INTL JOURNAL OF ELECTRONICS AND TELECOMMUNICATIONS, 2026, VOL. 72, NO. 3, PP. 1-6
Manuscript received December 21, 2024; revised June, 2026. doi: 10.24425/ijet.2026.1730

The design of Wind Power Plant (WPP) for conveyor lighting using Wind Turbine method

Budi Yanto Husodo, Lukman Medriavin Silalahi, Ahmad Rizal, and Imelda Uli Vistalina Simanjuntak

***Abstract*—This research addresses the issue of poor Public Street Lighting (PSL) in the Belt Conveyor (BC) tripper area, which causes limited visibility. So, this research proposes the design of a Wind Power Plant (WPP) using the 4-wind turbine method. The purpose of this research is the use of WPP technology for PSL development. The research hypothesis is supported by the local environmental conditions, with an average wind speed of 6.7 m/s. This research was conducted by Vertical Axis Wind Turbine (VAWT). The research test uses simulator software to display the voltage and current outputs, and then the output is compared with the results of direct measurements. There are 3 measurement points, namely the inverter output voltage of 226 VAC, the battery output voltage of 51.18VDC, and the full loading current of 7.48A. Significant results occurred at 400W load, because the reliability time to distribute electrical energy to a normal load took 21.2 minutes until the voltage drop was 48VDC, then 800Watt load for 13.48 minutes, and 1600W load for 7.1 minutes. And it is informed that the battery capacity is 200x4AH. Finally, the power output and system efficiency have succeeded in adding value to the diversification of the plant because the burden for PSL has used WPP as the power supply. Suggestions for potential improvements in future work are to measure the environmental impact, especially CO2 emissions, then the challenge of scaling up energy storage and infrastructure improvements as well as the development of maintenance strategies.**

***Keywords*—Inverter SNV-GH3041; Public Street Lighting; Vertical Axis Wind Turbine; Wind Energy; Wind Power Plant**

I. INTRODUCTION

INDONESIA is an archipelagic country with abundant natural energy potential, which can be converted into electrical energy, such as wind energy potential. Wind Power Plant (WPP) in this research uses the 4-wind turbine generator method type Vertical Axis Wind Turbine (VAWT) with a capacity of 2x600Watt and 2x800Watt [1]–[3].

The concept of New Renewable Energy (NRE) comes from sustainable natural processes and can be utilized as energy that can be developed over time [4]–[6]. This research uses hybrid inverters from the power grid [7]–[9]. That is, if the battery reaches its minimum value and charging mode, then the lamp power will switch from the battery to the Grid/Main Control Center (MCC). Wind Energy (WE) utilization is stored first in the Energy Storage System (ESS). The consistent and stable battery type proposed in this study is a Valve Regulated Lead Acid (VRLA) battery with a capacity of 200AH [10]–[12].

The power of wind turbines is very dependent on wind speed. Thus, Maximum Power Point Tracking (MPPT) is needed to achieve maximum power [13]. VAWT is a type of wind turbine with a vertical axis where the movement of the shaft and rotor is parallel to the wind direction. The VAWT receives wind from all directions and has self-starting capability, allowing the rotor to rotate at low speeds and produce high torque [14]–[17].

The inverter has three modes including Grid-Tied (GT), Off-Grid (OG), and Grid Tie With Backup (GTWB) [18]. GTWB mode allows for WE power regulation, grid power management, load power management, and battery charge control. Users can configure priorities for WE power supply, charging source, and load power supply priority [19]–[22]. In GT mode, the main power source for the load comes from the power grid, and the battery functions when there is interference or power off [23]. OG mode produces power from the WE to power the load and charge the battery [24]–[26].

Monitoring software is used to monitor multiple devices simultaneously via USB and serial ports. Its main functions include logging data for the device, power generation statistics, alarm messages, error messages, and parameter settings for the device [25]–[27].

An integrated WPP system can be designed with a scheme that allows the output voltage from WE to go to the inverter. This system has the advantage of no longer requiring a cut-off voltage regulator, since this function is executed by the SNV-GH3041 inverter [28]–[30].

The contribution of this research is preventive maintenance and economical maintenance plans to optimize production plans. Preventive maintenance, occurs when equipment failure can be anticipated so as to trigger proper maintenance. Then the economical maintenance plan pays attention to the use of measurement sensors, parametric analysis is carried out to determine when maintenance should be carried out before failure occurs. In general, maintenance in wind power generation systems has the goal of maintaining the performance of equipment during operation, utilizing it effectively, and avoiding malfunctions [31]–[33].

