Monitoring Solar Panel Energy in Pond Wheel Aerator System

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Abstract. Fish cultivation carried out by fish farmers is generally carried out from generation to generation. Ponds which are generally far from residential areas do not allow fish farmers to utilize technology which generally requires an electrical power source. Breeding and rearing fish in ponds is very dependent on oxygen levels in the water. Lack of oxygen can cause fish to be stressed, easily infected by disease, inhibit growth, which can cause death and reduce their productivity. The pond wheel aerator is planned to use energy from 6 x 100 Wp solar panels (3 series, 1 parallel), 24 Volt 200 Ah Lifepo4 battery and 24 Volt 250 W dc motor. The test was carried out for 5 hours using the empirical method where the wheel was not loaded with water. The average total energy produced by solar panels is 921,7143 Watthours with a pond wheel rotation of 150,5143 RPM. The average energy used by the aerator motor is 404.1429 Watthours (discharging) and the remaining average energy received by the battery is 517.5714 Watthours (charging). At night the average energy used by the motor is 431.14 Watthour (discharging). From the average total energy stored by battery of 517.5714 Watthours (charging) during the day it can still be used to turn the pond wheel at night which only requires an average of 431.14 Watthours of energy with a pond wheel rotation of 151.89 RPM. It can be concluded that this pond wheel PLTS system can rotate the pond wheel very well.

Keywords: Aerator, Motor Dynamo, Pond Wheel, Solar Panel

1 Introduction

The title of this research stems from the desire to help traditional pond farmers who are located far from PLN electricity sources, farmers who keep fish in small ponds, and individuals who generally do not use aerators. An aerator is a tool used to carry out aeration that aims to add oxygen to the water (Androva & Harjanto, 2017; Zamzani et al., 2019). By maintaining oxygen levels in the water, pond farming productivity will be better. For large ponds, entrepreneurs generally use electricity from PLN or fuel oil (BBM) to run the aerator (Asy'ari et al., 2014). Meanwhile, farmers who have small land and individuals rarely use aerators. In fact, aerators can increase fish productivity along with improving water quality. The author wants to utilize solar energy to run an aerator. The use of renewable energy is in line with the Bali State Polytechnic Research

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Strategic Plan (RENSTRA) 2021 – 2025. This also supports the government program which is proclaiming green energy. The motor used to move this pond wheel is planned to use a DC motor (DC Gear Brush Motor MY1016 12V 24V 250W High Speed Small Brush Motor MY1025) which is used by electric motorbikes which are being recommended by the government. This is intended to make it easy to get motorbikes and spare parts in the future. From several journals that have been published, there is a lot of research on the use of aerators with PLN electricity, where the installation of pond wheel aerators functions to refresh water or aerate by adding oxygen to the water. Lack of oxygen can cause fish stress, make them easily infected with disease, inhibit growth, which can cause death and reduce their productivity (Ma et al., 2013). From the design and manufacture of a solar-powered water wheel using 2 electric motors with a power of 500 watts each with a voltage of 24 V. The average voltage of the PV panel is 40.57 Volts, the average electric current when operated with a load is 8.87 Amperes with an average shaft rotation speed of 588.48 RPM (Makkulau et al., 2023). In the research "Monitoring Solar Panel Energy in Pond Wheel Aerator Systems", researchers will monitor the energy used by the motor dynamo and the energy charged to the accumulator simultaneously when the solar panels produce electrical energy during the day (Anoi et al., 2020; Gede et al., 2015; Ramadhan et al., 2016; Sapteka, 2018; Sugiarta et al, 2020; Yuliananda et al., 2015). At night, measurements were made of the energy used by the accumulator to rotate the pond wheel.

2 Methodology

The research flow can be seen as shown in Figure 1.

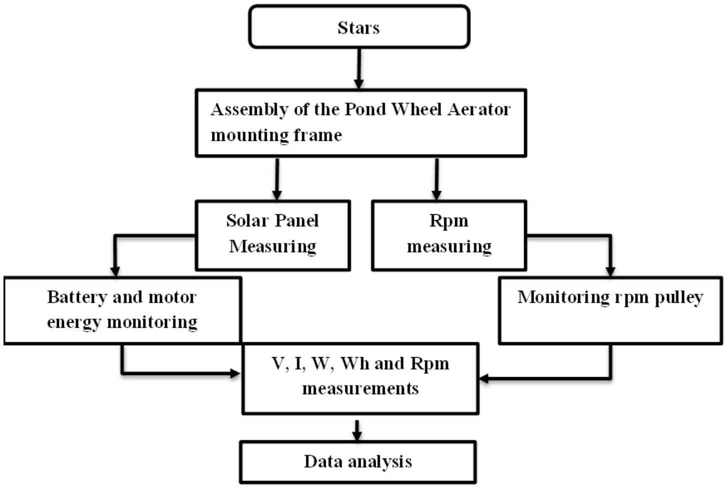
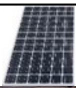
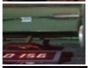
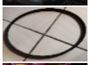
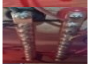
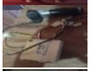


Figure 1. Research flow

The materials and measuring instruments used in this research are as shown in the Table 1.

