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Utilization of Solar Energy in the Substation Energy in Provider Connected to PT. PLN (Persero) Based on Iot

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Abstract: In organizing the Asian game event in Palembang in 2018, PT PLN Persero supported this activity by supplying electricity at several points in the Jakabaring Spot City (JSC) area with a total of 27 connecting substations with a loop system, but when the event was over the loop system was turned off and several locations of connecting substations. not deactivated due to operational constraints and the absence of activities at the location resulting in the supply to the substation shutting down but still operating distributing a voltage of 20 to several substations that are still operating in the JSC area, Indonesia has a very large renewable energy potential, especially solar energy which can supply a heater to maintain humidity prevent partial discharge and make cubicle equipment have a long lifetime. The results show that the radiation received by the PV system is sufficient to produce Stable electric power to turn on the heater continuously for 24 hours future research will be extended to monitoring via IoT.

Keywords: Energy, Solar Panels, PLN, PV, IoT, Photovoltaics

1. INTRODUCTION

Remote area consumers may be small and medium scale applications such as several residential houses, telecommunications stations, isolated military installations, institutions medical, street lighting and signaling, water supply system, etc. Consumers like this usually supplied by energy from sunlight with photovoltaic module technology (PV), Although energy sources are inexhaustible, affordable, and intermittent, forms of solar energy are highly unpredictable and are generally governed by geographic position and local climate [1] [2].

In the distribution of electric power in Jakabaring Sport City for support the success of the 2018 Asian game event made for some locations or meeting points are connecting substations at each venue and Loping system supplied from several feeders from GI Jakabaring so that they can support each other in the event of a disturbance quickly between venues.

However, by the time the Asian game event has finished several venues The support has been turned off at some point but it's still there the venue was activated, therefore several points were selected by PLN due to arrears and resulting in the supply obtained from the transformer customers have also died, resulting in the main supply of in cubicle no longer exists but still this incident has been going on for a long time however to date. and several supporting components such as heaters, mechanics, and relays

This is very dangerous if the supply at the substation is lost, Due to this tropical climate, the atmosphere in the substation is connected it's very humid with the power off making this heater can't maintain moisture to keep the busbar in the cubicle from corroding and result in a partial disc. What's more with the constant need for electricity develops between several SUTMs taken from the network that must be through the existing network in JSC, in the near future to some point the substation cannot be activated unless there is an event that will take place even that only lasts temporarily as long as the event lasts cause the cubicle can't be active [3] [4] [5].

Within 3 years after the asean game was held there are 9 faulty substations, 5 of them exploded and 4 others experiencing severe corrosion resulting in the cubicle must be replaced immediately because it is no longer feasible to operate. In a state in the JSC. area using a ground cable so it is very difficult to find a point for PT installation and the state of the substation that is only filled for fitting a few cubicles inside.

If it is obtained, the installation of this PLTS has several objectives, where at PT PLN can reduce maintenance at the substation where reduce the duration of consumer outages and most importantly the cubicle has long life where PT PLN does not need to replace the cubicle because it doesn't experience in cubicle disturbances such as exploding due to pasial discas in cubicle Because the function of the heater is very important to maintain humidity in the cubicle at this substation to keep the cubicle operating optimally and in distributing energy in the distribution of 20 kv to customers are still good and the equipment at the substation continues to work optimally maintain the reliability of the cubicle, therefore the author is very important install PLTS in the substation, In research i the temperature and humidity of the system distribution of 20 kV cubicle electricity, with known losses due to corona can be calculated minimized where the destructive stress value can be eliminated by optimizing value of humidity (RH) and temperature (T) in cubicles[6]

According to R. Farouq One of the causes of insulation failure in a cable is the emergence of Partial Discharge (PD) [7], PD is a positive and negative ion jump that should not meet so that it can result in a spark jump, a jump speed of 10 nano seconds at the time of the impulse and cause an effect. like the hiss of a snake in reaction to partial discharge. Several researchers have developed a method that can detect PD using the acoustic emission method [8].

