Frontiers in Health Informatics
ISSN-Online: 2676-7104
www.healthinformaticsjournal.com
2024; Vol 13: Issue 8
Open Access

A Study Examining The Feasibility Of Integrating Solar Panels With Sensors To Measure Heat Generation In Conjunction With Energy From Renewable Sources

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Cite this paper as: Zhao Xu, Mohammad Nizamuddin Inamdar (2024) " A Study Examining The Feasibility Of Integrating Solar Panels With Sensors To Measure Heat Generation In Conjunction With Energy From Renewable Sources". *Frontiers in Health Informatics,* (8), 5156-5164

ABSTRACT

It can occur that renewable energy sources can provide adequate electricity for both the present and the future. This study aims to provide a bibliometric overview of the state of research on solar panels and renewable energy in Scopus, a global index of scientific papers. This study's conclusions were derived via a bibliographic examination. Data visualization and analysis are also provided by the researcher. Evaluate search results with the help of the VOS Viewer app and the Scopus tool. This analysis included the review of 1,598 papers that were published between 1989 and 2020. The study claims that when compared to other universities and countries, China's National University is at the forefront of research into renewable energy and solar panels. The majority of the published literature on renewable energy and solar panels came from the energy and engineering fields. These portions of the exam were the most important. Eight group maps covering the whole globe were made possible by the combined efforts of scholars. The purpose of this research was to gather all scholarly articles published over the last 32 years that discussed solar panels and renewable energy sources and to create a bibliography of them. An abbreviation called SERMPTE was used to organize the data. It stands for Sunlight, Energy, Restoration, Leadership, Technology, and the Environment.

Keywords: *Renewable Energy, Solar Photovoltaic Systems, Economic Growth, International Scope.*

1. INTRODUCTION

Everyone agrees that energy is crucial to the development of economies across the world. Natural gas, nuclear power, renewable energy sources (solar, wind, geothermal, air, biomass, hydrogen, and ocean power), and fossil fuels are the three main types of energy that the Earth has available. Power may be supplied by a wide variety of renewable sources, including the sun, wind, water, geothermal heat, hydroelectricity, biomass biogas, and many more. The world's present energy sources will run out of juice sooner rather than later. Renewable energy sources are being promoted by the Indonesian government as a means to reduce dependency on fossil fuels, especially in the production of electricity (Firouzi & Farahani, 2020). The valuable byproduct of methane fermentation, biogas, has several possible uses, one of which is as a substitute for energy and fuel. This renewable energy source offers the researcher the chance to produce heat, power, and a significant amount of LPG gas for household use. Renewable energy sources have many benefits, and the technology that backs them up is important, safe, and evolving fast. In addition to meeting current and future needs, renewable energy

sources have the potential to enhance technology, increase global energy efficiency, and ease transmission capacity restrictions. Some countries have started to depend on renewable energy sources because of resource availability and geographical constraints. Indonesia, like many other tropical and equatorial countries, has sunlight throughout the year and has two distinct seasons, making it an ideal candidate for solar power, a renewable energy source. Sustainable energy sources in Indonesia include solar and wind power, as well as water, biomass, biodiesel, and biogas. The US government should be working on a strategy to wean the country off fossil fuels. Concerns about the world's increasing energy use have been voiced by scientists, engineers, and environmentalists. In particular, power quality has to be considered in military planning if the researches are to keep up with the ever-increasing need for energy (Bedi et al., 2018).

