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A Research Project Investigating The Viability Of Using Solar Panels Integrated With Sensors To Quantify Heat Generation Alongside Renewable Energy Sources

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ABSTRACT

Renewable energy sources may be able to provide enough power for today and tomorrow. The purpose of this work is to survey the solar panel and renewable energy research landscape in Scopus, an international index of scientific articles, from a bibliometric perspective. Bibliographic analysis formed the basis of this study's findings. The researcher also provide data visualization and analysis. Using the VOS Viewer app in conjunction with the Scopus tool to assess the search results. Researchers looked through 1,598 publications published between 1989 and 2020 for this investigation. According to the report, China's National University is leading the way in studying solar panels and renewable energy compared to other nations and colleges. The energy and engineering disciplines produced the bulk of the published works concerning solar panels and renewable energy. The test's most crucial sections were these. The collaborative work of academics resulted in the creation of eight worldwide group maps. This study set out to compile a bibliography of every academic publication addressing solar panels and renewable energy that has appeared in the previous 32 years. Sunlight, Energy, Restoration, Leadership, Technology, and the Environment (SERMPTE) was the acronym used to organize the data.

Keywords: *Energy-Saving Technology, Solar Photovoltaic Systems, Economic Advancement, Global Scale.*

1. INTRODUCTION

The importance of energy to global economic growth is universally acknowledged. Nuclear power, renewable energy (solar, wind, geothermal, air, biomass, hydrogen, and ocean power), and fossil fuels are the three primary categories of Earth's energy resources. Solar, wind, ocean, geothermal, hydropower, biomass biogas, and many other forms of renewable energy are all capable of meeting the energy needs. There will come a point when the world's current energy sources are no longer sufficient to meet demand. To lessen reliance on fossil fuels, particularly for electricity generation, the Indonesian government is advocating for the growth of renewable energy sources. Biogas is a valuable byproduct of methane fermentation that has several potential use, including as a fuel and an energy alternative. By tapping into this renewable energy source, the researcher can generate electricity, heat, and a substantial quantity of LPG gas for residential use (Aslam et al., 2020). There are several advantages to using renewable energy sources, and the technology that supports them is vital, secure,

and developing at a quick pace. Renewable energy sources may help alleviate transmission capacity constraints, improve technology, boost global energy efficiency, and meet present and future demands. For reasons related to both resource availability and geographical limits, some nations have begun to rely on renewable energy sources. Solar power, a renewable energy source, would be well-suited to tropical and equatorial nations like Indonesia because of its year-round sunshine and two distinct seasons (dry and wet). In addition to solar and wind power, Indonesia is also making use of water, biomass, biodiesel, and biogas as sustainable energy sources. The federal government need to be formulating a plan to gradually reduce reliance on fossil fuels. Environmentalists, engineers, and scientists are all worried about the world's rapidly expanding energy use. Specifically, in order to meet the increasing need for energy, military planning must include power quality (Abouaiana & Battisti, 2022).

2. BACKGROUND OF THE STUDY

Increasing electricity production via the interconnection of many renewable energy sources through distributed charging stations is a sustainable solution. Wind turbines and solar panels are examples of small-scale decentralized renewable energy sources that are gaining popularity as a consequence of public concern for the environment and ongoing government subsidies. Consequently, various forms of distributed generation will likely propel this technology's rapid expansion in the next years. In addition, a smart grid system that gets its power from renewable sources might be a good way to ensure consistent energy supply in the future. In order to enhance the effectiveness of electricity distribution and prevent resource breakdowns, smart network systems use contemporary information technology to communicate data. As an alternative, this green electricity will most likely come from both large-scale factories (like public or private companies) and smaller-scale installations in people's homes. Renewable energy sources are vital because of the enormous impact that humans have on the world's environment. As a last step, the researcher investigate the potential of solar power to reduce the reliance on finite resources. Most developing nations are still on the fence about renewable energy and alternative energy sources, even though they have the potential to significantly reduce fossil fuel consumption. In residential areas where solar panels are installed, the suggested approach is used for the accurate and reliable categorization of electrical loads. Solar panels and renewable energy studies in the past tended to focus on only one nation or set of countries. Even while records and metadata only constitute a tiny portion of the total, the creation and administration of records by people or organizations is expanding at a fast pace, particularly with the shift from print to electronic. Despite providing a yearly graphic map of the world updated with information from several research, the literature regrettably pays little attention to renewable energy sources and solar panels. Additionally, the effect of scientific papers is positively correlated with affiliation with academia, although this association has not been addressed in any research. In this research, the researcher will examine the current state of bibliometric data for articles published in English and included in the Scopus database that address solar panels and other forms of renewable energy on a worldwide scale. This study tracks the growth in the number of scholarly articles published between 1989 and 2020 that discuss renewable energy and solar panels in Scopus (Abu Adnan Abir et al., 2020).