The architecture of the Internet of Things consists of several complex networks and systems and very tight security, if these three elements can be achieved, then the automation control in the Internet of Things can run well, can also be used in the long term so as to generate profits. For a company, the Internet of Things (IoT) is a concept that aims to expand the benefits of continuously connected internet connectivity [9] [10]. Meanwhile, according to [11] IoT is a concept that aims to expand the benefits of continuously connected internet connectivity that allows us to connect machines, equipment, and other physical objects with network sensors and actuators to obtain data and manage their own performance, thus enabling machines to collaborate and even act on newly acquired information independently.

Mobile applications are software that runs on mobile devices such as smartphones or tablet PCs [12]. Mobile applications are also known as applications that can be downloaded and have certain functions that add to the functionality of the mobile device itself, in this application we also apply it to the device to measure the circulation of solar panels and measure the temperature of a cubicle in maintaining humidity in the environment.

2. METHODOLOGY

A solar power plant or abbreviated as PLTS is a power plant that converts solar energy into electrical energy. Electricity generation can be done in two ways, namely directly using photovoltaics and indirectly by concentrating solar energy. Photovoltaics converts light energy directly into electricity using the photoelectric effect. Concentration of solar energy using a system of lenses or mirrors combined with a tracking system to focus solar energy to a single point to drive a heat engine Photovoltaics (also known as solar cells) are semiconductor devices that can convert light directly into direct current (DC) using thin silicon (Si) crystals. A cylindrical crystal of Si is obtained by heating the Si with a controlled pressure so that the Si turns into a conductor. When the cylindrical crystal is cut 0.3 mm thick, thin silicon cells are formed, also known as photovoltaic (solar) cells. The silicon cells are mounted in parallel / series in a panel made of aluminum or stainless steel and protected by glass or plastic. Furthermore, at each cell connection is given an electrical connection. When the cells are exposed to sunlight then the connection will flow an electric current. The amount of current / electric power depends on the amount of light energy that reaches the silicon and the surface area of the cell.

Basically, a photovoltaic solar cell is a semiconductor diode that works in an unbalanced process and is based on the photovoltaic effect. In the process, the solar cell produces a voltage of 0.5-1 volt depending on the intensity of the light and the type of semiconductor used. Meanwhile, the intensity of energy contained in sunlight that reaches the earth's surface is about 1000 Watts. However, because the efficiency of converting radiant energy into electrical energy based on the photovoltaic effect has only reached 25%, the maximum electricity production produced by solar cells has only reached 250 Watts per m2. Photovoltaic is an active element (semiconductor) that utilizes the photovoltaic effect to convert solar energy into electrical energy without the use of moving mechanical parts and without the use of fuel [13], with Indonesia being a country located on the equator that has an average daily level of solar radiation. which is relatively high at 4.5 kWh/m2/day is very supportive in the installation of solar panels as alternative energy [14] [15] Solar panels that are very popular and widely used in the world today are Monocrystalline and polycrystalline cells. Both cells are made of silicon, which is a popular material and is widely available in nature and can work and last a very long time, there are key differences between the two types of technology to be aware of.

In the manufacturing process of monocrystalline PV cells are made with silicon that is formed into bars and sliced. This type of panel is commonly called 'monocrystalline' to prove that the silicon used is monocrystalline silicon. Because cells are made of single crystals, the electrons that generate electricity have more room to flow. Therefore, monocrystalline panels are more efficient than their polycrystalline rivals.

Polycrystalline solar panels are made of silicon. However, instead of using single-crystal silicon, manufacturers melt several pieces of silicon together to form wedges for the panels. Polycrystalline solar panels are also referred to as 'multi-crystalline', or multiple-crystal silicon. Since there are many crystals in each cell, the electrons are less free to move. This is because polycrystalline solar panels have a slightly lower efficiency than monocrystalline solar panels. [16]

The PV system is used to activate the heater where this heater has 50 watts of power to supply 2 cubicles using 200

Wp, the PV panel is installed above the substation located in Jakabaring sport city Palembang which functions to capture solar radiation [17].

