

NUCLEAR POWER GENERATION RESEARCH SEEN THROUGH SCOPUS: A SCIENTOMETRIC ANALYSIS

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Abstract

This paper attempts to analyze quantitatively the growth and development of nuclear power generation in global in terms of publication output as reflected in Scopus database during 1980 to 2012. A total of 9512 papers were published by the Nuclear Power Generation (NPG) researchers to various domains; In the subject category Engineering topped with 4716 documents, 46% publications were published in Journals as document type and the most preferred journals were Nuclear Engineering Design (214). Among 160 contributed institutions from 60 various countries, The Idaho National Laboratory ranked first with 137 papers. Country based analysis USA ranked 1st with 24% publications followed by Japan 7% and India ranked 11th with 1.4%. In Year wise analysis showed that Nuclear power generation papers gradually increased with average 288 papers per year, in 2008 topped with 745 articles slashed with 2009 with 545.

Keywords: Nuclear Power Generation (NPG), Scientometric Analysis, Year wise and Authorship pattern, Geographical distribution.

1. INTRODUCTION

Scientometrics is the quantitative study of the disciplines of science based on published literature and communication. This could include identifying the emerging areas of scientific research, examining the development of research over time, or geographic and organizational distributions of research. In the present study, we did the Scientometrics analysis of NPG

research, a significantly growing area in the knowledge driven world. Sciverse Scopus is the world's largest abstract and citation database of peer reviewed literature and quality web sources with smart tools to track analyze and visualize research. It's designed to find the information scientists need. Quick, easy and comprehensive, Scopus provides superior support of the literature research process. It contains 46 million records, 70% with abstracts. It has nearly 19,500 titles from publishers worldwide and includes over 4.6 million conference papers.

2. REVIEW OF LITERATURE

Thanuskodi¹ has showed in his study bibliometric analysis of articles and references provided at the end of each article contributed in Indian Journal of Chemistry from 2005-2009. The analysis cover mainly the number of articles, authorship pattern, forms of document cited, etc. All the studies point towards the merit and weakness of the journal which will be helpful for its further development. This study showed that most of the contributions are India. The authorship pattern of the articles published during the period of study. Maximum number of articles were contributed by two authors. This study also showed that majority of the contributors preferred journals as the source of information which occupied the top position. All the studies point towards the merits and weakness of the journal which will be helpful for its further development.

Pratt² utilized MEDLINE to perform a bibliometric analysis of the literature of AIDS for the period of 1981 to 1990. That study reported growth statistics for AIDS literature, number of different languages, countries of publication, and number of periodical titles. The AIDS literature grew from fewer than 700 entries from 1981 to 1983 to a cumulative total of 29,077 entries by the end of 1990. The greatest relative expansion came in 1983 with a 24-fold increase compared to the previous year. Gillaspay and Huber also employed Bradford's law to identify core journal publications for a collection focusing on AIDS in women. That study found that journal scatter for this subset of AIDS literature varied from the scatter in the general literature.

Thanuskodi³ examined the present study has been undertaken to assess the research performance of Indian scientists in ecology. The results of research have been published in different sources. The findings of the present study lead to the following observations: The largest number of publications was 54 in 2005.

Dutt, Garg and Bali⁴ analyzed 1317 papers published in the first fifty volumes of the International journal of Scientometrics during 1978 to 2001. They found that the share of papers by USA is constantly declining while that of the Netherlands, India, France and Japan is on the rise. The research output is highly scattered as indicated by the average number of papers per institution.

Yeoh and Kaur⁵ analyses the publication output of Research in Higher Education for subject support in collection development in the light of growing interest in diversified domains of

research in higher education. Consequently, analysis of 40 issues of publications revealed a diversified usage pattern of bibliographic reference sources by contributing researchers, with a cumulative total of citations being 8,374. A positive trend in research collaboration of contributing authors, and a steady growth in the use of reference sources, periodicals and web documents in the citations signify the trend of scholarly communication of research works in the electronic age. Similar to other disciplines of research findings, journals and books were the most cited source materials for researchers thrash out.

Thanuskodi⁶ identified the paper brings out the results of a bibliometric analysis of the journal titled "Indian Journal of Agricultural Research" for the period from 2001 to 2010. The data were downloaded from the journal's website. This study aims at analysing the research output performance of agricultural scientists on agricultural science subjects. The analysis cover mainly the number of articles, authorship pattern, subject wise distribution of articles, average number of references per articles, forms of documents cited, year wise distribution of cited journals etc. All the studies point towards the merits and weakness of the journal which will be helpful for its further development. The result showed that out of 602 articles joint authors contributed 564 (93.69%) articles while the rest 38 (6.31%) articles were contributed by single author. Study reveals that most of the contributions are from India with 98.67 % and the rest 1.33% only from foreign sources.

