Vol 8 No 3, September 2024
ABDI DOSEN
Jurnal Pengabdian Pada Masyarakat
pISSN: 2614-6509
eISSN: 2620-5156

INCREASING AGRICULTURAL PRODUCTION USING DC PV PUMP FOR MULYOARJO LAWANG ASSISTED VILLAGE

Aripriharta [1*], Suhiro Wongso Susilo [2], Ilham Faidzin [3], Sujito [4], Mokh. Sholihul Hadi [5], Siti Zubaidah [6], Muhammad Yazid [7]
[1,2,3,4,5,6] Universitas Negeri Malang
Jl. Cakrawala No.5, Sumbersari, Kec. Lowokwaru, Kota Malang, Jawa Timur 65145, Indonesia
[7] Institut Teknologi Sepuluh Nopember
Jl. Teknik Kimia, Keputih, Kec. Sukolilo, Surabaya, Jawa Timur 60111, Indonesia
Email: [*] ariprihata.ft@um.ac.id

Abstract

According to PLN data, electricity demand in Indonesia continues to grow until November 2022, reaching 3,128.8 MVA with 193,058 customers in the Agricultural Electrification (EA) sector. Indonesia has solar energy potential reaching 2,898 GW, but only 0.2 GW has been installed until 2021. In Mulyoarjo Village, Lawang District, our partners hope to utilise solar energy to support agriculture. The partner location has good sunlight potential for solar panel installation. This community service activity aims to apply Photovoltaic-Based Renewable Power technology (TTG DC PV Pump) to increase agricultural productivity in partner villages. The implementation method involves survey, design, installation, field test, and handover. The results showed that the peak of solar illumination occurred at 11.30 am with a voltage of 13.5V and a current of 14.58A on the solar panel. These findings can be the basis for improving agricultural efficiency in Mulyoarjo Village by optimally utilising the available solar energy.
Keywords: Battery, DC Pump, Photovoltaic

INTRODUCTION

Based on data from PLN, the electricity demand in Indonesia continues to increase, with the total power connected to Electrifying Agriculture (EA) customers until November 2022 amounting to 3,128.8 Mega Volt Ampere (MVA) with the number of customers reaching 193,058. This figure grew by 23.02 percent compared to the same period in the previous year (Putra et al., 2022; Syofiadi, 2022).

