ENERGY SALES FORECASTING IN A SUSTAINABLE DEVELOPMENT CONTEXT: BIBLIOMETRIC REVIEW

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Abstract This paper aims to present different patterns of keyword evolution and their co-occurrences in publications dedicated to energy sales forecasting in a sustainable development context, and indexed in the Scopus and Web of Science Core Collection (WoS) databases. The adopted method is the Structured Literature Review (SLR) variation method with queries supported by the Bibliometrix software as the analytical and visualisation tool. The number of publications has evolved in the context of indexed keywords, which are related. Research on energy sales forecasting and sustainability has earned considerable attention in multiple academic fields. Proposed queries syntaxes and searching procedures in Scopus and Web of Science databases present limitations related to the subscription of these databases and the interchangeability of syntaxes. The novelty of this study is based on the results and their presentation with the usage of Bibliometrix as a tool for the exploration of two independent scientific areas, namely energy sales forecasting and sustainability, and the presentation of connections between them. This paper can inspire researchers to develop the subject of energy sales forecasting evolution in a sustainable development context, as well as business practitioners interested in energy sector adaptation visible in keyword changes in their decision-making processes.

Keywords:
bibliometric analysis, energy carriers, sales volume, sustainability, thematic evolution

JEL:
C53, O13, Q001

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1 Introduction

In a dynamically changing economy, there is growing interest in the issues of Sustainable Development (SD). SD has become a well-known idea in the scientific literature influencing the activities of all economic sectors, and in particular the energy sector which fuels the economy of each country. The development of modern economies and society as a whole depends on electricity and requires its supply. The issue of energy security, on which its functioning and development depend, is also strategic for every country. Therefore, there is scientific literature, business reports and publications oriented not only on economic aspects, but also on social and environmental matters of interest. The energy industry, however, is also a sector of the economy with one of the most harmful impacts on the environment.

The aim of this paper is to explore the scientific literature, indexed in the Scopus and Web of Science databases, dedicated to the energy carriers and resources sales forecasting, which is anchored in the SD perspective. Analysis of the scientific literature can reveal the patterns and methods of the energy carriers sales forecasting. Therefore, the adopted method in this research is a bibliometric study (Nazari et al., 2021) as a variation of the Systematic Literature Review (SLR) based on the databases' research queries, developed in bibliometric maps with the use of the Bibliometrix program, version 4.0.1 (Aria & Cuccurullo, 2017).

This scientific paper has a classic structure, and presents the theoretical introduction and then materials and methods. In the same section, research gaps are highlighted along with the research approach and assumptions. Then, the results and their interpretation are presented in the third section. Discussion of the results and a conclusion constitute the fourth and fifth sections respectively. In this study, the limitations of the conducted research were discussed and presented alongside possible new research avenues for future studies.

2 Theoretical Background

Countries are taking steps to reduce the damaging effect of the energy sector on the environment by integrating energy policy with environmental policy. Therefore, the industry is slowly shifting from electricity generation from traditional sources to

renewable energy sources. Until recently, the majority of companies carried out their activities in order to achieve competitive advantage (Niemczyk et al., 2021). Changing social expectations have challenged the current model of business thinking about the management of natural resources. Their usage reduction, recycling, reuse and redesign became important parts of decision-making processes in modern business (Moreno-Mondéjar et al., 2021). More enterprises have begun to perceive and implement social and ecological activities, treating the environment as a kind of stakeholder in implementing the concept of SD. All organisational processes are influenced by the energy carriers sales forecasting, and relations between supply and demand, whose understanding is crucial for achieving Sustainable Development Goals (SDGs) (Bohanec et al., 2017; Kaleta et al., 2018). Therefore, the bibliometric review results presented in this paper can be valuable for researchers, managers and policy-makers interested in the energy sector and energy carriers sales forecasting. The presented method can be useful for all those interested in the subject evolution represented by the analysed keywords and scientific areas. Also, the energy sector itself has to address a challenge of transformation to achieve the 7th SDG, namely to 'ensure access to affordable, reliable, sustainable and modern energy for all' (United Nations, 2022). This specific SDG is a common point for the subjects of energy sales forecasting and sustainability, which concern this paper.

3 Methodology

The Scopus and WoS multidisciplinary scientific databases were examined. These databases contain peer-reviewed books, journal articles, conference proceedings etc. This research uses the SLR variation method with queries (Table 1). Publications are listed by query syntax. Scientists using bibliometric software analyse those publications. This study used Bibliometrix, a less popular research software, in order to analyse SLR results. Bibliometrix has more features for bibliometric and in-depth scientific literature analysis. Bibliometrix is preferred over other bibliometric programs because it supports original query syntaxes with keywords to improve query results and has developed the option of graphical presentation of analyses.