Table 1. Materials and measuring instruments

Photo tools	Tool's name
	Solar panel 6 x100 Wp (3 series and 1 parallel)
	SCC MPPT EPEVER solar panel (30 A)
	MT50
	Digital LED tachometer RPM speed meter proximity switch sensor NPN
	Battery analyzer digital PZEM-015 shunt 50 A
	Battery LifeFo4 shoto and BMS (100 Ah 12 V) max charging 50 A, max discharge 100A
	Pully and belt pully (D 7.62 cm and AS 0.8 cm)
	Pully D 17.8 cm and AS 2.5 cm
	V-Belt A-700-E
	2 Pinwheel (polypropylene material w/8 leaves L-W-H (25x25x15) cm and weight (2 x 2.1 kg)
	Iron wheel axle (D 25 mm, L 100 cm, Weight 3.9 kg)
	Motor berus DC gear MY1016 12V 24V 250W high speed small brush motor MY1025
	MC4 cable connector, 6 mm solar cell black / red power cable.
	SSR 40 DD input 3-32 V DC and output 5-60 V DC
	LVD XH M609 over discharging protection module
	Busbar 100 A
	Controller 24 v 350 wand handle gas BLDC motor
	Wattmeter and MCB DC 63 A

This planning is needed to design and plan the installation of Pond Wheel Aerator System. The seat frame with L-W-H (100x80x120) cm is designed to use mild steel. The wheel box is designed with dimensions of L-W-H (40x40x25) cm according to the size of the wheel L-W-H (25x25x15) cm. Tool holder frame design can be seen as shown in Figure 2 and Figure 3.

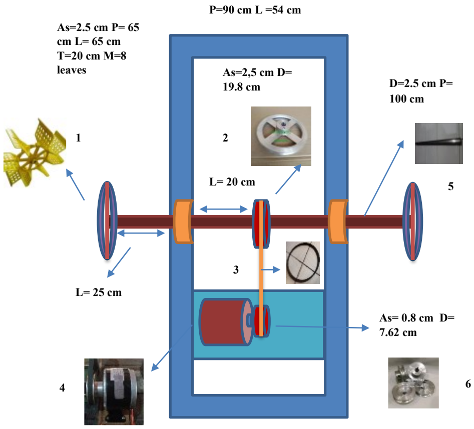


Figure 2. Tool holder frame

Caption:

1. Two pinwheel (polypropylene material w/8 leaves L-W-H (25x25x15) cm and weight (2 x 2.1 kg).
2. Pully D 17.8 cm as 2.5 cm.
3. V-Belt A-700-E MT50.
4. Motor berus DC gear MY1016 24V 250W high speed small brush motor MY1025.
5. Iron wheel axle (D 25 mm, L 100 cm, weight 3.9 kg).
6. Pully and belt pully (D 7.62 cm and AS 0.8 cm).

Figure 3. Wheel holder frame

3 Result and Discussion

3.1 Result

Empirical data measurements and monitoring are carried out day and night. The initial step begins by recording the weather conditions on that date with the condition of the wheel not being loaded with water. The motor rotation settings with the 24 v 350 wand handle gas BLDC motor controller are set to different values each time you carry out measurements and monitoring. Measuring the RPM value of the pond wheel uses a digital LED tachometer RPM speed meter proximity switch sensor NPN. In daytime testing, the energy charging and discharging process occur simultaneously, while in nighttime testing only the energy discharging process occurs. Data collection is carried out continuously, namely during the day the charging and discharging process is carried out simultaneously, while at night the discharging process is carried out. During the day, the process of charging and discharging a Lifepo4 battery by 6x 100 Wp solar panels (3 series and 1 parallel) is carried out for 5 hours of light per day. Meanwhile, at night the battery discharging process by DC aerator motor is carried out for 5 hours. The results of measuring the average RPM and energy of the Lifepo4 battery discharging process by dc aerator motor at night can be seen in Table 2.