Verma, Tamrakar and Sharma⁷ revealed that the majority of articles in journals published in India have two authors and that the majority of the contributions are from New Delhi. Patra, Bhattacharya and Verma⁸ analyzed the growth pattern, core journals and authors' distribution in the field of bibliometrics, using data from Library and Information Science Abstract (LISA). Tiew⁹ found that 53% of journal articles contained self-citations and that there was a tendency for authors affiliated to the institution that published the journal to cite the journal.

A study by Oyeniyi and Bozimo¹⁰ threw light on co-authorship patterns as a function of an author's productivity. Out of the 1260 articles written by 420 authors, 940 were single authored while 382 were co-authored. They found that the highest number of publications by one author was 44 papers followed by 28 and 27 papers respectively. Authors who had five publications and below constituted 94.53% while those with 6 and above constituted 5.47%. The study also revealed that authors who topped the rank of productivity also topped the rank of collaboration.

Alemna¹¹ examined the periodical literature of Library and Information Science in Africa for the period 1996-2000 as in African Journal of Library, Archives and Information Science (AJLAIS). He observed that the degree of representation by various African countries varied. West Africa topped with 50.6%, followed by South/Central with 32.9% and East Africa with 12.7%. Developed country participation in AJLAIS was very minimal with 2.5% UK representation and 1.3% Canada representation.

Adenaik¹² analyzed some characteristics of the citations taken from two bibliographies on cowpea covering the period from 1888 to 1973. It was found that the literature doubled every 20 years, English language accounted for 87% of the literature and journal was the most popular medium of publishing. Subbaiah¹³ who studied Indian grape research literature covering 1901-1981, found clustering of research in specific areas, increase in collaborative research, and journals as the main source of information. Meera¹⁴ studied the characteristics of 4,840 citations on ecological literature published during 1994-1995 in terms of their subject, language and geographic dispersion, and author ranking.

3. SCOPE AND METHODOLOGY

The present study attempts to find out the publication pattern of global researchers in the field of Nuclear Power Generation (NPG). The study is based on the references and aims to analyze quantitatively the growth and development of NPG research in world terms of publication output as reflected in Scopus database during years, 1980 to 2012.

4. OBJECTIVES OF THE STUDY

The main objective of the study is to present the growth of literature and make the quantitative assessment of status of Nuclear Power Generation (NPG) research by analyzing the various features.

The specific objectives are:

- To measure the Year wise growth of Publications
- To measure the Source wise publications
- To measure the Institution wise distribution
- To measure the Document wise publications
- To measure the Country wise distribution
- To measure the Subject wise publications
- To identify the Citations and counts by year wise and the highest cited papers.

5. RESULTS AND DISCUSSIONS

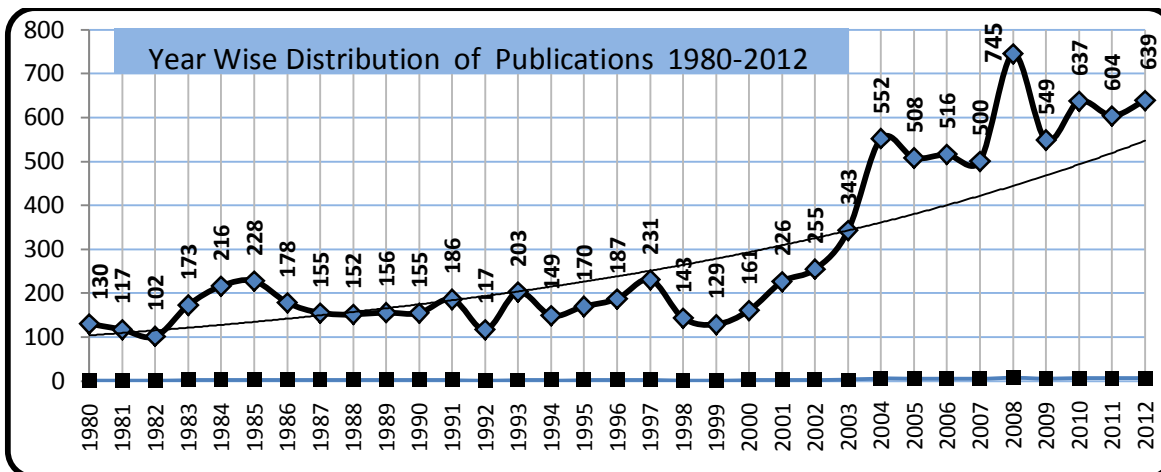
5.1. Year-wise distribution of Publications

During the study period 1980 to 2012, the Year wise analysis reflected with average 288 papers per year. In 2008 topped with 745 publications slashed with 2009 with 549 and the lowest were in year 1999 with 129 publications. The trend line (Fig.1) shows that Nuclear Power Generation (NPG) publications have gradually increased.