II. RESEARCH METHOD

The following are the needs of tools and materials to design and simulate WPP scheme:

1. VAWT Helix 600W and 800W 24 Volt with MPPT: The maximum power generated is a total of 2800W. This power is directly channeled for battery charging. This model was chosen due to its simple installation and relatively easy maintenance compared to other types of turbines. VAWT specifications can be seen in table I.

The first is with Universitas Mercu Buana, Indonesia (email: budi_yanto@mercubuana.ac.id).
The second author is with Universitas Presiden, Indonesia (email: lukman.silalahi@president.ac.id).
The third and fourth author is with Universitas Mercu Buana, Indonesia (email: rizal.d.ahma@gmail.com, imelda.simanjuntak@mercubuaca.ac.id).

TABLE I
SPECIFICATION OF VAWT

No	Parameters	Capability Values
1	Power	800W and 600W
2	Voltage	24V
3	Wind Speed	1.6m/s – 13m/s

TABLE II
SPECIFICATION OF INVERTER SNV-GH3041

No	Parameters	Capability Values
1	Power	3KW
2	Grid	220/230/240VAC
3	Input from battery	48V
4	Frequency	50Hz

TABLE III
SPECIFICATION OF BATTERY VRLA

No	Parameters	Capability Values
1	Float Charging Voltage	13,6-13,8V
2	Cycling Charging Voltage	14,5-14,9V

2. Inverter On Grid: SNV-GH3041 inverter has an automatic function of switching to the grid so that the output power from this inverter is very reliable. The specifications of the SNV-GH3041 inverter can be seen in table II.
3. Battery VRLA: WE utilization is stored in the ESS, so it requires the consistent and stable battery characteristics shown in Table III.

