Scientometric Analysis of Solar Energy Research Publications in Germany

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Abstract

The present study discuss on scientometrics analysis trends in solar energy research in Germany during from 2011to 2015. Further, publication output in year wise, document wise, author's productivity, sources wise, institution wise and language wise has been analysed. A total number of 2810 publications were obtained in the study period. The study reveals that the majority number of records was published in 2015, followed by 603 records published in 2014, 554 records have published in 2013, 508 record have published in 2012, and 473 records were published in 2011. The document type wise research publication in solar energy, the articles has a predominant place with 90.1 per cent, and followed by review 5.3 per cent, article; proceedings papers has third place with 3.6 per cent, Editorial Material and other types least percent number of have published

Keywords

Scientometrics, solar cells, solar energy, electricity generation, Germany
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INTRODUCTION

The branch of library information science that includes scientometrics has one of the research structures in solar energy. The term scientometrics was coin by Nalimove and Mulechenko in 1969. However the advent of scientometrics as a discipline was in 1978, when the journal 'scientometrics' was founded by Tabor Braun in 1978. Scientometrics includes all the quantitative aspects of the science of science, communication in science, and science policy. It is a part of sociology of science and has application to science policy making. It indicates the quality, maturity and productivity of the journal in the particular field and geographical region. The journal thus studied is regarded as the most important in the given subject area. Solar Energy is one of the vital sources of all over the world. In the 1980s research into silicon solar cells paid off and solar cells began to increase their efficiency. In 1985 silicon solar cells achieved the milestone of 20% efficiency. Over the next decade, the photovoltaic industry experienced steady growth rates of between 15% and 20%, largely promoted by the remote power supply market. The year 1997 saw a growth rate of 38% and today solar cells are recognized not only as a means for providing power and increased quality of life to those who do not have grid access, but they are also a means of significantly diminishing the impact of environmental damage caused by conventional electricity generation in advanced industrial countries.

Review of literature

Bakthavachalam Elango (2017), this study reveals that 55 per cent of publications were citable articles; average number of authors per article was 4.57; 136 per cent increase in impact factor and reviews received highest citations per paper. Harvard University had most number of publications, whereas University of Cambridge had highest CPP among the most productive institutes. Almost 50 per cent of publications were contributed by authors from the USA; 1 per cent of total publications received more than 1,000 citations. Thanuskodi (2010) he conducted a study on bibliometric analysis of articles and references in Library Philosophy and Practice from 2005 to 2009. The analysis covers the number of articles, authorship patterns, subject distribution of articles, average number of references per article, forms of documents cited, year-wise distribution of cited journals, rank list of journals, etc. Strong and weak

points are discussed, as the basis for improvement and development.

Adarsha Bala and Gupta BM(2010), This study analyses the research output in India in neurosciences during the period 1999-2008 and the analyses included research growth, rank, global publications' share, citation impact, share of international collaborative papers and major collaborative partner countries and patterns of research communication in most productive journals. India's global publications' share in neurosciences during the study period was 0.99% (with 4503 papers) and it ranked 21st among the top 26 countries in neurosciences. The average annual publication growth rate was 11.37%, shared 17.34% of international collaborative papers and the average citation per paper was 4.21. India was far behind China, Brazil and South Korea in terms of publication output, citation quality and share of international collaborative papers in neurosciences.

Objectives and Methodology

The analysis of study aims to research development of solar energy in scientometrics. It is also focused to trends in the area of research output in solar energy in Germany at the scientometric based on the sample data. The publication evaluates contribute on the research productivity in this during the year on 2011-2015.

Data collection

The study of publication research output on solar energy in scientometrics is obtained from various sources, such as review, proceedings paper, editorial material, meeting abstract, book chapter, correction and news item. The research data required for the present study are downloaded from the web of science database. The Histcite was used for the analysis. The overall data retrieved by the researcher 2810 publication has been analyzing for the present study.

The table-1 shows that year wise research publication in solar energy; totally 2810 records were published during the study period. The majority number of records was published 682 in 2015 followed by 603 records published in 2014, 554 records have published in 2013, 508 record have published in 2012, and 473 records were published in 2011.

