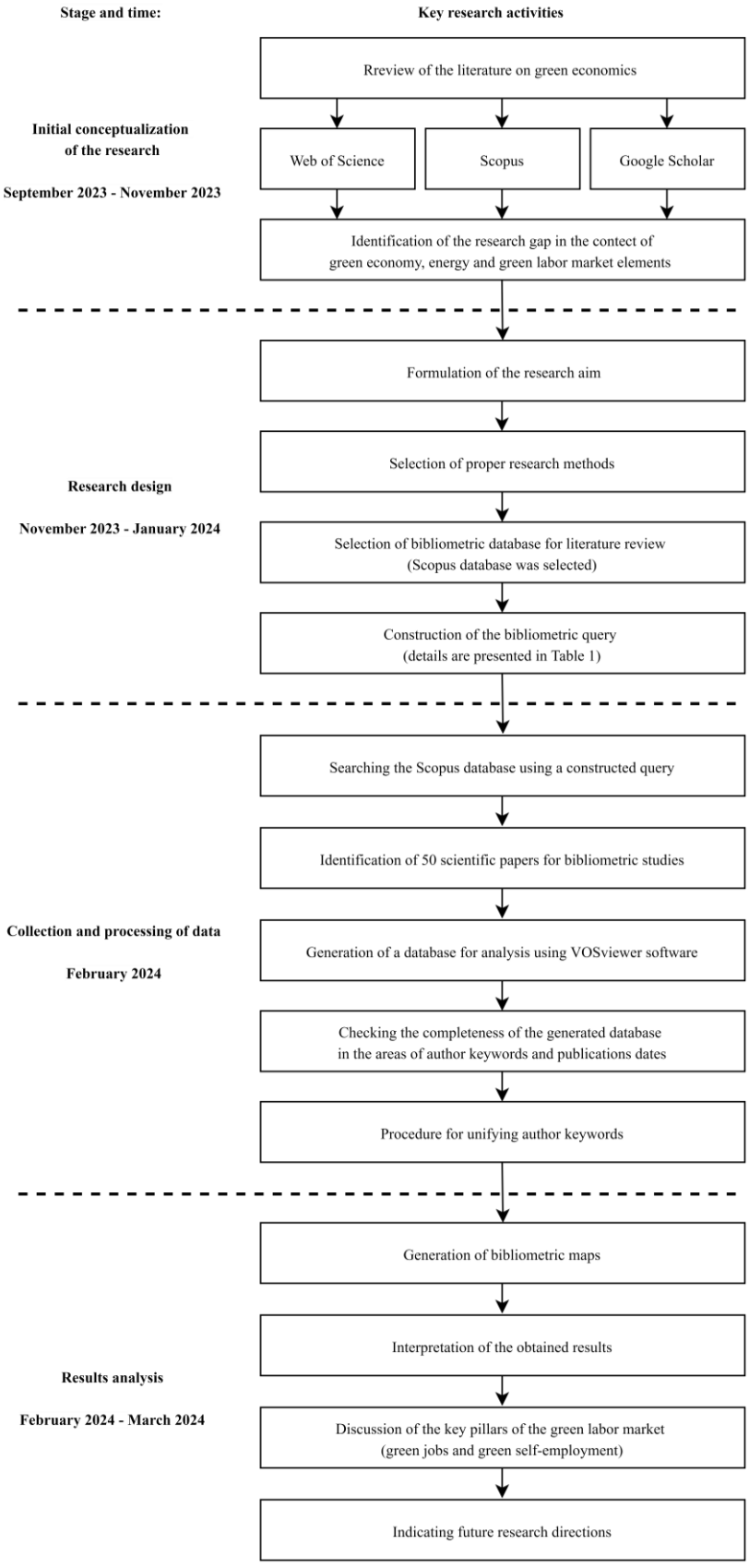

Figure 1. Systematic literature review procedure scheme.
Source: Authors' elaboration.