In this study, data collection will be carried out for 7 days where data collection is from July 24, 2022 to July 30, 2022, in this study utilizing solar power will require solar panel equipment, solar charger control, batteries, inverters and as a load here is heater on cubicles and IoT devices. In the process of working later, the solar panel will capture energy from sunlight and will enter the solar charge control which will share it in charging the battery as a storage medium in its utilization, it will run the heater in maintaining the humidity and temperature in the cubicle space. in the section below shows the planning of the circuit that will be used in this study,

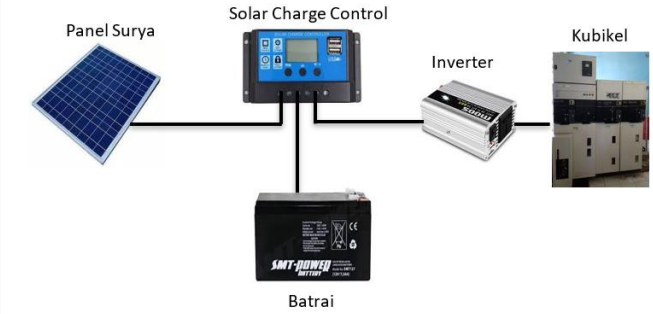

Figure.1 solar panel

Figure 1 shows the circuit that will be used in research where the solar panel will capture solar radiation and will produce energy where this energy will later go into the solar control to be divided into a battery storage area where at night it will be used as energy that is successfully stored and then will be used as a heater supply in the cubicle as a load in this research

as in Figure 2 attached below shows the solar panels are placed or installed at the top of the building so that it is intended to capture maximum solar radiation

Figure.2 Solar Panel

In the journal entitled Optimizing the Tilt Angle of Solar Panels on Prototypes of Active Solar Tracking Systems published in the Proceedings of the National Physics Seminar (E-Journal) SNF2016 the angle of inclination of solar panels that produce voltages and currents in larger quantities is at an angle of 10^{o} on the negative x axis. At the angle of the slope produces the maximum power value so that at that angle the solar panel can work optimally. Data collection is done by measuring the voltage, output current [18].

Solar panels capture solar radiation, which then converted into a source of electrical energy. and through the solar charge controller module will accept input voltage from the solar panel. 12 V battery stores the generated electrical energy by the solar panel [19] [20] to ensure the heater operates even though it does not have sunlight the heater is a burden in this study to maintain its temperature and will be monitored through IoT

Figure.3 Combiner Box

Monitoring is an activity carried out to find out the process of running a program that has been designed, whether it is running well as planned, knowing the obstacles that occur and how to overcome these obstacles [21]. Monitoring aims to ensure whether a process is carried out in accordance with applicable procedures. In this case the IoT will monitor the temperature in the cubicle and capture the solar panel below showing a schematic of the IoT circuit.

This data collection will be assisted by the internet of things (IoT) which utilizes several supporting components as below:

- Nodemcu 8266
  Is an electronic board based on the ESP8266 chip that can connect to the internet, making microcontroller devices connected to users
- Arduino Uno
  has a function that makes it easier for us to do programming where this program is stored in memory, you could say this Arduino is the brain to run sensors or equipment installed at the location.
- DHT 22
  Having a function as a digital sensor for humidity and room temperature, here we use DHT 22 because we intend to measure the room temperature in the cubicle copatermen which is in accordance with the goal of maintaining humidity and temperature in the cubicle
- LCD
  LCD (Liquid Crystal Display) is a type of display media that uses liquid crystals as the main viewer, and can display characters according to input or data taken on Arduino.
- Supply Module
  As a place to take the supply taken from this adapter, it has the main function as the main supply to turn on the Internet of Things (IoT) device.

