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A STUDY OF RENEWABLE ENERGY AND SOLAR PANEL LITERATURE THROUGH BIBLIOMETRIC POSITIONING DURING THREE DECADES

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BY

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Abstract

Renewable energy as a solution to supply future and current needs. This paper aims to review the status and visual map position of research in the internationally renewable energy and solar panel literature indexed Scopus that used a bibliometric positioning overview. The research was carried out using bibliometric techniques. Data analysis as well as visualization utilising VOSViewer program and the Scopus function for analyse search results. In this review, the details collected applied to 1,598 documents issued from 1989 through 2020. The study reveal that National University of Singapore and India Studies were the most active affiliated institutions scientists and nation in renewable energy and solar panel literature. In renewable energy and solar panel literature, the Engineering and Energy Procedia were the most areas of study and dissemination sources. There were eight worldwide group maps with collaborative researchers. In order to identify the body of knowledge created from thirty-two years of publication, this study constructed a convergence axis grouping comprising of renewable energy and solar panel literature: Solar energy, Energy, Renewable energy, Management, Power, Technology, and Environmental, abbreviated as SERMPTE.

Keywords: renewable energy. engineering, solar panel, economic development

Introduction

Energy is recognized as the engine of economic development worldwide. Global energy resources can be classified into three main groups, namely fossil energy (oil, gas, coal, etc.), nuclear energy, renewable energy (wind, solar, geothermal, air power, biomass, hydrogen, ocean, etc). The definition of renewable energy sources in the document Directive 2009/28 / EC attachment 1 is energy obtained from non-fossil and renewable sources, namely wind, solar, geothermal, ocean, hydropower, biomass and biogass, ect.(Sholikha, 2019). Most of the energy sources that are currently relied on are limited and will run out due to increasing demand (Zoghi et al., 2017). Renewable energy development is a way for the government to reduce the dependence of Indonesian people on fossil energy, especially to meet the need for electricity (Widjaja, 2020). For example, A biogase is a form of CH4 that can be used as a fuel as well as an alternative energy source. It is used as an alternative energy source for power generation, heat generation, and the production of a large amount of LPG gas for household use (Hariyanto et al., 2019). Renewable energy (Shahabi et al., 2014) is a very important, fast and safe innovation (Mehrjerdi & Rakhshani, 2019) (Tabor et al., 2018), renewable energy sources bring many benefits (Abazari et al., 2020) and benefits. (Corzine, 2017), renewable energy as a solution to supply future and current needs (Cabrera-Tobar et al., 2016), to provide technology effectiveness (Alippi & Galperti, 2008) and increase global energy efficiency, and reduce capacity requirements transmission (Song et al., 2019). Several countries have started to shift towards renewable resources based on geographic location and local resources (Akrami et al., 2020). For example, Indonesia, which is a country that

is on the equator, Indonesia's weather and climate have characteristics of the equatorial or tropical regions, with two seasons, namely the dry season and the rainy season (Wijoyo & Prihatiningtyasi, 2019), the regions in Indonesia are exposed to sunlight every year so that this phenomenon can be used for renewable energy, namely getting supply electricity by making use of solar energy radiation (Yansri, 2020). The Indonesian government should have a long-term strategy to shift energy use from non-renewable to renewable sources, such as solar and wind power, water, wind, biomass, biodiesel, biogas, and other renewable energy sources are all being used (Faizah, 2018). The world energy consumption rate is rapidly growing, coupled with the associated environmental impact of such energy consumption, which is based on various communities and among researchers, engineers, and even politicians (Alirezaei et al., 2016). Namely to determine war strategies (Zhao et al., 2014), such as the quality of power (Bialasiewicz, 2008) which is then to match the increasing need for power (Balasubrahmanyam & Gupta, 2020).