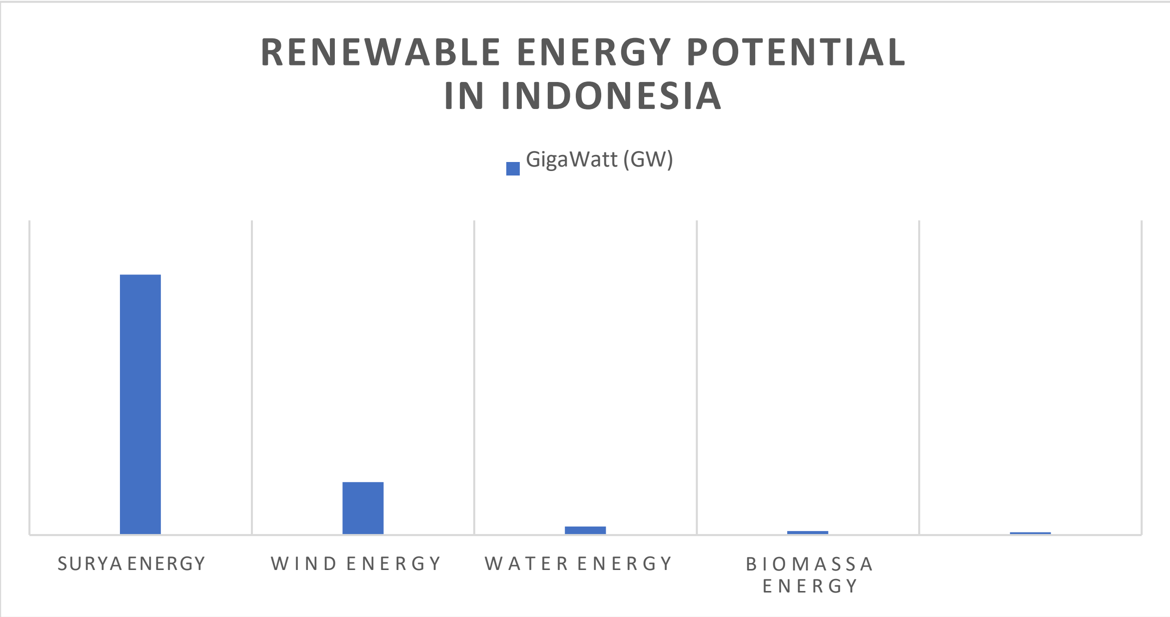

Figure 1. Potential Energy in Indonesia

As we know, Indonesia is a country with abundant energy potential, according to the International Renewable Energy Agency (IRENA). IRENA states that the potential for renewable energy in Indonesia reaches 3,692 gigawatts (GW). However, until 2021, the installed capacity is only 10.5 GW or about 0.3% of the total potential, with a percentage of solar energy of 2,898 gigawatts (GW), installed 0.2, which has the potential to move from fossil energy to independent energy (Hidayat, 2022; Rahman et al., n.d.). Therefore, the agricultural sector's production is expected to be maximised by utilising natural resources in the form of solar power as a power plant as a form of energy independence program (Ariansyah & Sariman, 2021; Rimbawati et al., 2021). It can be seen in Figure 1.

Based on what has been described above, our partners located in Mulyoarjo village, Lawang sub-district, expect a technological innovation that can be used to support electricity needs in the agricultural sector by utilising natural potential in the form of solar power (Bhat et al., n.d.; Fitri Andansari et al., 2022). The survey results show that the partner location is very strategic to get water and sunlight intensity (Figure 2).

Figure 2. Potential Partner Areas

The village government and the community are committed to not converting land to other crops, such as oil palm or rubber, which is very different from other regions that are generally competing to convert land (Nurman et al., 2014; Shao et al., 2009). This commitment becomes an enormous economic force if it is packaged and developed. Developing the tourism industry is inseparable from the availability of facilities and infrastructure (Yunus et al., 2022). One of the facilities that must be available is electrical energy (Mokeddem et al., 2011; Syafrianto et al., 2020).

By carrying out this community service activity, it is hoped that the DC PV Pump TTG can be applied to create productive agriculture (Setiawan et al., 2017). This community service activity positively impacts partners, both from the knowledge, social, and economic aspects that affect the surrounding community (Oliver et al., 2022). Thus, the addimas team can assist institutions in realising the achievement of RENSTRA UM, especially in food through advanced agriculture in the Regency/city.

IMPLEMENTATION METHOD

The implementation survey method was carried out in this service activity, where the procedure is described as follows:

1. Direct survey and interview with partners. The service team surveyed the partner location surveyed the partner location to examine in more detail the potential that exists at the partner location. Direct interviews were conducted to obtain qualitative data and documentation as TTG planning materials.
2. Designed and manufactured the TTG DC PV Pump. With consideration of non-APBN UM funds, the TTG will go through a design and manufacturing process by the partner's agreement.

3. Implementation of TTG is divided into two stages, namely, installation and testing of TTG in the field. Technical data will be generated from this stage for later analysis and publication.
4. Handover. TTG tools will be handed over ceremonially to the partners to use as intended.
5. Completion of reports, SPJ and Documentation. This activity is carried out with the team.

The following is a location map of the intended service partner (Figure 5). The partner location is 23.5 km away, with a travel time of 45 minutes from the State University of Malang.

