



## GLOBAL ASSESSMENT OF FOSSIL FUELS RESEARCH OUTPUT: A SCIENTOMETRIC STUDY

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### ABSTRACT

This paper has made an attempt to identify the characteristic features of scholarly publications in the field of fossil fuels at global level using scientometric analysis. For analysis, the data was gathered through Web of Science (WoS) database from Clarivate Analytics previously Thomas Reuters. The purpose of this study is to provide an overview of research activities at the global level on the subject for the period from 1989 to 2016 (28 years) describing various aspects of research output. This paper tries to focus on the various parameters of Fossil fuels literature output in terms of articles, reviews, proceedings papers, editorial materials, meeting abstracts, news items, book chapters, letters, book reviews, notes, corrections, data papers, retracted publications, reprints, discussion and bibliography. This paper which has evaluated the literature output of fossil fuels includes year wise growth rate of articles, document and language wise distribution, top ten subject, top ten leading authors of publications, International collaboration; Institution based collaboration, ranking of top ten journals, and productive research areas in the field of fossil fuels during the period of study.

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## INTRODUCTION

This century may be called as the century of metric science due to the development of science and technology and Information and Communication Technology. In the digital environment, a number of metrics are developed in the field of Library and Information Science such as Librametrics, Bibliometrics, Scientometrics, Infometrics, Webometrics, Cybermetrics, and now Altmetrics. There are a number of definitions for the term "Scientometrics" in the literature. According to Tague-Sutcliffe (1992). Scientometrics is defined as "the study of the quantitative aspects of science as a discipline or economic activity. It is part of the sociology of science and has application to science policy-making. It involves quantitative studies of scientific activities, including, among others, publications, and so overlaps bibliometrics to some extent". Scientometrics is "the quantitative study of the disciplines of science based on published literature and communication. This could include identifying emerging areas

of scientific research, examining the development of research over time, or geographic and organizational distributions of research" (Glossary of Thompson, 2008). Van Raan (1997) defined that "scientometric research is devoted to quantitative studies of science and technology. It aims at the advancement of knowledge and the development of science and technology; it is also in relation to social and political question". According to Dictionary of Bibliometrics, (Virgil Diodato, 1994). Scientometrics applies "the bibliometric techniques to science and examines the development of the sciences". Stock and Sonja (2006) identified in his book, 'Facets of Informetrics' that the major areas of Scientometrics are individual scientific documents, authors, scientific institutions, academic journals and regional aspects of science. Fossil Fuels are energy-rich substances that have formed from the accumulated remains of living organisms that were buried millions of years ago. For example, the gasoline that fuels our cars, the coal that powers electrical plants, and the natural gas that heats our homes are all fossil fuels. There are three major

group of primary energy such as Nonrenewable energy, Renewable energy and waste by Demirel, (2012). The fossil fuels which comes under non-renewable energy includes coal, crude oil, natural gas, and nuclear fuel. Primary sources of energy consisting of petroleum, coal, and natural gas amount to about 85% of the fossil fuels in primary energy consumption in the world (DOE/EIA, 2010 and EP UN, 2009). Fossil fuels are formed from the remains of dead plants and animals by exposure to heat and pressure in the earth's crust over the millions of years. Fossil fuels (Demirel, 2012), contain high percentages of carbon and include mainly coal, petroleum, and natural gas. The burning of fossil fuels produces around 21.3 Gigatons of carbondioxide per year, and the natural processes can only absorb about half of that amount, so there is a net increase of 10.65 billion tons of atmospheric carbondioxide per year (Jacobson, 2009).

In this paper, in order to evaluate the research contributions of fossil fuels during the period 1989 to 2016, an attempt has been made to analyze globally, the research areas in fossil fuels and the core journals publishing it, the language wise distribution, year wise contribution, relative growth rate of fossil fuels, ranking of top ten institutions, authors, and the related funding agencies during the period of study.