Renewable energy systems and integrated renewable energy systems are used to take advantage of available renewable sources (Vishnupriyan & Manoharan, 2018). Renewable energy sources play an important role in the generation of electrical energy (García et al., 2014), because they function to overcome dependence on non-renewable resources (Sahu & Raheman, 2020). Renewable energy sources (RE) are the best option available to meet the demand for electricity. The main sources of RE based systems are solar PV systems, wind power generation systems, fuel cells (FC), micro-turbines etc. RE sources are gaining more and more popularity for domestic as well as industrial applications due to their advantageous features such as availability, reliability and environmental friendliness. Solar energy is considered a reliable, promising and profitable energy source. It has various advantages such as pollution free, long life, low maintenance etc. (Gupta et al., 2016). Solar energy is the most abundant source of energy that can meet community needs that come from sustainable economic development (Husain et al., 2018). The trend of increasing rapid PV energy use is associated with increased efficiency of solar cells as well as improvements in solar panel manufacturing technology (Dondi et al., 2008). In many cases, desalination plants powered by non-renewable energy sources rely on fossil fuel energy to power solar generators, resulting in environmental pollution and greenhouse gas emissions (Elmaadawy et al., 2020). Therefore, real power control is also an effective way to regulate voltage interactions in a network distribution (Safayet et al., 2017) (Rottondi et al., 2016). As well as management strategies (Merei et al., 2016), for electricity efficiency (Monjezi et al., 2020), namely the cost of installing a solar tracking system, various moving parts, maintenance costs and motorization must all be considered while considering an increase in total power production (Hasan & Dincer, 2020).

Renewable energy sources are environmentally friendly (Herez et al., 2018), one of which is by increasing power generation by using distributed charging stations based on renewable energy sources (Torreglosa et al., 2016). With increasing public awareness of environmental protection and strengthening continued government support, more and more home users have installed small scale distributed renewable energy power generation systems such as solar power and wind energy (Zatsarinnaya et al., 2020) (Sun et al., 2020). Therefore, it is highly expected that future markets will see high growth of this technology with different types of distributed generation (Wang et al., 2020). Moreover, the generation of electricity from renewable energy sources integrated into a smart grid system can be one of the best choices for future energy security. Smart network system overcomes resource breakdown and modern information technology for communication and

improves power distribution efficiency. However, this renewable energy is likely to be produced not only at the industrial level (for example, on a large-scale state or private company) but also at the household or individual level (Strielkowski et al., 2019). Human activities contribute to climate change and consequently, environmentally friendly energy generation is needed. For this, finally, we explore the possibility of utilizing solar energy (Strušnik et al., 2020), because it can be used to overcome dependence on non-renewable resources (Sahu & Raheman, 2020).

Renewable and alternative energy has great potential benefits to replace dependence on fossil fuels, progress bringing it into the mainstream slowly in most developing countries (Vaka et al., 2020). In a study conducted by JX Sun, JN Wang, WX Yu, ZH Wang, and YH Wang shows that the proposed algorithm is applied for household electrical load sorting with solar panels, with high accuracy and reliability (Sun et al., 2020). In general, previous research related to Renewable energy and solar panels has only examined one research topic, such as one country (Pantua et al., 2020), one affiliation (Preston et al., 2020), and one field (Ioannidis & Koutsoyiannis, 2020). The creation and management of records by individuals or organizations is growing rapidly, especially the change from print to electronic, and the smallest fraction of records or metadata (Wicaksono & Nurpratama, 2017). Unfortunately, although it displays a broad image map visualized from year to year with details from several published studies on a global scale, there is not much literature on renewable energy and solar panels. The strong positive relationship regarding affiliation, scholars, and the impact of scientific studies has also not been explicitly discussed by any publication. This study aims to study the position of literature in the field of renewable energy and solar panels by researchers at the global level published internationally indexed by Scopus using bibliometric position. We monitor an increasing number of scientific documents related to renewable energy and solar panels published and indexed by Scopus from 1989 to 2020.

Energy is one of the most important factors affecting and shaping our daily life. Basic life necessities such as water and food are also obtained and transported by energy. Therefore, having high quality and uninterruptible energy is a basic need, for reasons such as rising fuel prices, energy requirements, pollution and greenhouse gases, the use of environmentally friendly renewable energy sources is increasing rapidly. Due to the high potential of renewable energy in our country, renewable energy systems are also increasingly popular (Demiroren & Yilmaz, 2010). Therefore, the use of renewable energy to supply electricity has grown in recent years, especially wind and solar.

