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A RESEARCH PROJECT EXAMINING THE FEASIBILITY OF USING SOLAR PANELS EQUIPPED WITH SENSORS TO MEASURE HEAT PRODUCTION IN CONJUNCTION WITH RENEWABLE ENERGY SOURCES

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Abstract

Renewable energy sources have the potential to meet both the present and future energy needs. This effort aims to provide a bibliometric strategic overview of the current state of research on solar panels and renewable energy in Scopus, a worldwide index for scientific publications. The results of this study were based on bibliometric analyses. Analysis and visualisation of data are also offered. Applying the Scopus feature in tandem with the VOS Viewer application to evaluate the search results. For this study, the researchers combed over 1,598 articles published between 1989 and 2020. Researchers found that when compared to other universities and countries, China's National University was the most engaged in researching renewable energy and solar panels. The majority of the literature on renewable energy and solar panels came from the engineering and energy fields. These were the most important parts of the test. Eight global group maps were created as a consequence of scholars' combined efforts. The primary goal of this research was to catalogue all of the scholarly articles written on renewable energy and solar panels within the last 32 years. The data was organised using the acronym SERMPTE, which stands for Solar energy, Energy, Restoration power, Leadership part of power, Technology, and Ecological.

Keywords: Renewable energy, Engineering, Solar panels, Economic development

Introduction

Everyone agrees that energy is the key to a growing economy across the world. There are mainly three types of energy resources on Earth: nuclear power, alternative sources of energy (including solar, geothermal, wind, and geothermal airpower, biomass, hydrogen, and ocean power), and fossil fuels. Renewable energy sources include wind, solar, ocean, geothermal, hydropower, biomass biogas, and many more. Current energy sources will be depleted in due time due to increasing demand. The Indonesian government is pushing for the expansion of energy from renewable sources to reduce the country's dependency on fossil fuels, especially in meeting its electrical demands (Gilbert, 2020). One of the many useful outcomes of methane fermentation is biogas, which may be used for both fuel and energy replacement. The exploitation of this alternative energy source allows for the production of heat, power, and a large amount of LPG gas for home use. Renewable energy sources have many benefits, and the technology behind them is crucial, safe, and evolving rapidly. To reduce the strain on transmission capacity, enhance technology, increase energy efficiency globally, and satisfy current and future needs, renewable energy is a viable option. Various countries have switched to renewable energy sources due to resource availability and geographical constraints (Faizah, 2018). Indonesia, like many other countries in the tropics and equatorial regions, has two distinct seasons the dry and the rainy and is thus exposed to sunlight all year round, making it an ideal candidate for solar power, a source of clean energy. Solar and wind power, as well as water, biomass, biodiesel, and biogas, are among the renewable energy sources that Indonesia is using. A long-term strategy to wean the nation off of fossil fuels should be in the works at the federal level. Concern among scientists, engineers, and lawmakers alike is the increasing pace of global energy use as well as its negative impact on the environment. In particular, military planning must take power quality into account to keep up with the rising energy demand (Monjezi, 2020).

BACKGROUND OF THE STUDY

A sustainable alternative would be to increase power generation by connecting various renewable energy sources via dispersed charging stations. As a result of growing public concern for the environment and continued government subsidies, an increasing number of homes are getting their power from small-scale decentralised renewable sources including wind turbines and solar panels (Calautit, 2020). The consequent fast growth of this technology in the next years will most likely be driven by several types of distributed generation. Furthermore, one potential solution for future energy reliability would be a smart grid system that uses renewable energy sources to produce electricity. Smart network systems use modern information technology to exchange data to improve the efficiency of power distribution and avoid resource failures. Alternatively, this green power will likely originate from both big-scale manufacturing plants (such as public or private enterprises) and smaller-scale household installations. Human activities have a significant influence on the global climate, making renewable energy sources crucial. The possibility of using solar energy to lessen dependence on non-renewable resources is lastly explored (Riaz, 2020). Renewable energy and other energy sources might drastically cut down on fossil fuel use, but they are still in the early stages of acceptance in most developing countries. The proposed method is used for the precise and trustworthy classification of electrical loads in residential regions powered by solar panels, according to research conducted by JX Sun, JN Wang, WX Yu, ZH Wang, and YH Wang. Much of the earlier research on solar panels and renewable energy has narrowly targeted a single country or group. The development and management of records by individuals or organisations is rapidly growing, especially with the transition from print to electronic, even if records and metadata only make up a small fraction of the total. Unfortunately, renewable energy sources and solar panels are under-discussed in the literature, even though it provide an annual visual map of the globe updated with information from many studies. Furthermore, no article has specifically discussed the strong positive correlation between affiliation, academia, and the impact of scientific publications. This study aims to analyse the bibliometric status of English-language papers indexed by Scopus that discuss renewable energy sources and solar panels globally. The researcher follows the increasing amount of Scopus-ranked academic publications about solar panels and renewable energy from 1989 to 2020 (Purnomo, 2020).