2. BACKGROUND OF THE STUDY

Distributed charging stations that link several renewable energy sources may increase electrical output, which is a sustainable option. Public concern for the environment and continuing government subsidies are driving the appeal of small-scale localized renewable energy sources like solar panels and wind turbines. The therefore expected fast spread of this technology in the next years is anticipated to be driven by several types of distributed generation. Another potential future-proofing measure is a smart grid system that draws electricity from renewable sources. Smart network systems use modern information technology to transmit data in an effort to improve the efficiency of power distribution and avoid resource failures. Instead, this green power will likely originate from both large-scale energy plants (such as governmental or private firms) and smaller-scale installations in people's homes (García et al., 2020). The tremendous influence that people exert on the global ecosystem makes renewable energy sources critical. Finally, in order to lessen the burden on limited resources, the researcher looks into the possibility of solar electricity. Even though they might drastically cut down on fossil fuel use, most developing countries are still hesitant to commit to renewable and alternative energy. The proposed method is used for the precise and dependable classification of electrical loads in residential areas that have solar panels installed. In the past, research on renewable energy sources, such as solar panels, often isolated a single country or group of nations. The development and management of records by individuals or organizations is rapidly growing, especially with the transition from print to electronic, even if records and metadata only make up a small percentage of the total. Regrettably, renewable energy sources and solar panels get less attention in the literature, despite the fact that they provide an annual visual map of the globe that is updated with information from various studies. Furthermore, there is a favorable correlation between academic affiliation and the impact of scientific articles, but no studies have specifically examined this link. This study will look at the bibliometric data that is currently available for English-language papers that are part of the Scopus database and discuss renewable energy sources like solar panels all around the globe. This research follows the increase of Scopus-indexed academic publications covering renewable energy and solar panels from 1989 to 2020 (Bhau et al., 2021).

3. PURPOSE OF THE STUDY

Understanding the potential applications of the different renewable energy sources is the primary objective of the research team conducting this study. Through the use of sensor technologies, this research aims to quantify and monitor the thermal output of solar panels. This research aims to determine the relationship between heat production and energy efficiency in order to discover methods to improve the performance of solar panels. A more gradual transition away from fossil fuels and toward renewable energy sources should be aided by the study's findings.

4. LITERATURE REVIEW

Solar, wind, hydro, and fuel cell power are just a few examples of the many renewable energy sources that make up the renewable energy spectrum. Among the most prominent is solar electricity, which is both environmentally friendly and capable of stably meeting the growing demand. In light of increasing energy needs, concerns about the sustainability of traditional fuels, and the urgent need to reduce pollution, scientists have developed a novel method to harness renewable energy sources. With respect to this argument. The PV system converts solar energy into electrical power by means of the photovoltaic effect. The photovoltaic cell is able to transform any light that reaches it into a useable charge. A positive charge is introduced to holes and a negative charge to electrons when an electric field is applied across the junction, separating the charge carriers. Current flows through a circuit whenever a load is attached to it, forming a closed channel. The use of solar energy has skyrocketed on a worldwide scale. The total amount of energy generated and consumed by solar panels is increasing at an exponential rate of 29.6 percent. The tracking system's depth is determined by the angular displacement of the solar panels, which may be adjusted horizontally, vertically, or in both directions. Two main types of solar tracking systems are often used. An other method involves the use of one-axis tracking, which permits the horizontal and vertical movement of the solar panel. Two- or dual-axis tracking allows for simultaneous changes to the azimuth and tilt angles, and is the second kind of solar tracking system. Two equally important features of solar tracking systems are their affordability and their swivelability. Motors, gears, and cantilevers allow for the manual manipulation of solar tracking devices. Most importantly, in order to enhance the proposed solar tracking systems, it is necessary to ascertain the ratio of energy gained to energy 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 systems are differentiated by the control technique of the photovoltaic module. Differentiating between "active" and "dormant" tracking systems was the primary ability of the researcher. An active tracking system uses electric motors and gear trains to direct the solar panel towards the sun. Potentially replacing electricity with gaseous fluids that expand when heated by sunlight or other substances that go through phase shifts is one option for passive tracking systems (Cho & Kim, 2019).

5. RESEARCH QUESTION

- How does resistance of the conductor affect in the amount of heat produced?

6. RESEARCH METHODOLOGY

Quantitative research refers to studies that examine numerical readings of variables using one or more statistical models. The social environment may be better understood via quantitative research. Quantitative approaches are often used by academics to study problems that impact particular individuals. Objective data presented in a graphical format is a byproduct of quantitative research. Numbers are crucial to quantitative research and must be collected and analyzed in a systematic way. Averages, predictions, correlations, and extrapolating findings to larger groups are all possible with their help.