Electrical energy has been universally accepted as one of the most important aspects of electrical energy for human development and economic growth (Vishnupriyan & Manoharan, 2018). To match the ever-increasing demand for power, the concept of renewable-based power generation is being implemented and a lot of research is being done on the same (Balasubrahmanyam & Gupta, 2020). solar energy is one of the cheapest, pollution free, inexhaustible renewable energy resources. It is used to provide heating, hot water, electricity, and even cooling to residential, commercial and industrial centres (Zoghi et al., 2017). Solar energy is considered a reliable, promising and profitable energy source. It has various advantages such as pollution free, long life, low maintenance etc. (Gupta et al., 2016). Solar energy is used in at least 4 different ways in our daily lives, and these range from heating water to generating electricity (Husain et al., 2018).

Research Method

This review maps the status of studies carried out in the last 36 years at a global level based on "Renewable Energy and Solar Panels". In January 2021, this study collected data from Scopus using a document search query. The study was conducted using bibliometric techniques. The most widely discussed research topics were extracted from Scopus abstracts that were subjected to content review (Srirahayu, D. P., Eliyana, A., & Usman, 2020). Bibliometric analysis aims to see how the results of the Scopus database publication are visualized and mapped in relation to bibliometric data (Sukoco et al., 2021). Data analysis and visualization uses the VOSViewer program and the Scopus function to analyse search results (Purnomo, Sari, et al., 2020) (Purnomo, Susanti, et al., 2020).

This study identifies renewable energy and solar panel keywords to recognize and look for Scopus database publications with 1,598 globally published documents from 1989 through 2020. The research confined collection of data to 2020 and excluding 2021. In order to reflect the state of the study over the entire year, the annual academic data collected from January to December. (TITLE-ABS-KEY (“Renewable Energy”) AND TITLE-ABS-KEY (“Solar Panel”)) AND PUBYEAR < 2021 AND (LIMIT-TO (SUBJAREA, "ENGI”) OR LIMIT-TO (SUBJAREA, "ENER”)) is the query input command which is implemented while mining academic publication data on online database of Scopus.

The research applies a co-authorship analysis with authors' analysis units and full calculation systematic techniques utilizing VOSViewer to gain the collaboration research network of the international researcher. The research conducted an in-depth co-occurrence analysis with keyword relation analysis as well as a full systematic technique of calculation utilizing VOSViewer to generate a keyword map network.

Result and Discussion

Renewable energy and solar panel literature appear to be likely to increase and grow per year. The tallest point for international publication was 240 documents in 2020. Since 1989, publishing on renewable energy and solar panel has already started.

A. Renewable Energy and Solar Panel Literature Most Common Organizational Affiliations

The leading research organizations in renewable energy and solar panel literature was National University of Singapore with 13 documents. Then with 12 document Vellore Institute of Technology, Vellore followed. CNRS Centre National de la Recherche Scient fique with 11 documents. National Institute of Technology Kurukshetra with 10 documents. Universidad de Jaen with 9 documents. Bangladesh University of Engineering and Technology with 9 documents. University Lebanese with 9 document, Delft University of Technology with 8 documents. University degli Study at Napoli Federico II with 8 document, and Clemson University with 8 documents.

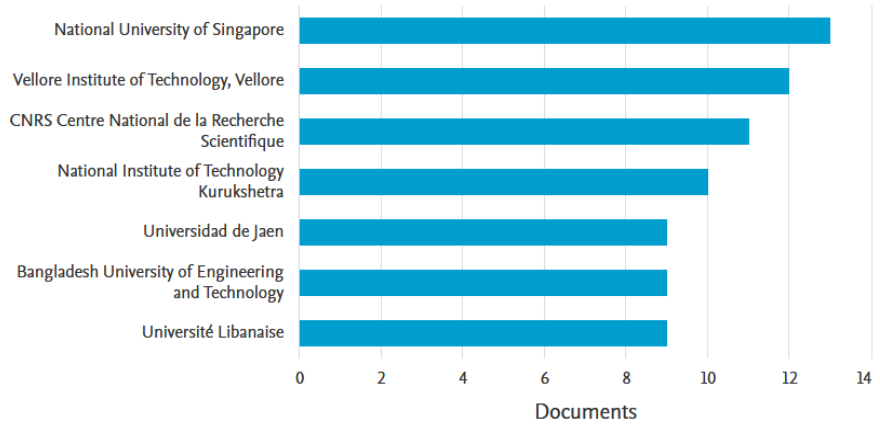

Figure 1: Organizational Affiliation Number of Annual Publication of Renewable Energy and Solar Panel Literature