Purpose Of The Study

By conducting this study, the research team aims to get a better understanding of the potential applications of solar power and other forms of renewable energy. Incorporating sensor technology into solar panels is the goal of this project to monitor and assess the heat they generate. This research aims to determine the relationship between heat production and energy efficiency to discover methods to improve the performance of solar panels. Findings from the research should help promote green energy sources and reduce reliance on fossil fuels.

LITERATURE REVIEW

Solar, wind, hydro, fuel cell, and other renewable energy sources are all part of the renewable energy spectrum. A standout among them is solar electricity, which is both environmentally beneficial and has the potential to meet the growing demand sustainably and dependably (Raheman, 2020). In light of increasing energy needs, concerns about the future of traditional fuels, and the necessity to protect the environment from pollution, researchers have developed a new approach to harnessing renewable energy sources. With this consideration given. The PV system can convert solar energy into electrical power through the photovoltaic effect. Whenever light reaches the photovoltaic cell, its energy is transformed into a charge that may be used. Positively charged holes and negatively charged electrons are produced when the charge carriers are separated by an electric field that spans the junction. Current flows through a circuit whenever a load is attached to it, forming a closed channel. The use of solar energy on a worldwide scale has seen a remarkable surge. Both the amount of energy generated and used by solar panels is increasing at an exponential rate, with a total growth rate of 29.6 per cent. The depth of the tracking system is proportional to the angular displacement of the solar panels, which may be either horizontally or vertically shifted, or both. In general, solar tracking devices may be grouped into two types (Usman, 2020). The solar panel may be moved horizontally and vertically using one-axis tracking, which is one option. The second kind of solar tracking system is known as dual-axis tracking or two-axis tracking, and it allows for simultaneous changes to the azimuth and tilt angles. Both the price and the convenience of swivelling solar tracking devices from side to side are equally important. Solar tracking systems may be actively moved by hand using cantilevers, gears, or motors. The single most important thing that may help the proposed solar tracking systems is figuring out how much energy is gained to how much energy is lost by the tracker modules. Motors, hardware, resistors, and the size of the solar panels are some of the variables that affect the gain. The two main types of solar tracking mechanisms are differentiated by how the photovoltaic module is controlled. The researcher may classify tracking systems mainly into two types: active and dormant. An active tracking system uses electric motors and gear trains to direct the solar panel towards the sun. One kind of energy that passive tracking systems may utilise instead of electricity is a gaseous fluid that expands when heated by solar heat or another substance that undergoes a phase change (Vaka, 2020).

RESEARCH QUESTIONS

What improvements may be made to the surveillance and productivity of heat generation from renewable energy sources by the addition of electronics in solar panels?

Research Methodology

China's many different organisations were responsible for carrying out the research. The researcher chose a quantitative technique because of the limited resources and the limited time available. Using a random sampling process, every respondent was contacted for the survey. Following this, a sample size of 754 was determined using Rao Soft. Individuals confined to wheelchairs or who were unable to read and write would have the survey questions read aloud by a researcher, who would then record their answers word for word on the survey form. While participants waited to complete their surveys, the researcher would inform them about the project and field any questions they may have. On occasion, it was asked that people finish and send back questionnaires simultaneously.