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- Sensors VDC
  Functions as a DC voltage measurement module, this device is placed on the input section of the solar panel to the solar control and on the battery section
- Sensors VAC
  Functions as an inverter output ac voltage measurement module
- Sensors IDC
  Functioning as a DC current measurement module, this device is placed on the input section of the solar panel to the solar control and on the battery section
- Sensors IAC
  Functions as an AC current measurement module at the output of the inverter

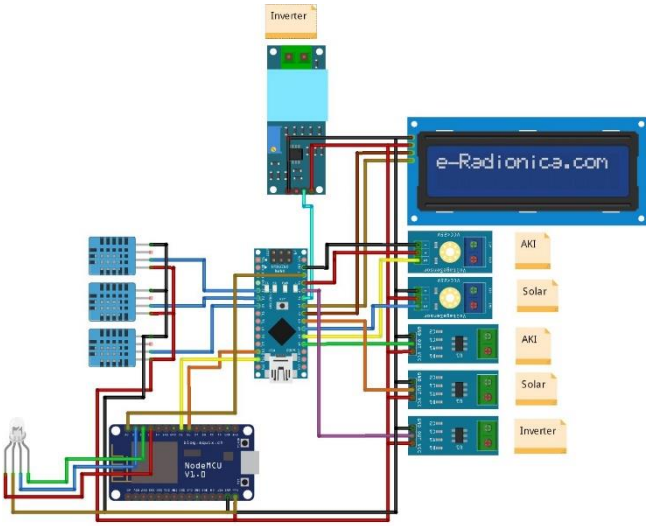

Figure.4 Skematik IoT

In Figure 4, the Internet of Things schematic is an illustration of the IoT circuit used in this study where the Arduino which has been programmed will get data from installed sensors such as IDC sensors, IAC sensors, VAC sensors, VDC sensors and DHT 22 sensors.

Where this sensor will be used as a module or sample data retrieval will later be sent via Nodemcu 8266 where we eat third party applications as data storage providers that have been collected during data retrieval

Here we eat the LED indicator where it shows whether the Nodemcu 8266 module is connected to the internet or just standby, and we use the LCD which will display data regularly where the data is taken such as AC voltage, solar panel voltage, and temperature measured from the 3 modules. have been installed. For this data collection will be taken every 10 minutes to see the rate of increase or decrease in temperature that occurs with precision which will support good and accurate data.

3. RESULTS AND DISCUSSIONS

The data taken in this study was for a week from June 24 to June 30, 2022, from 08.00 to 16.00. radiation per day was measured using an irradiance meter and entered into table 2 as measurement data. Radiation per day of the week is similar, in some cases where the peak irradiance is made at the time of measurement at 11.00 to 15.00.

In this data collection, measurements were carried out in the data collection area at Jakabaring Sports City, where the research was taking place.

Table 1. Irradiance

Time	24-06-2022	25-06-2022	26-06-2022	27-06-2022	28-06-2022	29-06-2022	30-06-2022
08.00	213	225	220	305	264	382	307
09.00	534	604	268	612	567	475	539
10.00	645	768	546	864	821	567	845
11.00	854	915	807	1089	1142	871	958
12.00	1054	1035	958	1189	1187	975	1175
13.00	1120	1145	1124	1241	1207	1123	1198
14.00	1021	978	984	1034	1077	1074	987
15.00	784	647	875	904	897	875	751
16.00	485	245	524	514	458	264	498

From table 1, we get irradiance data from one week of sampling at Jakabaring Sports City, showing on a sunny day like on 27 June with the highest value at 13.00 with a value of 1241 w/m2. and on unfavorable day conditions or cloudy outside conditions occur on 26 June and 29 June the irradiance obtained is less than the maximum, and at the bottom shows the irradiance graph from table 1, it can be seen that the graph on 27 June shows a good value in the process of utilizing solar panels in energy extraction.