B. Renewable Energy and Solar Panel Literature Most Individual Researcher

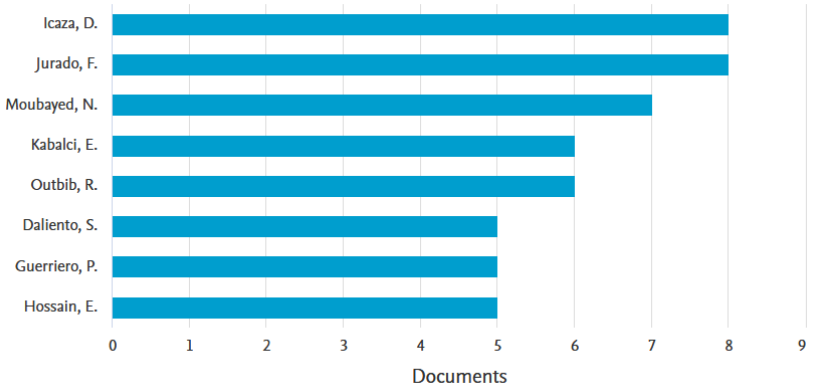

Figure 2: Most individual Renewable Energy and Solar Panel Literature Researcher

The researcher in the area of Renewable energy and solar panel to the most writings was Icaza, D. 8 document with it Jurado, F. with 8 documents. Pursued by Moubayed, N. with 7 documents, Kabalci, E. with 6 document Outbib, R. with 6 documents, Daliento, S. with 5 documents, Guerriero, P. with 5 document Hossain, E. with 5 documents, Abdollahi, Z. with document, and Biroon, R.A. with document.

C. Nation Number of Annual Publication of Renewable Energy and Solar Panel Literature

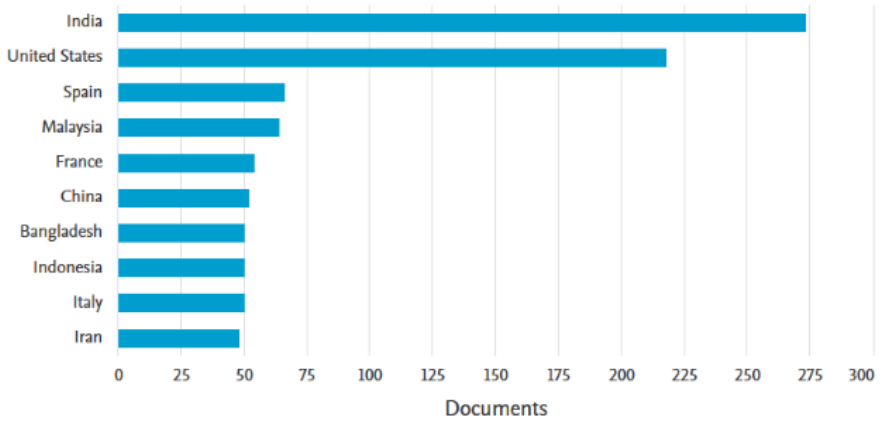

Figure 3: Number of Documents by Nation from the Renewable Energy and Solar Panel Literature

In Renewable energy and solar panel literature publications, the India with 273 academic documents was the leading research nation. Pursued with 218 documents, the United States, then Spain with 66 documents, Malaysia with 64 documents, France with 54 documents, China with 52 documents, Bangladesh with 50 documents, Indonesia with 50 documents, Italy with 50 documents, and Iran with 48 documents.