Table 2. Measurement of nighttime average discharging energy and RPM

No	Date	Energy total (watt hour) average	RPM average
1	19-May-24	307	140.5
2	20-May-24	270	136.6
3	22-May-24	340	144
4	24-May-24	604	167.5
5	27-May-24	481	157.6
6	1-Jun-24	526	160.3
7	6-Jun-24	490	156.7
	Average	431.1429	151.8857

Results of measuring the average energy of the charging process for a Lifepo4 battery by 6x 100 Wp solar panels (3 series and 1 parallel). Measurements were carried out using a pzem-015 shun 100A battery meter. The process of charging and discharging the battery by dc aerator motor is carried out simultaneously for 5 hours. The results can be seen in Table 3 and Table 4.

Table 3. Measurement of average RPM and discharging energy during the day

No	Date	Weather	Time	Energy total (watt hour) average	RPM average
1	20-May-24	Cloudy	09.00	285	140.8
2	21-May-24	Clouds and sun	09.10	281	136.2
3	23-May-24	Partly cloudy	08.45	367	149.7
4	26-May-24	cloudy and sun	08.40	537	162
5	27-May-24	Mostly cloudy	11.56	500	157.9
6	1-Jun-24	Partly cloudy	08.40	415	153.8
7	6-Jun-24	Partly cloudy	09.35	444	153.2
			Average	404.1429	150.5143

Table 4. Measurement of average RPM and charging energy during the day

No	Date	Weather	Time	Energy total (watt hour) average	RPM average
1	20-May-24	Cloudy	09.00	349	140.8
2	21-May-24	Clouds and sun	09.10	310	136.2
3	23-May-24	Partly cloudy	08.45	390	149.7
4	26-May-24	cloudy and sun	08.40	613	162
5	27-May-24	Mostly cloudy	11.56	590	157.9
6	1-Jun-24	Partly cloudy	08.40	805	153.8
7	6-Jun-24	Partly cloudy	09.35	566	153.2
			Average	517.5714	150.5143

3.2 Discussion

Comparison of the average discharging energy (watthours) used by the aerator motor to rotate the pond wheel (revolutions per minute/ RPM) in 5 hours during the day is 404.1429 Watthours resulting in an average pond wheel rotation of 150.5143 RPM, while the average charging energy for Lifepo4 battery is 517.5714 Watthour. The graph can be seen in Figure 4 below.

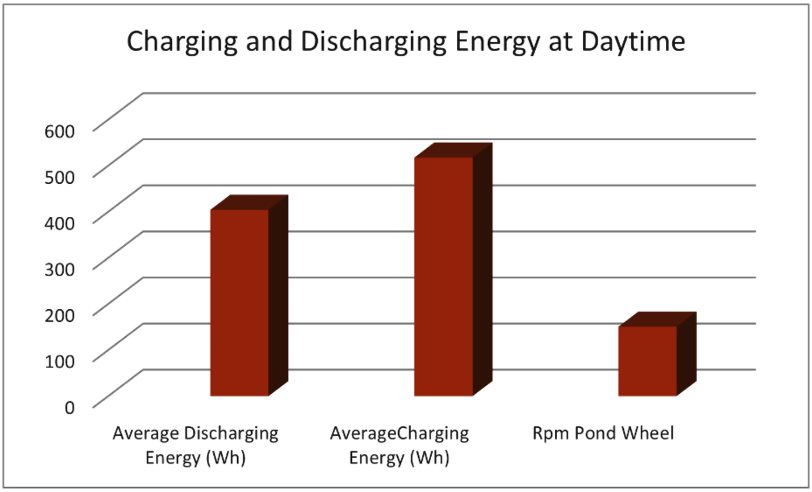


Figure 4. Average RPM, charging and discharging energy of the pond wheel during the day

At night the average energy used in the process of discharging dc aerator motor in 5 hours is 431.14 Watthours, with the resulting pond wheel rotation being 151.89 RPM. The graph can be seen in Figure 5 below.