3. PURPOSE OF THE STUDY

The research team's overarching goal in doing this study is to get a deeper comprehension of the various renewable energy sources' prospective uses. The objective of this project is to measure and track the amount of heat produced by solar panels by integrating sensor technologies into them. In order to find ways to make solar panels work better, this study is trying to figure out how heat generation relates to energy efficiency. The study's results should contribute to the push for renewable energy sources and the gradual phase-out of fossil fuels.

4. LITERATURE REVIEW

A wide variety of renewable energy sources are included in the renewable energy spectrum, including solar, wind, hydro, and fuel cells. One of the most notable is solar power, which can reliably and sustainably supply the increasing demand while also being good for the environment. Scientists have come up with a fresh way to tap into renewable energy sources in response to rising energy demands, worries about conventional fuels' long-term viability, and the pressing need to curb pollution. Regarding this point being made (Azhar et al., 2019). By using the photovoltaic effect, the PV system is able to transform solar energy into usable electrical power. The photovoltaic cell converts light into a usable charge whenever it hits it. An electric field across the junction separates the charge carriers, creating holes with a positive charge and electrons with a negative charge. When a load is connected to a circuit, creating a closed channel, current flows through it. There has been an astounding increase in the global utilization of solar energy. Solar panels are seeing overall increase of 29.6 percent in both energy produced and consumed, which is an exponential growth rate. The solar panels' angular displacement, which may be horizontally or vertically moved, or both, determines the tracking system's depth. Solar tracking systems often fall into one of two categories. One alternative is to use one-axis tracking, which allows the solar panel to be moved horizontally and vertically. Altering the azimuth and tilt angles at the same time is possible with the second kind of solar tracking system, which is called dual-axis tracking or two-axis tracking. Solar tracking systems' affordability and their ability to be swiveled side to side are of equal importance. Manually manipulating solar tracking systems is possible with the use of motors, gears, or cantilevers. Determining the ratio of energy acquired to energy lost by the tracker modules is the most critical factor that might improve the suggested solar tracking systems. A number of factors influence the gain, including motors, hardware, resistors, and solar panel size. The control method of the photovoltaic module distinguishes the two primary kinds of solar tracking technologies. The researcher could primarily distinguish between "active" and "dormant" tracking systems. The solar panel is guided towards the sun by means of electric motors and gear trains in an active tracking system. Gaseous fluids that expand when heated by solar heat or other substances that undergo phase changes are one potential alternative to power that passive tracking systems might use (Agostini et al., 2021).

5. RESEARCH QUESTION

- How does the duration of current flow influence 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.

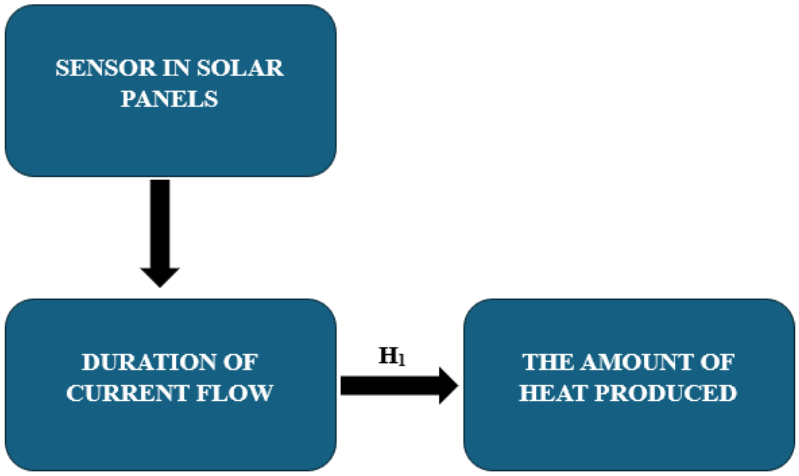
6.2 Sampling: Research participants filled out questionnaires to provide information for the research. Using the Rao-soft program, researchers determined that there were 754 people in the research population, so researchers sent out 852 questionnaires. The researchers got 980 back, and they excluded 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.		.836
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 0.836 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