D. The Largest Frequency of Publication of Renewable Energy and Solar Panel Literature by Subject Area

With 1,108 documents (33.4 percent), Engineering in the subject area was the most frequent subject areas in international research on Renewable energy and solar panel Literature. Pursued by Energy (26.3 percent) with 874 documents, Computer Science (11.7%) with 389 document, Mathematics (6.0%) with 200 document, Environmental Science (5.8%) with 193 document, Materials Science (4.0%) with 134 document, Physics and Astronomy (2.3%) with 77 document, Social Sciences (2.3%) with 77 document, Business, Management and Accounting (1.7%) with 55 document, and Chemical Engineering (1.4%) with 48 documents.

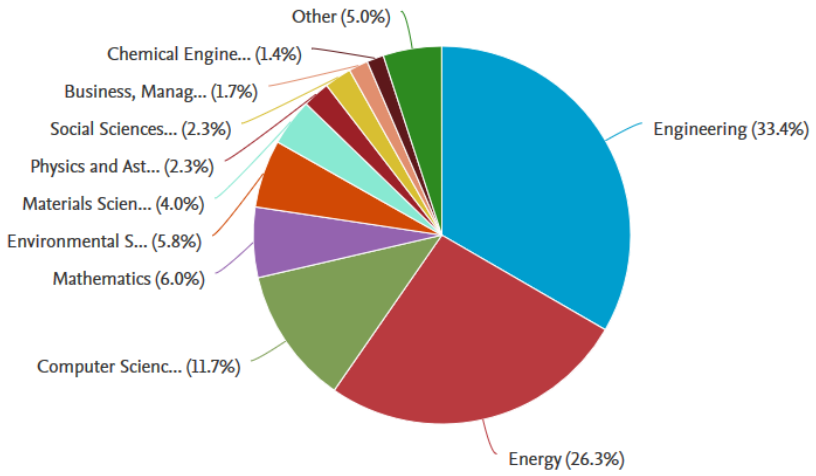

Figure 4: The Largest Frequency of Publication of Renewable Energy and Solar Panel by Subject Area

E. The Largest Frequent Type Document of Publication of Renewable Energy and Solar Panel Literature

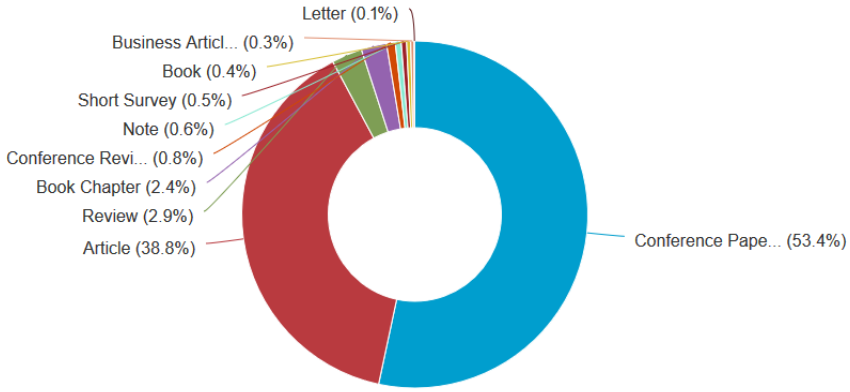

Figure 5: Most Frequent Type Document of Renewable Energy and Solar Panel Literature

The most document types in renewable energy and solar panel are Conference Paper (53.4%) with 856 papers, then pursued by Article (38.8%) with 622 papers, Review (2.9%) with 46 papers, Book Chapter (2.4%) with 38 papers, Conference Review (0.8%) with 13 papers, Note (0.6%) with 9 papers, Short Survey (0.5%) with 8 papers, Book (0.4%) with 6 papers, Business Article (0.3%) with 5 papers, and Letter (0.1%) with 1 paper.