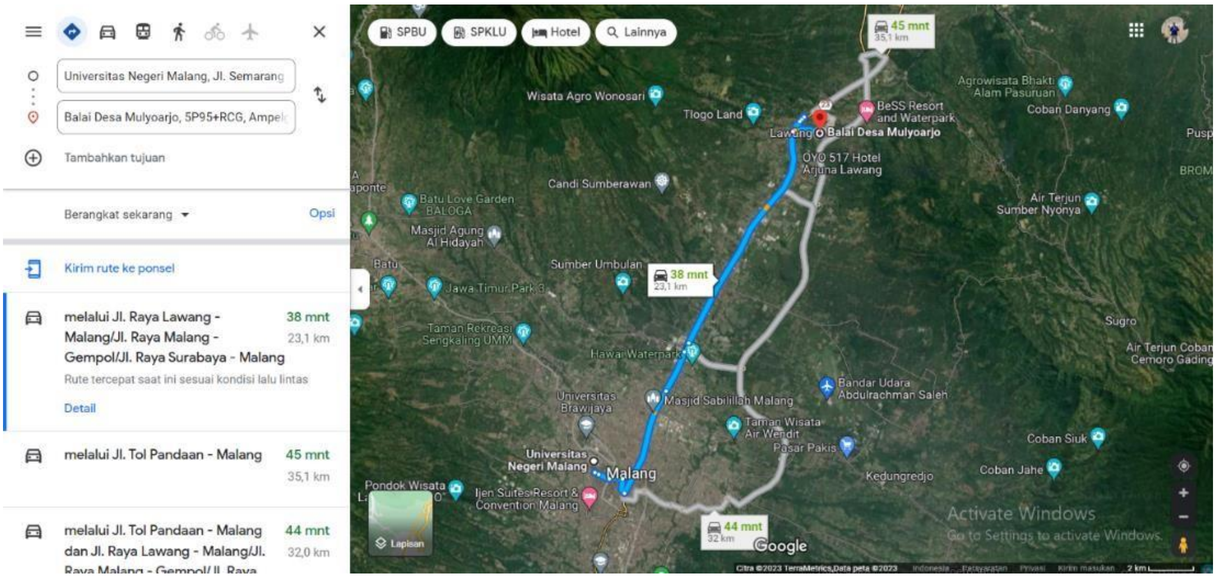

Figure 3. Partner Location Map

The partner location for this service activity is located at Jl. Dorowati Selatan, Paras Hamlet, Mulyoarjo Village, Lawang District, Malang Regency, East Java Postal Code 65216.

RESULTS AND DISCUSSION

Based on the results of the location survey that has been carried out, it was found that the water supply in the village is taken from toll absorption water. The data we get will be used to plan the design and manufacture of the DC PV Pump Products.

1. Manufacturer Products

There are several stages in making the DC PV Pump: TTG design, system installation, frame installation, and finishing.

a. Appropriate Technology Design

We are designing appropriate technology using SketchUp Pro 2022 software. This software is used to create a 3D TTG design. The TTG design results can be seen in Figure 4.