Sensors allow solar panels to know when they are working at peak efficiency. These sensors keep an eye on a number of variables, such as the current voltage, the ambient light level, and temperature. To maximize sunlight collection, sensors can track the quantity of light entering the system throughout the day and use that data to calculate the best angle at which to place the panels. In order to keep the solar cells operating at peak efficiency, temperature sensors are required to monitor the internal temperatures of the cells. Then there are solar panels with built-in sensors that can detect when surrounding objects cast shadows on them. The system may shift the panels or notify the user when maintenance is required to clear the way. The detection of dark patches allows this to be carried out. Analysis and troubleshooting may be done in real-time using the data obtained by these sensors when integrated into monitoring systems. By foreseeing potential problems and resolving them before they escalate, the researcher can keep the solar panels operating at peak efficiency. Incorporating sensors into solar energy systems generally makes them more reliable and increases their energy production. Because of this, cleaner energy sources are produced (Abdulkadir et al., 2021).

- **Factor**

Duration of current flow

A current's flow through a circuit or conductor is defined as the time it takes for an electric current to go through that medium. The characteristics of the power source and the operating circumstances of the circuit determine the usual units of measurement, which might be seconds, minutes, or hours. A basic idea in physics and electrical engineering is the duration of current flow. The requirement to comprehend or regulate the time-dependent behavior of current makes it especially pertinent in a

number of scenarios (Ali et al., 2019).

❖ **Dependent Variable**

The Amount of Heat Produced

Solar panels' effectiveness and usefulness are highly dependent on the amount of heat they produce. When solar panels convert sunlight into electricity, some of that energy will inevitably escape as heat. This heat production is affected by a number of factors, such as the materials used to make the solar cells, the angle of solar radiation, the surrounding temperature, and the speed and direction of the wind. It is critical to comprehend the processes of heat production since excessive heat reduces the efficiency and lifespan of solar panels. Researchers can enhance energy management strategies and optimize solar panel performance with the use of data collected from heat output sensors. By maintaining a close watch, issues like overheating may be detected early on and promptly resolved, resulting in improved system performance. Realizing the full potential of renewable energy sources and advocating for more sustainable energy solutions requires an in-depth understanding of solar panels' heat production process (Ali & Paracha, 2020).

❖ **Relationship Between the Duration Of Current Flow And The Amount Of Heat Produced**

In a conductor, electrical energy is transformed into thermal energy, which is why the quantity of heat generated is directly proportional to the duration of current flow. Electricity loses some of its kinetic energy as heat as it travels through a resistive material. The length of time a stream flows has a direct correlation to the heat it produces. So, the amount of heat produced increases as the duration of current flow through the conductor increases.Time, squared current, and conductor resistance are the three variables that determine the amount of heat that is generated. Because the equation squares the current, a higher current causes a much larger increase in heat output. Likewise, for the same amount of time and current, materials with a greater resistance generate more heat. The collisions between the atomic structure of the material and the electrons carrying the current cause this process to occur, which in turn generates thermal energy. This idea is often seen in devices that transform electrical energy into heat, such as heating appliances. However, overheating may result in material deterioration, lower efficiency, or component failure in electrical systems where heat production is desired. From designing energy-efficient systems to making sure high-power systems are safe, knowing and controlling the length of current flow is vital (Amaducci et al., 2018).

H_{01}: "There is no significant relationship between The Duration of Current Flow and The Amount of Heat Produced."

H_1: "There is a significant relationship between The Duration of Current Flow 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	385	5655.517	1123.872	.000
Within Groups	532.241	572	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 Duration of Current Flow and The Amount of Heat Produced."*** Is accepted and the null hypothesis is rejected.