Table 1: Year wise distribution of publications

S. No.	Year	Articles	% of 9512	Cumulative	Cumulative %
1	1980	130	1.366695	130	1.3669
2	1981	117	1.230025	247	2.5967
3	1982	102	1.07233	349	3.669049622
4	1983	173	1.818755	522	5.487804878
5	1984	216	2.270816	738	7.75862069
6	1985	228	2.396972	966	10.15559294
7	1986	178	1.87132	1144	12.02691337
8	1987	155	1.629521	1299	13.65643398
9	1988	152	1.597981	1451	15.25441548
10	1989	156	1.6400	1607	16.89444912
11	1990	155	1.629521	1762	18.52396972
12	1991	186	1.955425	1948	20.47939445
13	1992	117	1.2300	2065	21.70941968
14	1993	203	2.134146	2268	23.85407906
15	1994	149	1.566442	2217	25.41000841
16	1995	170	1.787216	2587	27.19722456
17	1996	187	1.965938	2774	29.16316232
18	1997	231	2.428511	3005	31.59167368
19	1998	143	1.503364	3148	33.09503785
20	1999	129	1.356182	3277	34.45121951
21	2000	161	1.692599	3438	36.14381833
22	2001	226	2.375946	3664	38.51976451
23	2002	255	2.680824	3919	41.20058873
24	2003	343	3.605971	4262	44.80656013
25	2004	552	5.803196	4814	50.6097561
26	2005	508	5.340622	5322	55.95037847
27	2006	516	5.424727	5838	61.37510513
28	2007	500	5.256518	6338	66.63162321
29	2008	745	7.832212	7083	74.46383516
30	2009	549	5.771657	7632	80.23549201
31	2010	637	6.696804	8269	86.93229605
32	2011	604	6.349874	8873	93.28216989
33	2012	639	6.71783	9512	100
Total		9512	100		

Figure 1: Year Wise Publication



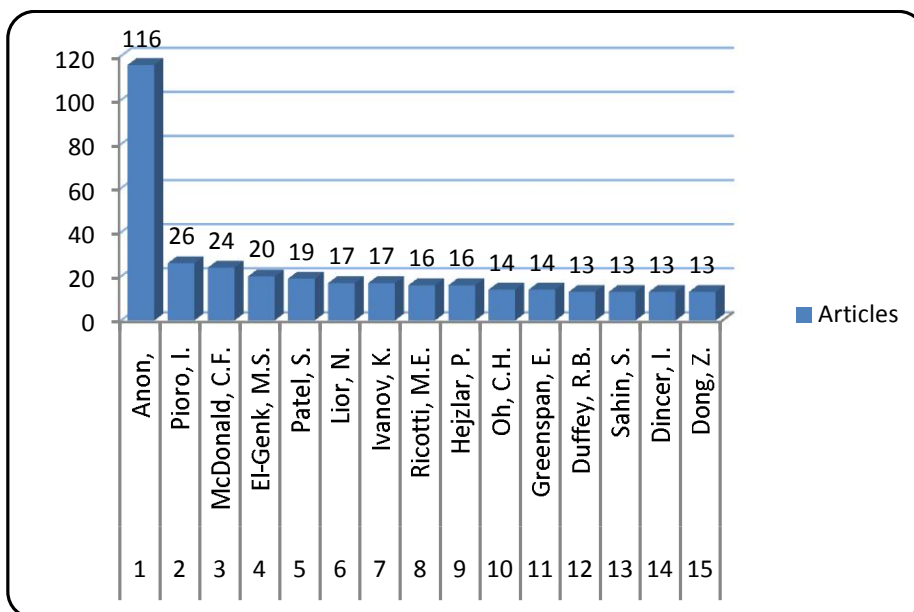
5.2. Author wise contributions

Author wise contributions shows, the total 157 authors published their contributions in the field of Nuclear Power Generation (NPG). Anon ranked first and published 116 articles, Poro, L. with 26 and C.F. Mc Donald with 24. (Table 2 and Figure 2 shows top 15 authors contributions).

Table 2: Author wise contributions

S. No.	Author	Articles
1	Anon,	116
2	Poro, I.	26
3	McDonald, C.F.	24
4	El-Genk, M.S.	20
5	Patel, S.	19
6	Lior, N.	17
7	Ivanov, K.	17
8	Ricotti, M.E.	16
9	Hejzlar, P.	16
10	Oh, C.H.	14
11	Greenspan, E.	14
12	Duffey, R.B.	13
13	Sahin, S.	13
14	Dincer, I.	13
15	Dong, Z.	13

Figure2: Author wise contributions



5.3. Authorship pattern analysis

During the study period 1980 to 2012, the authorship pattern analysis revealed that multiple authors contributions dominant in the field, the 5644 documents with 59%. Single authors with 3359 documents with (35%) followed by double authors 1747 documents with (18%), three authors 1300 documents with (14%) , four authors 1097 documents with (12%), five authors just 491 documents with (5%), six authors 387 with (4%) and more than six authors 622 with (7%). Among 509 documents with (5%) No author name available in the Nuclear power generation (NPG) field. Following Table 3 & 4 and Figure 3 & 4, stated clearly).