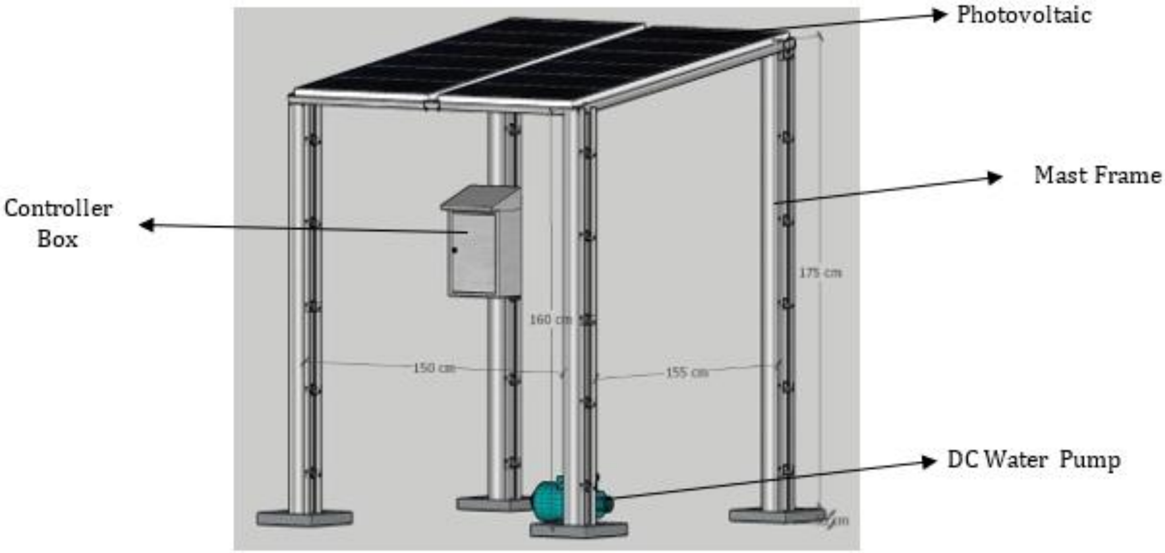

Figure 4. TTG Design Using SketchUp Pro 2022

b. System Installation

The system on this TTG consists of MPPT Solar Charge Control, which is used to keep the PV working point at the MPP point when there is a change in environmental conditions and also regulates the charging power on the battery (Sinaga et al., 2021). The DC MCB is used as a protective component in case of overcurrent in the load and prevents short circuit current (Al Nehru et al., 2021). Batteries with a capacity of 100 Ah are used as energy storage generated by solar panels so that TTG can be used when solar panels cannot provide energy supply. The wiring diagram can be seen in Figure 5, and the system installation process can be seen in Figure 6.

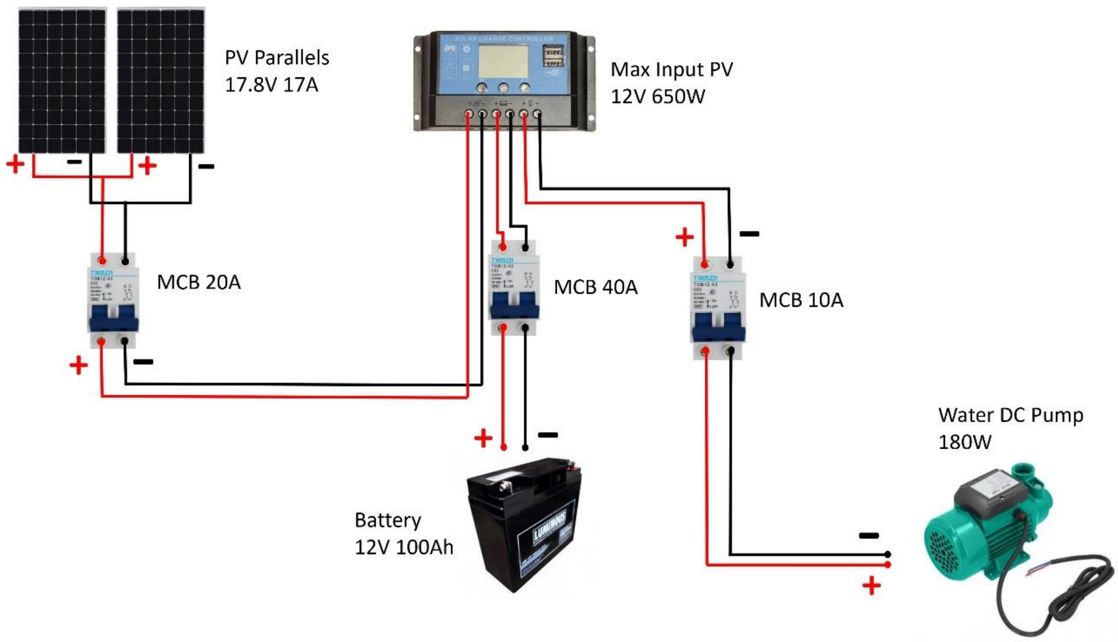

Figure 5. Wiring Diagrams

Figure 6. Panel Box Installation

c. Installation of Mast Frame

The mast frame is made of galvalume, which is double-installed to increase the strength of the support pole. The support poles have two sizes; the first size is 175 cm long with as many as two poles for the support poles at the back, and the second size is 160 cm long with as many as two poles for the support at the front. The process of installing the support poles can be seen in Figure 7.

