OPTIMISATION OF CAMPUS ENVIRONMENT BASED ON INTERNET OF THINKS FOR POWER ENHANCEMENT OF MONOCRYSTALLINE SOLAR PANELS

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ABSTRACT

The energy source of power generation still depends on fossil energy sources or in other words non-renewable energy sources. The amount of fossil use as energy material touched 22.58%, coal 37.15% and natural gas 20.13%. Meanwhile, the use of renewable energy is still very small, around 9.15%. One of the renewable energy that will not run out is solar energy. In Indonesia, the potential of solar energy is around 4.8 kWh/m2 or equivalent to 112.00 GWp, but its current utilisation is only around 10MWp. Solar panel is a tool that is able to utilise solar energy into electrical energy, this tool is able to work according to the state of the environment. This tool works optimally at normal temperatures around 25 ° C, the temperature of the solar panel if it is too hot then its performance will decrease. This research will be conducted at Pakuan University by designing a cooling system to optimise the temperature of monocrystalline solar panels to increase the power income generated. This system will be supported by the internet of things to make it easier to control the system, and research will also be carried out on the power income of solar panels before using the system made.

Keywords*: Renewable energy; Cooling system; Temperature; Monocrystalline; Internet of things.*

1. INTRODUCTION

The National Energy Council argues that currently the use of energy sources as fuel for power plants still relies heavily on fossil energy sources or in other words non- renewable energy sources, which will gradually run out and will certainly have an impact on natural damage. fossil energy is still very dominant in the form of petroleum which touches 33.58%, coal 37.15% and natural gas 20.13% while for new renewable energy it is still very small at 9.15% (Alamsyah et al., 2019).

One of the energy on Earth that can be renewed and never runs out is solar energy. Sunlight will always be there every day for a long time, which is approximately 12 hours. The utilisation of sunlight is also very profitable because it does not require costs to get it, besides that it is also environmentally friendly, what consumers must do is to design a tool to convert solar energy into energy that we can use every day, namely electrical energy (Amalia et al., 2022). The Ministry of Energy and Mineral Resources stated that the potential for solar energy in

Indonesia is very large, which is around 4.8 kWh/m2 or equivalent to 112,000 GWp, but only about 10 MWp has been utilised. (Alamsyah et al., 2019).

Tools that can convert sunlight energy into electrical energy are solar panels. Solar panels are a device used to convert solar light into electrical energy (Sukmawaty et al., 2019).Afriandi argues that solar panels will produce electrical energy according to the amount of light intensity it receives from sunlight, the temperature of solar panels that work at normal temperature standards (25ºC) will work optimally. Rifaldo also suggested that if the temperature of the solar panel is too hot, it will reduce the performance of the solar cell. The voltage and current produced by solar panels always change depending on the amount of sunlight intensity that falls on the surface of the solar panel (Rahajoeningroem & Jatnika, 2022). Based on the description above, it is necessary to conduct research on the optimisation of the campus environment based on the Internet of Thinks to increase the monocrystalline temperature power of solar panels. As a form of effort to increase and optimise the use of renewable energy. Therefore, it is necessary to conduct research to ensure that the conditions allow for installing solar panels. With the Internet Of Thinks-based campus environment optimisation technology for monocrystalline solar panel power enhancement, it can provide the potential to use solar panel installations as a learning and research tool for students. They can study the efficiency of solar panels, develop better energy storage systems, or conduct optimisation research related to solar energy and internet of things systems. This will provide an opportunity for the University to contribute to renewable energy research and technological innovation.

2. RESEARCH METODOLOGY

The research method used for the design and development of the Optimisation of the campus environment based on the Internet of Thinks to increase the monocrystalline temperature power of solar panels at Pakuan University is to use the Hardware Programming field research method shown in the following figure.

