# Monitoring of iot-based Wind and Solar Hybrid Power Plants for Agricultural Irrigation Systems

Budhi Prasetiyo(1), Wiwik PW(2), Yusuf Dewantoro H* (3), Suwarti (4), Jin-Cherng Shyu(5)
1,2,3,4 D3-Energy Conversion Engineering, Mechanical Engineering Department, Semarang State Polytechnic
Jalan Prof. H. Soedarto, SH Tembalang 50275, Semarang City, Central Java, Indonesia
5National Kaohsiung University of Science and Technology, Taiwan
Email address : ***masyusufdh@polines.ac.id**

**ABSTRACT-** The use of renewable energy, one of which is *Hybrid* Power Plants (PLTH). The PLTH used in this study is a wind and solar power plant. To keep the plant from being damaged and prevent a decrease in tool performance, PLTH was developed based on the *Internet of Things* (*IoT*). *IoT* will later monitor the performance of the plant. In this study using the ESP32 TTGO SIM800L microcontroller, the sensors used were DC voltage sensors, current sensors (ACS712), wind speed sensors (*anemometers*), wind direction sensors (*wind vanes*), and water flow sensors. The research began with designing the relationship between components, working on monitoring and programming systems on software, installing outdoor sensors and installing monitoring systems, and ending with data observations. The results obtained on the observation of data, the best error percentage values are presented by various sensors with values less than 6%.

**Keywords :** Hybrid Power Plant, IoT, ESP32, *monitoring*.

## I. INTRODUCTION

Renewable energy is energy from nature and energy that can be used freely. Its utilization can be in the form of Hybrid Power Plants (PLTH). PLTH is a power plant consisting of 2 (minimal) plants with various energy sources [2]. Renewable energy that can be used includes wind energy and solar energy. However, wind energy and solar energy have their own advantages and disadvantages. Wind energy is energy that exists throughout time (during the day and night) and can produce large energy , but there can be overvoltage if the wind blows strongly, besides that wind energy is also influenced by time and season. Meanwhile, solar energy is energy that is in accordance with the tropics but has a limited time where it can only be used during the day [1].

The hybrid system in the plant is sought to support sufficient electricity results and overcome each other for the supply of electrical power. To keep the plant from being damaged and prevent a decrease in tool performance, PLTH was developed based on the Internet of Things (IoT). IoT is a concept of communication technology between devices using an internet connection [3]. Based on the problems presented, it is necessary to design a tool that can monitor the PLTH in real-time conditions so as to create a well-maintained power plant and avoid damage .

## II. METHODS

The activities of making this Final Project tool include the planning stage, work stage, installation stage and testing stage depicted in the flowchart of the following implementation activities:


Figure 1. *Flowchart* Toolmaking

The installation stage is carried out to install *the panel box*, connect the sensors, and install the use of tools after which they will be used for testing. The testing phase consists of programming testing using esp 32-connected applications and actual testing . With an interval of each test for approximately 5 minutes, data testing is in the form of: solar panel voltage, alternator voltage, solar panel current,



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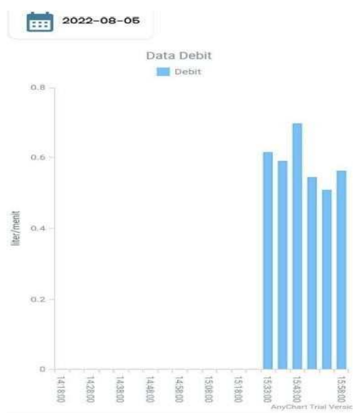
ISSN 0216-8685 (print); 2528-6889 (online)

alternator current, wind speed, direction wind, and water pump discharge.

## III. Results and Discussion

System testing is carried out to determine the accuracy of data from the performance of the system that has been created. The data display is in the form of a real-time graph for voltage, current, and discharge, while the display for wind speed values is in the form of a speedometer, and the wind direction is in the form of a compass display.