This paper uses bibliometric SLR to study energy sales forecasting in (Visser et al., 2021). This paper does not detail the SLR procedure. The SLR method used the original set of queries to create a comprehensive and similar query syntax for each database. Query syntaxes affect the quantity and quality of results (Table 1), which

Bibliometrix analyses. The query order shows the database exploration steps with the accuracy of Bibliometrix's autocorrection. The popularity and trust placed on those databases among researchers were primarily the reasons behind their choice. The literature collected in those databases consists of peer-reviewed publications organised as digital collections of books, journal articles, conference proceedings etc.

Table 1: Queries used in the Scopus and Web of Science exploration on 27 December 2022

No.	Query syntax	Number of analysed files	
		WoS	Scopus
1	TITLE-ABS-KEY (("renewable energy" OR "natural resources" OR "energy carriers") AND (sales OR volume OR quantity) AND (forecast* OR predict*) AND sustainab*)	421	306
2	TITLE-ABS-KEY (("renewable energy" OR "natural resources" OR "energy carriers") AND (sales OR volume OR quantity) AND (forecast* OR predict*) AND sustainab*)[1]	181	235

Source: Authors' elaboration.

Table 1 shows quantitative differences between the WoS and Scopus databases on 27 December 2022. The query syntax and keywords of these two scientific literature collections affect the results. No rule indicates that one database is a subset of another based on result numbers. Thirty-five Scopus and WoS publications overlapped (Visser et al., 2021). Scopus and WoS cover documents differently. WoS has 181 documents relevant to query 2 and Scopus 235. In query 2 (Table 1), scientific interest areas were chosen to explore only relevant publications on energy sales forecasting in SD.

3 Results

Each set of query results for the two databases (Table 1) were merged, analysed in the Bibliometrix software and presented in graphical format. There is a visible evolution of the energy sales forecasting in the SD perspective visible throughout the main periods (Figure 1). Despite the query syntax and structure, among the

[1] Query 2 was limited by selected "categories" in WoS (Energy Fuels; Green Sustainable Science Technology; Materials Science Multidisciplinary; Engineering Environmental; Engineering Multidisciplinary; Management; Business; Mathematics Applied; Business Finance; Computer Science Artificial Intelligence; Computer Science Information Systems; Economics) and selected "subject areas" in Scopus (Environmental Science; Social Sciences; Business; Management and Accounting; Computer Science; Mathematics; Economics, Econometrics and Finance; Multidisciplinary).

results in Figure 1 there are no "forecasting" or "modelling" keywords. The first period covers years 1992–2008 and contains four keywords: "sustainability", "computer simulation", "sustainable development" and "eurasia", in the original form generated by Bibliometrix automatically. Those keywords influence another period of the subject of energy sales in the sustainability context covering the years 2009–2013. In these years, new keywords, such as "power", "generation", "agriculture" and "photovoltaic" joined the previous keyword collection (Figure 1). Another stage of evolution in the researched subject is characterised by period 2014–2023, where new keyword merges constituted another set of keywords, for example the new "performance" keyword. The "renewable energy" keyword merged in this evolution on the basis of "sustainable development", "agriculture", "land use", "life cycle" and "forestry" with "empirical research". Figure 1 presents the analysis of query 2 results, related to the energy sales forecasting in the sustainability context, the subject of the bibliometric review. Keyword evolution in this context is characterised by the snowball effect, in which both new keywords are added to the previous period, and new keywords are proposed by the Bibliometrix software (Bran et al., 2021). The program displays results in accordance with existing and future directions of scientific interests presented in the publications.