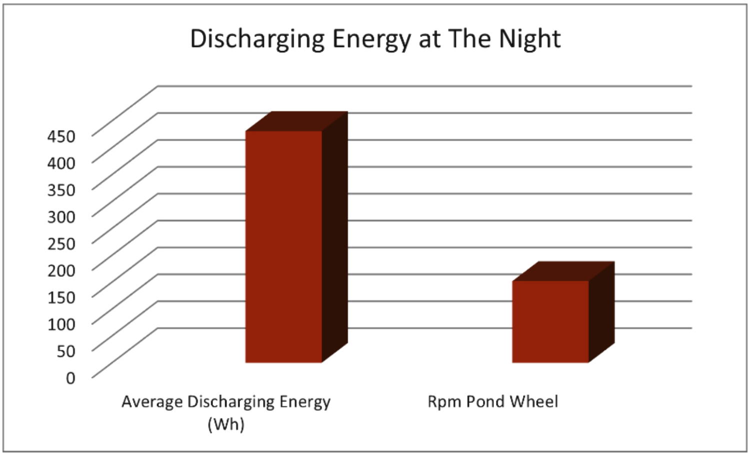


Figure 5. Average RPM and discharging energy of the pond wheel at night

4 Conclusion

In daytime testing, the energy charging and discharging process occurs simultaneously, while in nighttime testing only the energy discharging process occurs. Based on the results of monitoring and data measurements carried out continuously during the day with overcast and cloudy weather conditions, the average total energy produced by 6 x

100 Wp solar panels (3 series, 1 parallel) is 921.7143 Watthours with a pond wheel rotation of 150.5143 RPM. Where the average energy used by dc aerator motor is 404.1429 Watthours (discharging) and the remaining average energy received by Lifepo4 battery is 517.5714 Watthours (charging). At night the average energy used by dc aerator motor is 431.14 Watthour (discharging). From the average total energy stored by Lifepo4 battery of 517.5714 Watthours (charging) during the day it can still be used to turn the pond wheel at night which only requires an average of 431.14 Watthours of energy with a pond wheel rotation of 151.89 RPM. It can be concluded that this pond wheel PLTS system can rotate the pond wheel without being properly loaded with water.

Acknowledgment

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References

Androva, A., & Harjanto, I. (2017). Studi peningkatan kadar dissolved oksigen air, setelah di injeksi dengan aerator kincir angin savonius arreus, menggunakan do meter type lutron DO-5510. *Jurnal Ilmiah Teknosains*, *3*(2). https://doi.org/10.26877/jitek.v3i2.1889

Anoi, Y. H., Yani, A., & W, Y. (2020). Analisis sudut panel solar cell terhadap daya output dan efisiensi yang dihasilkan. *Turbo : Jurnal Program Studi Teknik Mesin*, *8*(2). https://doi.org/10.24127/trb.v8i2.1051

Asy'ari, H., Rozaq, A., & Putra, F. S. (2014). Pemanfaatan solar cell dengan PLN sebagai sumber energi listrik rumah tinggal. *Emitor: Jurnal Teknik Elektro*, *14*(1). https://doi.org/10.23917/emitor.v14i1.12775

Gede, C., Partha, I., Wijaya, W. A., Janardana, G. N., & Budiastra, N. (2015). Pengaruh ketinggian panel surya terhadap daya listrik untuk menekan pemakaian energi listrik. In *Seminar Nasional Sains dan Teknologi (Senastek)*.

Ma, J., Liu, J., & Liang, S. (2013). Study on the changing law of dissolved oxygen and dissolved oxygen saturation in baiyang lake. *Nature Environment and Pollution Technology*, *12*(3).

Makkulau, A., Fikri, M., & Afrianda, R. (2023). The effect of solar panel efficiency due to temperature changes using halogen lamps on polycrystalline type solar modules. *EKSERGI Jurnal Teknik Energi*, *19*(3), 85–90.

Ramadhan, A. I., Diniardi, E., & Mukti, S. H. (2016). Analisis desain sistem pembangkit listrik tenaga surya kapasitas 50 WP. *Teknik*, *37*(2). https://doi.org/10.14710/teknik.v37i2.9011

Sapteka, A. A. N. G. et al. (2018). A Study of heat pipe as thermal management on 30 Wp solar panel. *Atlantis Highlights in Engineering (AHE)*, *International Conference on Science and Technology (ICST).* volume 1.

Sugiarta I N., Suparta, I N. & Teresna, I W. (2020). Comparison of Polycrystalline solar panel energy supply in on-grid PLTS. *6th National Seminar on Applied Innovative Research (Sentrinov)*, Vol. 6 No. 1, E-Issn: 2621-9794, P-ISSN: 2477-2097

Yuliananda, S., Sarya, G., & Hastijanti, R. (2015). Pengaruh perubahan intensitas matahari terhadap daya keluaran panel surya. *Jurnal Pengabdian LPPM Untag Surabaya Nopember*, *01*(02).

Zamzani, M., Bahri, S., & Jufriadi. (2019). Pembuatan cetakan dan produksi sudu aerator kincir dari bahan komposit dengan variasi diameter lubang. *Jurnal Mesin Sains Terapan*, *3*(2).