First, publications in the field of green economics were reviewed, and it was noted the issue of the energy sector combined with labor market issues that can be categorized as green labor market elements. Then it was recognized that the area of the green labor market is still insufficiently discussed in the literature. There is a lack of comprehensive studies combining the issues of green jobs and green self-employment. Therefore, in the next step, the purpose of the research was formulated. After the initial conceptualization of the research, the research design details were chosen. Another step was to determine the purpose and research area. Next, the research methods were selected to answer the formulated research aim. After this step the Scopus database was selected. Therefore, the subject of the study is scientific literature indexed in the Scopus database. The Scopus database was chosen because of its quality of the data it contains and its rigor in indexing the publications included in it. In addition, the Scopus database is widely used for bibliometric research in the fields of sustainable development (Ertz and Leblanc-Proulx, 2018; Shome et al., 2023), green economics (Tamasiga et al., 2022), green development (Us et al., 2020), green labor market elements (Araújo et al., 2018; Kozar and Sulich, 2023a) and the energy sector (Sulich and Zema, 2023). The Scopus database is highly regarded among researchers. Other databases such as Web of Science and Google Scholar are often compared to the Scopus database.

In the next step, keywords relevant to the construction of the Q1 query were determined. Using the selection option buttons in the sidebar of the Scopus database, the criteria for selecting publications were established. A search was performed and, among the initial results, publications that did not meet the specified inclusion and exclusion criteria were excluded. The pool of results thus isolated was downloaded from the Scopus database as a file and subjected to further analysis in VOSviewer (version 1.16.20). Fifty scientific papers were identified in the Scopus database for the bibliometric studies.

As outlined in the research procedure, the Scopus database was searched using the Q1 query (**Table 1**). This query, due to the design of the Scopus database, makes it possible to repeat the study in the future. In addition, the contrasted query can be used in other scientific databases after adjusting its syntax. The purpose of such an exploration was to identify elements of the green labor market in the context of the green economy and the energy sector. **Table 1** shows the detailed syntax of the Q1 query.

Table 1. Search Query syntax details.

Symbol	Query syntax	No. results (11 February 2024)
Q1	TITLE-ABS-KEY ((“green econom*” AND energy) AND (“green job*” OR “green self-employment”)) AND PUBYEAR > 1991 AND PUBYEAR < 2024 AND (LIMIT-TO (SRCTYPE, “j”)) AND (LIMIT-TO (PUBSTAGE, “final”)) AND (LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (LANGUAGE, “English”))	50

Source: Authors’ elaboration.

The Q1 query used keywords annotated with the operator ‘*’ which allows searching for different spelling forms and grammar versions. The keywords selected were green economy, energy, green job, green self-empowerment. The Q1 query

submission also specifies the years in which published articles in scientific journals were searched. The search years were determined automatically by Scopus (the oldest record from 1991) and the most recent record was determined manually by only the current year, 2024. The search of the Scopus database took place on 11 February 2024, which forced the abandonment of publications published in 2024. This is a good practice in bibliometric research aimed at reproducibility of the results obtained. Another limitation was the search for publications in English only. **Table 2** collects the conditions for inclusion and exclusion of publications for further steps in the research procedure. This query resulted in 50 scientific publications.

Table 2. Search criteria for the data collection stage.

Criteria	Details
Database	Scopus
Search area	Article title, Abstract, Keywords
Time span	< 2024
Document type	Articles
Publication stage	Final
Source type	Journal
Language	English

Source: Authors' elaboration.

The search criteria presented in **Table 2** are a limitation of the study conducted. These are the criteria for the inclusion of publications for further analysis identical to the content of the query presented in **Table 1**. Together with the full syntax of the Q1 query, these criteria allow the study to be replicated by other researchers (e.g., for comparison purposes in the future). At the same time, the criteria used are a limitation of the research procedure used (a different scope of the study may result in different results). After identifying 50 scientific papers, the next step involved verifying the completeness of the generated database with respect to author keywords and publication dates. Finally, at this stage, a procedure to standardize the author keywords was applied as outlined in **Table 3**.