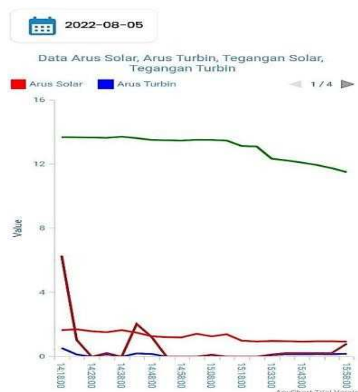
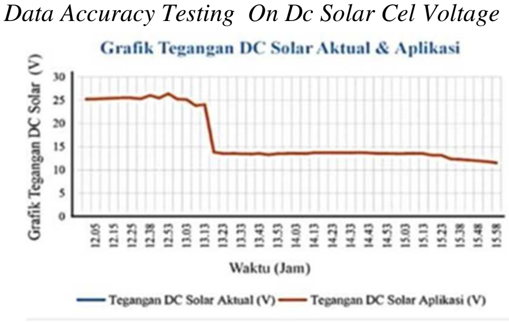






Figure 2. Display on The App

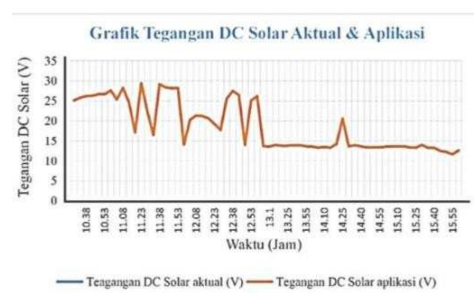
Data accuracy testing aims to compare the data read by the sensor through the application with the actual data using a measuring instrument directly.

### A. *Data Accuracy Testing On Dc Solar Cel Voltage*




Actual and Application *Solar Cell* DC Voltage Graph Aug 5, 2022

The Graph shows the difference in the actual solar cell DC voltage data with the application DC solar cell voltage almost no noticeable difference. So that on the chart shows the same line pattern. The error value in the data is very small, which is only 0.008711749% (0.0087%)




Actual *solar cell* DC Voltage Graph and Application August 6, 2022

On the Graph, it can be seen that the difference in the actual solar cell DC voltage data with the application SOLAR cell



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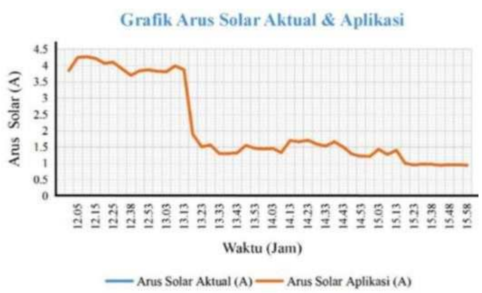
ISSN 0216-8685 (print); 2528-6889 (online)

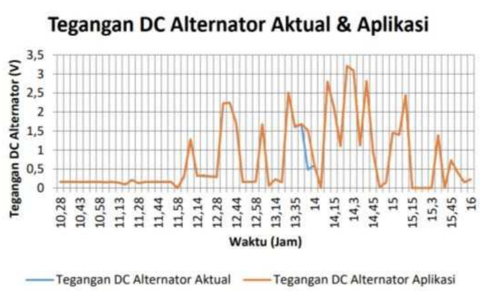
DC voltage is almost no difference. So that the chart shows almost the same pattern and even looks like there is no difference in pattern. The error value generated in the data is very small, which is only 0.00901785% (0.009 %).

*B. Testing Data Accuracy on Solar Cell Current*




Actual *Solar Cell* Current Chart and Application August 5, 2022

On the Graph it can be seen that the difference in the data of the actual solar cell current and the application solar cell current is almost invisible. The average error value in the solar cell current observation data is very small where the error value is only 0.099571642% (0.01 %).

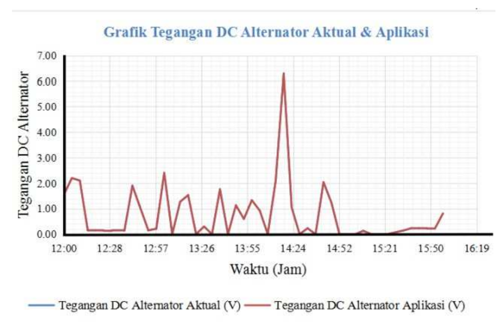



Actual *Solar Cell* Current Graph and Application August 6, 2022

The graph shows that there is a similarity in the form of a graph between the actual solar cell current data and the application solar cell current at 10.28 WIB to 13.20 WIB. In the data after 13.20 WIB, it can be seen that the graph experiences a difference in pattern because there are different reading data between the actual solar cell current and the application solar cell current, thus causing a difference in the value of the difference which is quite large. For example, the data at 14.20 WIB is the data with the largest difference, which is 2,021. The average error value generated is also quite large , which is 8.095% (8.10 %).