Table 3: Authorship pattern contributions

S. No.	Authorship pattern	Articles	% of 9512
1	Single Author	3359	35.31329
2	Double Authors	1747	18.36627
3	Three Authors	1300	13.66695
4	Four Authors	1097	11.5328
5	Five Authors	491	5.161901
6	Six Authors	387	4.068545
7	More than Six Authors	622	6.539108
8	No Author name available	509	5.351135
Total		9512	100

Figure 3: Author wise contributions

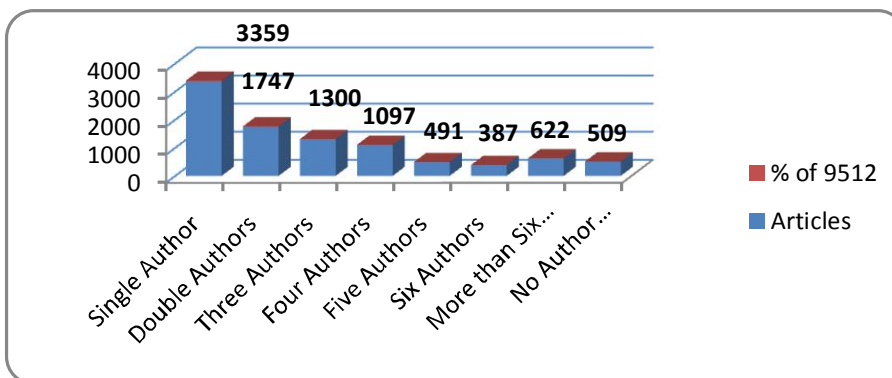
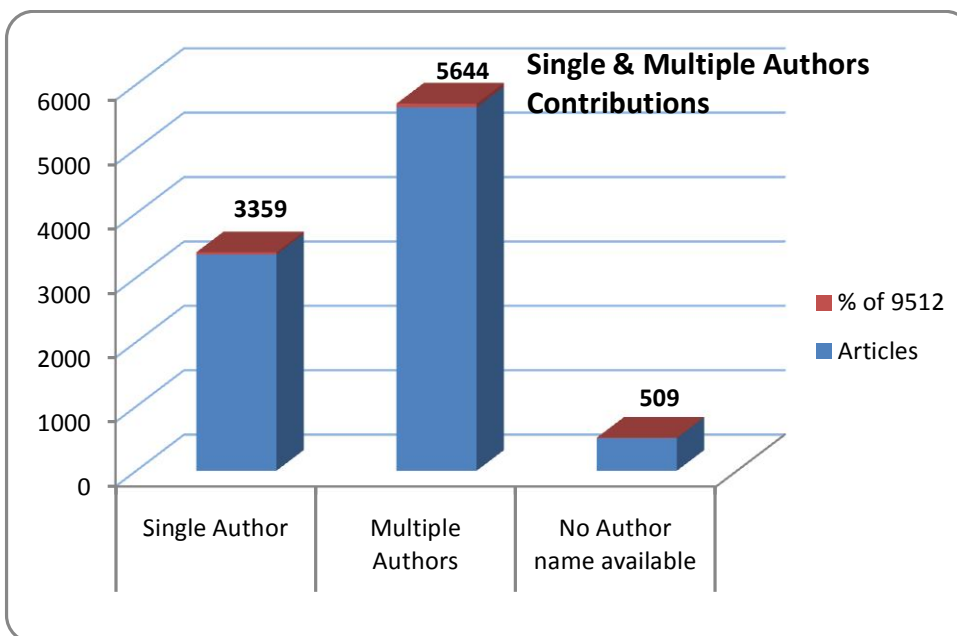


Table 4: Authorship pattern analysis

S. No.	Authorship pattern	Articles	% of 9512
1	Single Author	3359	35.31329
2	Multiple Authors	5644	59.33558
3	No Author name available	509	5.351135