Table 1: Year Wise Publication in Solar Energy

S. No	Publication Year	Records	Percent	TLCS	TGCS
1	2011	473	16.7	448	16097
2	2012	508	18.1	478	15352
3	2013	544	19.4	357	12766
4	2014	603	21.5	247	9566
5	2015	682	24.3	83	6031
	Total	2810	100	1613	59812

Table 2: Document Type Wise Publication

S.No.	Document Type	Records	Percent	TLCS	TGCS
1	Article	2532	90.1	1408	48274
2	Review	148	5.3	148	9975
3	Article; Proceedings Paper	100	3.6	43	1067
4	Editorial Material	14	0.5	11	319
5	Review; Book Chapter	7	0.2	3	147
6	Meeting Abstract	5	0.2	0	0
7	Article; Book Chapter	2	0.1	0	6
8	Correction	1	0.0	0	0
9	News Item	1	0.0	0	24
	Total	2810	100	1613	59812

Table-2 indicates that the document type wise research publication in solar energy, among the 2810 records, the articles has a predominant place with 90.1 per cent, and followed by review 5.3 per cent, article; proceedings papers has third place with 3.6 per cent, Editorial Material 0.5 per cent, Review; Book chapter and Meeting Abstract have the same of 0.2 per cent, Article; Book chapter 0.1 per cent and correction have 0.0 percent.

Table 3: Authorship Pattern

S.No.	Year	Single	Double	Three	Four	Five	Above five	Total
1	2011	20	62	73	70	51	197	473
2	2012	29	54	75	83	59	208	508
3	2013	27	54	92	75	65	231	544
4	2014	27	49	75	93	68	291	603
5	2015	19	63	78	81	94	347	682
	Total	**122**	**282**	**393**	**402**	**337**	**1274**	**2810**

Table-3 Shows that authorship pattern wise research publication in Solar Energy, single author were published 122 records, double authors were published 282 records, three authors were published 393, four authors were published 402, five authors were published 337records,and more than five authors were published 1274 records. Moreover, collaborative contributions are high compare with single authorship publications.

Table 4: Top 10 Source Wise Research Output in Solar Energy in Germany

S. No	Journal	Records	Percent	TLCS	TLCS/t	TGCS	TGCS/t	TLCR
1	Astronomy & Astrophysics	178	6.3	0	0.00	3003	989.72	37
2	Astrophysical Journal	125	4.4	0	0.00	2382	754.83	21
3	Journal of Physical Chemistry C	79	2.8	59	21.15	1001	388.10	83
4	Solar Energy Materials and Solar Cells	68	2.4	67	22.42	1383	477.00	40
5	Solar Energy	60	2.1	37	12.57	939	338.85	33
6	Journal of Applied Physics	58	2.1	0	0.00	627	183.50	33
7	Physical Chemistry Chemical Physics	54	1.9	34	12.38	879	339.55	45
8	Applied Physics Letters	46	1.6	0	0.00	400	143.45	28
9	Journal of Geophysical Research-Space Physics	46	1.6	4	2.00	434	140.68	14
10	Monthly Notices of The Royal Astronomical Society	44	1.6	19	7.52	810	356.75	6

Table-4 shows that Top ten sources published in solar energy research during the study period. Totally 2810 records were published in 525 sources, among them sources top 10 sources only pointed out in the table-4. Among the top ten sources "Astronomy & Astrophysics" has first place with 178 records and followed by Astrophysical Journal" is second place with 125 records, "Journal of Physical Chemistry C" is third place with 79 records. "Solar Energy Materials and Solar Cells", were fourth place with 68 records and followed by "Solar Energy" has 60 records, Journal of Applied Physics has 58 records, Physical Chemistry Chemical Physics has 54 records, Applied Physics Letters has 46 records, Journal of Geophysical Research-Space Physics has also 46 records, and Monthly Notices of The Royal Astronomical Society has 44 records respectively. Moreover the remaining 515 sources have published less than 44 papers in the research during the study period.

Table 5: Top 10 Authors' Contributions in Solar Energy

S.No.	Author	Recs	Percent	TLCS	TLCS/t	TLCSx	TGCS	TGCS/t	TLCR
1	Guldi DM	44	1.6	32	7.88	7	847	270.65	32
2	Leo K	37	1.3	63	16.77	21	1029	324.32	60
3	Brabec CJ	36	1.3	53	19.43	8	873	376.92	75
4	Wiegelmann T	34	1.2	37	10.07	3	586	167.13	36
5	Riede M	26	0.9	56	14.27	21	851	230.28	45
6	Roeb M	26	0.9	40	16.47	7	411	194.87	38
7	Sattler C	25	0.9	39	15.47	7	409	189.12	34
8	Bauerle P	24	0.9	41	9.83	15	1287	402.42	36
9	Peter H	22	0.8	2	0.67	0	366	144.68	1
10	Ameri T	21	0.7	44	16.17	8	635	263.92	51

Table-5 Indicates that top 10 author's contributed in solar energy during the study period. Guldi DM contributed are first place with 44 publications, followed by Leo K 37, Brabec CJ 36, Wiegelmann T 34, Riede M 26, Roeb M 26, Sattler C 25, Bauerle P 24, Peter H 22 , and 21 publications were published by Ameri T respectively.