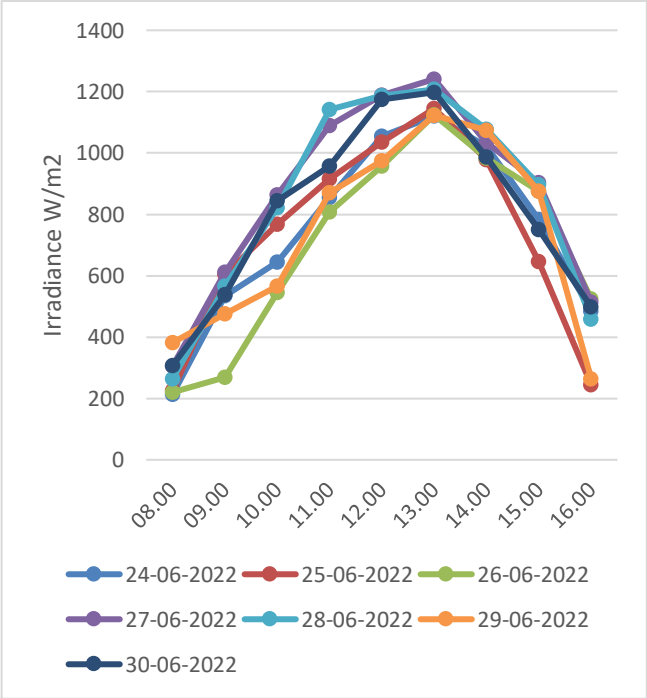

Figure.4 Measurement Irradiance

As mentioned earlier, the amount of radiation received by the PV panel greatly affects the electricity generated by PV panels. Measurements carried out show that at 08:00, lowest solar radiation while at 13.00 WIB the highest solar radiation.

in the data above, it is found that the lowest irradiance is at 8 am where the average obtained is 274W/m2 where at the optimal time it occurs in the range of 12.00 to 14.00 where the value at 12.00 with an average of 1082W/m2 at 13.00 obtained the highest value of 1165W/m2, and at 14.00 the data obtained is 1022W/m2.

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The most optimal Irradiance value from the data above is obtained at 12.00 to 14.00 where the value is obtained from the average value taken in 7 days of research where the battery can charge optimally in the process of utilization.

Table 2. Data Collection on 27 June

Time	VDC (V)	IDC (A)	IRRADIANCE (W/m2)
08.00	13.7	2.76	305
09.00	15.5	3.3	612
10.00	17.4	3.51	864
11.00	18.7	3.77	1089
12.00	19.4	3.9	1189
13.00	19.6	3.83	1241
14.00	15.2	3.87	1034
15.00	14.9	3.73	904
16.00	14.6	3.37	514

For data collection above, samples were taken every 1 hour where measurements were carried out from 08.00 to 16.00 the data was taken such as VDC (V), IDC (A), and Irradiance (W/m2) and obtained data as shown in table 2 where the highest value is at 13.00 where the VDC value is recorded at 19.6V and the IDC is 3.83A with an Irradiance of 1241 W/m2 where this data retrieval is taken in a very good position in sunny conditions.

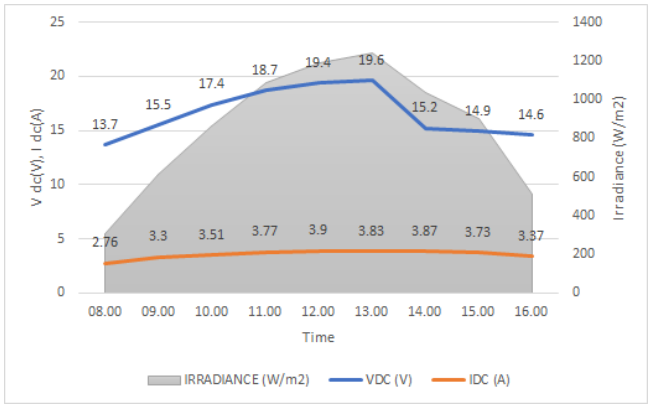

Figure.5 Measurement 27 June 2022

Figure 5 shows that the captured irradiance is directly proportional to the power obtained, the largest value at 12.00 with a VDC value of 19.4V and IDC 3.9A and a small value at 08.00 with a VDC value of 13.7V and an IDC value of 2.76A.