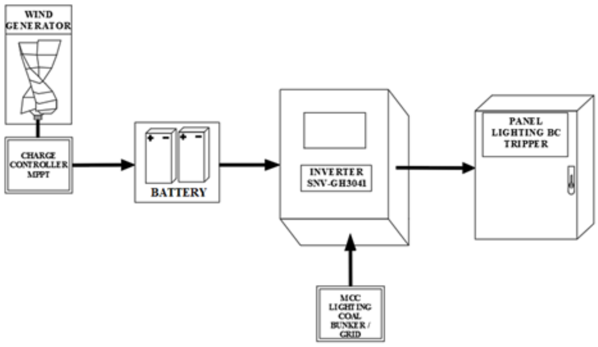

Fig. 1. Single line diagram WPP

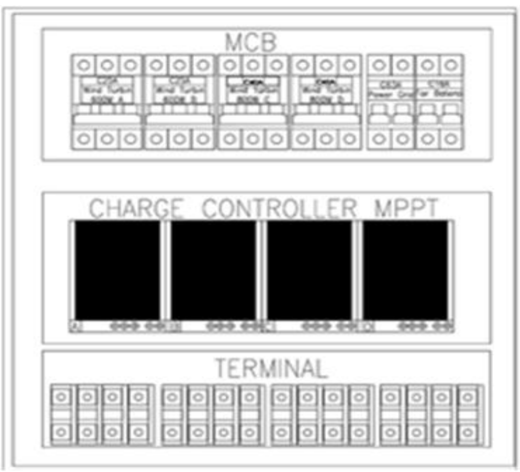

Fig. 2. Main box

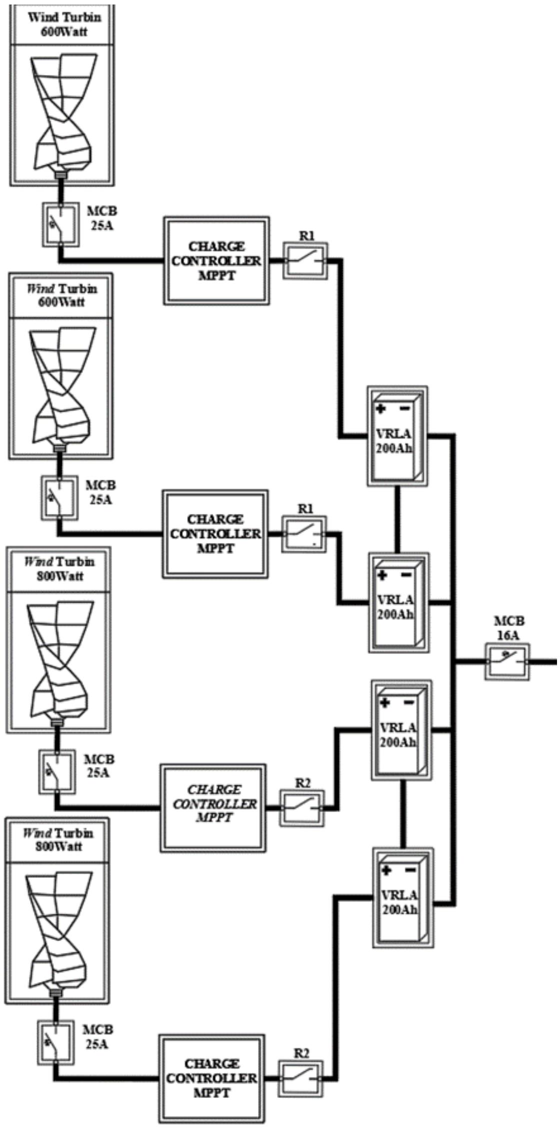

Fig. 3. Charger circuit

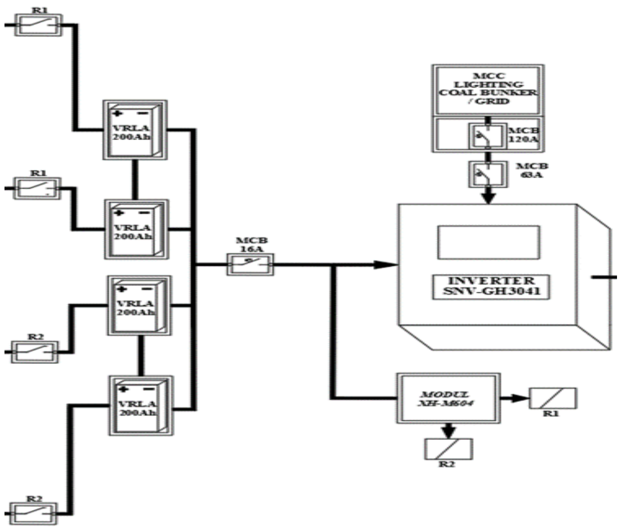

Fig. 4. Battery and inverter circuits

A. *Wind Power Plant Battery Priority (WPP BP) Design*

Figure 1 shows a series of single line diagrams consisting of important parts including:

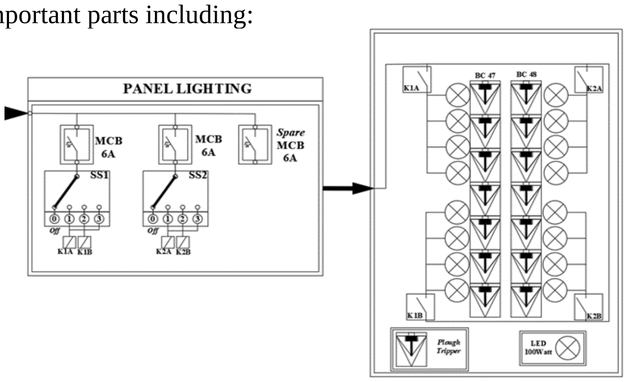

Fig. 5. Circuit load

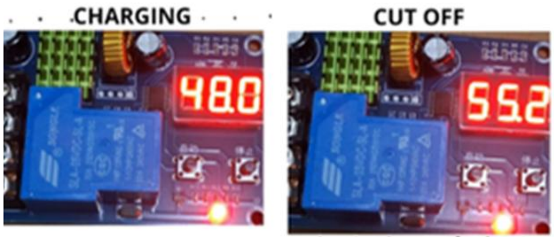

Fig. 6. Setting mode WPP systems

1. Figure 2 shows the main box of WPP consisting of Miniature Circuit Breaker (MCB), MPPT charge controller and terminal.
2. Figure 3 shows the WPP design has a charging system circuit.
3. Figure 4 shows the battery and inverter circuit as a power supply provider to the load (lights) and acts as a power supply from the grid as a substitute for the load power for the battery when the battery capacity is low.
4. Figure 5 shows a load circuit consisting of 16 lights with a capacity of 100 W each leading to the BC-Tripper 47 and 48 areas.

