Contemporary Engineering Sciences, Vol. 11, 2018, no. 3, 121 - 128
HIKARI Ltd, www.m-hikari.com
https://doi.org/10.12988/ces.2018.816

Scientific Analysis of the Low Carbon Energy Research from 2007 to 2016

Daniel Ojeda Ossa

Mechanical Engineering Program, Universidad del Atlántico
km 7 antigua vía Puerto, Colombia

Alfonso Rodríguez Peña

Mechanical Eng., Materials, Processes and Manufacturing Technologies Research Group – IMTEF, Universidad del Atlántico, km 7 antigua vía Puerto, Colombia

Guillermo Valencia Ochoa

Mechanical Eng., Efficient Energy Management Research Group – Kaí, Universidad del Atlántico, km 7 antigua vía Puerto, Colombia

Abstract

This article presents a scientometric analysis of the research trend on the use of low carbon energy, based on the information obtained from the Web of Science database in 2000 and 2016. Quantitative and qualitative results about the annual production, the country, the institution, the impact of citations and the dating relationships in the field of study are presented, which was tabulated through the HistCite program. The trend analysis shows growth during the last five years regarding the number of publications, with People R China and Chinese Academic of Science as, respectively, the country and the institution with the highest research production. Realizing a classification regarding the Total Local Citations Score, China and United Kingdom are the two most developed countries on the topic. Finally, it is shown that the journal with the highest production was ENERGY POLICY, with 8% of the total publications among all journals.

Keywords: Coal energy, low consumption, scientometric analysis

1 Introduction

The implementation of modern energy services and the new trend of electricity generation by low carbon economies as a part of climate change mitigation strategies are results of a complete strategy to manage global warming, such like carbon neutrality, geoengineering, and adaptation to global warming [1]. An example of these policies was the Kyoto Protocol, which comes into force on February 16, 2005, in which the most industrialized countries decided to reduce their emissions [2]. The main advantage of the use of renewable energy is that they do not produce emissions of CO_2 and other polluting gases into the atmosphere, thus reducing the greenhouse effect [3]. The use of renewable energy for the sustainability of a country has been tried to be implemented all over the world, presenting good results, such as the case of Norway, which is the main country that generates renewable energy concerning the use of this kind of energy [4]. On the other hand, the United States in recent years has grown a lot in the renewable energy sector, acquiring know-how; the most considerable opportunities arise in companies that have a competitive advantage or with specific services, ahead of significant solar developers that offer standard services [5]. The supply chains that make up the parts of energy systems have evolved over many decades to meet the energy, heat, transport, manufacturing and service needs of the continuously developed society. They are complex and dynamic, involving many different actors, technologies, fuels, operating at different scales and locations, and are shaped by current policies, rules, and regulations [6]. An excellent example of this is People R China that after the announcement of the China 2020 national target of reducing the intensity of carbon dioxide emissions per unit of GDP by 40-45% compared to 2005 levels, the Chinese provincial governments prepared to restructure the rural energy policy and plan their contribution to the realization of the target state of reduction [7]. Energy consumption in Bangkok also accounts for a large part of Thailand's total energy consumption; however, few carbon and energy studies have focused on the city levels. International research indicates that cities are the key drivers of energy use and associated carbon emissions [8]. There is a growing scientific consensus that it is necessary to limit the increase in global average temperature to around 2 °C above pre-industrial levels to avoid an unacceptable impact on the climate system, this requires that emissions from developed countries be radically reduced over the next 40 years [9].

2 Methodology

2.1 Study objective

The present study aims to identify the main actors in the research of renewable energies, low carbon energies and environmental economics in the world. The analysis of the results of the investigations that were obtained through the Web of Science was processed with HisCite software to achieve the behavior of the bibliometric indicators in the study period. The problem that motivated this study is summarized in the following problem question: what is the behavior of the bibliome-

tric indicators of the results obtained from a database about the research on the use of renewable energies and new environmental economies in the world. The general objective of this work is based on the study of clean energy research trends and their different applications, through the analysis of bibliometric indicators between 2000 and 2016. As specific objectives of this work, the following are proposed: • Define the source of scientific information and search criteria, to obtain a database that allows the calculation of bibliometric indicators. • Process the information gathered from scientific production, which facilitates analysis of the quantity of publications by countries, institutions, authors, journals and their relationship among them. • Analyze the bibliometric indicators found, to identify sources of publications with better research quality.

