Research Article

Journal of Environmental And Sciences (ISSN 2836-2551)

Analysis Of Solar Power Generation System For Green Building Prototype In King Mongkut's University Of Technology Thonburi.

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Received Date : November 29, 2024
Accepted Date : November 30, 2024
Published Date : January 03, 2024

ABSTRACT

Solar power generation system has been erected at KMUTT. Learning Exchange Building (LX Building) has solar panels that can generate 40 kW of electricity, which may be utilized inside the structure. In terms of conservation and energy efficiency the LX Building is regarded as a green prototype. In order to determine if it would be feasible to expand the usage of the solar cell system in other university building, it has been tested and measured. Temperature, humidity, and the intensity of solar radiation all crucial elements in the functioning of the solar cell power generation system were investigated and analyzed. According to the measurement data, the average solar radiation intensity for the test day was 442.22 W/m2 the maximum was 704.56 W/m2 at 12:00 P.M. and the minimum was 89.32 W/m2 at 6:00 A.M. Throughout the test period, the average ambient temperature was 30 OC, with the peak recorded at 12:00 P.M. at 33 OC and the lowest at 6:00 A.M. at 29.5 OC. The average relative humidity for the test period was 59%Rh, with the highest and lowest values being 65%Rh and 50%Rh, respectively. On August 9, 2024, the greatest power that the solar cell system could generate was measured and expressed as 80.33% for 32.13 kW at 12:00 P.M. The lowest number, in relation to the installation value was 0.09 kW at 6:00 A.M. while the average amount of electricity produced by the solar cell system during the day was 13.16 kW. According to the findings of the analysis of the total amount of power that the solar cell system can generate daily between July 27, 2024, and August 25, 2024, the maximum amount of electricity that the system can generate was 202.27 kWh/day, while the lowest amount was 116.14 kWh/day. It was discovered that the total amount of electricity that the solar cell system could generate during the course of the study would be 4,663.66 kWh/month. Furthermore, it was discovered that the solar cell system's monthly average total electricity production was 155.46 kWh.

Keywords : *Electric Power, Electric Energy and Solar Cell System.*

INTRODUCTION

Currently, Thailand's energy demand is rising annually in tandem with the nation's social and economic development. Fossil fuel energy sources, or energy that can be depleted and affect the environment, are directly impacted by the growing demand for electricity [1,2] Because it increases the ability to update industries to be stable and contemporary, electricity is regarded as a significant variable in economic development. This crucial objective for economic growth. Therefore, finding a solution to shift the energy usage pattern by using more renewable energy is essential for energy security and to lessen reliance on fossil fuels. By 2037, Thailand wants to raise the share of alternative and renewable energy in total energy consumption by 30%. Solar energy has emerged as one of the cleanest renewable energy sources with the greatest potential to displace fossil fuels [3, 4]. An estimated 23,000 TW of power might be produced annually using solar energy, particularly from solar cell systems [5–6]. The efficiency of solar cells sold commercially can reach 15 -20% [7]. However, the amount of sunshine that reaches the solar panels and the dirt that covers them are significant factors that lower the energy conversion efficiency of solar cell power generation systems [8].
All organizations, but particularly those with significant energy usage, can profit from energy conservation. Additionally, it lowers the nation's overall energy usage, lowering the possibility of energy shortages. Consequently, there is a

Journal of Environmental And Sciences (ISSN 2836-2551)

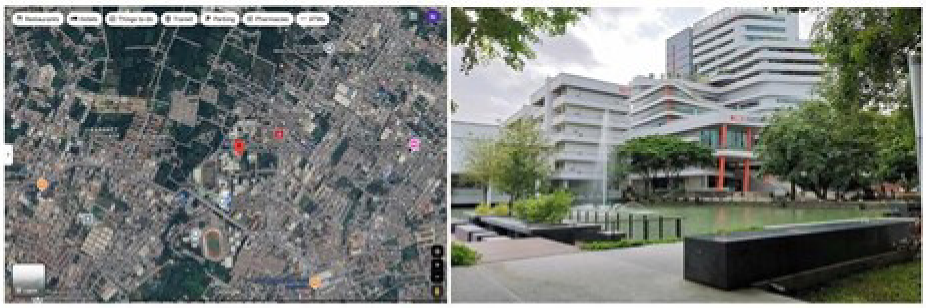
decrease in foreign energy imports. Energy conservation is a crucial strategy that people worldwide follow during energy crises, especially in the electricity producing sector where fuel is the primary expense. This is because it is a simple technique that can be used by anyone in the nation. Examples include modifying energy-wasting behaviors like shutting off and unplugging electrical devices right away after use, setting the air conditioner's temperature to be at least 26 degrees Celsius, cleaning the air conditioner every six months, washing or ironing large amounts of clothing at once, minimizing the amount of time spent opening and closing the refrigerator door, and not filling the refrigerator to overflowing keeping electrical equipment in good working order and always ready for use, as well as choosing appliances that are energy-efficient and extremely efficient, as shown by the 5-star energy-saving rating. or energy-efficient buildings through the use of several types of renewable energy sources to generate power, the design of buildings with effective ventilation systems, the use of energy-efficient building materials, etc.