The installation steps for the WPP equipment include:

1. Install 2 x 600W and 2 x 800W wind turbines on the roof of the tripper area.
2. Run the cable pulling from the wind turbines to the charge controller in the MCC Coal Bunker Bay.
3. Execute the cable pulling from the 3kW on-grid inverter to the lighting load in the tripper area.
4. Carry out the cable pulling for the connection between the MPPT battery storage and the 3kW inverter in the MCC Coal Bunker.
5. Construct a battery rack to accommodate 4 units of 12 VDC VRLA Batteries in the MCC Coal Bunker.
6. Install 16 x 100W LED lighting in the BC tripper.
7. Connect the wind turbine load to the BC tripper area lighting panel.

B. *Setting Mode WPP Systems:*

Next, Figure 6 shows the nominal voltage value on the inverter nameplate is 48 VDC. In this condition, the cut-off inverter didn't work because the battery charging source didn't pass through the inverter system. The battery cut-off is set as an additional charging system safety. If the maximum value, then the Relay on R1 and R2 is active releasing the charging line to the battery.

1. WE Supply Priority Setting
   Priority: 1st Load, 2nd Battery, and then 3rd Grid. WE will provide power to the load first. Then, the WE power that is sidelined will charge the battery.
2. Battery Charging Source
   This research uses the WE-only option for the battery charging source.
3. Load Supply Source
   There are two conditions:
   a. When (WE) power is available
      1st option: 1st WE, 2nd Battery, and 3rd Grid.
      WE power will supply the load first. If insufficient, battery power will supply the load. When battery power is depleted or unavailable, the grid will back up the load.
      2nd option: 1st WE, 2nd Grid, and 3rd Battery.
      WE power will supply the load. If insufficient, the grid will supply the load. If grid power is not available at the same time, battery power will take over supplying power to the load.
   b. When Wind Energy (WE) power is not available
      1st option: 1st Grid, 2nd Battery
      The grid will supply power to the load initially. If the grid is not available, battery power will provide backup power.
      2nd option: 1st Battery, 2nd Grid.
      Battery power will supply the load initially. If battery power is depleted, the grid will back up the load.

III. RESULT AND DISCUSSION

A. *Wind Strength Measurement in the BC Tripper*

Data collections on wind speed were carried out with an interval of 2 hours each during the 5 days as shown in table IV.

TABLE IV
DATA COLLECTION ON WIND SPEED

Day	Time	Wind Speed (m/s)	Power VAWT (W)	
			600W	800W
	08:00	6	150	200
1	13:30	6.8	110	185
	16:30	9.1	251	400
	08:00	7.12	229	327
2	12:00	12:00	9.01	247
	15:00	15:00	9.33	238
	08:00	08:00	7.79	204
3	12:30	12:30	7.48	295
	15:30	15:30	8.4	189
	08:00	08:00	7.5	141
4	12:00	12:00	6.62	177
	15:47	15:47	8.69	231
	08:00	08:00	7.32	148
5	13:00	13:00	6.49	233
	16:13	16:13	9.1	266
Average wind speed		7.78		
Total Power Generated			3109	3748
Average Power			207.27	249.87

The analysis explains that the wind power at the research site is very suitable for designing the VAWT model because the average wind speed is 7.78 m/s. Based on the NRE, the average wind speed of 7.78 m/s is in the 4th class (Good) and the results of this measurement are direct measurements for 5 days in the November 2023 period.

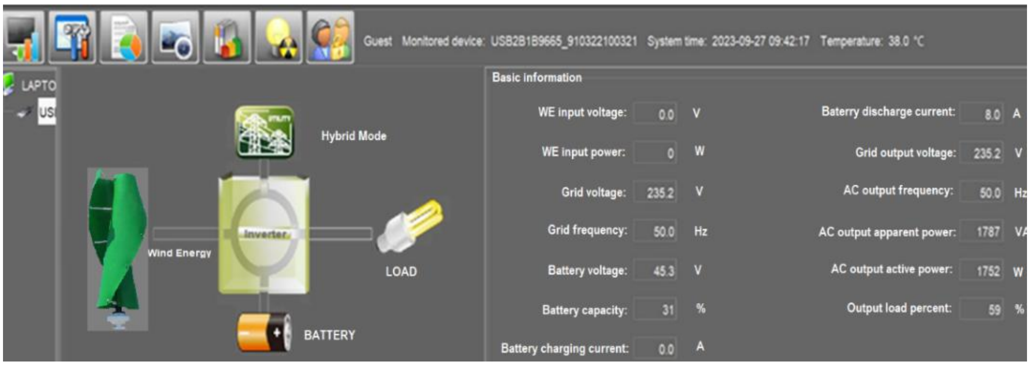

Fig. 7. Full load operating parameters display

However, wind speeds lower than 7 m/s will not be suitable for WPP [34]. The 600W type VAWT has an average load of 207.27W, and the 800W Type VAWT has an average load of 249.8W.