Figure 4: Authorship pattern contributions



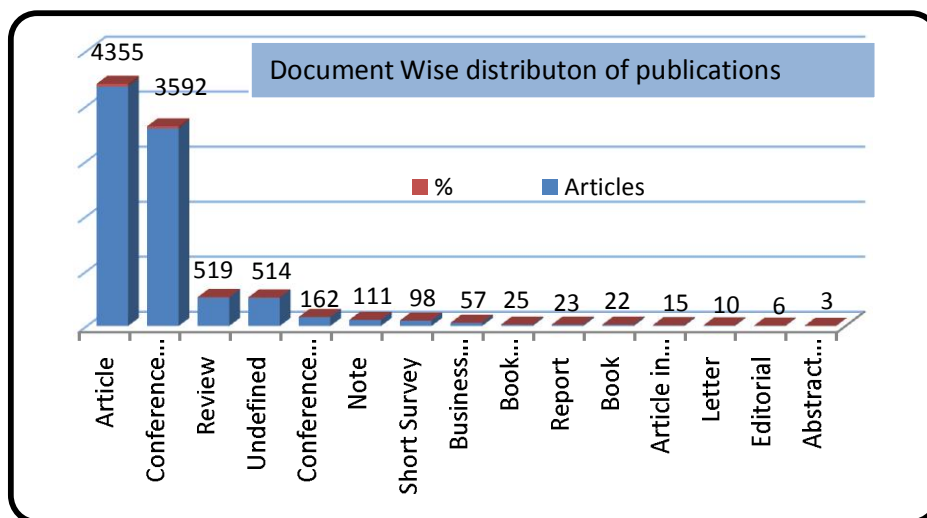
5.4. Document Wise Distribution

The global Nuclear Power Generation (NPG) has produced a total of 9512 publications. The highest number of publications was 4355 (45.8%) Journal articles, Conference Paper 3592 (38%), Review 519(5.4%), there Undefined documents were 514 (5.4%) and so on. (Table 5 and Figure 5 show the document wise contributions clearly).

Table 5: Document Wise Publication

S. No.	Document Type	Articles	%
1	Article	4355	45.78427
2	Conference Paper	3592	37.76283
3	Review	519	5.456266
4	Undefined	514	5.403701
5	Conference Review	162	1.703112
6	Note	111	1.166947
7	Short Survey	98	1.030278
8	Business Article	57	0.599243
9	Book Chapter	25	0.262826
10	Report	23	0.2417
11	Book	22	0.231287
12	Article in Press	15	0.157696
13	Letter	10	0.10513
14	Editorial	6	0.063078
15	Abstract Report	3	0.031539

Figure 5: Document Wise Publication



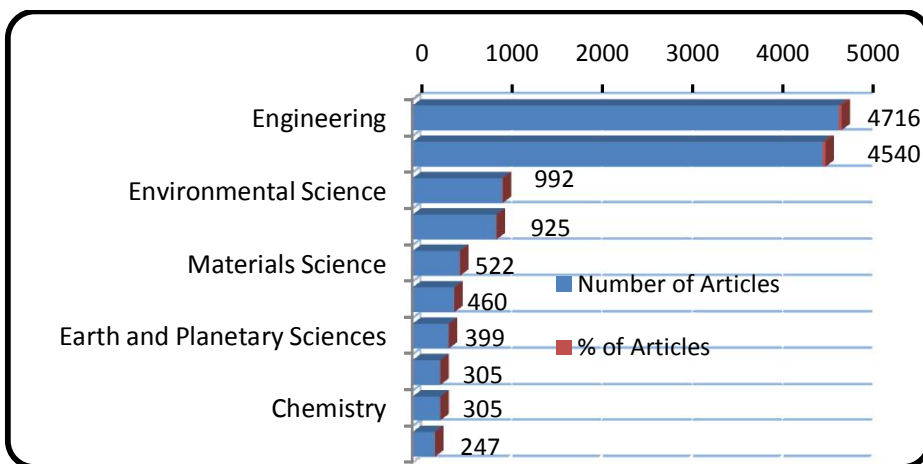
5.5. Subject wise Publication

The global Nuclear Power Generation (NPG) has produced 27 subfields into which Scopus classifies papers it indexes, Engineering 4716 (33%), Energy 4540 (32%), Environmental Science 992 (7%) Physics and Astronomy 925 (6.4%) and so on (Table 6 and Figure 6).

Table 6: Subject Wise Publication

S. No.	Subject	Articles	%
1	Engineering	4716	32.779593
2	Energy	4540	31.556266
3	Environmental Science	992	6.8951136
4	Physics and Astronomy	925	6.4294154
5	Materials Science	522	3.6282755
6	Chemical Engineering	460	3.1973309
7	Earth and Planetary Sciences	399	2.773337
8	Medicine	305	2.1199694
9	Chemistry	305	2.1199694
10	Computer Science	247	1.7168277
11	Social Sciences	223	1.5500104
12	Biochemistry, Genetics and Molecular Biology	115	0.7993327
13	Mathematics	115	0.7993327
14	Economics, Econometrics and Finance	113	0.7854313
15	Business, Management and Accounting	112	0.7784806
16	Agricultural and Biological Sciences	70	0.4865504
17	Multidisciplinary	66	0.4587475
18	Health Professions	39	0.2710781
19	Pharmacology, Toxicology and Pharmaceutics	30	0.2085216
20	Neuroscience	25	0.173768
21	Decision Sciences	23	0.1598665
22	Psychology	19	0.1320637
23	Arts and Humanities	10	0.0695072
24	Undefined	7	0.048655
25	Immunology and Microbiology	5	0.0347536
26	Nursing	3	0.0208522
27	Dentistry	1	0.0069507
Total		14387	100