Figure 7. Installation of Mast Framed

d. Finishing

Finishing is the final stage in tool-making. Finishing is needed to tidy up and beautify the appearance of the TTG. The last appearance of the TTG can be seen in Figure 8.

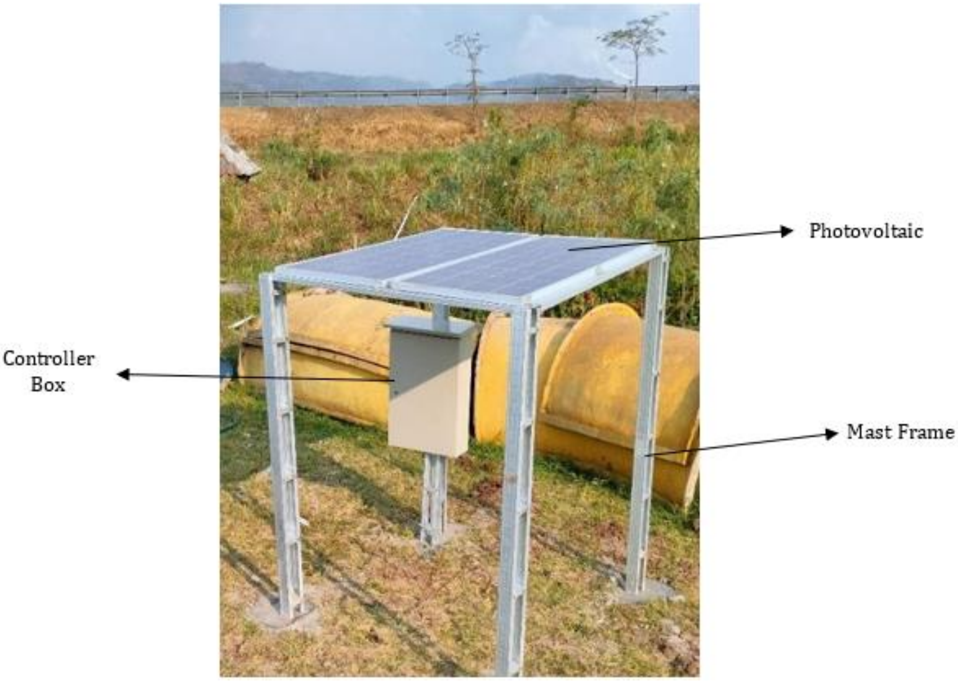

Figure 8. TTG Final Look

2. Running Test

a. Laboratory Testing

Laboratory testing was conducted at the Outdoor Learning Space of the Joint Lecture Building, State University of Malang. The data collection process can be seen in Figure 9. The results of the experimental data can be seen in Table 1.

Table 1. Experimental Data Result

Time	Photovoltaic		Battery		Load		Weather Conditions
	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Voltage (V)	Current (A)	
09.30	12.45	8.43	12.27	5.78	11.7	2.06	Sunny
10.00	12.33	8.21	12.18	5.37	11.54	1.98	Sunny
10.30	12.38	7.42	12.09	4.84	11.45	1.78	Sunny
11.00	12.68	7.38	12.39	4.57	11.86	2.33	Sunny
11.30	12.45	7.56	13.94	4.03	11.92	2.48	Sunny
12.00	12.75	7.23	12.49	4.03	11.95	2.75	Sunny
12.30	13.34	7.14	12.42	4.41	11.79	3.07	Sunny
13.00	13,24	6,73	12,38	4,86	11,6	3,28	Sunny

13.30	13,17	6,46	12,57	4,51	11,84	3,42	Sunny
14.00	13.36	6.17	13.49	5.577	11.70	3.75	Sunny
14.30	12.28	5.85	12.19	3.85	11.51	4.10	Sunny
15.00	12.16	5.43	12.11	4.25	11.42	4.58	Sunny

This experiment was conducted with all sunny weather conditions. As seen in the table, the peak sun hour occurred at 09.30 WIB with a voltage of 12.45V and a current of 8.43A on the solar panel. Meanwhile, the largest power supply from the battery to the pump occurred at 2:00 pm with a voltage of 13.49V and a current of 5.577A.