Table 3. Unification process for author keywords used in the research.

Keywords	Replaced by
co-benefits	co-benefit
energy policies	energy policy
energy transition	energy transitions
green job	green jobs
labour market	labor markets
low carbon economy	low-carbon economy
low carbon society	low-carbon society
renewable energy sources	renewable energy source
res	renewable energy source

Source: Authors' elaboration.

According to the adopted research procedure (**Figure 1**), once the final set of publications was isolated, it was analyzed in VOSviewer software. It was assumed that author keywords would be examined. Authors of publications indicate through such keywords, in their opinion, the most important research issues that were addressed in the content of the prepared article. Thus, in the scope of these words, new research areas appear, which are often in vain in the scope of words indexed in individual journal databases (elements of the green labor market should still be considered a relatively new research area). Before generating bibliometric maps, the replacement of synonyms and identical grammatical forms of the author's keywords was carried out in accordance with **Table 3**. The full counting method was chosen. Continuing with the procedure of creating bibliometric maps in the VOSviewer software in terms of the analyzed authorial keywords, "2" was assumed as the minimum coefficient of their occurrence. Such a value of this coefficient was adopted due to the novelty of the explored research area. In the next step of the analysis, the VOSviewer software identified 23 author keywords that will be included in the bibliometric map in the form of nodes grouped into clusters. The word 'China' was excluded from these keywords, a common practice in this type of analysis that involves removing names of countries, geographic regions, and research methods.

Hence, 22 keywords were used to create the bibliometric map and this was the first step of the Results analysis stage as presented in **Figure 1**. Presented in the **Figure 1** last stage outlined the further content and section of this article. Finally, the maps were created on the basis of 21 author keywords, since one author keyword did not have connections to other keywords. The results of this post-processing are presented in the next section of the article. The descriptive content of the results analysis was not generated by the VOSviewer software. The presented description of the analyses is not only a description of the obtained research results, but also contains the author's observations on the described problems.

3. Results

The results of the analysis, obtained using the VOSviewer software, are shown in **Figure 2**. In the obtained bibliometric map showing the co-occurrences of the author's keywords, the largest nodes centrally located are green jobs and green economy. These keywords are not among the most numerous clusters indicated by the VOSviewer software. It should also be pointed out that these words are strongly connected among themselves despite belonging to different clusters. All the clusters and keywords belong to these clusters are additionally shown in **Table 4**.