Figure 6: Subject Wise Publication



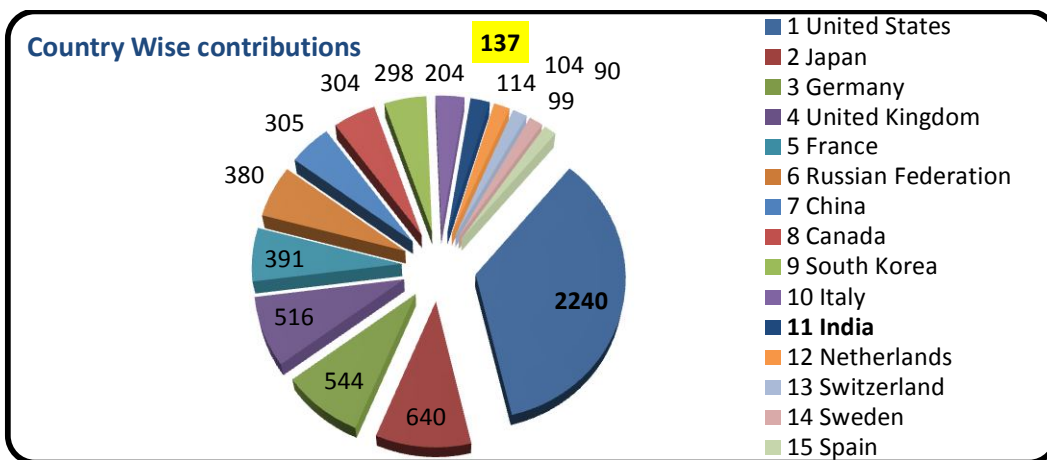
5.6. Country wise Distribution

The country wise distribution said that 90 different countries with 9512 documents in the field of Nuclear Power Generation (NPG). The USA ranked topped with 2240 (24%) publications, Japan 640 (7%), Germany 544 (6%), UK 516 (5.4%), France 391 (4.1%), Russian Federation 380 (4%) and China 305 (3.2%). India published 137 (1.4%publications with 11th position. The following Table 7 and Figure 7 show the top 15 countries contributions in this field.).

Table 7: Country wise Distribution

S. No.	Country	Articles	%
1	United States	2240	23.5492
2	Japan	640	6.7283
3	Germany	544	5.7190
4	United Kingdom	516	5.4247
5	France	391	4.1195
6	Russian Federation	380	3.9949
7	China	305	3.2064
8	Canada	304	3.1959
9	South Korea	298	3.1328
10	Italy	204	2.1446
11	India	137	1.4402
12	Netherlands	114	1.1984
13	Switzerland	104	1.0933
14	Sweden	99	1.0407
15	Spain	90	0.9461

Figure 7: Country wise Distribution



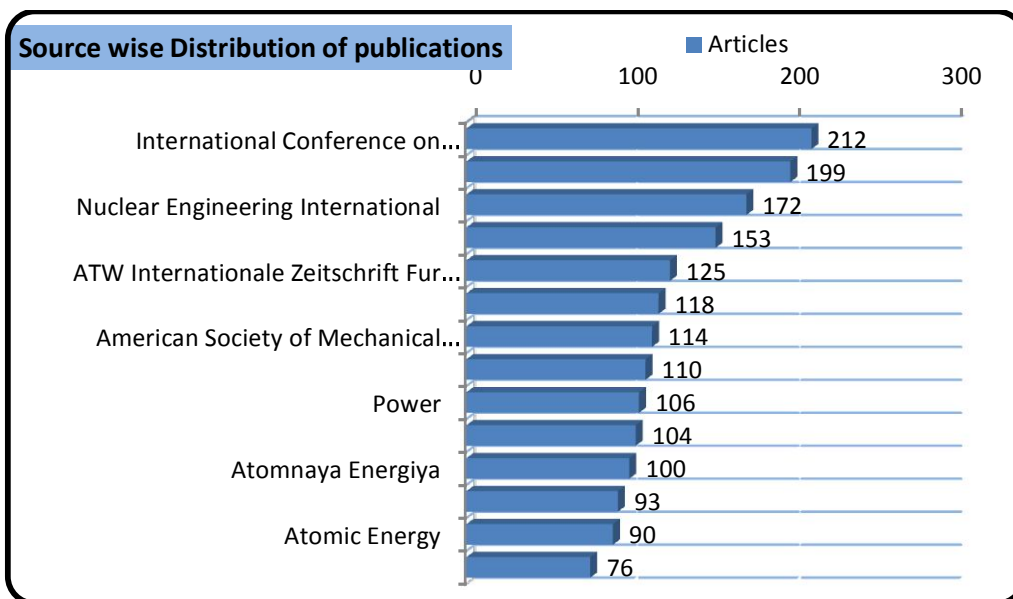
5.7. Source wise Distribution

Source wise analysis shows that, Nuclear Power Generation (NPG) publications published in 159 journals. The highest numbers of publications were in Nuclear Engineering and Design (214) and followed by International Conference on Nuclear Engineering Proceedings ICONE (212), in Proceedings of the Intersociety Energy Conversion Engineering Conference (199) and so on. The following Table 8 and Figure 8 show the top 15 ranking journals during the period study period.