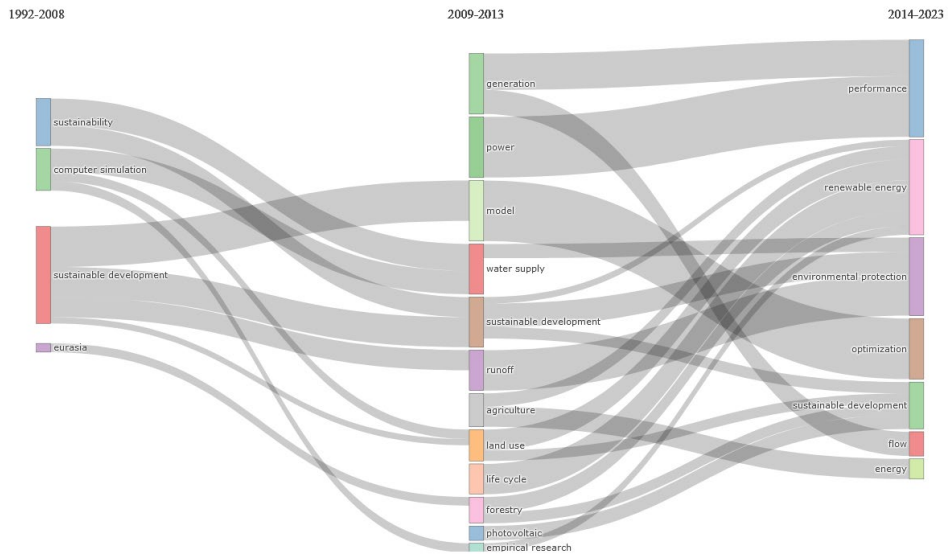

Figure 1: Thematic evolution of merged Scopus and WoS databases for query 2 results
Source: Authors' elaboration in Bibliometrix Software version 4.0.1.

Figure 1 shows most keywords in 2009–2013. The Bibliometrix software divided the time span into periods. As shown, SD and related topics are crucial to keyword evolution. "Performance" and "Optimization" are management science keywords. Bibliometrix created Figure 1. Thematic evolution parameters: 250 words minimum, 6. weight index was 0.1, inclusion index weighted by word-occurrences, clustering algorithm was Walktrap, which is important for Bibliometrix. Time slices: 2 cutting points, 2008 start year, 2013 stop year.

Figure 2 shows another Bibliometrix evolution analysis. The authors excluded two keywords from the analysis of Bibliometrix results as shown in Figure 2, in order to focus on the most related keywords to improve readability. "Sustainable development" and "article" were those keywords (grey colour in the legend of the chart). Figure 2 shows the similar phases (temporal parallelism of curves) of interest in energy sales forecasting since 1992. Figure 2 shows cumulative characteristics in each coloured keyword in the figure legend. Field was Keyword Plus, occurrences were cumulate, and words were 10. Clarivate's Keywords Plus algorithm uses words or phrases that frequently appear in an article's references but not in its title.

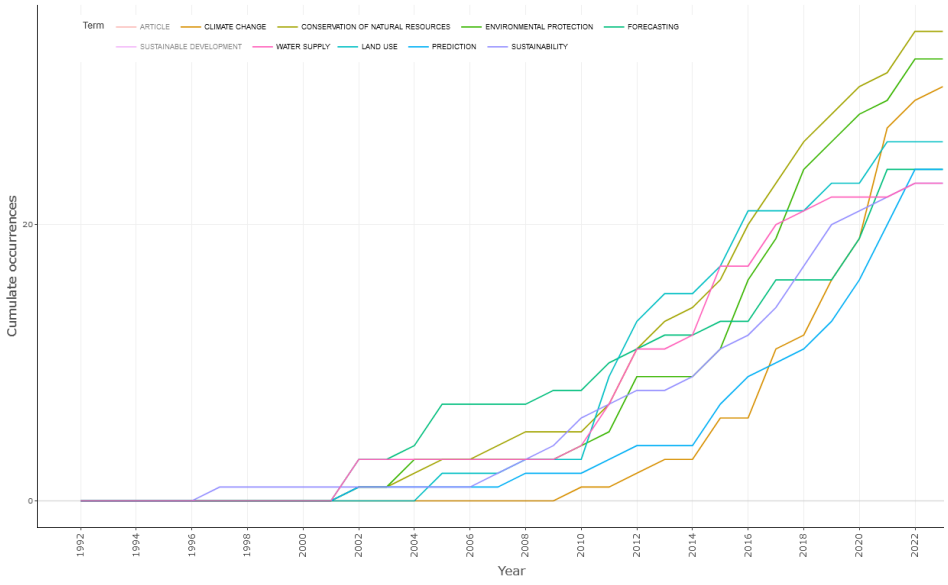

Figure 2: Thematic evolution of merged Scopus and WoS databases for query 2 results

Source: Authors' elaboration in Bibliometrix Software version 4.0.1.

As shown in Figure 2, keywords overlap in the subject evolution, demonstrating the interrelationships between energy sales forecasting and SD.