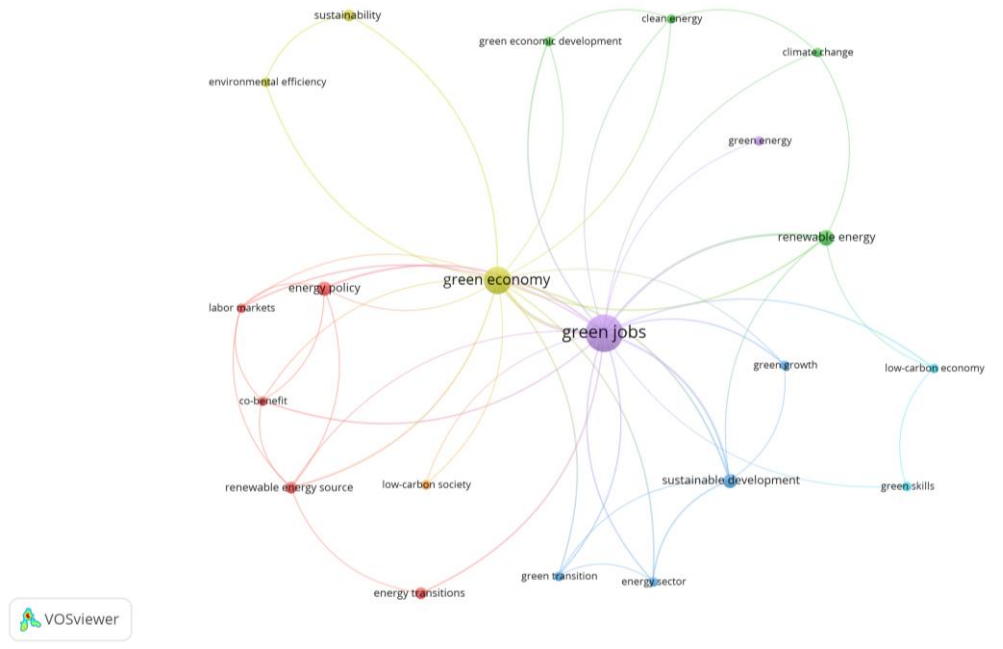

Figure 2. Authors' keywords co-occurrences in full counting method of Q1 results.
Source: Authors' elaboration in VOSviewer software (1.6.20 version).

Table 4. Clusters of keywords co-occurrences presented in Figure 2.

Cluster	Color	Keywords
1	Red	co-benefit (*O* = 2, *L* = 5, *TLS* = 6); energy policy (*O* = 4, *L* = 5, *TLS* = 7); energy transitions (*O* = 3, *L* = 2, *TLS* = 3); labor markets (*O* = 2, *L* = 5, *TLS* = 6); renewable energy source (*O* = 3, *L* = 6, *TLS* = 7);
2	Green	clean energy (*O* = 2, *L* = 4, *TLS* = 4); climate change (*O* = 2, *L* = 3, *TLS* = 3); green economic development (*O* = 2, *L* = 3, *TLS* = 4); renewable energy (*O* = 5, *L* = 5, *TLS* = 10);
3	Blue	energy sector (*O* = 2, *L* = 4, *TLS* = 7); green growth (*O* = 2, *L* = 3, *TLS* = 4); green transition (*O* = 2, *L* = 4, *TLS* = 6); sustainable development (*O* = 4, *L* = 6, *TLS* = 12);
4	Yellow	environmental efficiency (*O* = 2, *L* = 2, *TLS* = 4); green economy (*O* = 15, *L* = 15, *TLS* = 33); sustainability (*O* = 3, *L* = 2, *TLS* = 4);
5	Purple	green energy (*O* = 2, *L* = 1, *TLS* = 1); green jobs (*O* = 28, *L* = 18, *TLS* = 45);
6	Turquoise	green skills (*O* = 2, *L* = 2, *TLS* = 2); low-carbon economy (*O* = 2, *L* = 3, *TLS* = 4);
7	Orange	low-carbon society (*O* = 2, *L* = 2, *TLS* = 2);

Source: Authors' elaboration.

The clusters shown by color in **Figure 2** are listed in descending order of the number of keywords in **Table 4**. The map and table show author keywords that co-occur a minimum of two different publications. **Table 4** indicates not only the co-occurrence figures (O) but also the number of links (L) and total links strength (TLS). The colors of the clusters were assigned automatically, with a given keyword assigned to one cluster only.

The most numerous of all clusters is the red cluster, which included 5 author keywords. This cluster addresses issues of transformation in the energy sector. Three of the five author keywords in this cluster relate to the energy sector and are: energy policy energy transitions renewable energy source. This cluster also includes a general reference to labor markets.

Another cluster is the green cluster. There are four terms identified as nodes, expressed in form of digrams (bigram). In this cluster, energy issues (clean energy,

renewable energy) are presented in relation to climate change and green economic development.

The blue cluster contains as many words as the green cluster but deals with different issues. This cluster is dominated by sustainability issues. This cluster also addresses issues related to green issues. These are green growth and green transition. The central author keyword of this cluster which is sustainable development is combined with the yellow cluster (green economy), green (renewable energy) and purple (green jobs).