Table 8: Source wise Distribution

S. No.	Source type	Articles	%
1	Nuclear Engineering and Design	214	2.2497
2	International Conference on Nuclear Engineering Proceedings ICONE	212	2.2287
3	Proceedings of the Intersociety Energy Conversion Engineering Conference	199	2.0920
4	Nuclear Engineering International	172	1.8082
5	Energy Policy	153	1.6084
6	ATW Internationale Zeitschrift Fur Kernenergie	125	1.3141
7	Nuclear Technology	118	1.2405
8	American Society of Mechanical Engineers Pressure Vessels and Piping Division Publication PVP	114	1.1984
9	Progress in Nuclear Energy	110	1.1564
10	Power	106	1.1143
11	Societe Francaise D Energie Nucleaire International Congress on Advances in Nuclear Power Plants Icapp 2007 the Nuclear Renaissance at Work	104	1.0933
12	Atomnaya Energiya	100	1.0513
13	Proceedings of the American Power Conference	93	0.9777
14	Atomic Energy	90	0.9461
15	Annals of Nuclear Energy	76	0.7989

Figure 8: Source wise Distribution



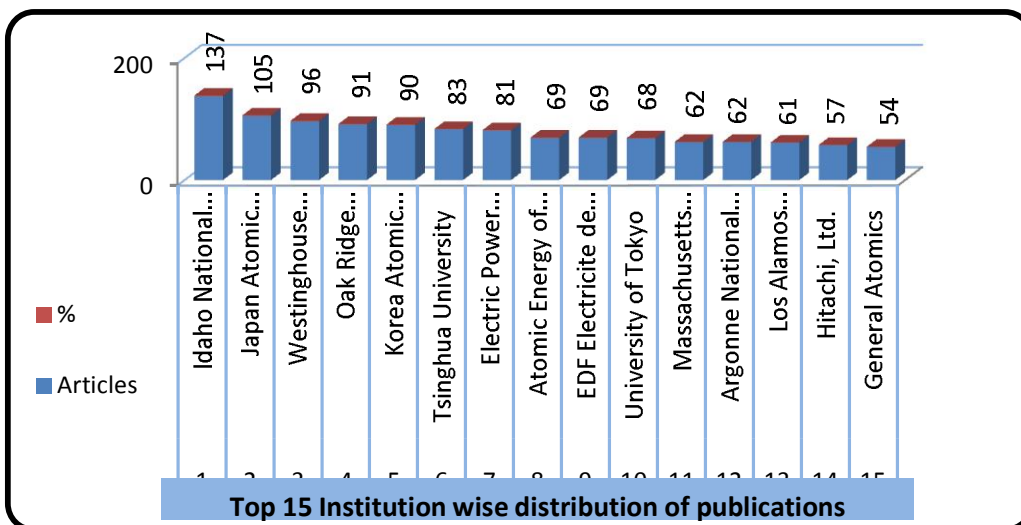
5.8. Institution wise Distribution

Although 160 institutions have published the articles in Nuclear Power Generation (NPG), only 16 institutions have published more than 50 papers in the study period. The Idaho National Laboratory, United States is top leading research institutions with 137 publications followed by Japan Atomic Energy Agency 105, Westinghouse Electric Company with 96, and so on. The following Table 9 and Figure 9 show that top 15 most productive institutions in NPG field.

Table 9: Institution wise Distribution

S. No.	Institution	Articles	%
1	Idaho National Laboratory	137	1.4402
2	Japan Atomic Energy Agency	105	1.0723
3	Westinghouse Electric Company	96	1.0092
4	Oak Ridge National Laboratory	91	0.9566
5	Korea Atomic Energy Research Institute	90	0.9461
6	Tsinghua University	83	0.8725
7	Electric Power Research Institute	81	0.8515
8	Atomic Energy of Canada Limited - Chalk River Lab	69	0.7253
9	EDF Electricite de France	69	0.7253
10	University of Tokyo	68	0.7148
11	Massachusetts Institute of Technology	62	0.6518
12	Argonne National Laboratory	62	0.6518
13	Los Alamos National Laboratory	61	0.6412
14	Hitachi, Ltd.	57	0.5992
15	General Atomics	54	0.5667