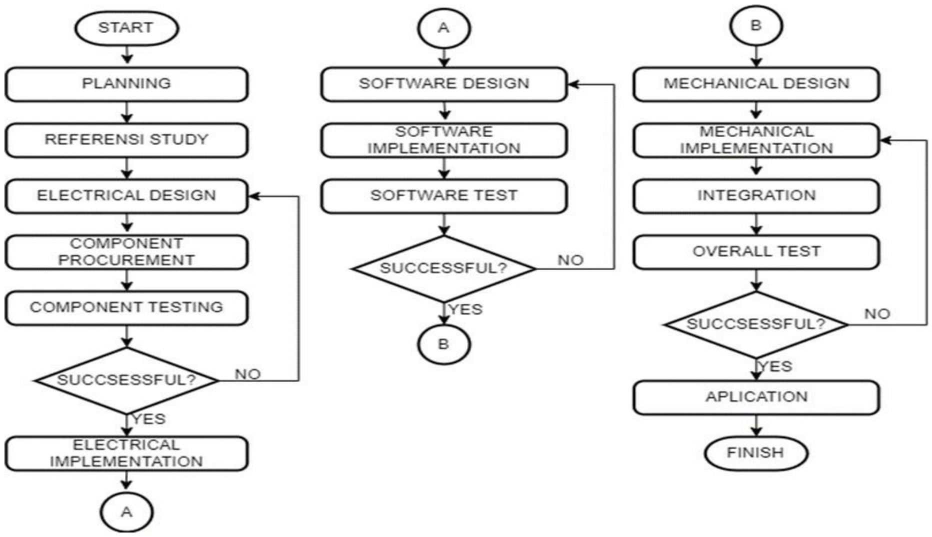

Figure 1. Hardware Programming Research Method

3. RELATED RESEARCH/LITERATUR REVIEW

According to Djamila Rekioua in her journal, solar power plants are power plants that convert sunlight radiation into electrical energy. Solar panels play a role in converting sunlight radiation into electrical energy. Therefore, the selection of solar panels is very important in producing the output power produced by solar panels. The output of solar panels is still direct electrical energy (DC) which must still be converted into alternating electrical energy using an inverter (Adipradana et al., 2019). Sinaga emphasised that solar cells work using the p-n junction principle, which is a junction between p-type and n-type semiconductors. These semiconductors consist of atomic bonds in which there are electrons as basic constituents. N-type semiconductors have excess electrons (negative charge) while p-type semiconductors have excess holes (positive charge) in their atomic structure. The condition of excess electrons and holes can occur by doping the material with dopant atoms. For example, to obtain p-type silicon material, silicon is doped by boron atoms, while to obtain n-type silicon material, silicon is doped by phosphorus atoms. The illustration below depicts p-type and n-type semiconductor junctions (Alamsyah et al., 2019). The temperature of solar panels that work at normal temperature standards (25ºC) will work optimally (Rahajoeningroem & Jatnika, 2022).

Figure 2. Solar Power Generation

Monocrystalline solar panels are the most efficient panels produced with the latest technology & produce the highest power per unit area. Monocrystalline is designed for applications that require large electricity consumption in places with extreme climates and with very harsh natural conditions. The disadvantage of this type of panel is that it will not function well in a place with less sunlight (shade), its efficiency will drop dramatically in cloudy weather (Adi S, 2023). According to Setiawan, one type of panel from silicon material that is widely used is Monocrystalline with a high efficiency level of 17% - 18% (Agustina et al., 2019).Solar cells or can also be called *Photovoltaic* (PV) is a device used to convert sunlight into electrical energy (Sukmawaty et al., 2019). This conversion is called the *Photovoltaic* effect *,* in other words, this effect is a phenomenon where a PV cell can absorb light energy and convert it into electrical energy. In simple terms, solar cells consist of a junction of p and n type semiconductor materials (p-n junction semiconductor) which if exposed to sunlight, there will be a flow of electrons, this flow of electrons is referred to as the flow of electric current (Kaban et al., 2020).Luque suggested that solar panels are an important component in solar power plants. Solar panels work to convert sunlight into DC electrical energy (Adipradana et al., 2019). Safitri also stated that solar panels are devices consisting of cells that are able to convert sunlight into electricity. The sun is a light source whose energy can be utilised, then it can be converted into direct current (DC) electricity (Ricardo, 2022).Temperature is the main discussion in testing and applying electronic devices. Solar panels have a *Standard Test Condition (STC)* which is at a light intensity of 1000Watt per square metre, AM 1.5 Spectrum or with the Earth's atmospheric conditions with a sun angle of 48.5º and with the panel temperature required to be 25ºC. In other words, the solar panel will work optimally at normal temperature or 25ºC.Gumilang said the cooling system is a system that works to maintain or reduce the temperature in ideal conditions by transferring heat from a field to water or air. Heat transfer is basically the transfer of energy from one place to another and there is a temperature difference between two parts of the object. Heat will move from high temperatures to low temperatures (Loegimin et al., 2020).Yandri said that solar energy or solar energy is one type of renewable energy emitted by the sun through certain equipment to become a resource in different forms and can be used as an alternative energy (Lubna et al., 2021). Solar energy emits light and heat as solar energy, so from there solar energy can be utilised as a solar power plant. This energy is one of the sources of alternative energy that can be used massively. Electric current is energy that can be transmitted through a conductor in the form of a cable. This electric current arises due to a change in charge that moves past a point per charge of time in an electrical conductor (Prima Satya et al., 2020).Voltage or potential difference*(voltage*) is the work done to move one charge (equal to one coulomb) on an element or component from one terminal / pole to another terminal / pole, or the two terminals / poles will have a potential difference (Rosman N et al., 2019).An inverter is a circuit that converts DC voltage into AC. Or more precisely the inverter moves the voltage from the DC source to the AC load. The inverter voltage source can be a battery, solar panel or other DC voltage source. Batteries for the use of PLTS are commonly known and use deep cycle lead acid, meaning that the charge of this type of battery can be discharged continuously to a maximum of nominal capacity. Batteries are the main component of PLTS that requires the largest initial investment costs after solar panels and inverters (Alamsyah et al., 2019).