F. Documents by Funding Sponsor of Renewable Energy and Solar Panel Publications

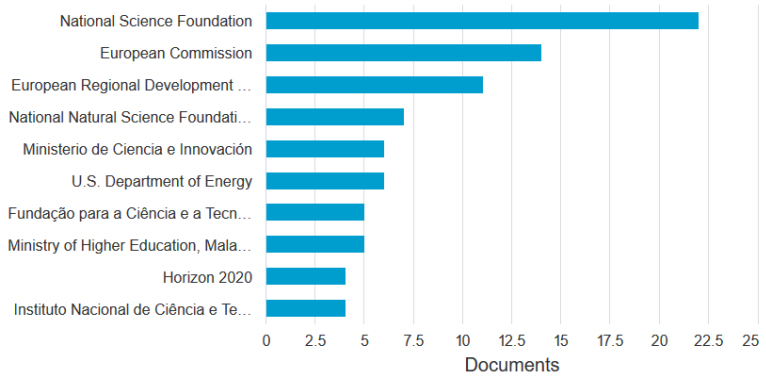

Figure 6: Most Frequent of Renewable Energy and Solar Panel Literature by Funding Sponsor

Fig. 6 shows the top sponsoring Funding agencies that were most helpful in publishing renewable energy and solar panel are then National Science Foundation with 22 papers, then followed by European Commission with 14 papers, European Regional Development Fund with 11 papers, National Natural Science Foundation of China with 7 papers, Ministerio de Ciencia e Innovación with 6 papers, U.S. Department of Energy with 6 papers, Fundação para a Ciência e a Tecnologia with 5 papers, and Ministry of Higher Education, Malaysia with 5 papers.

G. Year Documents of Renewable Energy and Solar Panel Literature Publication Sources

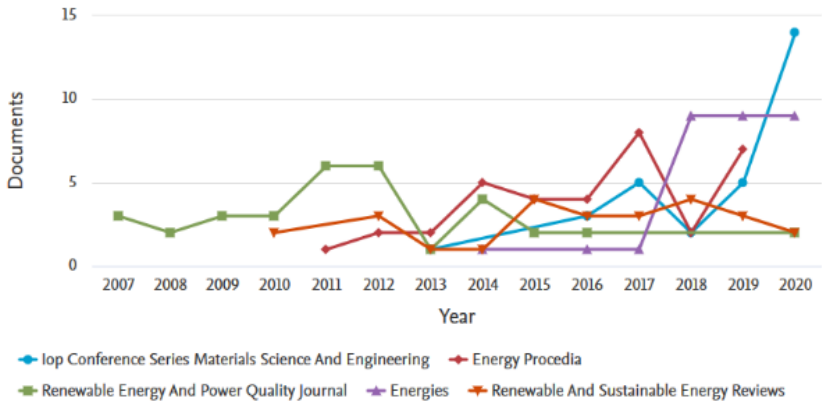

Figure 7: Year Annual Documents of Renewable Energy and Solar Panel Literature Publication Sources

The leader in the annual number of sources of Renewable energy and solar panel Literature publications is the Energy Procedia with 35 document, Renewable Energy and Power Quality Journal with 34 documents, Energies with 30 document, Iop Conference Series Materials Science and Engineering with 30 documents, and Renewable and Sustainable Energy Reviews with 26 documents.

H. Annual documents from the Renewable Energy and Solar Panel Literature

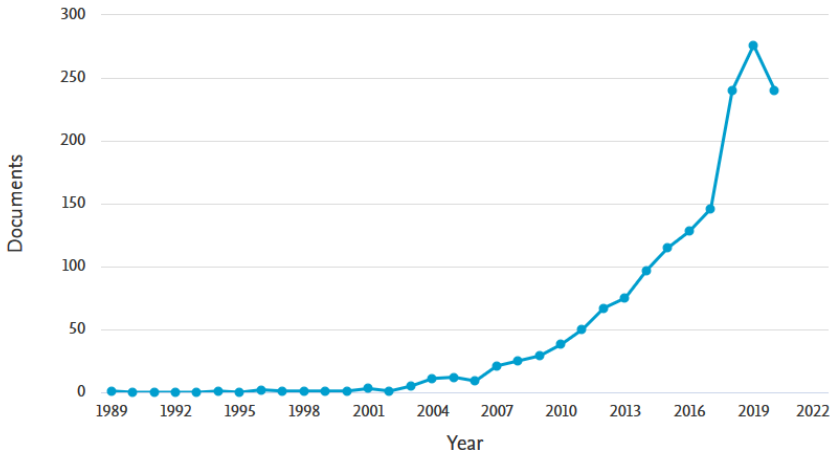

Figure 8: Annual Number of Documents Per Year from the Renewable Energy and Solar Panel Literature

The annual number of international publications from Renewable energy and solar panel literature has shown an increasing trend every year. The annual number of documents per year in Renewable energy and solar panel publications is that in 2020 there were 240 papers, and in 2019 there were 276 papers.