9. DISCUSSION

The incorporation of sensors into solar panels is a significant advancement in the discourse around alternative energy sources, particularly solar power. Knowing how solar panels work is becoming increasingly important as the need for alternative energy sources increases. While solar panels do a fantastic job of converting sunlight into power, the excessive heat they produce limits their efficiency. Solar panel operating conditions might be better understood with the use of heat-generating sensor technologies. With the use of these sensors, the researcher can track the rapid variations in temperature that occur during energy production. By analyzing this data, they may be able to determine the potential effects of environmental factors and panel orientation on heat generation. It is also possible to detect problems before they cause major performance drops by keeping an eye on heat levels. Take solar panels as an example; when they become too hot, they lose some of their efficacy and eventually break down. Improvements in energy production may be achieved by gaining a better understanding of these dynamics and then making modifications, such as increasing airflow around the panels or using cooling technology. More generic methods of managing renewable energy sources may be impacted by sensor data. The creation of smart grids, which adjust electricity distribution in response to real-time data, is one such use. Isolated solar installations and integrated renewable energy systems alike may benefit from this all-encompassing method, which opens the door to even deeper integration into existing energy networks. Improving efficiency, sustainability, and energy management might be achieved by exploring renewable energy sources and discovering methods to integrate solar panels with sensor technologies. Stakeholders may enhance solar energy systems, encourage greater resource utilisation, and contribute to an environmentally responsible energy future by making educated choices based on the collected data.

10. CONCLUSION

Researchers have a great chance to discover ways to make the most of renewable energy sources,

especially solar panels with sensors, and improve the efficiency and longevity of these power sources. If student want to know how solar panels work, student have to know how much heat they generate as they convert sunlight into electricity. Using cutting-edge sensors, the researcher may collect data in real-time that reveals the influence of heat generation on system performance and the locations of any hidden defects. Overheating reduces the efficiency and lifespan of solar panels; nevertheless, this problem is manageable with the right kind of system management. It is possible that the monitoring data might help optimize renewable energy systems as a whole by enhancing design and operational practices. Integrating renewable energy sources with existing monitoring technology is crucial for optimizing energy collection and enhancing the efficiency of the energy infrastructure in the future, when sustainable energy will play a more significant role. Ultimately, this integration aims to create an energy environment that is stronger and more sustainable (Archibong et al., 2020).

REFERENCE

Abouaiana, A., & Battisti, A. (2022). Multifunction land use to promote energy communities in mediterra-nean region: Cases of Egypt and Italy. Land, 11(5), 673

Abu Adnan Abir, S. M., Anwar, A., Choi, J., & Kayes, A. S. M. (2021). Iot-enabled smart energy grid: Applications and challenges. IEEE Access, 9, 50961–50981.

Agostini, A., Colauzzi, M., & Amaducci, S. (2021). Innovative agrivoltaic systems to produce sustainable energy: An economic and environmental assessment. Applied Energy, 281, 116102.

Ahmed Abdulkadir, A., & Al-Turjman, F. (2021). Smart-grid and solar energy harvesting in the IoT era: An overview. Concurrency and Computation: Practice and Experience, 33(4), e4896.

Ali, A. R., Al Nabulsi, A., Mukhopadhyay, S., Awal, M. S., Fernandes, S., & Ailabouni, K. (2019). IoT-solar energy powered smart farm irrigation system. Journal of Electronic Science and Technology, 17(4), 100017

Ali, M., & Paracha, M. K. (2020). An IoT based approach for monitoring solar power consumption with adafruit cloud. International Journal of Engineering Applied Sciences and Technology, 04(09), 335–341

Amaducci, S., Yin, X., & Colauzzi, M. (2018). Agrivoltaic systems to optimise land use for electric energy production. Applied Energy, 220, 545–561.

Archibong, E. I., Ozuomba, S., & Ekott, E. (2020). Internet of things (IoT)-based, solar powered street light system with anti-vandalisation mechanism

Aslam, A., Mehmood, U., Arshad, M. H., Ishfaq, A., Zaheer, J., Khan, A. U. H., & Sufyan, M. (2020). Dye-sensitized solar cells (DSSCs) as a potential photovoltaic technology for the self-powered internet of things (IoTs) applications. Solar Energy, 207, 874–892

Azhar, M. R. A., Hamid, M., Irfan, M. H., Awais, M., Khan, U. S., & Zeb, A. (2019). Automated green-house system. In 2019 2nd international conference on communication, computing and digital sys-tems, C-CODE 2019 (pp. 215–219).