#### Related work

Ho (2012) investigated the characteristics of top-cited articles published in the Web of Science on Chemical Engineering discipline during 1899-2011. For analysis, five bibliometric indicators were used to evaluate source countries, institution and authors. A new indicator, Y-index, was created to assess quantity and quality of contribution to articles. The findings of the results revealed that 3828 articles were produced from 1931 to 2010 and 54% published before 1991, and 49% top-cited articles originated from US. The top eight productive institutions were all located in US. Velmurugan and Radhakrishnan (2017) have found the observations of research publications on Phytochemistry in India as seen from the Web of Science (WoS) database during 1994-2014. It was identified that a total 1280 scholarly publications with 1216 citations and 2083 cited references were found and have retrieved in worldwide and from India. The highest number of research articles (11.6%) were published in 2014 throughout the world and the majority of Indian literature (23.1%) were produced in 2011 and most of the documents were research articles (50.4%) and are placed in the first rank.

Huang and Ho (2011) analyzed the research on corporate governance research publications in journals collected from SSCI, throughout the period from 1992 to 2008. It was identified that the mainstream of corporate governance research was in finance business, economics, management and business fields, whereas research in the law category somewhat played a less important role. 'Ownership structure' found the most frequently used author keywords and followed by 'board of directors'. Chitra and Jeyshankar (2012) examined growth rate of research output on Neuroscience during the period from 1972 to 2011 using Scopus database found the number of records in all source forms published in the field of Neuroscience to be 35869. 2.46% of the articles had no author information. USA obtains 1st rank in world research output, only 0.59% of the articles were contributed by authors in India ranking 18<sup>th</sup> among top 20 countries. Velmurugan and Radhakrishnan (2016) have examined the

publication research productivity of Malaysian Journal of Library and Information Science (MJLIS) for a period of nineteen years between 1996 and 2014 with total of 315 research publications. The results showed that 8.89% was the maximum research output in 2011 and the minimum number 4.13% was in 1998. The highest number of average authors per paper was 2.90 in 2012 and the average Exponential growth rate was 1.007 and it showed the increasing trend in the journal and the highest number of citations was in 2010 whereas the least number of citations was in 1998. Velmurugan and Radhakrishnan (2016) have analysed the literature growth of Nanotechnology in Canada retrieved from web of science database with 576 scientific research papers during the period between 1994 and 2014. It was found that the average number of literature output per year was 33.88 and the highest productivity was published during 2013 – 2014. The maximum number of authors was 364 with the mean value of 4.77 (2014) and the huge number of (2791) citations was in 2008 and the highest average citation per paper was 60.74 in 2007. Jeyshankar and Vellaichamy (2014) analyzed the research productivity of Cervical Cancer research output which were retrieved from Scopus database for the period of ten years from 2003-2012. A total number of 18, 060 records were found during the study period. The results of the study revealed that USA was the most productive country on cervical cancer research with 26.04% of publications. Indian researchers have contributed 730(4.04%) papers on cervical cancer research and ranked seventh. Gynecologic Oncology (1079 papers) was the most productive journal and C.J.L.M. Meijer (119 papers) was the most productive author on cervical cancer research. Analysis on Energy and Environment Research Productivity in Australia (Velmurugan and Radhakrishnan, 2015); research publications in Indian Journal of Pure and Applied Physics (IJPAP) during 2009-2012, Velmurugan (2014); and the nature of research publications in Journal of Information Literacy was done by Velmurugan and Radhakrishnan (2015).