The yellow cluster contains (cluster number 4) references to the green economy. This word is also the second strongest keyword by the criterion of the number of co-occurrences in the bibliometric map obtained (**Figure 2**). Green economy is also the author's keyword characterized by the highest number of connections. It is connected to almost all clusters (no connection to any keyword from the turquoise cluster). In contrast, the most frequent author keyword is green jobs. The VOSviewer software assigned this word to cluster 5, where it co-occurs with only one author keyword, which is green energy. Green jobs are not exclusively combined with two keywords (sustainability, environmental efficiency).

In contrast, the sixth cluster is the turquoise cluster, which includes green skills and low-carbon economy. These are keywords that do not have a connection to the green economy on the bibliometric map. They do, however, connect to green jobs. The last listed cluster (orange) represents one word, which is low-carbon society. This word is linked exclusively to the green economy and green jobs, drawing attention to the issue of decarbonizing societies. More extensive information on this topic is available in the publications by Long et al. (2023) and Yi (2014).

The size of the nodes indicates how many publications the author keywords appear in, although trends in word popularity can only be traced using the overlay bibliometric map (**Figure 3**). This bibliometric map uses light and dark colors to show the popularity of research topics undertaken over time as identified by author keywords. The scale of the time interval of years was determined automatically by the VOSviewer software.

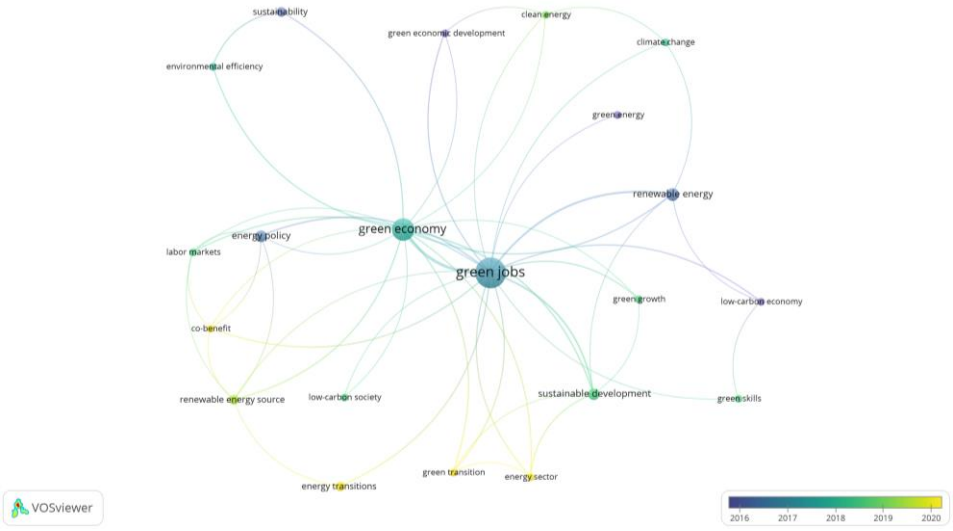

Figure 3. Overlay map of the authors' keywords co-occurrences.
Source: Authors' elaboration in VOSviewer software (1.6.20 version).

In **Figure 3**, the following words co-benefit, green transition, energy sector, energy transition are marked in yellow. These author's keywords should be considered the most recent research areas around the issue at hand. The oldest keywords are marked in dark blue. These are well-established terms in the scientific literature such as low-carbon economy, renewable energy, green energy, green economic development, sustainability. The most common co-occurring words green jobs and green economy are marked with intermediate colors, keeping the size of these nodes. One can see a strong connection between them in the form of a bold network edge.

Figure 4 was created in the results of dynamic analysis of the keyword co-occurrence map (**Figure 2**) in VOSviewer. It is a screenshot taken after hovering the cursor over the term green jobs. Hence, this figure shows the keyword green jobs as the most important issue, and only shows the connections of this term with other identified and linked author keywords. **Figure 4** suggests that green jobs are closely linked to the issue of green transformation in the energy sector.