B. WPP System Simulation

The WPP simulator serves to simulate and monitor the WPP system with parameters taken from the inverter. Figure 7 represents the software interface.

C. WPP Measurement

Table V displays the measurement results using a multimeter and clamp meter. The results of WPP measurements are in accordance with the design plan that has been made.

TABLE V
WPP LOAD TESTING

Parameter	Output
Measurement of inverter output voltage	226VAC
Measurement of battery output voltage.	51.18VDC
Measurement of total current and current distribution	7.48A
Current distribution	I_1:3.85A I_2: 3.65A

D. WPP Load Testing

Table VI displays the measurement results using a multimeter and clamp meter. The results of WPP measurements are in accordance with the design plan that has been made.

TABLE VI
WPP LOAD TESTING

Load	Time	Drop Voltage (VDC)
1600W	00:00	51.18
	03:00	49.34
	06:00	48.91
	07:01	48
800W	00:00	52
	03:00	49.7
	06:00	49.55
	09:00	49.12
	12:00	48.71
	13:45	48
400W	00:00	52
	03:00	49.91
	06:00	49.85
	09:00	49.11
	12:00	49.01
	15:00	48.93
	18:00	48.44
	21:00	48

Analysis results that 1/4 full load lasts longer so that the operational scheme can be divided into 3 conditions:

1. Normal operation (400 operation load)
   This operation is used for the delivery of coal into BC tripper. Figure 8 shows that the Selector Switch (SS) coded SS1 points to position 1 then activates the contactor K1A so that the L47A lamp lights up and L47B turns off. If you want to evaluate the L47B part, then SS1 is directed to position 2 so that the K1B contactor works so that L47B turns on and L47A turns off.

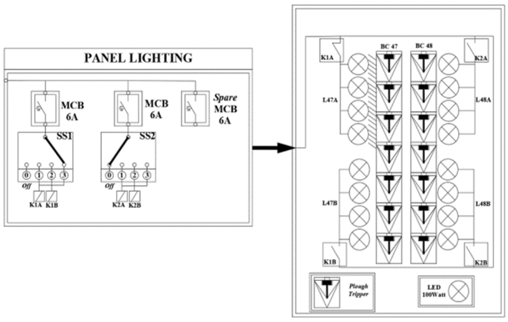

Fig. 8. Normal operation

2. Maintenance operation (800 operation load)
   This operation is carried out when repairing a specially damaged / broken belt requires lighting on one of the BC tripper lines. If maintenance is carried out on BC tripper 47, then SS1 is directed to position 3 so that it activates the contactors K1A and K1B causing the L47A and L47B lights to light up. Figure 9 shows the maintenance scheme.

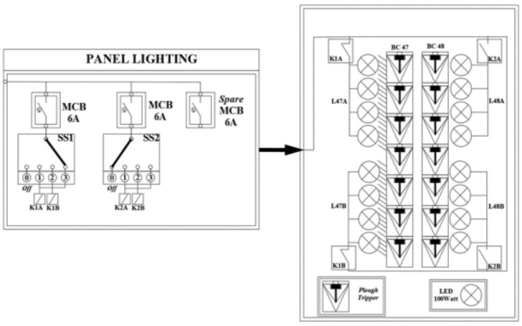

Fig. 9. Maintenance operation

3. Back-Up lighting operation (1600W operating load)
   This scheme is carried out when the main lighting of the BC tripper is turned on, the WE light will be operated which is shown in figure 10. Figure 10 shows that SS1 and SS2 are pointed to position 3, activating the K1A, K1B, K2A, and K2B contacts, so that all lights in the tripper area are lit.