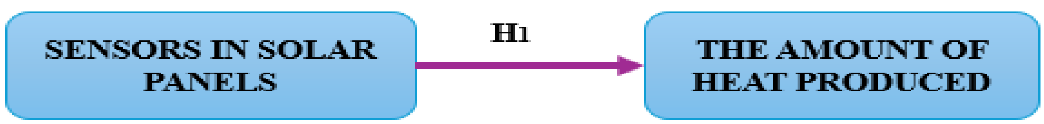
Sampling: Research participants filled out questionnaires to provide information for the research. Using the Rao-soft programme, researchers determined that there were 754 people in the research population, so researchers sent out 852 questionnaires. The researchers got 980 back, and they excluded 22 due to incompleteness, so the researchers ended up with a sample size of 958.

Data and measurement: A questionnaire survey was used as the main source of information for the study. Two distinct sections of the questionnaire were administered: Both online and offline channels' (A) demographic information, and (B) replies to the factors on a 5-point Likert scale. Secondary data was gathered from a variety of sites, the majority of which were found online.

Statistical Software: SPSS 25 was used for statistical analysis.

Statistical tools: To get a feel for the data's foundational structure, a descriptive analysis was performed. A descriptive analysis was conducted to comprehend the fundamental characteristics of the data. Validity was tested through factor analysis and ANOVA.

CONCEPTUAL FRAMEWORK



RESULT

Factor Analysis

The process of verifying the underlying component structure of a set of measurement items was a widely used application of Factor Analysis (FA). The observed variables' scores were believed to be influenced by hidden factors that were not directly visible. The accuracy analysis (FA) technique was a model-based approach. The primary emphasis of this study was on the construction of causal pathways that connect observable occurrences, latent causes, and measurement inaccuracies. The appropriateness of the data for factor analysis may be assessed by using the Kaiser-Meyer-Olkin (KMO) Method. The adequacy of the sampling for each model variable as well as the overall model was assessed. The statistics quantify the extent of possible common variation across many variables. Typically, data with lower percentages tends to be more suited for factor analysis.

KMO returns integers between zero and one. Sampling was deemed adequate if the KMO value falls within the range of 0.8 to 1.

It is necessary to take remedial action if the KMO is less than 0.6, which indicates that the sampling is inadequate. Use their best discretion; some authors use 0.5 as this, therefore the range is 0.5 to 0.6.

• If the KMO is close to 0, it means that the partial correlations were large compared to the overall correlations. Component analysis is severely hindered by large correlations, to restate.

Kaiser's cutoffs for acceptability are as follows:

A dismal 0.050 to 0.059.

• 0.60 - 0.69 below-average

Typical range for a middle grade: 0.70–0.79.

Having a quality point value between 0.80 and 0.89.

The range from 0.90 to 1.00 is stunning.

Table 1: KMO and Bartlett's

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.894
Bartlett's Test of Sphericity	**Approx. Chi-Square**	3252.968
	df	190
	Sig.	.000

The overall significance of the correlation matrices was further confirmed by using Bartlett's Test of Sphericity. A value of 0.894 was the Kaiser-Meyer-Olkin sampling adequacy. By using Bartlett's sphericity test, researchers found a p-value of 0.00. A significant test result from Bartlett's sphericity test demonstrated that the correlation matrix was not a correlation matrix.

TEST FOR HYPOTHESIS

Dependent Variable

The Amount of Heat Produced:

The efficiency and functionality of solar panels are greatly affected by the quantity of heat they generate. There is an inevitable energy loss in the form of heat when solar panels transform sunshine into electricity. Some variables, including solar cell materials, solar radiation angle, ambient temperature and wind speed and direction, contribute to this heat output. Solar panels lose efficiency and life expectancy when exposed to too much heat, thus it's crucial to understand the mechanisms of heat creation. Using sensors to measure heat output allows scientists to collect useful information that improves energy management methods and aids in solar panel optimisation. By keeping an eye on things, they can catch problems like overheating in their tracks and fix them quickly to make the system work better. To maximise the advantages of sources of renewable energy and promote more sustainable energy solutions, it is essential to have a thorough grasp of how heat is produced in solar panels n (Khalid, 2020).

Independent Variable

Sensors in Solar Panels

Solar panels depend on their sensors to ensure that they are operating at their full potential. Several different parameters, including temperature, the amount of light that is present, and the voltage output, are monitored by these sensors. Sensors can assess the light intensity throughout the day and use that information to determine the optimal angle for the panels to be positioned to collect the most amount of sunlight. Temperature sensors are necessary to monitor the temperatures that are found inside the solar cells to ensure that they continue to function at their highest possible efficiency. In addition, there are solar panels that come equipped with sensors that can determine when shadows are being thrown on them by things that are located nearby.