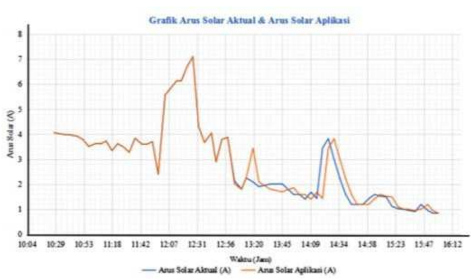
**a.**

C. Data Accuracy Testing On DC Alternator Voltage




*Actual and Application ALTERNATOR DC Voltage* Chart Aug *5, 2022*

The Graph shows that the data difference between the actual alternator's DC voltage and the application alternator's DC voltage is almost invisible. The average error value in the data is very high, which is only 0.04031366% (0.04%).




*Actual and Application ALTERNATOR DC Voltage* Chart *Aug 6, 2022*

The Graph shows that there is a data difference between the actual alternator's DC voltage and the application alternator's DC voltage which is almost invisible. However, at 13.35 WIB to 13.55 WIB there is a difference in values in the actual and application measurement results so that the graph looks not in line. The average error value of the actual and application differences in the results of the difference in measurements is only 0.04031366% (0.04 %).



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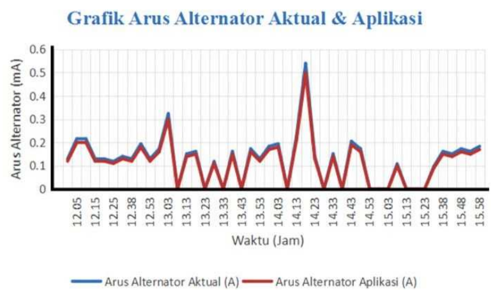
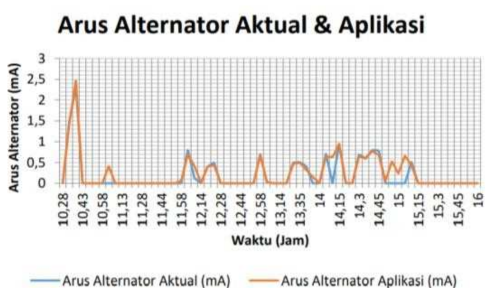
D. Data Accuracy Testing On Alternator Current




Actual and Application Alternator Current Chart Aug 5, 2022

The Graph shows that the difference between the actual alternator current data and the application alternator current is slightly noticeable but still remains one pattern line. The average error value in the data is quite small, which is 5.31%.




*Actual and Application Alternator Current* Graph *Aug 6, 2022*

On the Graph shows that the difference between the actual alternator current data and the application is quite obvious. The average value of the resulting error is very high , which is 5.73466 % (5.74%).

E. Testing Data Accuracy at Wind Speed


Actual wind speed graph and application August 5, 2022

The Graph shows that the difference in data between actual wind speed and wind speed in application looks almost non-existent. The average error value in the data was very large, which was 1.0878313 % (1.088%).


*Actual wind speed* graph *and application August 6, 2022*

On the Graph shows that the difference in actual and application wind speed data looks almost non-existent. The average error value in the data is quite large, which is 1.7207375% (1.72%).

F. Testing Data Accuracy on Water Pump Discharge


*Actual and Application* Water *Pump Discharge* Chart *August 5, 2022*

On the Graph shows that the difference in the data on the chart is slightly noticeable. The average value of the error on the data is relatively large where the error value is 1.19507 %.