Figure 9: Institution wise Distribution



5.9. Citations contributions (Year wise)

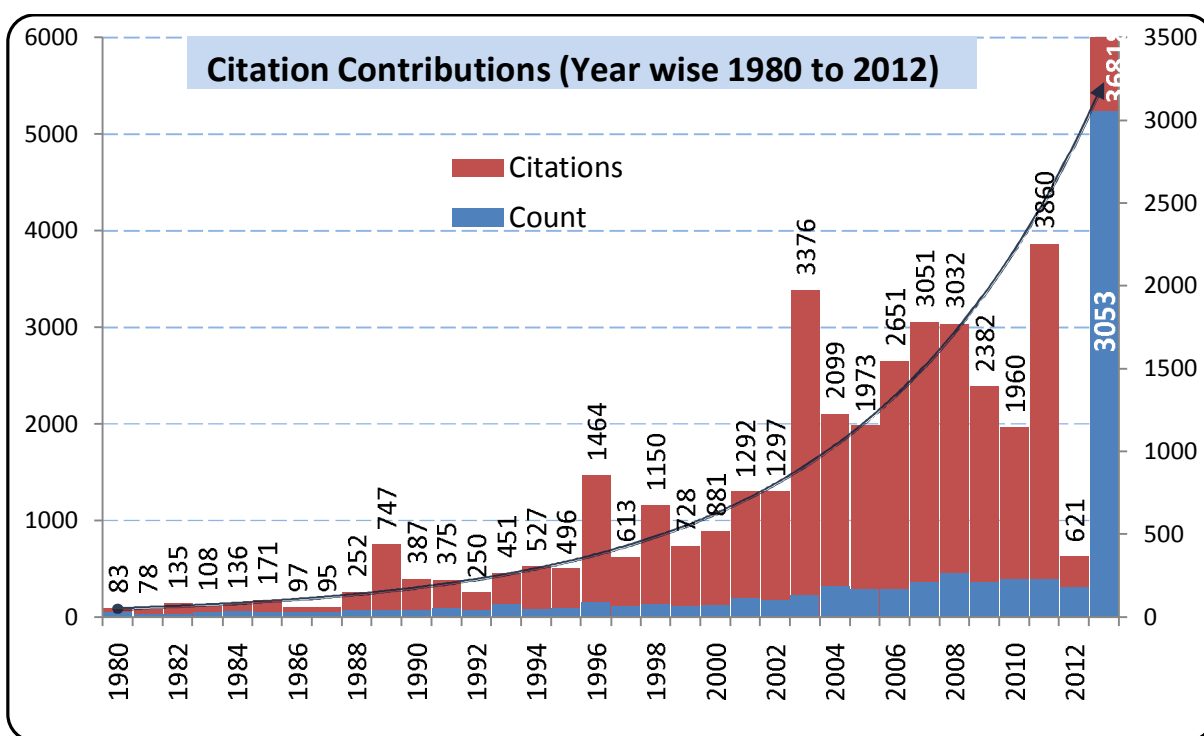
During the study period 33 (1980 to 2012) years the total number of citations 36,818 was identified on Nuclear Power Generation (NPG) indexed in Scopus database and citations count 3053. The citations were increased from 1989 onwards, particularly 2003, 2007 and 2008 more than 3000 citations identified. Notably that in the year 2011 scored highest 3860 citations (Table 10 and Figure 10).

Table 10: Citations contributions

S. No.	Year	Articles	Count	Citations
1	1980	130	23	83
2	1981	117	19	78
3	1982	102	13	135
4	1983	173	24	108
5	1984	216	32	136
6	1985	228	24	171
7	1986	178	29	97
8	1987	155	22	95
9	1988	152	37	252
10	1989	156	38	747
11	1990	155	40	387
12	1991	186	47	375
13	1992	117	36	250
14	1993	203	75	451
15	1994	149	45	527
16	1995	170	53	496
17	1996	187	88	1464
18	1997	231	58	613
19	1998	143	73	1150
20	1999	129	62	728
21	2000	161	67	881
22	2001	226	112	1292
23	2002	255	98	1297
24	2003	343	130	3376

25	2004	552	181	2099
26	2005	508	164	1973
27	2006	516	167	2651
28	2007	500	205	3051
29	2008	745	264	3032
30	2009	549	206	2382
31	2010	637	223	1960
32	2011	604	223	3860
33	2012	639	175	621
Total		9512	3053	36818

Figure 10: Citations contributions



6. CONCLUSION

This paper has highlighted quantitatively the contributions made by the Nuclear Power Generation (NPG), as reflected in Scopus database. During 33 years period the USA is lead in nuclear research publications and USA ranked 1st with 24% publications followed by Japan 7% and India ranked 11th with 1.4%. In Year wise analysis showed gradually increased with average 288 papers per year, in 2008 topped with 745 articles slashed with 2009 with 545. Generally, results of this study revealed that the contribution of Nuclear Power Generation (NPG) research literature is on gradual rise.

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