NodeMCU ESP8266 is an IoT-based platform that is opensource. Consists of hardware in the form of System OnChip ESP8266. Currently, NodeMCU has undergone 3 upgrades. The device we use is NodeMCU version 3 (V1.0) which has better capabilities than previous versions (Boy Panroy Manullang et al., 2021). Arduino Uno R3 is a microcontroller development board based on the ATmega328P chip. Arduino Uno has 14 digital input / output pins (or commonly written I / O, where 14 of them can be used as PWM outputs including pins 0 to 13), 6 analogue input pins, using 16 MHz crystals including pins A0 to A5, USB connection, power jack, ICSP header and reset button (Auliya Saputra, 2020). Abdullrazzak discloses a DHT22 sensor digital relative humidity and temperature sensor. The DHT22 sensor uses a capacitor and thermistor to measure the surrounding air and outputs a signal on the data pin. DHT22 is claimed to have good reading quality, judging from the fast response of the data acquisition process and its minimalist size, and at a relatively low price when compared to thermohygrometer devices (Puspasari et al., 2020). Imron revealed that the DC voltage sensor is a voltage divider circuit made into a module. The DC voltage sensor module can measure voltages up to 25V (Adi S, 2023). This ACS 712 sensor is one of the sensors that can detect AC or DC current. The ACS712 sensor has a higher accuracy value, better linearity, is supplied by 5V DC; the output voltage is 4.5V, and needs less circuitry for data processing. The ACS 712 current sensor is made compactly by the factory in the form of an IC which works with the principle of responding to and measuring the magnetic field arising around a current wire by combining the functions of a shun resistor and current transformer as an AC and DC current sensor which has a high level of reading accuracy (Prima Satya et al., 2020). The Internet of Things, often known as IoT, is an embedded system that aims to expand the utilisation of continuous internet connectivity. Capabilities such as data sharing, remote control, and so on, are also included in real-world objects such as food, electronics, equipment connected with sensors

and connected to the network (Susanto et al., 2022). Previous research conducted (Prima Dewi et al., 2022) entitled Implementation of Solar Panel Cooling System to Maintain Panel Surface Temperature. In this study, the surface temperature of solar panels will be maintained no more than 40 ° C to reduce power losses due to the hot temperature of the panel surface. The surface temperature of the panel is measured by the DS18B20 temperature sensor and then sent to the NodeMCU ESP8622 so that it can be displayed through the bylink application on the smartphone. When the temperature of the solar panel is above 40°C, the cooling system will turn on automatically, so the average time required for the cooling system to reach temperatures below 40°C is 1.5 minutes. From 3 days of experiments, it is known that the cooling and temperature monitoring system made successfully runs well. The temperature sensor can read the surface temperature of the panel, the cooling system can work automatically, and the application can display the sensor reading results. Research (Sariman et al., 2022) entitled Cooling System Using Water to Optimise the Performance of Arduino-Based Solar Panels. The results showed that the cooling system using water on solar panels succeeded in reducing the average surface temperature on solar panels by 27.56 ° C, and that the difference in voltage, current and power produced was 1.18V, 103.55mA and 2210mW. The most influential parameter with the addition of a cooling system is current. So that charging a 5.5Ah battery is 1.48 hours faster than without using a cooling system. This shows that the solar panel cooling system with water is able to improve the performance of solar cells by accelerating the battery charging time. Research (Rahajoeningroem & Jatnika, 2022) entitled Solar Panel Automatic Cooling System for Increased Output Power Based on Microcontroller. In this test using 50 Wp solar panels that use cooling and without cooling. The average power of the solar panel without cooling is 22.32Watt and the efficiency is 12.62%, while the average power of the solar panel using the cooler is 27.8Watt and the efficiency is 15.09%. when compared to solar panels without cooling, solar panels that use cooling have a greater efficiency increase of 2.47%.