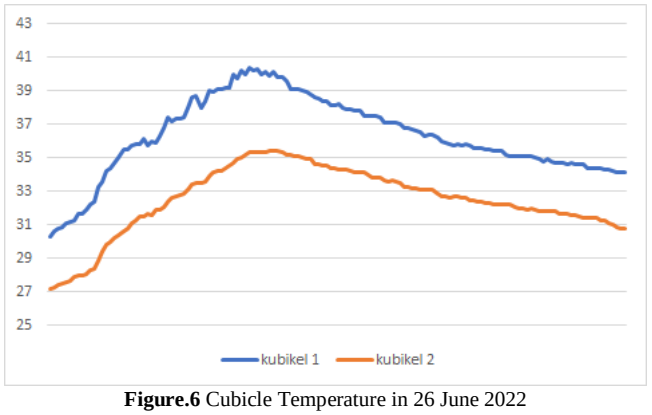

Figure.6 Cubicle Temperature in 26 June 2022

At the time of temperature measurement, good values were also obtained in cubicle 1 where the temperature could be kept stable, although at night it was touched at 27°C it was known that the value in cubicle 2 was less than optimal where this temperature could cause dampness in the cubicle, data collection was taken under conditions that bright, still the 2nd cubicle is still lacking in maintaining moisture.

And in the study for 1 week there were days that were less than optimal in capturing light on solar panels, on June 26 on that date the weather was cloudy and it had rained resulting in the value of the solar panels being unable to work optimally.

Table 3. Data Collection on 26 June

Time	VDC (V)	IDC (A)	IRRADIANCE (W/m2)
08.00	13.3	3.01	220
09.00	13.8	3.12	268
10.00	14.6	3.31	546
11.00	18.0	3.52	807
12.00	18.3	3.58	958
13.00	18.9	3.7	1124
14.00	17.9	3.6	984
15.00	17.1	3.39	875
16.00	14.1	3.11	524

From data retrieval on June 26, the data obtained as in Table 3 where the highest value was at 13.00 where the VDC value was recorded at 18.3V and IDC was 3.53A with an Irradiance of 1124 W/m2 where this data collection was taken in cloudy and rainy conditions.

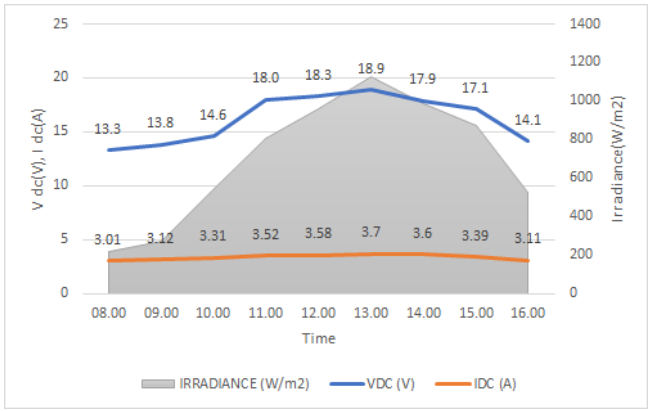

Figure.7 Measurement 26 June 2022

Figure 7 shows that the captured irradiance is directly proportional to the power obtained, the largest value at 13.00 with a VDC value of 18.3V and IDC 3.7A and a small value at 08.00 with a VDC value of 13.3V and an IDC value of 3.01A.

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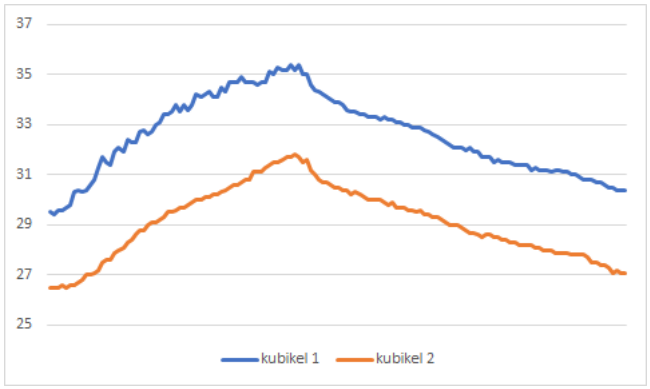