2.2 Population and sample

The target population of this study consists of 519 records, among them scientific articles, conference articles, books and chapters of books, editorial material, and review book. Scientific articles accounted for 77.8% of the total number of records, between the years 2000-2016 to search for the word "coal" in the title and the word "energy" in the subject. The system used to locate records of the investigations on the use of clean energy was the result of finding information in the database Web of Science, which is a platform based on web technology that collects the leading publications in a specific area of knowledge.

3 Results and discussion

3.1 Type of document and language

Ten types of documents were identified in 519 records, where most of them belong to the category of journal articles, which represent 77.8% of the total records, indicating that these are the main means of scientific communication. The works were written in 4 languages, of which dominated English, with 95.8% of the total records, this result makes senses because English is the international language for researchers around the world.

3.2 Annual production of research

Figure 1 shows the production of the corresponding annual research between the years 2000 and 2016. According to the data collected up to 2016, during this period of 16 years, the general trend has been a steady increase in annual production, especially, the number of registrations between 2013 and 2014 increased considerably.

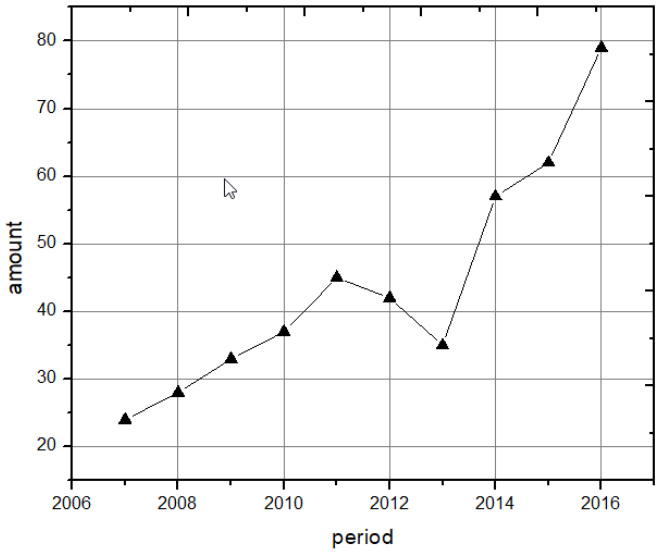

Figure 1. Yearly production of clean energy uses from 2000 to 2016

3.3 Distribution by countries

The analysis by the country distribution of the research shows the development capacity of new technologies in the nations with most influence concerning the topic. A total of 64 countries contributed to the research on low carbon energies. From Table 1 it can be seen that UK heads the list with a total of 108 publications followed by People R China, USA, Germany, and Japan. The citations show the impact of the publications, these are measured by the indicator of TLCS, (Total local citation Score) as the indicator to measure the total investigative influence between these countries. In Table 1 it is observed that the UK not only produces the highest number of publications, but the articles produced are the most referenced, they are the ones with the most significant impact and at the same time those with the highest TLCS index. Among the 13 countries with TLCS values of more than 5, there are two developed countries *(The United States and Peoples R China).*

Table 1. Distribution by countries

Country	Records	Country	TLCS
UK	108	UK	32
Peoples R China	104	Peoples R China	18
USA	92	Japan	17
Germany	35	USA	11
Japan	30	Netherlands	10
India	22	Italy	6
Spain	20	Sweden	6
France	19	Denmark	5
Italy	18	Thailand	5
Netherlands	18	Austria	3

3.4 Institutional-based distribution

The distribution based on institutions shows the research capacity and the activities of institutions around the world. This distribution determines the leading institutions in low carbon energy research as shown in Table 2, the institutions with the highest production of articles were Univ Leeds, Sch Earth & Environment and Natl Univ Singapore, Energy Studies Inst of which was found 6 and five articles, respectively. The following two universities are the Beijing Normal Univ, Sch Environm and NTT Corp, NTT Basic Res Labs. The institution-based distribution was different from the production that was shown in the country distribution shown in Table 1. Using TLCS, the five major institutions regarding citations were NTT Corp, NTT Basic Res Labs, Tohoku Univ, Grad Sch Engn, Dhurakij Pundit Univ, Fac Engn, Lulea Univ Technol, Econ Unit and Lund Univ, AgriFood Econ Ctr then the number of citations per publication was analyzed (TLCS/records).