Balasubramani and Murugan (2011) measured the literature output of Tapioca (Sago) in India for the period from 1997 to 2010. A total number of 447 research publications were retrieved from the Web of Science software and analyzed to fulfill the objectives of the study. The major purpose of the study was to analyze the research performance of India in Tapioca in the national and global level. The results showed that the contribution of literature output of Tapioca to English language was 447 (100%) publications and the average number of publications produced per year was 11.76%. The highest number of publications produced was in the year 2008 and the number was found to be 38. The most productive author is Moorthy SN with 38 papers and Central Tuber Crops Research Institute has topped the list with 74 publications followed by CSIR with 28 publications and Central Food Technological Research Institute with 22 publications. Murugan and Balasubramani (2012) in this paper, they have analyzed Remote Sensing research output at the international level during 1975 – 2010 with a total number of 1188 research article publications and the cited references were 30654. It was found that the average number of publications published per year was 38.07. The highest number of paper (119) was published in 2009. USA topped the list (39.8%) of publications, followed by UK (10.8%) publications, India (7.8%) publications respectively. The highly productive author was Kaufman YJ with 13 (1.1%) publications, and the next productive author was Wagner W with 10 (0.8%) publications.

## Objectives of the study

The main purpose of this study is to evaluate the research performance in the field of fossil fuels at global level for the period 1989 to 2016. The other objectives are:

- To evaluate the document wise publications of fossil fuels;
- To measure the language wise distribution;
- To know the year wise contribution;
- To find out the relative growth rate of fossil fuels;
- To identify the top ten institutions, authors, research areas and funding agencies globally and
- To rank the core journals of fossil fuels during the period of study.

## MATERIALS AND METHODS

For analysis, the Web of Science core collection (WOSCC) database by Clarivate Analytics (formally Thomas Reuters) has been chosen to collect data. The search string "Fossil fuels" was given in the topic tag globally which were indexed by SCI-EXPANDED, SSCI, A & HCI during 1989-2016. A total number of 18,131 scholarly communications were identified at the global level. To evaluate the research papers of Fossil fuels, relative growth rate (RGR) and Doubling Time (DT), trend line analysis such as Exponential Growth Model and R-squared value ( $R^2$ ) statistical tools were used.

## RESULTS AND DISCUSSION

For analysis, a total number of 18131 scholarly articles were collected from web of science database for the period of 28 years (1989-2016). The fossil fuels literature has been measured and the data was analyzed for various factors such as year wise growth rate of articles, document and language wise distribution, top ten subject, top ten leading authors of publications, International collaboration, Institution based collaboration, ranking of top ten journals, and productive research areas in the field of fossil fuels during the period of study.

news items, book chapters, letters, book reviews, notes, corrections, data papers, retracted publications, reprints, discussion and bibliography. It was identified that the maximum number of (84.05%) research papers were in the form of journal articles and ranked first and the next productive document was reviews with 2121 (11.63%) research output. The third position was received by conference proceedings with 302 (1.64%) research papers during the study period. It is to be noted that the below five research output were retracted publications, reprints, discussion and bibliography.

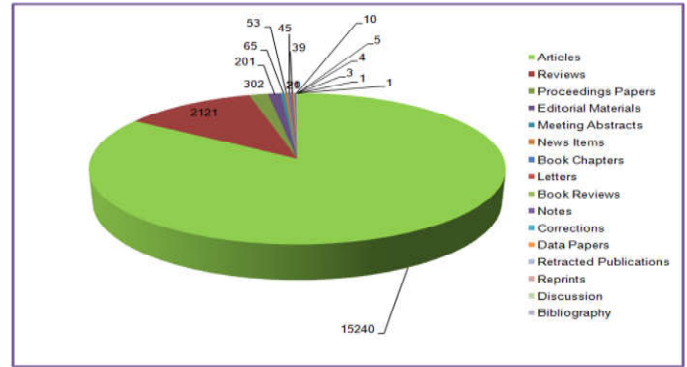


Figure 1. Document wise

## Language wise distribution

Generally, languages are the back bone of any nation, all over the world. So, language of fossil fuels literature has been taken into account for evaluation. Fossil fuels literature is published in 22 languages such as English, German, Japanese, Chinese, French, Polish, Spanish, Portuguese, Czech, Slovak, Serbo Croatian, Croatian, Turkish, Swedish, Slovenian, Russian, Korean, Italian, Serbian, Hungarian, Finnish and Dutch during the period of study. It was found that the major portion of (97.838 %) research papers were written in English and it has ranked first and followed by German with 107 research papers and the research papers in the Japanese language has scored third rank with 47 published literature. It is to be noted that only less than six papers were written in Turkish, Swedish, Slovenian, Russian, and Korean with three research