Energy conservation is a component of King Mongkut's University of Technology Thonburi operations since the institution strives to become a green university by promoting energy conservation and the use of all renewable energy sources to achieve sustainable development in line with the Sustainable Development Goals (SDGs). In addition to helping to lower greenhouse gas emissions into the atmosphere and work toward carbon neutrality, it raises awareness of energy conservation, the effects of global warming, and the proper methods for resolving energy-related issues among staff and students. As a result, a solar power generation system has been installed at King Mongkut's University of Technology Thonburi. The Learning Exchange Building, often known as the LX Building, has solar panels that can generate 40 kW of electricity, which may be utilized inside the structure. In terms of conservation and energy efficiency, the LX Building is regarded as green prototype.

TOOLS AND METHODS FOR INNOVATION

Learning Exchange Building is a green building that was constructed with collaborative learning and energy conservation in mind. This structure was constructed to foster collaborative learning and the creation of new information for the institution and the general public. The structure high 70.75 m including the basement and rooftop. Prefabricated reinforced concrete and lightweight brick walls that are 75 mm thick, smooth plastered, and painted on the interior and outside make up the walls. Low volatile organic compounds, or VOCs, are the type of paint that is utilized. The building's average WWR is 0.32, its concrete slab roof is 30 cm thick, and its green light-blocking laminated glass is 8.38 mm thick. More than 70% of the building's materials are made in the United States, and over 30% of those elements which include steel, cement, aluminum, and glass are recycled. The Thai Green Label and the Carbon Reduction Label have approved some of the materials used. There are ecological open spaces and water permeability zones all around the building. For every 100 m2 of open area, there is one tree. The solar cell system can generate electricity at 40 kWp.

Figure 1. Learning Exchange Building.

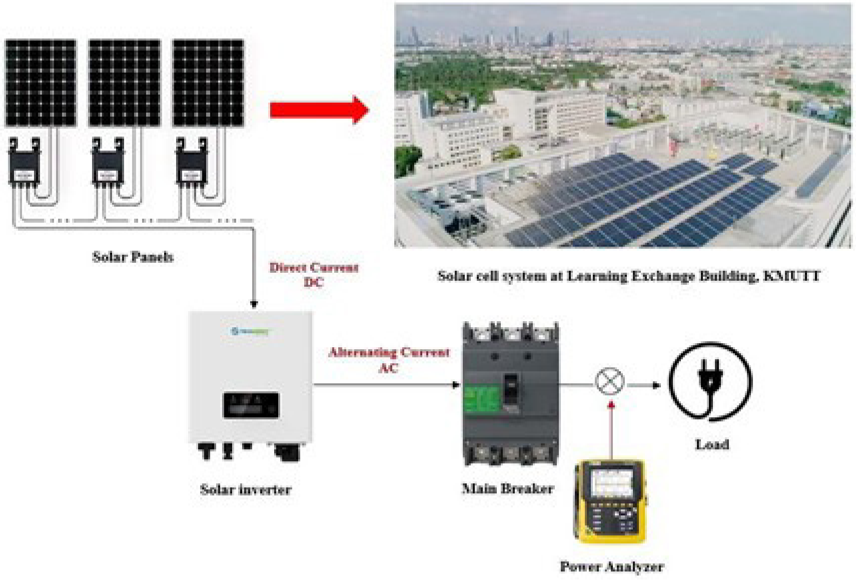


Design and measurement

Consideration is given to the most suitable location to receive the most sunlight. Factors affecting the efficiency of the solar power generation system must also be taken into account, such as temperature, the angle of the solar panel, and maintenance. The solar power generation system starts by connecting the solar panels together to obtain the required voltage to produce direct current (DC). The electricity is then sent through a solar inverter to convert it from direct current to alternating current (AC). After that, it is sent to the Main Breaker to control the power supply to the equipment (Load). For measurement, a meter is installed to measure the electric power and electric energy in the location connected to the Load, as shown in Figure 2. The values are recorded every 15 minutes for 30 days to find the electric power and electric energy that the solar system can produce per month.

Journal of Environmental And Sciences (ISSN 2836-2551)

Figure 2. Solar cell systems installed in Learning Exchange Building.