6.1 Research design: In order to analyse quantitative data, SPSS version 25 was used. The direction and severity of the statistical association were determined using the odds ratio and the 95% confidence interval. researchers reported a statistically significant level at $p < 0.05$. To identify the primary features of the data, a descriptive analysis was used. Data acquired by surveys, polls, and questionnaires, or by modifying existing statistical data using computing tools, is often assessed mathematically, numerically, or statistically using quantitative methods.

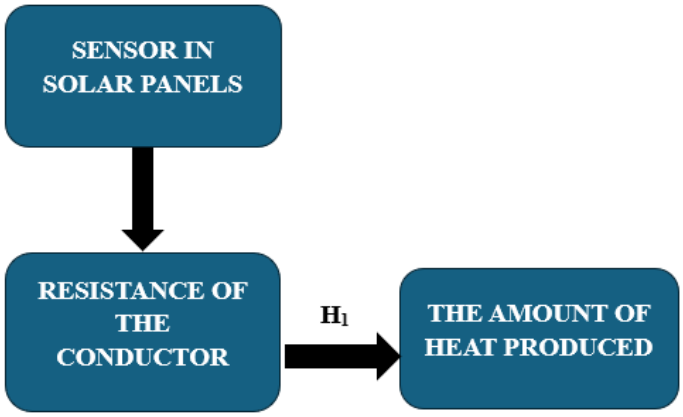
6.2 Sampling: Research participants filled out questionnaires to provide information for the research. Using the Rao-soft program, researchers determined that there were 754 people in the research population, so researchers sent out 852 questionnaires. The researchers got 980 back, and they excluded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

6.3 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.

6.4 Statistical Software: SPSS 25 was used for statistical analysis.

6.5 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.

7. CONCEPTUAL FRAMEWORK



8. 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: KMO and Bartlett's

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.771
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 0.771 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.

❖ **Independent Variable**

Sensors in Solar Panels

Solar panels can detect when they are operating at their most efficient via the use of sensors. The current voltage, ambient light level, and temperature are just a few of the factors that these sensors monitor. Sensors can monitor the amount of light entering the system all day long and use that information to determine the optimal panel placement angle, allowing for maximum solar collecting. Solar cells need temperature sensors to monitor their interior temperatures so they can maintain optimal performance. A further option is solar panels equipped with sensors that can identify when nearby objects produce shadows. In order to make room for repair, the system may move the panels or alert the user. This may be accomplished by detecting areas of darkness. When these sensors are included into monitoring systems, the data they collect may be used for real-time analysis and troubleshooting. The researcher can maintain the solar panels' optimal performance by anticipating and addressing any issues before they become more serious. Solar power systems are often more efficient and dependable when they have sensors installed. This leads to the production of energy sources that are less harmful (Cirillo et al., 2020).

❖ **Factor**

Resistance of the conductor

A conductor's resistance to electric current flow is a physical property of the material. It measures the material's resistance to the conduction of electric charges when a voltage is passed through it. A conductor's resistance may be affected by its material, size, and temperature. A conductor's resistance is its capacity to obstruct the passage of an electric current. It starts when the atoms of the material used as a conductor interact with the free-moving electrons that carry the current. Electrons in a conductor lose energy, often in the form of heat, as they collide with atoms and other electrons as they travel through the material. The resistivity of a substance is one of the parameters that determine its resistance. Exceptional conductors with almost little resistance to current flow via materials with low resistivity, such as silver and copper. On the other hand, insulators with a high resistivity, such as rubber or glass, greatly oppose the passage of current. Crucial as well is the shape of the conductor. Because electrons meet more impediments over longer distances, the resistance of longer conductors is higher. The opposite is true for reduced resistance: a bigger cross-sectional area offers more pathways for electrons to pass. Another crucial consideration is temperature (Díaz et al., 2020).

❖ **Dependent Variable**

The Amount of Heat Produced

The efficiency and practicality of solar panels are directly correlated to the quantity of heat they generate. Some of the heat produced by solar panels as they transform sunlight into electricity is inevitable. Several variables influence this heat generation, including solar cell materials, solar radiation angle, ambient temperature, wind speed and direction, and overall environmental conditions. Overheating shortens the life and effectiveness of solar panels, therefore understanding how heat is produced is essential. Information gathered from heat output sensors may help scientists improve

energy management methods and maximize the efficiency of solar panels. By keeping a careful eye, problems like overheating may be caught early and fixed quickly, leading to better system performance. A thorough comprehension of the heat generation process by solar panels is necessary to fully use renewable energy sources and to promote more sustainable energy options (Dinesh et al., 2021).