Table 1. Document Wise

S. No	Document Types	Records	% of 18131	Cumulative	Cumulative %
1	Articles	15240	84.05	15240	84.05
2	Reviews	2121	11.63	17361	95.68
3	Proceedings Papers	302	1.64	17663	97.32
4	Editorial Materials	201	1.19	17864	98.51
5	Meeting Abstracts	65	0.33	17929	98.84
6	News Items	53	0.27	17982	99.11
7	Book Chapters	45	0.34	18027	99.45
8	Letters	39	0.21	18066	99.66
9	Book Reviews	21	0.12	18087	99.78
10	Notes	20	0.11	18107	99.89
11	Corrections	10	0.051	18117	99.94
12	Data Papers	5	0.021	18122	99.96
13	Retracted Publications	4	0.020	18126	99.97
14	Reprints	3	0.016	18129	99.98
15	Discussion	1	0.005	18130	99.99
16	Bibliography	1	0.005	18131	100
Total		18131	100		

## Document wise distribution

It is inferred from the table 1 (Fig.1) the global distribution of document wise on fossil fuels literature are articles, reviews, proceedings papers, editorial materials, meeting abstracts,

publications in each language as output and one each in Serbian, Hungarian, Finnish and Dutch languages respectively (Table 2).

Table 2. Language wise distribution

S. No	Languages	Records	% of 18131	Cumulative	Cumulative %
1	English	17739	97.838	17739	97.838
2	German	107	0.59	17846	98.428
3	Japanese	47	0.259	17893	98.687
4	Chinese	41	0.226	17934	98.913
5	French	40	0.221	17974	99.134
6	Polish	38	0.21	18012	99.344
7	Spanish	33	0.182	18045	99.526
8	Portuguese	27	0.149	18072	99.675
9	Czech	20	0.11	18092	99.785
10	Slovak	6	0.033	18098	99.818
11	Serbo Croatian	6	0.033	18104	99.851
12	Croatian	6	0.033	18110	99.884
13	Turkish	3	0.017	18113	99.901
14	Swedish	3	0.017	18116	99.918
15	Slovenian	3	0.017	18119	99.935
16	Russian	3	0.017	18122	99.952
17	Korean	3	0.017	18125	99.969
18	Italian	2	0.011	18127	99.98
19	Serbian	1	0.006	18128	99.986
20	Hungarian	1	0.006	18129	99.992
21	Finnish	1	0.006	18130	99.998
22	Dutch	1	0.006	18131	100
Total		18131	100		

Table 3. Year wise distribution

S. No	Publication Years	Records	% of 18131	Statistical measures	
1	2016	2217	12.228	Mean	647.5357
2	2015	1906	10.512	Standard Error	117.863818
3	2014	1708	9.42		
4	2013	1599	8.819	Median	325.5
5	2012	1418	7.821	Standard Deviation	623.6767
6	2011	1334	7.358		
7	2010	1064	5.868		
8	2009	961	5.3	Sample Variance	388972.628
9	2008	777	4.285		
10	2007	665	3.668	Kurtosis	0.289281
11	2006	459	2.532		
12	2005	413	2.278	Skewness	1.2165070
13	2004	367	2.024		
14	2003	331	1.826	Range	2189
15	2002	320	1.765		
16	2000	273	1.506	Minimum	28
17	1996	264	1.456		
18	1998	263	1.451	Maximum	2217
19	1999	256	1.412		
20	1997	250	1.379	Count	28
21	2001	244	1.346		
22	1995	239	1.318	Confidence level (95.0%)	241.83657
23	1993	225	1.241		
24	1994	209	1.153	Sum	18131
25	1992	154	0.849		
26	1991	151	0.833		
27	1990	36	0.199		
28	1989	28	0.154		
Total		18131	100		