Electrical Power Analysis

The electrical power consumed in a minute, expressed in joules per second or watts (w). The relationship can be expressed as equation 1, where the electrical power is equal to the product of the electric current and the potential difference, as in Eq.1 and the electrical power will largely depend on the amount of electric current passing through the load and the potential difference to which the load is connected.

$$Electrical\ Power\,(P) = \frac{Energy\ converted\ in\ joules\,(E)}{time\ required\ in\ seconds\,(t)} \qquad (1)$$

Electric Energy Analysis

When used to explain the energy received or delivered by an electrical circuit, energy derived from potential energy or kinetic energy of electricity can be calculated using the relationship equations, as seen in Eq.2

$$Energy\ Electric = \frac{Power\ Electric}{time} \qquad (2)$$

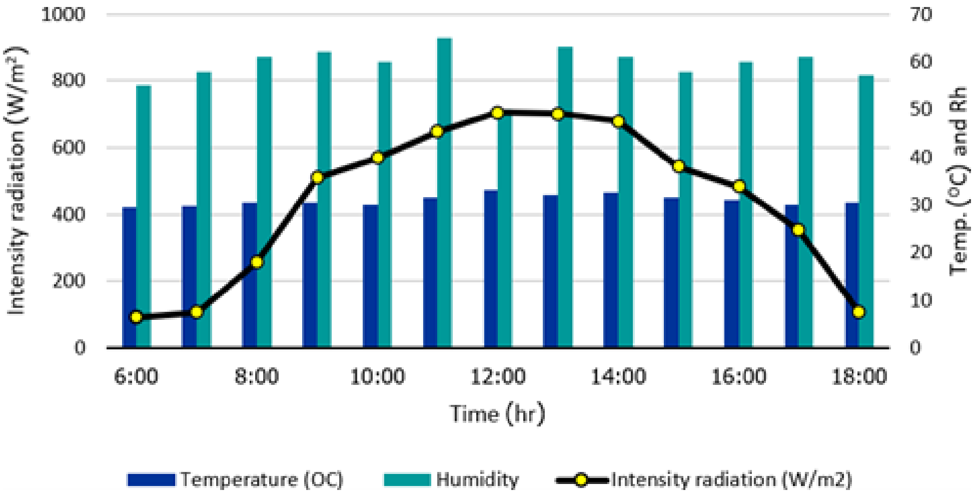
RESULTS AND DISCUSSION

Effect of solar radiation intensity, temperature, and relative humidity

From the test, it was found that the intensity of solar radiation affects the ambient temperature by testing from 06:00 A.M. - 18:00 P.M. which found that the intensity of solar radiation will increase in the morning and then in the afternoon, the intensity of solar radiation will decrease. It was found that the highest intensity of solar radiation will be equal to 704.56 W/m 2 at 12:00 P.M. the lowest intensity of solar radiation will be equal to 89.32 W/m2 at 06:00 A.M. and the average intensity of solar radiation throughout the test day will be equal to 442.22 W/m 2 respectively. For the ambient temperature throughout the test day, it was found that the highest value was equal to 33 OC at 12:00P.M. the lowest value was equal to 29.5 OC at 06:00 A.M. and the average temperature throughout the test day will be equal to 30 OC respectively. If we consider the relationship between the intensity of solar radiation along with other factors such as relative humidity, they will also be related. That is, when the ambient temperature increases, it will result in the relative humidity being lower. Throughout the test period, the highest relative humidity was found to be 65%Rh, the lowest relative humidity was 50%Rh, and the average relative humidity throughout the test period was 59%Rh.

Journal of Environmental And Sciences (ISSN 2836-2551)

Figure 3. Relationship of time to solar radiation intensity, temperature and relative humidity.



The effect of the electrical power that a solar cell system can produce

The solar power generation system installed on the rooftop of the Learning Exchange Building N16 at King Mongkut's University of Technology Thonburi has a total installation rating of 40.00 kWp. It was found from the graph shown in Figure 4 that the maximum electricity power that the solar cell system can produce is measured on August 9, 2024, which is 32.13 kW at 12:00 P.M. which is 80.33%. When compared to the installation rating, the lowest value is 0.09 kW at 06:00 A.M. and the average electricity power that the solar cell system can produce throughout the day is 13.16 kW, respectively.

For the analysis of the total electricity that the solar cell system can produce each day between July 27, 2024 - August 25, 2024, as shown in the graph in Figure 5, it was found that the maximum total electricity that the solar cell system can produce is 202.27 kWh/day (August 22, 2024) and the minimum is 116.14 kWh/day (July 27, 2024). It was found that if we consider the total electricity that the solar cell system can produce throughout the study period, the total accumulated electricity is 4,663.66 kWh/month. In addition, the average total electricity that the solar cell system can produce throughout the month is 155.46 kWh/month.