When maintenance is necessary to remove obstructions, systems may adjust the panel location or warn users of the need for maintenance. This is accomplished by sensing darkish spots. Incorporating the data that is gathered by these sensors into monitoring systems makes it possible to conduct analysis and troubleshooting in real-time. The researcher can maintain the solar panels' functioning at their highest possible efficiency if they anticipate future issues and take action before they become more severe. Solar energy systems, in general, are more dependable and generate more energy when sensors are incorporated into them. This results in energy sources that are less harmful to the environment (Preston, 2020).

A Relationship between Sensors in Solar Panels and The Amount of Heat Produced

Improving solar energy systems relies heavily on understanding the connection between solar panel sensors and heat output. Due to inefficiency in the conversion process, solar panels will inherently produce heat as they transform sunlight into energy. Because of this heat, the panels' overall efficiency may be severely compromised. In this setting, temperature sensors play a crucial role by keeping tabs on the solar cells' surface temperatures. Solar cells may lose some of their efficiency and produce less energy when exposed to temperatures that are too high. These sensors are great for preventing overheating since they continually measure temperature and give useful data for making modifications to operations (Javadi, 2020).

Based on the above discussion, the researcher formulated the following hypothesis, which was to analyse the relationship between Sensors in Solar Panels and The Amount of Heat Produced.

"H01: There is no significant relationship between Sensors in Solar Panels and The Amount of Heat Produced."

"H1: There is a significant relationship between Sensors in Solar Panels and The Amount of Heat Produced."

Table 2: H_1 ANOVA Test

ANOVA					
Sum					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	38452.260	563	5655.517	1123.872	.000
Within Groups	532.241	394	5.356		
Total	38984.501	957			

In this study, the result is significant. The value of F is 1123.872, which reaches significance with a p-value of .000 (which is less than the .05 alpha level). This means the “H1: There is a significant relationship between Sensors in Solar Panels and The Amount of Heat Produced.” is accepted and the null hypothesis is rejected.

DISCUSSION

One noteworthy development in the discussion of alternative energy sources, namely solar power, is the integration of sensors into solar panels. As the need for energy from renewable sources grows, understanding how solar panels function becomes more crucial. Although solar panels are great at turning sunshine into electricity, they aren't as effective as they might be because of all the heat they generate. The application of heat-generating sensor technology could provide light on the operating circumstances of solar panels. The researcher can monitor the temperature changes that occur when they produce energy in real time with the aid of these sensors. This data may show they how heat production could be affected by various conditions, like the environment or the panels' orientation. Monitoring heat levels also allows for the detection of issues before they lead to significant performance declines. As an example, consider solar panels; their effectiveness and lifespan are both diminished when they become too hot. When these dynamics are understood, adjustments like boosting airflow around the panels or employing cooling technologies may be made to improve energy output. Sensor data may potentially influence more generalised approaches to renewable energy management. For instance, it might be useful in developing smart grids, which alter power distribution based on real-time data. This comprehensive approach improves the efficiency of both integrated renewable energy systems and isolated solar installations, paving the way for their further integration into larger energy networks. Investigating renewable energy sources and finding ways to combine solar panels with sensor technology could improve efficiency, sustainability, and energy management. By using the gathered data to make informed decisions, stakeholders may improve solar energy systems, promote higher resource utilisation, and help create an ecologically responsible energy future.

CONCLUSION

Researchers have a fantastic opportunity to learn how to maximise the use of alternative sources of energy, particularly solar panels equipped with sensors, and thus increase energy efficiency and sustainability. One must be able to quantify the heat produced during energy conversion to understand the dynamics of solar panels in action. The researcher can gather real-time data showing how heat production impacts system performance and where errors may be hiding using state-of-the-art sensors. It is possible to manage solar systems in a manner that prevents panels from overheating, which decreases their efficiency and longevity, by implementing preventive steps. The monitoring data may also aid in the overall optimisation of renewable energy systems via the improvement of design and operational practices. To optimise energy collection and improve the efficiency of our energy architecture as they move towards a future when sustainable energy is more important, it will be essential to combine clean sources of energy with current monitoring equipment. A stronger and more sustainable energy environment is the ultimate goal of this integration.

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