Figure.8 Cubicle Temperature in 26 June 2022

On cloudy days and rainy conditions in this study showed that the 2nd cubicle was very difficult to touch the temperature of 30°C where the lowest point touched 26°C. On the other hand, the 1st cubicle was able to control the room temperature where the cubicle could maintain temperatures above 30°C.

uring the research that was conducted for 1 week from June 24 to June 30, we have seen several situations that occurred at the research site where when the climate was cool or rainy, it greatly affected the condition of the cubicle room in this sample.

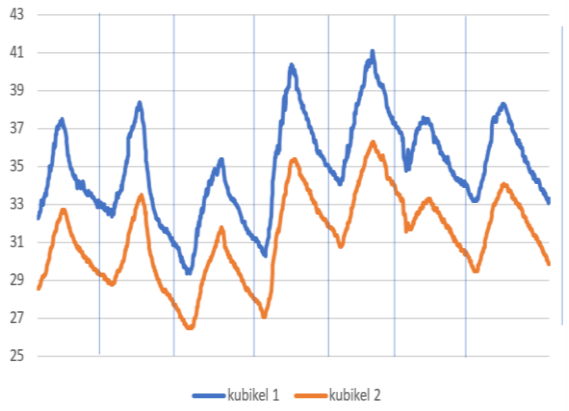

Figure.9 Temperature During Research

Figure 9 shows a graph for 1 week where the 2nd cubicle still has a low temperature and it is very difficult to get the expected temperature, which is above 30°C, especially in rainy or cloudy conditions compared to the 1st cubicle which is undesirable because it is feared that the 2nd cubicle will experience partial discharge and resulted in the supporting compartment in the cubicle room experiencing obstacles or a dangerous corona.

For cubicle 1, it has met the requirements because the room temperature is above 30°C, which is meant to prevent the room in the cubicle from being humid.

4. Conclusion

In this study, the results of the measured irradiance measurement have a maximum value for capturing light at 12.00 to 14.00 where the value at 12.00 with an average of 1082W/m2 at 13.00 obtained the highest value of 1165W/m2, and at 14.00 the data obtained is 1022W. /m2 While the smallest value was obtained at 8 am where the average value was 274W/m2.

In this study, there were also 2 sempers that attracted attention on June 26, which occurred when the weather was cloudy and rainy had the maximum value in capturing light, the largest value was at 13.00 with VDC 18.3V and IDC 3.7A and the smallest value was at 08.00 with a VDC value of 13.3V and an IDC value of 3.01A and on a sunny day on June 27 here the average value is at 12.00 with a VDC value of 19.4V and an IDC 3.9A and a small value is at 08.00 with a VDC value of 13.7V and a VDC value of 13.7V. IDC 2.76A

From this value, it shows that the use of solar panels to turn on the cubicle heater can be done because it can support 24-hour operation

In the temperature there is a problem where cubicle 2 has problems where the room temperature of the cubicle is very difficult to touch 30°C where it is feared that the cubicle will be humid and the occurrence of partial discharge where this is a lot of factors from the condition of the connecting substation that is wet or there is a puddle of water or a heater whose function has decreased or not optimal in working because it has not been operating for a long time, this is very unfortunate because the humid conditions of the cubicles are dangerous and can harm users here, customers and PT PLN are due to require large investment costs and some of these cubicles have high prices.

In the results of this study, it is very necessary for a heater to maintain humidity or temperature in the cubicle to prevent unwanted things from happening and for PT PLN with this tool it can be a monitoring for cubicles that often occur partial discharge (PD) to ensure the temperature and the feasibility of the substation room due to although in the same substation, as in this study, there is a large temperature difference between the two cubicles, even though the heater is on, it will be in the spotlight so that PT PLN pays more attention to its equipment and can serve consumers better.

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