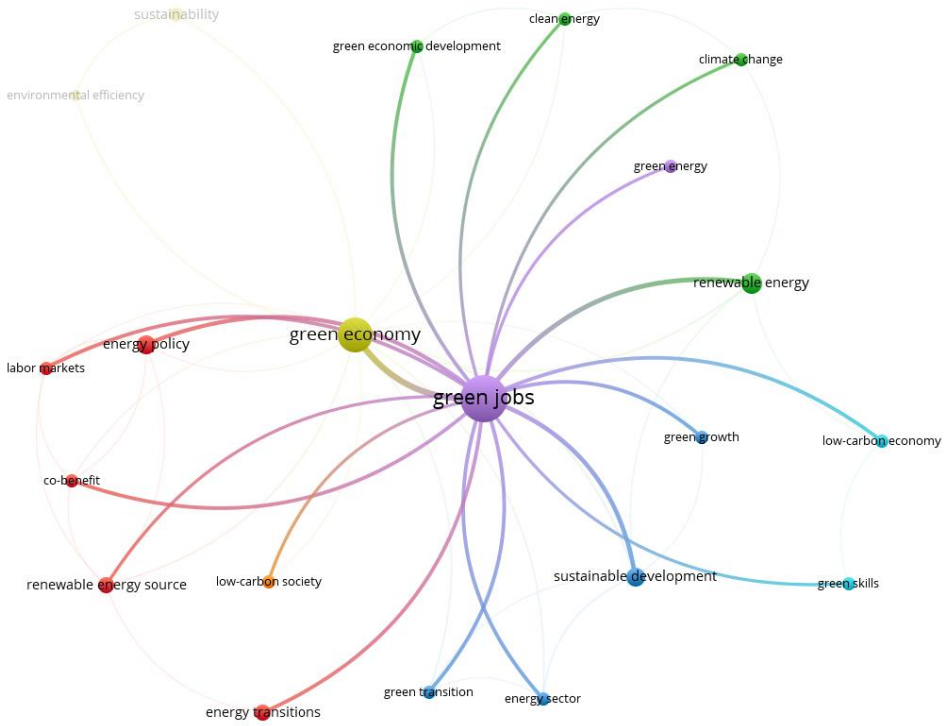

Figure 4. Keyword "green jobs" relations with other keywords.
Source: Authors' elaboration in VOSviewer software (1.6.20 version).

Figure 4 also includes a very important element of the green labor market which are green jobs. Such specific jobs, in the opinion of the authors of this article, are even the main pillar of the green labor market. Changes in the economy and its orientation towards green tracks support the process of creating green jobs in the energy sector (Kryk, 2019b). This is because they are being created as a result of the development of the renewable energy sector.

4. Discussion and conclusion

In the scientific discourse, one notices scientific studies in which references to

green economy issues in the context of energy follow (Thompson, 2023; Ziabina and Pimonenko, 2020; Zwane et al., 2022). A part of them was aimed at various bibliometric analyses, in which the Scopus database was used similarly to the one conducted in this article Scopus (Khan et al., 2022; Zaharia et al., 2016). The bibliometric analyses presented in the article differ from the indicated analyses in the syntax of the bibliometric query (the explored words are green economy, energy, green jobs, green self-employment) and in that they are aimed at identifying elements of the green labor market.

In the bibliometric maps obtained, references were spotted to only two issues that can be considered elements of the green labor market. These are green jobs and green skills. Green jobs, as already indicated, are a very important element of the green labor market. Green jobs are strongly connected to the green economy, as illustrated in bibliometric maps. Green skills, in turn, are, as it were, the basis for the formation of green forms of employment. Without the appropriate competencies, in the opinion of the authors of this article, it is impossible to say that a person can correctly perform green professional activities. Hence, further discussion was further supported by the CLR method based on all the author's keywords available in the analyzed articles. This was to deepen the discussion that was carried out and to identify other elements of the green labor market that were perceived by the researchers. The scientific contribution of this article, therefore, is to address this new research issue.