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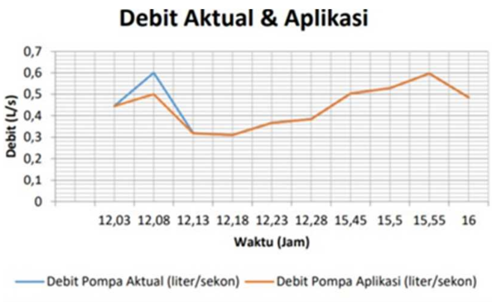


*Actual and Application* Water *Pump Discharge* Chart *Aug 6, 2022*

On the Graph it can be shown that the difference in data is very clearly visible at the beginning of data retrieval.but entering 12:13 the data begins to stabilize until it is finished data retrieval, the average value of errors in data retrieval shows a fairly small value of 1.75863%.

## IV. Conclusion

1. Based on the research carried out, the conclusions of the Final Project "Monitoring System in IoT-Based Wind and Solar Hybrid Power Plants for Agricultural Irrigation Systems" were as follows:
2. The results of the monitoring design were successfully carried out as their function and based on the results of observations obtained after carrying out the study, the average error value with the minimum results and can be said to be good for three days of testing, including: DC voltage solar cell 0.0087% (August 5 , 2022), solar cell current 0.099% (August 5 , 2022), DC alternator voltage 0.04% (August 5 , 2022), alternator current 5.31% (August 5, 2022), wind speed 1.087% (August 5, 2022), pump discharge 1.758% (August 6, 2022).
3. Monitoring technology makes it easier to monitor hybrid wind and solar power plants at a distance through an application on an installed Android smartphone. Data in a day can also be exported to a smartphone so that it can monitor the performance of the plant at that time of the day.

## Acknowledgment

The author would like to thank Desinta Nur R., Ika Melinda P., Oktaviyan Alansyah, Micah Riksi Fananda who provided support for this research

## REFERENCES

[1] Hermansyah, B. 2019. Designing a Hybrid System of Pv Panels and Wind Turbines Interconnecting with the Grid to Meet Electricity Needs in Vannamei Shrimp Cultivation in Bayan District, North Lombok Regency , Nusa West Southeast (Doctoral dissertation, Sepuluh Nopember Institute of Technology).

[2] Ramadan et al. 2019. Design and Implementation of Water Discharge Measurement Using IoT-Based Water Flow Sensors. Vol. 6, No. August 2, 2019.

[3] Ramadan, inspiration & Santoso, Dian. 2022. Application of the Internet Of Things to Hybrid Generation Monitoring Systems. Karawang, Scientific Journal of Educational Vehicles, August 2022, 8(3), 168-176.

[4] Dr.Hamdi,M.Si.Renewable Energy 2016.Rawamangun.Jakarta

[5] Ikhwanul Ikhsan, 2011. Analysis of the Effect of Loading on a Propeller Type Windmill on a Simple Wind Tunnel. Hasanudin University pp. 8. Downloaded on July 16, 2019 at 23.30.

[6] Marsudi, Central Java. 2005. Electrical energy generation. Jakarta: Erlangga

[7] Maulana, Wind Energy Utilization, accessed on July 16 at 23:00

[8] Maryadi, Agus. 2002. Study of Solar Cell Surface Conditions on Electrical Energy produced. Palembang: Sriwijaya State Polytechnic

[9] Nursuhud, Djati and Atsu Pudjana, Energy conversion engine (Yogyakarta: Andi publisher, 2013

[10] Permana, Faith. 2008. Introduction to Solar Power Technology. Bandung : PPPPTK BMTI

[11] Sutarno, Energy Resources (Yogyakarta: Publisher Graha Ilmu, 2013)

[12] Suryatmo, F 2014. Basics of Electrical Engineering, Jakarta : Rineka Cipta

[13] Ulya, Hybrid power plant. Retrieved July 16, 2019 at 22:19

[14] Virgiawan, Resita.2017. Design of wind power generation systems and solar power plants for street lamp lighting in the taipa village, afternoon, takalar district. Hasanudin University.

[15] Pahlevi, Reza (2014). Testing the characteristics of solar panels based on the intensity of solar power. Thesis. Muhammadiyah Surakarta university.BRAC University, IEEE Power & Energy Society, & Institute of Electrical and Electronics Engineers. (n.d.). *International Conference on Energy and Power Engineering : 2019 ICEPE : Theme: Power for Progress : 14-16 March, 2019, BCOM, Savar, Dhaka, Bangladesh, Department of Electrical & Electronic Engineering, Brac University..*



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ISSN 0216-8685 (print); 2528-6889 (online)