Figure 3 shows the keyword co-occurrence map of Bibliometrix's Keyword Plus algorithm. The bibliometric map's nodes (coloured dots) are keywords co-occurring in scientific publications represented by the edges (lines). Keyword clusters are coloured automatically by scientific field (Figure 3). Bibliometrix found "forecasting" in the red econometrics cluster. "Sustainable development" in the second largest red network is crucial. The blue cluster in Figure 3 contains keyword group studies on "conservation of natural resources" in nature. The green cluster is agriculture and bioresources. The fourth, violet cluster keywords contain mathematical operations. Thus, sustainable energy sales forecasting requires business, mathematics and agriculture. In the keyword co-occurrences bibliometric map (Figure 3), network layout was automatic and clustering algorithm was Louvain, normalisation in association procedure, repulsion force was 0.2, number of nodes was 31, minimum number of edges was equal to 4, remove isolated nodes field was "yes," and node colour by year was deselected. There are 31 nodes and 4 edges, isolated nodes field were deselected, node colour by year was deselected.

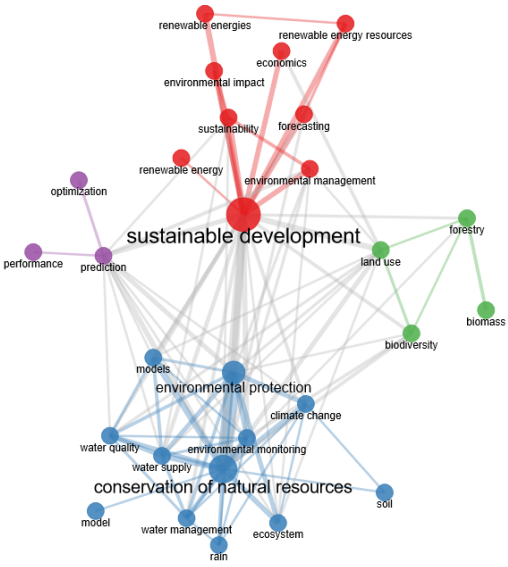

Figure 3: The bibliometric map of keyword co-occurrences based on merged query 2 results
Source: Authors' elaboration in Bibliometrix Software version 4.0.1.

The three keywords were removed from the bibliometric map in Figure 3 to enhance the quality and readability of the results (Aria & Cuccurullo, 2017). This is standard procedure. The first keyword to be removed was "energy efficiency". It was deleted from the red cluster due to its exceedingly long distance from the other nodes. The second keyword to be removed was "article" from the blue cluster. The third was the "china" (original form proposed by Bibliometrix) keyword located also in the blue cluster. This keyword was removed because country comparison is not within the aims of this paper. It is also good practice in bibliometric research to remove all names of countries, organisations or geographical objects.

3 Discussion

Despite the query used, there were no nodes in Figure 3 representing energy sales forecasting. There were some identified, however, among the specific results presented in bibliometric maps and similar analysis related to energy sales forecasting. Those keywords were searched in raw results to generate Figure 2 and were transformed into a tabular form in Bibliometrix. The occurrences of keywords "sales" and "forecasting" were identified 8 and 24 times respectively. "Sales" and "forecasting", however, are not among the most frequent words.

The problem of searched keyword identification is either caused by the query syntax or the rarity of those words in the examined databases. These results should be checked against another popular bibliometric software, i.e. VOSviewer. Technical problems, however, can be encountered while importing the data in a compatible format for the VOSviewer software. Although the field of sales forecasting was identified, there is no investigation of forecasting methods or prognosis models. The aim of this article to explore and present keyword evolution in the subject of energy sales forecasting in the SD context was achieved.

5 Conclusions

The energy carriers sales forecasting (including fuels) in the context of SD is important for understanding the processes of energy transition (shift from fossil fuels to renewable and green fuels) and achieving SDGs in the energy sector. The bibliometric analysis illustrates the evolution of this process in the scientific literature, by the presentation of the most significant keywords. The scientific

contribution of this article lies in its provision of a general pattern in the form of a diagram of the evolution of keywords (Figure 2). In the future, in-depth bibliometric research combined with SLR can consider the general pattern of the sales forecasting method, which can be specific to renewable and non-renewable energy sources. Further research will focus on selected types of energy carriers: liquid fuels, gas and coal.

Predicting energy sales can be useful for the management processes of a company. It can help managers plan inventory, set prices and make decisions about staffing and marketing. Additionally, accurate energy sales predictions can help managers identify trends and respond to changes in the market, which can ultimately improve the overall performance of the business. Energy sales forecasting is important for businesses in the SD context because it allows them to plan for future energy demand and make informed decisions about investments in renewable energy sources and energy efficiency measures. This can help businesses to reduce their environmental impact and become more sustainable, while also potentially reducing costs and increasing profits. Additionally, accurate energy sales forecasts can help businesses to comply with regulations and policies related to energy use and emissions.

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