❖ **Relationship Between Resistance of the conductor and The Amount of Heat Produced**

In Joule's Law of Heating, the link between a conductor's resistance and the heat generated is regulated. A conductor's heat production is proportional to its resistance, the square of the current passing through it, and the time the current has been running through it, according to this rule. According to Joule's Law of Heating, the heat that a conductor can generate is proportional to its resistance. A conductor's heat production is proportionate to its resistance, the square of the current passing through it, and the duration of that current, according to this concept. A conductor's resistance prevents electrons from freely flowing through it, leading to the loss of energy in the form of heat. More energy is heated up for the same amount of time and current when the resistance is higher because there is more opposition. Both real-world applications and energy management place a premium on this connection. Electric heaters and toasters, for example, purposefully utilize heating components made of materials with a high resistance to increase heat output. On the flip side, low-resistance materials like copper or aluminum are preferred in power transmission systems to reduce heat loss and maximize energy efficiency. Heating up too quickly because of a high resistance could cause insulation and electrical components to melt. Consequently, in planning reliable and effective electrical systems, it is essential to comprehend and control this connection (Divakaran et al., 2021).

H_{01}: "There is no significant relationship between The Resistance of Conductor and The Amount of Heat Produced."
H_1: "There is a significant relationship between The Resistance of Conductor 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	422	5655.517	1123.872	.000
Within Groups	532.241	535	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 ***"H_1: There is a significant***

relationship between The Resistance of Conductor and The Amount of Heat Produced." is accepted and the null hypothesis is rejected.

9. DISCUSSION

A major step forward in the discussion of renewable energy sources, and solar power in particular, is the integration of sensors into solar panels. Since there is a growing need for renewable energy, understanding how solar panels function is critical. Solar panels are great at turning sunshine into electricity, but they're not very efficient because of all the heat they generate. The utilization of heat-generating sensor technologies could provide a better understanding of the working characteristics of solar panels. These sensors allow the researcher to monitor the quick temperature changes that take place during energy generation. They want to learn how panel orientation and environmental variables affect heat production by examining this data. Keeping an eye on temperature levels may also helps the student catch issues before they lead to significant performance decreases. once an example, consider solar panels; once they become too hot, they begin to degrade and lose part of their effectiveness. Increasing airflow around the panels or using cooling technologies are two examples of how a greater grasp of these dynamics could lead to improvements in energy output. Information gathered from sensors could have an effect on less specific approaches to renewable energy source management. One such use is the development of smart grids, which utilize real-time data to modify power distribution. This comprehensive approach paves the way for even deeper integration with current energy networks and can be useful for both standalone solar installations and renewable energy systems with integrated components. Investigating alternative energy sources and finding ways to combine solar panels with sensor technology could lead to better energy management, sustainability, and efficiency. With the right information, stakeholders can improve solar energy systems, push for more efficient use of resources, and help ensure a sustainable energy future.

10. CONCLUSION

Scientists have a fantastic opportunity to find methods to maximize the use of renewable energy sources, particularly solar panels equipped with sensors, and to make these power sources more efficient and last longer. Understanding the amount of heat produced by solar panels as they transform sunlight into energy is essential for students interested in learning about how these devices function. To find out how heat production affects system performance and where any hidden faults are, researchers may use state-of-the-art sensors to gather data in real-time. Solar panels lose efficiency and life expectancy due to overheating, however this issue is controllable with proper system management. The collected data from the monitoring systems may provide light on how to improve the overall design and operation of renewable energy systems. When sustainable energy plays a larger role in the future, it will be essential to integrate renewable energy sources with current monitoring technologies to optimize energy collection and improve the efficiency of the energy infrastructure. The end goal of this integration is to provide a more robust and long-lasting energy environment (Elahi et al., 2021).

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