### Year wise distribution

Table 3 (Fig.2) gives the data for the year wise literature on fossil fuels after analyzing at international level with 18,131 record counts during the period from 1989 to 2016. The range of productive literature output was from 28 in the beginning year 1989 to 2217 research papers in the year 2016 during the period of study. The analysis indicates that the majority of scholarly papers i.e. 2217 (12.228%) were published in the year 2016 at the global level which was followed by 1906 (10.512%) research papers in the year 2015 and the next productive year 2014 with 1708 (9.42%) papers. On scrutinizing the whole data for year wise distribution it was found that only a meager number of research papers, 28 (0.154%) were published during the year 1989.

It was evaluated from the trend line based exponential growth rate of fossil fuels literature that the y value is  $2447.2e^{-0.125x}$  and  $R^2$  value is 0.8968 and found that the growth level indicates progressively. Researchers have measured the data statistically using SPSS software and has presented the values in Table 3.

### Growth of scholarly publications

The growth of scholarly publications was evaluated using two parameters such as Relative Growth Rate (RGR) and Doubling time (DT) which were already used by Mahapatra<sup>21</sup> in 1985. RGR is a measure to study the increase in number of articles over time. It is measured as:

$$RGR = (\ln N_2 - \ln N_1) / (t_2 - t_1)$$

Where  $N_2$  and  $N_1$  are the cumulative number of publications in the years  $t_2$  and  $t_1$ .

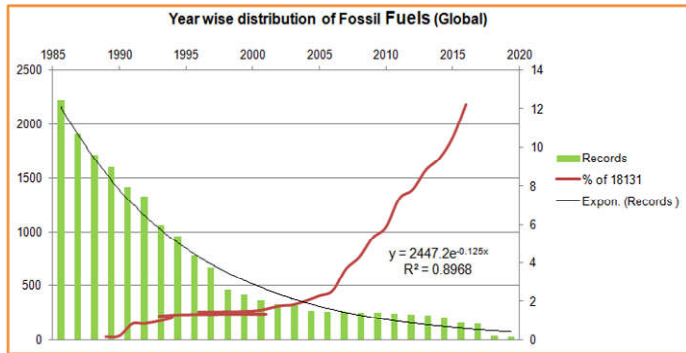


Figure 2. Year wise distribution

Table 4. Relative growth rate and Doubling time of Fossil fuels literature

S. No	Year	Record count	Cumulative	Log <sub>e</sub> N <sub>1</sub>	Log <sub>e</sub> N <sub>2</sub>	RGR	DT
1	1989	28	28	3.33	-	-	-
2	1990	36	64	3.58	4.15	0.57	1.22
3	1991	151	215	5.01	5.37	0.36	1.92
4	1992	154	369	5.03	5.91	0.88	0.78
5	1993	225	594	5.41	6.38	0.97	0.71
6	1994	209	803	5.34	6.68	1.34	0.52
7	1995	239	1042	5.47	6.94	1.47	0.47
8	1996	264	1306	5.57	7.17	1.60	0.43
9	1997	250	1556	5.52	7.34	1.82	0.38
10	1998	263	1819	5.57	7.50	1.93	0.35
11	1999	256	2075	5.55	7.63	2.08	0.33
12	2000	273	2348	5.61	7.76	2.15	0.29
13	2001	244	2592	5.49	7.86	2.37	0.31
14	2002	320	2912	5.76	7.97	2.21	0.30
15	2003	331	3243	5.80	8.08	2.28	0.30
16	2004	367	3610	5.90	8.19	2.29	0.30
17	2005	413	4023	6.02	8.29	2.27	0.30
18	2006	459	4482	6.12	8.40	2.28	0.30
19	2007	665	5147	6.49	8.54	2.05	0.33
20	2008	777	5924	6.65	8.68	2.03	0.34
21	2009	961	6885	6.86	8.83	1.97	0.35
22	2010	1064	7949	6.96	8.98	2.02	0.34
23	2011	1334	9283	7.19	9.13	1.94	0.35
24	2012	1418	10701	7.25	9.27	2.02	0.34
25	2013	1599	12300	7.37	9.41	2.04	0.33
26	2014	1708	14008	7.44	9.54	2.10	0.33
27	2015	1906	15914	7.55	9.67	2.12	0.32
28	2016	2217	18131	7.70	9.80	2.10	0.33
Total		18131					