The issues in the context of green jobs addressed in scientific articles that simultaneously refer to green economy and energy issues are diverse. Researchers, however, emphasize that the issue of such specific jobs is gaining strength and importance (Betini, 2013). One of the many research issues raised around green jobs is the scientific discourse on the question of whether the green economy brings green jobs (Cai et al., 2011). The answer to this question, in turn, raises another issue seen in numerous studies in the form of how to measure such specific jobs (Allan et al., 2017; Kattumuri and Kruse, 2019). The whole situation in this matter is complicated by the fact that green jobs are simultaneously considered by some researchers to be so-called "decent jobs" (Dell'Anna, 2021).

Nevertheless, the development of the green economy at the same time, as the authors of this article recognize, is not possible without access to skilled workers with the right competencies. Hence, the development of a green job's education model is a challenge for the further development of this pillar of the green labor market (Wagner, 2013). Such a model should be aimed at shaping green skills among employees (Brown, 2015; Cledumas et al., 2020; Napathorn, 2022). This process gradually contributes to the greening of a given employee, and thus the acquisition of the right skills for a green workplace. Hence, it is increasingly apparent that in the face of greening economies, various types of green human resource management strategies are being adopted by individual business entities (Scully-Russ, 2015).

An important research problem that projected the shape of the bibliometric maps presented is the issue of different naming of green jobs. While the issues related to the use of the singular or plural number do not raise major objections, many other names or definitions of this type of jobs can be found in scientific studies. For example, green employment (Bowen et al., 2018) or green-collar jobs (Torres-Vélez, 2011) have been spotted within the scope of the analyzed scientific articles. The conducted analyses

supported by the CLR method showed that a still unsolved problem is how to categorize and count green jobs in the economy. This makes it difficult to know the size of employment in the green labor market. In addition, it should be noted that some researchers treat self-employment as green jobs, as there is no statistical data to distinguish between them.

In contrast, the issue of green self-employment does not appear on the bibliometric maps obtained. This is a new research area, which, along with green jobs, is one of the pillars of the green labor market. The issue of green self-employment was indicated only by Kozar and Sulich (2023b). Researchers, in the opinion of the authors of this article, should distinguish between the issue of green self-employment and green jobs in their analyses in the context of the energy sector, which is an important theoretical implication for researchers and business practitioners.

The practical implication of this study is that it can bridge the gap between the worlds of academia and business. This is because the article offers insights into research perspectives that are often inaccessible to the business community. The methodological implication is to repeat the analyses carried out according to the assumptions made in this article in another database and another period of analysis. Perhaps, in the future, the issue of green self-employment will already be visible on the bibliometric maps, and other elements of the green labor market will appear, including the issue of green social enterprises dealing with energy issues (Kozar, 2023b). This study comprehensively presents the research landscape and perspectives. The novelty of the article is expressed through the distinctive use of database queries and the research context aimed to be showcased, which is related to elements of the green job market. Thus, the study, along with the presented results and reflective analysis, constitutes a significant contribution to science, provides an important cognitive aspect for practice, and lays the groundwork for future collaboration between academia and business.

In conclusion, it should be noted that the dominant element of the green labor market addressed in the context of the green economy and energy is green jobs. At the same time, it should be noted new emerging challenges related to, for example, research focused on green self-employment as one of the pillars of the green labor market. The space between these pillars is filled by green competencies, the process of shaping of which is very important not only in the process of green transformation of economic entities, but also in the greening of the labor market. Hence, future researchers of the issue of the green labor market in the energy industry should be expected to be able to distinguish between green jobs and green self-employment.

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