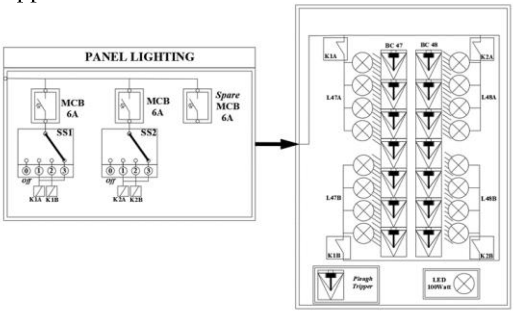

Fig. 10. Backup operation

Significant results occurred at a 400W load because the reliability time to distribute electrical energy to a normal load took 21.2 minutes until the voltage drop was 48VDC, and the 1600W load was only used in the backup scheme. We have analyzed the design of the turbine, or the optimization of the energy storage system and the influence of the average wind speed condition has an impact on the performance of the designed WPP.

CONCLUSION

The conclusion of this research emphasizes on preventive maintenance and economical maintenance plans, then wind power solutions have been able to solve the PSL issue, namely limited visibility where previously there was no proper PSL system, so this is the novelty in this research. Installation and simulation requirements have been established. Wind speed collection using a measuring instrument resulted in an average wind speed of 7.78 m/s. The average electrical power produced is 431.9W. The measured inverter output voltage is in accordance with the planned voltage, which is 226VAC. The battery output is 51.18VDC, and the total current is 7.48A. The WPP system shows reliable operation at 400W, 800W, and 1600W load conditions. Load testing has been carried out including 21 minutes and 12 seconds at a 400W load, 13 minutes 48 seconds at an 800W load, and 7 minutes 1 second at a full load capacity of 1600W. Finally, it can be stated that the design of this WPP system is good with a predetermined operation scheme. The lighting in the BC Tripper area has been successfully optimized. Finally, the power output and system efficiency have succeeded in adding value to the diversification of the plant because the burden for PSL has used WPP as the power supply. Then, suggestions for potential improvements in future work are to measure the environmental impact, especially CO2 emissions, then the challenge of scaling up energy storage and infrastructure improvements as well as the development of maintenance strategies.

ACKNOWLEDGEMENTS

We would like to thank Universitas Mercu Buana and Universitas Presiden for the national collaboration research. This research is supported by Universitas Mercu Buana on the Internal Research, contract number 02-5/938/B-SPK/III/2024. hopefully this article will be published and become a consumption for scholars.

REFERENCES

[1] Z. Ren, A. S. Verma, Y. Li, J. J. E. Teuwen, and Z. Jiang, “Offshore wind turbine operations and maintenance: A state-of-the-art review,” *Renew. Sustain. Energy Rev.*, vol. 144, no. January, 2021, doi: 10.1016/j.rser.2021.110886.

[2] L. Yang, G. Li, Z. Zhang, X. Ma, and Y. Zhao, “Operations & Maintenance Optimization of Wind Turbines Integrating Wind and Aging Information,” *IEEE Trans. Sustain. Energy*, vol. 12, no. 1, pp. 211–221, Jan. 2021, doi: 10.1109/TSTE.2020.2986586.

[3] M. A. Al-Rawajfeh and M. R. Gomaa, “Comparison between horizontal and vertical axis wind turbine,” *Int. J. Appl. Power Eng.*, vol. 12, no. 1, p. 13, Mar. 2023.

[4] I. U. V. Simanjuntak, J. Haidi, R. F. A. Putra, and L. M. Silalahi, “Comparison of MPPT optimization methods for P&O and PSO solar panels to overcome partial shading,” *Int. J. Electron. Telecommun.*, vol. 70, no. 4, pp. 1023–1029, Nov. 2024, doi: 10.24425/ijet.2024.152090.

[5] I. U. V. Simanjuntak, H. Heryanto, A. W. Dani, K. S. Salamah, L. M. Silalahi, and M. Marsuki, “Analysis Of Solar Power Public Street Lighting Optimization With Pvsyst Software In A Residential Complex Area,” *Int. J. Electron. Telecommun.*, vol. 70, no. 3, pp. 743–749, 2024, [Online]. Available: https://ijet.pl/index.php/ijet/article/view/10.24425-ijet.2024.149604

[6] L. M. Silalahi, M. Rafi Indrawan, S. Budiyanto, D. Hanafi, A. Hamid, and D. Ronaldo, “Smart Home Control System Design using Internet of Things Based Energy Harvesting Technology,” in *2024 IEEE 6th Symposium on Computers & Informatics (ISCI)*, Aug. 2024, pp. 43–48. doi: 10.1109/ISCI62787.2024.10667797.

[7] S. Budiyanto *et al.*, “Design of control and monitoring tools for electricity use loads, and home security systems with internet of things system based on Arduino Mega 2560,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 909, no. 1, p. 012020, Dec. 2020, doi: 10.1088/1757-899X/909/1/012020.