Doubling time is the time required for articles to become double of the existing amount. This is expressed as:

$$Dt = (t_2 - t_1) \ln 2 / (\ln N_2 - \ln N_1)$$

or

$$Dt = \ln 2 / RGR$$

This study has evaluated the relative growth rate and the doubling time of research papers published on fossil fuels. It is inferred from the table 4 that the relative growth rates of total scholarly publications showed a fluctuation trend. The growth rate was 0.36 in 1989 and it has been steadily increasing up to 2.37 in the year 2001 and the average growth rate was 1.824. The doubling time has been measured during the period of study and it was identified to be 1.22 in the beginning year 1989 and gradually decreased in 2016 i.e. 0.33.

### Ranking of Global Organizations on Fossil fuels (Top 10)

Table 5 illustrates the list of global organizations which participated to publish their research papers on fossil fuels during the period from 1989 to 2016. A total of 9,735 organizations produced 18,131 literature output. Out of 9,735 organizations, researchers have examined only top ranked institutions and found the maximum number of research output were published by ‘Chinese Academic Science’ from china with 459 (2.532%) publications and ranked first and the next productive organization was ‘University of Malaya’ with 189 (1.042%) research articles and the third most productive organization was ‘University of California, Berkeley’ with 185 (1.02%) literature output and the tenth rank was secured by ‘University of London Imperial College of Science and Technology Medicine’ with 109 (0.601%) articles. It was noted that the predominant research organization was ‘Chinese Academic Science’ and China is the most productive country on fossil fuels during the period of study.

Table 5. Global Organizations on Fossil fuels (Top 10)

Rank	Organizations	Records	% of 18131
1	Chinese Academic Science	459	2.532
2	University of Malaya	189	1.042
3	University of Calif Berkeley	185	1.02
4	NOAA	173	0.954
5	University of Colorado	158	0.871
6	Oak Ridge National Lab	151	0.833
7	Indian Inst Technology	136	0.75
8	Harvard University	128	0.706
9	University of Calif Irvine	123	0.678
10	University of London Imperial Coll Sci Technol Med	109	0.601

### Ranking of top ten Countries/Territories on Fossil fuels

Table 6 represents the ranking of top ten global countries on fossil fuels research based on the research output. A total of 151 Countries/Territories have produced 18,131 literature on fossil fuels during 1989-2016. Researchers have examined only the top ten countries such as United States, People’s R China, England, Germany, India, Canada, Japan, Spain, Italy and Australia. Out of 151 countries, it was found that the most productive country was United States with 4,841 (26.7%) research articles and has got first position among the ten countries during the study period. The next productive country was China with 1657 (9.139%) publications on fossil fuels and followed by England, which has occupied third rank with 1417 (7.187%) research output and India has ranked fifth position with 943 (5.201%) research papers among the top ten countries.

Table 6. Countries/Territories wise distribution

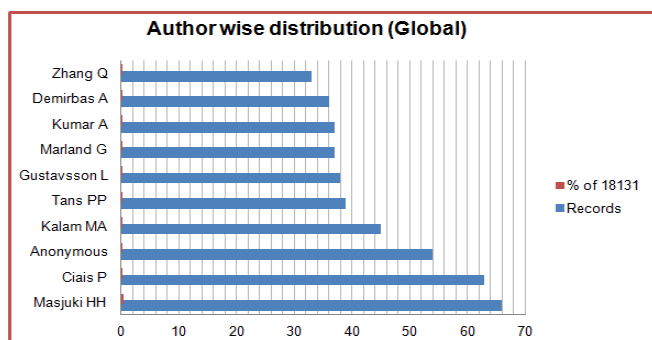
Rank	Countries/Territories	Records	% of 18131
1	United States	4841	26.7
2	People’s R China	1657	9.139
3	England	1417	7.815
4	Germany	1303	7.187
5	India	943	5.201
6	Canada	938	5.173
7	Japan	779	4.297
8	Spain	693	3.822
9	Italy	676	3.728
10	Australia	670	3.695