Table 2. Institutional-based distribution

Institution	records	Institution	TLCS
Univ Leeds, Sch Earth & Environment	6	NTT Corp, NTT Basic Res Labs	10
Natl Univ Singapore, Energy Studies Inst	5	Tohoku Univ, Grad Sch Engn	5
Beijing Normal Univ, Sch Environm	4	Dhurakij Pundit Univ, Fac Engn	4
NTT Corp, NTT Basic Res Labs	4	Lulea Univ Technol, Econ Unit	4
Armored Inst Technol, Dept Mech Engn	3	Lund Univ, AgriFood Econ Ctr	4
Chinese Acad Sci, Grad Univ	3	Lund Univ, Dept Polit Sci	4
Chinese Acad Sci, Inst Geog Sci & Nat Resources Res	3	Queens Univ Belfast, Ctr Med Biol	4
Chinese Acad Sci, Lanzhou Inst Chem Phys	3	Queens Univ Belfast, Ctr Plasma Phys	4
Chinese Acad Sci, Shanghai Inst Appl Phys	3	Tokyo Univ Sci, Dept Phys	4
Fdn Eni Enrico Mattei	3	Univ Birmingham, Birmingham B15 2TT	4

3.5 Distribution of journals and research documents

Table 3 shows the top 20 journals, which include 201 articles, the magazine with the highest production was Energy Policy, with 8.3% of the total publications of the top 20 journals.

Additionally, Table 3 shows the list of journals with high scores of TLCS after energy policy which are: energy, applied energy, renewable & sustainable energy reviews and energies.

Table 3. The 20 journals with the highest citation averages

Journal	Records	Percent	TLCS
Energy Policy	43	8,3	21
Energy	17	3,3	5
Applied Energy	15	2,9	6
Renewable & Sustainable Energy Reviews	14	2,7	3
Energies	12	2,3	1
Journal Of Applied Physics	9	1,7	0
Nuclear Instruments & Methods In Physics Research Section B-Beam Interactions With Materials And Atoms	9	1,7	2
Carbon	8	1,5	6
Journal Of Cleaner Production	8	1,5	1
Journal Of Nuclear Materials	8	1,5	1
Renewable Energy	8	1,5	0
Sustainability	8	1,5	0
Energy Economics	6	1,2	3
Journal Of Physical Chemistry C	6	1,2	6
Applied Physics Letters	5	1	0
Energy And Buildings	5	1	1
Energy Research & Social Science	5	1	0
International Journal Of Hydrogen Energy	5	1	1
Journal Of Renewable And Sustainable Energy	5	1	0
Physical Review B	5	1	0

It should be noted that the high-impact authors were chosen using TLCS. As shown in Table 4, the author with the highest TLCS value was Kobayashi Y with four published articles and a TLCS value of 10, the second has the same number of articles and the same TCLS, therefore, share the first place. The third and fourth place belong to Eyre N and Nakata T.

Table 4. High Impact Authors

Author	Records	TLCS
Kobayashi Y	4	10
Suzuki S	4	10
Eyre N	2	6
Nakata T	2	5
Rodionov M	2	5
Silva D	2	5
Bouzarovski S	1	4
Bradshaw M	1	4
Bridge G	1	4
Davies RJH	1	4

4 Conclusions

In general, the predilection of the investigation of clean energy or energy with low carbon consumption has increased steadily in the year 2000 until 2016 with a notable research increase about the topic between 2013 and 2014. These inclinations show the growing importance of low carbon energies and the use of these energy sources to contribute to the reduction of emissions of harmful gases for health and the environment. Due to current government policies, it is believed that the use and research related to the use of low carbon energies will increase.
Currently, 64 countries contribute significantly to the research of low carbon economies and renewable energies, which focuses on the reduction on the climate changes impact; the production is concentrated in the UK followed by China, the United States, Germany, and Japan. The research papers were published in journals such as Energy and Progress in energy and combustion science, Energy Efficiency, and Nature, by authors with greater publication such as Suzuki S and Kobayashi Y which are part of the evidence that Japan and countries from the east, they are promoting research on a large scale regarding the subject of study. Finally, research on low carbon energies is developing, driven by policies and needs of society.

Acknowledgements. This research was supported by the Mechanical Engineering Program of Universidad del Atlántico, with the Efficient Energy Management Research Group – Kaí as support for D. Ojeda and G. Valencia, and the Materials Processes and Manufacturing Technologies Research Group – IMTEF as support for A. Rodríguez.

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Received: January 19, 2018; Published: February 5, 2018