I. The Renewable Energy and Solar Panel Literature Article Cited

The study of Bialasiewicz, J.T. was the most widely cited publication on Renewable energy and solar panel literature. the most cited number was in 2008 entitled "Renewable energy systems with photovoltaic power generators: Operation and modelling", cited 323 documents (Bialasiewicz, 2008).

J. *Map of Study Themes*

With analysis and visualization of the VOS Viewer program, construction was developed on the Renewable energy and solar panel keyword framework for the Renewable energy and solar panel literature of publication theme map. Five repetitions were the criterion for the minimum number of keyword-related documents. Therefore, 729 keywords among 9,387 keywords reached the thresholds. From figure. 9. there were seven publication theme groups dependent on study

keywords regarding the international academic publication of Renewable energy and solar panel literature, simplified as well as abbreviated as SERMPTE themes.

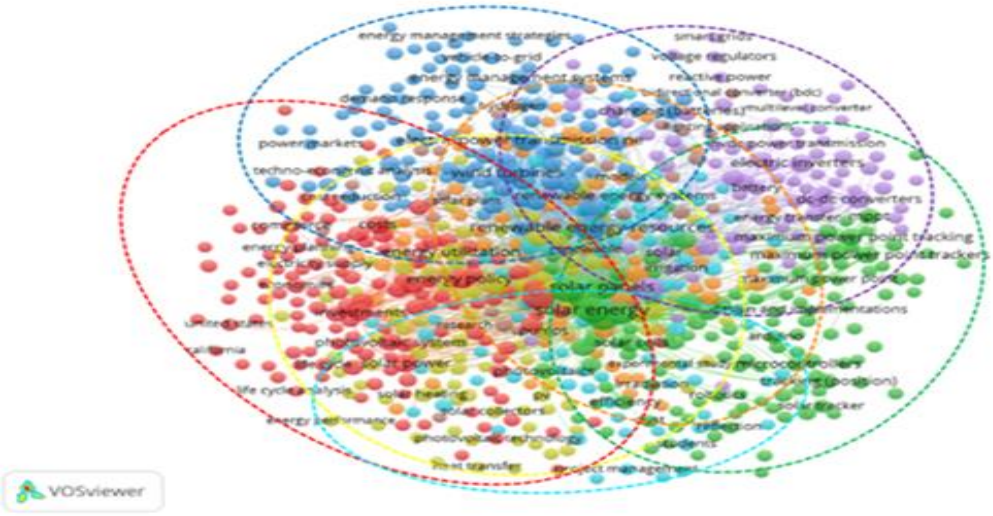

Figure 9: Map of Study Themes

1) Solar Energy cluster (green). The keywords solar cells, solar tracker, tracking (position). dominated in this cluster. Many of these keywords are linked to themes in Solar Energy.
2) Energy cluster (red). The keywords energy planning, energy policy, and energy utilization dominated in this cluster.
3) Renewable Energy cluster (blue). The keywords renewable energy systems, renewable energy resources, energy management strategies, and energy management systems. dominated in this cluster. Many of these keywords are linked to in renewable energy themes
4) Management cluster (light blue). The keywords project management, and efficiency dominated in this cluster.
5) Power cluster (Purple). The keywords reactive power, hydro power transmission, maximum power point tracking, maximum power point trackers dominated in this cluster. Many of these keywords are linked to in power themes.
6) Technology cluster (Yellow). The keywords energy performance, heat transfer, and photovoltaic technology dominated in this cluster. Many of these keywords are linked to in technology themes.
7) Environmental cluster (Orange). We can find environmental themes in this cluster. This cluster was related by the keyword's hydrogen, solar plant, irrigation, and irradiation.