### Ranking of top 10 Authors on Fossil fuels

After evaluation, the ranking of authors' productivity on fossil fuels during the period of study is given in Table 7. A total number of 44,943 authors have published 18,131 research output. Out of 44,943 authors, researchers have measured only top ten productive authors for the purpose of analysis. It was identified that the major portion of 66 (0.364%) research papers were published by 'Masjuki HH' and he was ranked first. The next productive author was 'Ciais P' with 63 (0.347%) articles and was placed second. Third rank was scored by 'Anonymous authors' who has published papers on fossil fuels. It is to be noted that the minimum number of papers published among top ten authors was by 'Zhang Q', who has occupied 10<sup>th</sup> place with 33 (0.182%) scholarly papers.

**Table 7. Author wise distribution**

Rank	Authors	Records	% of 18131
1	Masjuki HH	66	0.364
2	Ciais P	63	0.347
3	Anonymous	54	0.298
4	Kalam MA	45	0.248
5	Tans PP	39	0.215
6	Gustavsson L	38	0.21
7	Marland G	37	0.204
8	Kumar A	37	0.204
9	Demirbas A	36	0.199
10	Zhang Q	33	0.182



**Figure 3. Author wise distribution**

### Ranking of Research Areas on Fossil fuels (Top 10)

Table 8 provides information on the ranking of research areas on fossil fuels during the period of study. A total number of 112 research areas were found on fossil fuels literature. Based on the analysis, a huge number of 6838 (37.714%) research publications were published in 'Energy Fuels' and ranked first. The next productive subject is 'Engineering' with 4962 papers (27.367%) which was followed by 'Environmental Sciences Ecology' ranking third position with 4797 records (26.457%). Among the top 10, a minimum number of 718 research articles (3.96%) were published in the field of Materials Science. It shows that the maximum numbers of researchers are interested to publish their research papers in the field of Energy Fuels.

### Funding Agencies on Fossil fuels (Top 10)

Table 9 shows the list of top ten funding agencies for research on fossil fuels during the period of study. A total number of 10,416 funding agencies have sponsored and produced 18,131 scholarly publications. Out of 10,416 funding agencies, only top ten funding agencies were taken into account for

analysis. It was found that out of 10,416 funding agencies, the maximum number of 483 (2.664%) research articles were published by National Natural Science Foundation from China which was followed by National Science Foundation with 205 (1.131%) and the third productive funding agency was European Commission with 114 (0.629%) articles and minimum number of 69 (0.381%) publications on fossil fuels were funded by European Union during the period of study.

**Table 8. Ranking of Research Areas on Fossil fuels**

Rank	Research Areas	Records	% of 18131
1	Energy Fuels	6838	37.714
2	Engineering	4962	27.367
3	Environmental Sciences Ecology	4797	26.457
4	Science Technology Other Topics	2743	15.129
5	Chemistry	2238	12.344
6	Meteorology Atmospheric Sciences	1475	8.135
7	Thermodynamics	1282	7.071
8	Biotechnology Applied Microbiology	1128	6.221
9	Agriculture	1044	5.758
10	Materials Science	718	3.96

**Table 9. Global Funding Agencies on Fossil fuels (Top 10)**

S. No	Funding Agencies	Records	% of 18131
1	National Natural Science Foundation of China	483	2.664
2	National Science Foundation	205	1.131
3	European Commission	114	0.629
4	NSF	103	0.568
5	European Union	103	0.568
6	Fundamental Research Funds for the Central Universities	88	0.485
7	Chinese Academy of Sciences	77	0.425
8	Swedish Energy Agency	76	0.419
9	NASA	72	0.397
10	EU	69	0.381