Table 6: Top 10 Institution Wise Research Output in Solar Energy

S.No.	**Institution**	**Records**	**Percent**	**TLCS**	**TGCS**
1	University Erlangen Nurnberg	136	4.8	113	3250
2	Max-Planck-Institut für Sonnensystemforschung	109	3.9	59	1377
3	Technische Universität Dresden	86	3.1	94	1922
4	Technical University of Munich	83	3.0	80	2204
5	University of Jena	83	3.0	67	1437
6	Karlsruhe Institute of Technology	75	2.7	42	1113
7	Ruhr University Bochum	75	2.7	35	1180
8	University of California, Berkeley	75	2.7	79	3691
9	NASA	68	2.4	28	2204
10	University of Wurzburg	68	2.4	68	1893

Table-6 shows that top ten institution contributions in solar energy, "University Erlangen Nurnberg" has first place with 136 publications in solar energy research, followed by "**Max-Planck-Institut für Sonnensystemforschung**" has published 109 records, "Technische Universität Dresden" has published 86 records, "Technical University of Munich" has published 83 records, "University of Jena" has also published 83 records, "Karlsruhe Institute of Technology" , "Ruhr University Bochum" and "University of California, Berkeley" has published 75 records respectively, "NASA" and "University of Wurzburg" has published 68 records respectively.

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Table 7: Language Wise Research Output in Solar Energy

S.No.	**Language**	**Recs**	Percent	**TLCS**	**TGCS**
1	English	2772	98.6	1609	59750
2	German	37	1.3	4	61
3	Chinese	1	0.0	0	1

Table-7 Indicates that language wise research output in solar energy, English has occupies that first place with 2772 records, German occupies second place with 37 records, and Chinese occupies third place with one record

Table 8: Top 10 Citied Authors in Solar Energy Cited Reference Records

S.No.	**Author / Year / Journal**	**Recs**	**Percent**
1	Oregan B, 1991, Nature, V353, P737, DOI 10.1038/353737a0	98	3.5
2	Scharber MC, 2006, Advanced Materials, V18, P789, DOI 10.1002/adma.200501717	72	2.6
3	Shockley W, 1961, J Applied Physics, V32, P510, DOI 10.1063/1.1736034	66	2.3
4	Hagfeldt A, 2010, Chemical Reviews, V110, P6595, DOI 10.1021/cr900356p	61	2.2
5	Fujishima A, 1972, Nature, V238, P37, DOI 10.1038/238037a0	56	2.0
6	Dennler G, 2009, Advanced Materials, V21, P1323, DOI 10.1002/adma.200801283	54	1.9
7	Perdew JP, 1996, Physical Review Letters, V77, P3865, DOI 10.1103/PhysRevLett.77.3865	52	1.9
8	Lewis NS, 2006, Proceeding of the National Academy of Sciences of the United States of America, V103, P15729, DOI 10.1073/pnas.0603395103	50	1.8
9	Gratzel M, 2001, Nature, V414, P338, DOI 10.1038/35104607	49	1.7
10	Yu G, 1995, Science, V270, P1789, DOI 10.1126/science.270.5243.1789	49	1.7

Table-8 shows that top ten cited articles in solar energy research. Among the 2810 records, "Nature" is first place with 98 cited records its article written by Oregan B, followed by "Advanced Materials" 72 cited records, written by " Scharber MC", "Applied Physics" 66 cited records, written by Shochley W, "

Chemical Reviews" 61 cited records, written by Hagfeldt A, "Nature" has published 56 cited records, written by Fujishima A, "Advanced Materials" has published 54 cited records, written by Dennler G, "Physical Review Letters" has published 52 cited records, written by Perdew JP, "Proceeding of the National Academy of Sciences of the United States of America" has published 50 cited records, written by Lewis Ns, "Nature" has published 49 cited records, written by Gratzel M, and followed by " Science" has published 49 cited records respectively written by Yu G.

Conclusion

Conclusion from the study, the year wise research publication shows increasing trends is found only during the study period 2011-2015. Among the 2810 records the article has predominant place with 90.1 percent. The authorship pattern of the research output has conclude more than five authors has published 1274 records, among the top ten sources in solar energy research, Astronomy & Astrophysics published 178 records and Monthly Notices of the Royal Astronomical Society has published 44 records. Among the top ten authors contribution Guldi DM has first place with 44 records. Language wise research output occupies English has first place with 98.6 percent. More over nature this article were cited 98 records it's written by OREGAN B during the study period.

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