K. Network of Authorship

With the VOS Viewer program, construction was developed on the renewable energy and solar panel researcher framework for the authorship network map. Five documents were one of the requirements for the minimum collection of publications per author. Thus, out of 4,833 researchers, 12 researchers who reached the thresholds were recognized. As shown in the figure 8, there were one group partnership networks between international researchers in renewable energy and solar panel literature publications. The red cluster of renewable energy and solar panel literature which contains

1) Red Cluster: Hoffmann, J., Salleh, N.A.M., Zainuddin, A., Kuzaiman, N.A., and Kasolang, S.
2) Green cluster: Kabalci, E., Hossain, E.
3) Blue cluster: Kumar, A.
4) Blue light cluster: Jurado, F.
5) Yellow cluster: Outbib, R., Moubayed, N.
6) Purple cluster: Icaza, D.
7) Orange cluster: Patel, S.
8) Brown cluster: Zhang, D.

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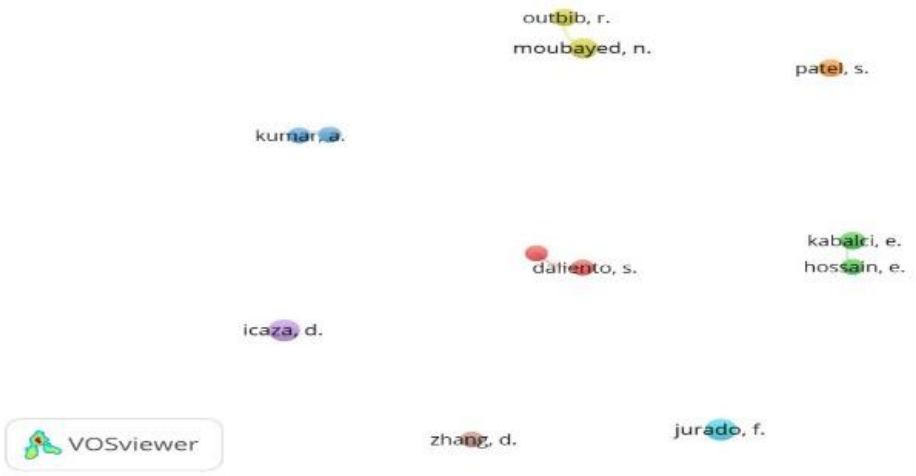

Figure 10: Authorship Network Map

Conclusion

The results of this research revealed that there is an annual trend towards a spike in the number of international publications on " Renewable Energy and Solar Panel ", there were maps and visual patterns. In the publication of the renewable energy and solar panel publications, National University of Singapore studies was the most active research institution with 13 papers. Meanwhile, In the renewable energy and solar panel literature publication, the individual academic researcher with the most prolific publications was Icaza, D. 8 papers with it. With 273 documents, the India was the country with the greatest contribution to publications in renewable energy and solar panel literature. With 1,108 documents (33.4 percent), the most intensively studied areas published in the renewable energy and solar panel t literature publication were engineering. The most document types in renewable energy and solar panel are Conference Paper (53.4%) with 856 papers, the top sponsoring Funding agencies that were most helpful in publishing renewable energy and solar panel are then National Science Foundation with 22 papers. The “Energy Procedia” with 35 documents was the majority of annual documents by the source in the renewable energy and solar panel literature publication. With 240 papers, the highest publication of worldwide scholarly publications in renewable energy and solar panel literature was in 2020. The works of Bialasiewicz, J.T. were mostly publications with the most citations. In 2008, cited 386 documents entitled “Renewable energy systems with photovoltaic power generators: Operation

and modelling". There were eight researcher partnership groups linked to the publication of renewable energy and solar panel literature.

In terms of contributing knowledge implications, this study recommends a classification of the convergence axis comprising of publication in renewable energy and solar panel literature to classify the body of knowledge created from thirty-six years of academic publication: Solar energy, Energy, Renewable energy, Management, Power, Technology, and Environmental, abbreviated as SERMPTE themes. The identification of key themes in the renewable energy and solar panel leads, as practical implication, contributes to an awareness of the creation of practical studies to clarify general contexts and topics, as well as research gaps. All this will lead to fresh research addressing a lack of study and specialized expertise in the disciplines. The most studied themes often reflect the ability to contribute of renewable energy and solar panel to engineering, environmental, technology, and management.

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