[8] S. Budiyanto, I. U. V. Simanjuntak, L. M. Silalahi, A. D. Rochendi, and F. A. Silaban, “1 X 1000 Kva Transformator Measurement Analysis Using Vector Group Dyn-11 and Off Load Tap Changer,” in *Proceedings of the Conference on Broad Exposure to Science and Technology 2021 (BEST 2021)*, Atlantis Press, 2022, pp. 155–159. doi: 10.2991/aer.k.220131.026.

[9] S. Budiyanto *et al.*, “1 X 1000 kVA Transformer Measurement Analysis using Dyn-11 Vector Group and Off Load Tap Changer,” *J. Integr. Adv. Eng.*, vol. 1, no. 2, pp. 73–80, 2021, doi: 10.51662/jiae.v1i2.14.

[10] J. Li, Y. Fu, C. Li, J. Li, Z. Xing, and T. Ma, “Improving wind power integration by regenerative electric boiler and battery energy storage device,” *Int. J. Electr. Power Energy Syst.*, vol. 131, p. 107039, 2021, doi: https://doi.org/10.1016/j.ijepes.2021.107039.

[11] A. Iqbal, D. Ying, A. Saleem, M. A. Hayat, and M. Mateen, “Proposed particle swarm optimization technique for the wind turbine control system,” *Meas. Control*, vol. 53, no. 5–6, pp. 1022–1030, Feb. 2020, doi: 10.1177/0020294020902785.

[12] Y. Liu, X. Wu, J. Du, Z. Song, and G. Wu, “Optimal sizing of a wind-energy storage system considering battery life,” *Renew. Energy*, vol. 147, pp. 2470–2483, 2020, doi: https://doi.org/10.1016/j.renene.2019.09.123.

[13] P. Buduma, N. K. Vulisi, and G. Panda, “Robust Control and Kalman MPPT for Grid-Assimilated Wind Energy Conversion System,” *IEEE Trans. Ind. Appl.*, vol. 57, no. 2, pp. 1274–1284, Mar. 2021, doi: 10.1109/TIA.2020.3047585.

[14] H. Benbouhenni, I. Colak, N. Bizon, and E. Abdelkarim, “Fractional-order neural control of a DFIG supplied by a two-level PWM inverter for dual-rotor wind turbine system,” *Meas. Control*, p. 00202940231201375, Oct. 2023, doi: 10.1177/00202940231201375.

[15] X. He, H. Geng, and G. Mu, “Modeling of wind turbine generators for power system stability studies: A review,” *Renew. Sustain. Energy Rev.*, vol. 143, p. 110865, 2021, doi: 10.1016/j.rser.2021.110865.

[16] L. M. Silalahi, S. Budiyanto, F. A. Silaban, H. B. H. Sitorus, A. D. Rochendi, and M. F. Ismail, “Analysis of the effectiveness of online electronic learning system using data traffic network performance management to succeed merdeka learning--Merdeka campus during the

Covid-19 pandemic," *Int. J. Electron. Telecommun.*, vol. 67, no. 4, pp. 595–601, 2021.

[17] E. Darmawan, S. Budiyanto, and L. M. Silalahi, "QoS Analysis on VoIP with VPN using SSL and L2TP IPSec Method," in *2022 IEEE International Conference on Communication, Networks and Satellite (COMNETSAT)*, IEEE, Nov. 2022, pp. 130–136. doi: 10.1109/COMNETSAT56033.2022.9994572.

[18] P. S, A. T. Sriram, and S. Nagaraja Rao, "Wind energy conversion system using perturb & observe-based maximum power point approach interfaced with T-type three-level inverter connected to grid," *Clean Energy*, vol. 6, no. 4, pp. 534–549, Aug. 2022, doi: 10.1093/ce/zkac034.

[19] B. Sahoo, S. K. Routray, and P. K. Rout, "Robust control approach for the integration of DC-grid based wind energy conversion system," *IET Energy Syst. Integr.*, vol. 2, no. 3, pp. 215–225, Sep. 2020, doi: https://doi.org/10.1049/iet-esi.2019.0112.

[20] L. M. Silalahi, S. Budiyanto, F. A. Silaban, I. U. V. Simanjuntak, A. D. Rochendi, and G. Osman, "Optimizing The Performance Of The Power Station Generator Space Lighting System Performance Based On Internet Of Things Using ESP32," in *2021 3rd International Conference on Research and Academic Community Services (ICRACOS)*, IEEE, Oct. 2021, pp. 219–224. doi: 10.1109/ICRACOS53680.2021.9702010.