Figure 4. The power that the solar cell system can produce on August 9, 2024 in kW.

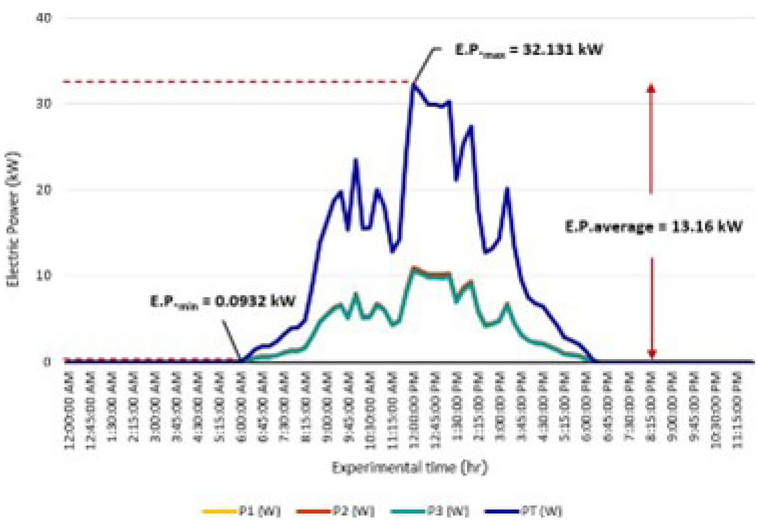
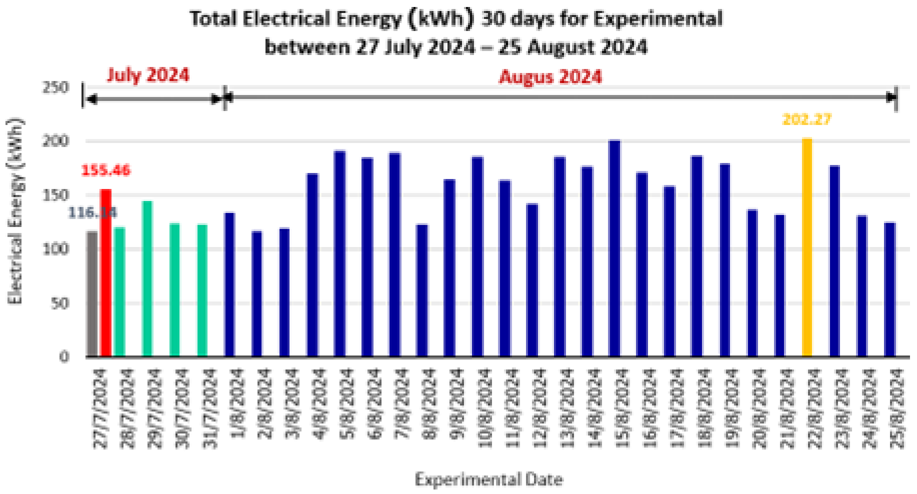


Figure 5. Total electricity that the solar cell system can produce each day, for the data set between 27 July 2024 – 25 August 2024 (30 days).



CONCLUSION

Average solar radiation intensity for the test day was 442.22 W/m2 the maximum was 704.56 W/m2 at 12:00 P.M. and the minimum was 89.32 W/m2 at 6:00 A.M. Throughout the test period, the average ambient temperature was 30 OC, with the peak recorded at 12:00 P.M. at 33 OC and the lowest at 6:00 A.M. at 29.5 OC. The average relative humidity for the test period was 59%Rh, with the highest and lowest values being 65%Rh and 50%Rh, respectively. On August 9, 2024, the greatest power that the solar cell system could generate was measured and expressed as 80.33% for 32.13 kW at 12:00P.M. The lowest number, in relation to the installation value was 0.09 kW at 6:00 A.M. while the average amount of electricity produced by the solar cell system during the day was 13.16 kW. According to the findings of the analysis of the total amount of power that the solar cell system can generate daily between July 27, 2024, and August 25, 2024, the maximum amount of electricity that the system can generate was 202.27 kWh/day, while the lowest amount was 116.14 kWh/day. It was discovered that the total amount of electricity that the solar cell system could generate during the course of the study would be 4,663.66 kWh/month. Furthermore, it was discovered that the solar cell system's monthly average total electricity production was 155.46 kWh.

Acknowledgement

We would like to thank the Energy, Environment, Safety and Health Management Center, Building and Grounds Management Office, King Mongkut's University of Technology Thonburi, for supporting testing and analysis equipment, as well as facilitating the venue.

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