### Ranking of Core Journals on Fossil fuels (Top 10)

Table 10 shows the ranking of top ten core journals on fossil fuels literature. A total of 2,316 Source Titles were found with 18,131 research output during the study period. Out of 2316 core journals the analysis was made only for the top ten core journals on fossil fuels. On evaluation of the top ten core journals, it was identified the most productive source title was 'Renewable Sustainable Energy Reviews' with 829 (4.572%) publications out of 18,131 articles and has occupied first rank. The next productive source title was 'Energy Policy' with 710 (3.916%) articles and got ranked second and the third source title was 'Energy' with 499 (2.752%) research papers and the least number of research papers was received by 'Environmental Science Technology' sources title with 279 (1.539%) articles during the period of study.

**Table 10. Source Titles on Fossil fuels**

Rank	Source Titles	Records	% of 18131
1	Renewable Sustainable Energy Reviews	829	4.572
2	Energy Policy	710	3.916
3	Energy	499	2.752
4	Applied Energy	450	2.482
5	International Journal of Hydrogen Energy	392	2.162
6	Energy Conversion And Management	376	2.074
7	Renewable Energy	360	1.986
8	Biomass Bioenergy	315	1.737
9	Fuel	288	1.588
10	Environmental Science Technology	279	1.539

## Ranking of Web of Science Categories

Table 11 indicates the ranking of web of science category based research output on fossil fuels publications. A total of 180 Web of Science Categories was found on fossil fuels through the Web of Science database with 18,131 research papers. Out of 180 categories, only top ranked ten categories were analyzed by researchers. It was examined that Energy Fuels has received 6838 papers (37.714%) and was ranked first, followed by Environmental Sciences category securing second position with 4525 (24.957%) articles and third most productive category was Engineering Chemical with 2454 (13.535%) papers and the Chemistry Physical category was ranked last comparatively, with small number of papers (923) (5.091%).

**Table 11. Web of Science Categories on Fossil fuels**

Rank	Web of Science Categories	Records	% of 18131
1	Energy Fuels	6838	37.714
2	Environmental Sciences	4525	24.957
3	Engineering Chemical	2454	13.535
4	Green Sustainable Science Technology	2120	11.693
5	Engineering Environmental	1510	8.328
6	Meteorology/ Atmospheric Sciences	1475	8.135
7	Thermodynamics	1282	7.071
8	Biotechnology/ Applied Microbiology	1128	6.221
9	Environmental Studies	1076	5.935
10	Chemistry Physical	923	5.091

## Conclusion

The scientometric analysis is one of the paramount ways to measure the scholarly publications in any discipline. For the present study, Fossil fuels has been chosen for analysis as it is one of the upcoming and thrust areas in the digital society. The finding of the results shows that the maximum number of (84.05%) research papers was in the form of journal articles and ranked first. The major portion of 66 (0.364%) research papers was published by 'Masjuki HH' and he was ranked first. Out of 10,416 funding agencies, the maximum number of 483 (2.664%) research articles was published by National Natural Science Foundation from China and minimum number of 69 (0.381%) publications on fossil fuels was funded by European Union during the period of study. The most productive source title was 'Renewable Sustainable Energy Reviews' with 829 (4.572%) publications out of 18,131 articles and has occupied first rank. The most productive country was United States with 4,841 (26.7%) research articles and has secured first rank and India has ranked fifth position with 943 (5.201%) research papers among the top ten countries. Energy Fuels has received 6838 papers (37.714%) and is in first position and the Chemistry Physical category stands last with 923 papers (5.091%). As far as the topic of fossil fuels is concerned, we have identified that this is the first scientometric study which is done in the field of fossil fuels research output worldwide for the period of 1989-2016.

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