[21] L. M. Silalahi, D. Jatikusumo, S. Budiyanto, F. A. Silaban, I. U. V. Simanjuntak, and A. D. Rochendi, "Internet of things implementation and analysis of fuzzy Tsukamoto in prototype irrigation of rice," *Int. J. Electr. Comput. Eng.*, vol. 12, no. 6, p. 6022, 2022.

[22] S. Budiyanto, L. Medriavin Silalahi, F. Artadima Silaban, U. Darusalam, S. Andryana, and I. M. Fajar Rahayu, "Optimization Of Sugeno Fuzzy Logic Based On Wireless Sensor Network In Forest Fire Monitoring System," in *2020 2nd International Conference on Industrial Electrical and Electronics (ICIEE)*, IEEE, Oct. 2020, pp. 126–134. doi: 10.1109/ICIEE49813.2020.9277365.

[23] M. Tahmasbi Fard and M. Tarafdar Hagh, "Current Source Inverter Based Grid Connected Hybrid PV-Wind Power Generation Unit," *Int. J. Electron.*, vol. 107, no. 5, pp. 839–857, May 2020, doi: 10.1080/00207217.2019.1692242.

[24] S. D. Ahmed, F. S. M. Al-Ismail, M. Shafiullah, F. A. Al-Sulaiman, and I. M. El-Amin, "Grid Integration Challenges of Wind Energy: A Review," *IEEE Access*, vol. 8, pp. 10857–10878, 2020, doi: 10.1109/ACCESS.2020.2964896.

[25] I. Mahmood *et al.*, "Modeling, simulation and forecasting of wind power plants using agent-based approach," *J. Clean. Prod.*, vol. 276, p. 124172, 2020, doi: 10.1016/j.jclepro.2020.124172.

[26] H. Sun, C. Qiu, L. Lu, X. Gao, J. Chen, and H. Yang, "Wind turbine power modelling and optimization using artificial neural network with wind field experimental data," *Appl. Energy*, vol. 280, p. 115880, 2020.

[27] S. Budiyanto, F. A. Silaban, L. M. Silalahi, S. Kurniawan, and S. Andryana, "Design and monitoring body temperature and heart rate in humans based on WSN using star topology," *Indones. J. Electr. Eng. Comput. Sci.*, vol. 22, no. 1, pp. 326–334, 2021.

[28] E. Rakhshani, H. Mehrjerdi, and A. Iqbal, "Hybrid wind-diesel-battery system planning considering multiple different wind turbine technologies installation," *J. Clean. Prod.*, vol. 247, p. 119654, 2020, doi: 10.1016/j.jclepro.2019.119654.

[29] A. Khan and N. Javaid, "Jaya Learning-Based Optimization for Optimal Sizing of Stand-Alone Photovoltaic, Wind Turbine, and Battery Systems," *Engineering*, vol. 6, no. 7, pp. 812–826, Jul. 2020.

[30] L. M. Silalahi, V. Amaada, S. Budiyanto, I. U. V. Simanjuntak, and A. D. Rochendi, "Implementation of auto failover on SD-WAN technology with BGP routing method on Fortigate routers at XYZ company," *Int. J. Electron. Telecommun.*, pp. 5–11, 2024.

[31] W. Frijters, "Design of a Supply Chain Coordination System-of-systems: Applied to offshore wind power park maintenance." 2021.

[32] R. Gianto, M. I. Arsyad, P. Purwoharjono, F. Imansyah, and K. H. Khwee, "Distributed Generation in Electric Power Systems: An Overview and Important Issues," *WSEAS Trans. POWER Syst.*, vol. 18, pp. 172–178, Oct. 2023.

[33] S. Budiyanto, C. S. Aprihansah, L. M. Silalahi, I. U. Vistalina Simanjuntak, F. A. Silaban, and A. D. Rochendi, "Auto Discover Virtual Private Network Using Border Gateway Protocol Route Reflector," in *2022 IEEE International Conference on Communication, Networks and Satellite (COMNETSAT)*, Nov. 2022, pp. 123–129. doi: 10.1109/COMNETSAT56033.2022.9994439.

[34] T. Letcher, *Wind energy engineering: A handbook for onshore and offshore wind turbines*. Elsevier, 2023.