4. RESULTS AND DISCUSSION

The research results obtained based from stages existing research . Stages study use method development device hard to use ie method Hardware Programming. Design and manufacture manufacturing tools prototype system optimization solar panel temperature Monocrystalline For enhancement Power based internet of things at Pakuan University as following :

1) Analysis Results Need

Analysis results need This produce specification need from design and development systems and mechanisms tool that will designed.

1. Tools and materials used in study This is NodeMCU ESP8266, Arduino Uno, ACS712 current sensor, voltage sensor, DHT22 temperature and humidity

sensor , relay, fan , LCD, solar panel Monocrystalline 120WP, 12V 33AH battery

2. ,inverter, laptop, device electronics supports , XAMPP Server, Arduino IDE, Visual Studio Code, Fritzing, Tinkercad and Google Colab.
3. Planning prototype on the system optimization solar panel temperature Monocrystalline For enhancement Power based internet of things in research This consists from planning device hardware and devices soft as well as planning design mutual prototypes relate in making tool This.
4. Test method done No just at the moment tools and systems Already made , but components that have not put together will tested For know function and performance component the . Testing system whole will done from function device hard Already walk with OK , then next testing system cooler until testing connection device hard with device soft through network mobile .
5. Analysis design related with How flow Work from tools and systems the . On research This create a block diagram For makes it easier reading How tools and systems This Work .

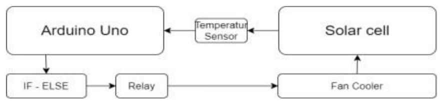

Figure 31. System Block Diagram Cooling

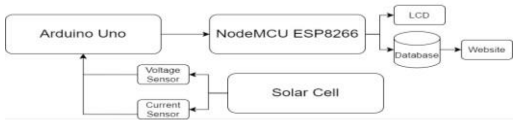

Figure 2. Solar Panel Monitoring Block Diagram

2) Design Results

Design/design results from study This refers to the prototype system optimization solar panel temperature Monocrystalline For enhancement Power based internet of things at Pakuan University according to with system block diagram. In research This shared become two design planning ie design planning system cooling and solar panel monitoring system . besides That results design planning system device soft required To use maximizing desired result. 1.Planning device hard shared become two part planning design , that is design planning system cooling and solar panel monitoring system like Figure 4 and Figure 5.

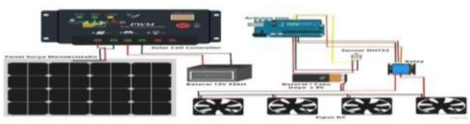

Figure 4. System Design Cooling

Figure 5. Solar Panel Monitoring System Design

3) Development / Implementation Results

Implementation done in space room with intensity light enough sun without obstruction , This done so that the solar panels get energy optimal solar like figure 6. For tool or connected systems with solar panels can stored inside room or room closed so that the tool No easy damaged consequence exposure ray sun or rain water splashes can seen from Figure 7. As well as the system cooler mounted under the solar panel like figure 8.

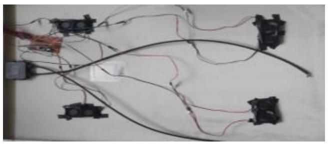

Figure 6. Solar Panel Placement Figure 7. System Control and Monitoring Figure 8. System Cooling

5. CONCLUSION

The research "optimisation of the campus environment based on the internet of thinks for increasing the monocrystalline temperature power of solar panels at pakuan university" was carried out to create an optimisation tool for energy absorption in solar panels and can be monitored in real time either through the website or can be seen directly on the available lcd. The dht22 sensor is an indication of whether or not the cooling system turns on when the temperature reaches more than 25 ° c. Acs712 voltage sensor and current sensor are also important in this research, voltage, current and energy data can be read by these sensors to monitor the data generated by solar panels. In this study, an optimisation level of 6.49% was obtained for a decrease in panel temperature, 4.74% for an increase in voltage, 20.6% for an increase in current and 25.4% for an increase in energy.

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