Figure 9. Day 1 Data Collection

b. Appropriate Technology Testing at Partner Sites

The last testing phase was carried out at the partner location on September 28, 2023. Data collection was carried out from 09.30 to 14.00 with clear weather conditions. The results of the experiment can be seen in Table 2. The data collection process can be seen in Figure 10.

Table 2. Experiment Results at Partner Sites

Time	Photovoltaic		Battery		Load		Weather Conditions
	Voltage (V)	Current (A)	Voltage (V)	Current (A)	Voltage (V)	Current (A)	
09.30	13	13	12,62	3,83	12,24	10,96	Sunny
10.00	13,22	13,36	12,82	4,04	12,45	11,24	Sunny
10.30	13,34	14,2	12,9	4,3	12,58	11,17	Sunny
11.00	13,48	14,3	13,41	4,13	12,70	10,84	Sunny
11.30	13,5	14,58	13,01	4,16	12,64	11,16	Sunny
12.00	13,31	13,5	12,9	4,18	12,58	10,97	Sunny
12.30	13,40	13,58	12,93	4,20	12,61	10,64	Sunny
13.00	13,03	13,55	12,65	4,08	12,34	10,82	Sunny
13.30	12,56	13,08	12,17	3,92	11,90	10,50	Sunny
14.00	12,35	12,32	11,96	3,8	11,23	10,19	Sunny

The experiments conducted at the partner location were carried out in sunny weather conditions. As seen in the table, the peak sun hour occurred at 11:30 am with a voltage of 13.5V and a current of 14.58A on the solar panel. Meanwhile, the largest power supply from the battery on the pump occurs at 14.00 WIB with a voltage of 11.96V and a current of 1.8A. The experimental results at the partner location showed a significant difference in the supply current on the solar panel due to the different number of solar panels installed.

Figure 10. Data Collection at Partner Sites

The installation of TTG proved to be able to help the village community get adequate water supply for the surrounding area. After a series of installation activities were completed, a handover ceremony followed. This event was held officially and ceremonially, taking place at Mulyoarjo Village Hall on October 7, 2023. The event began at 08.30 WIB with an attendance check of participants and organisers. In this event, a symbolic handover of the PV DC Pump was carried out to our partners, namely Mr Rokhim as the Village Head and Mr Alwan as the Head of Mulyoarjo Hamlet. The Handover Procession can be seen in Figure 11.

Figure 11. Handover of TTG

Acknowledgement

This work was supported by PNBP UM 2023 under contract number: 5.4.1269/UN32.20.1/PM/2023

CONCLUSION

- Tools that can utilise solar energy as a source of electrical energy supply to drive a water pump are realised with a PV DC Pump product with the name GALENG using 300 Wp solar panels with MPPT 50A. The name GALENG uses 300 Wp solar panels with MPPT 50A. This product has been tested and can move water from the pond to the filter as far as 4m.
- This product is based on PV off the grid, so it does not burden the cost of electricity bills.
- Reduce electricity costs so that investment can be diverted to increase sources of partners' income.
- Training on the use, maintenance, and repair of PV pumps was conducted on October 7, 2023, at the Mulyoarjo village office. 2023 at the Mulyoarjo village office, and the participants were very enthusiastic.

REFERENCES

Al Nehru, M. J., Alfaresi, B., & Ardianto, F. (2021). Analisa Performansi Photovoltaic 200 WP dan Pompa Air Dc pada Implementasi Sistem Pembangkit Listrik Tenaga Surya (PLTS). Jurnal Ilmiah Universitas Batanghari Jambi, 21(3), 1197. https://doi.org/10.33087/jiubj.v21i3.1637

Ariansyah, M. D., & Sariman, S. (2021). Analisa Performa Pompa Air DC 12V 42 Watt terhadap Variasi Kedalaman Pipa Menggunakan Baterai dengan Sumber Energi dari Matahari. Jurnal Syntax Admiration, 2(6), 1083–1102. https://doi.org/10.46799/jsa.v2i6.251

Bhat, S. R., Pittet, A., & Sonde, B. S. (n.d.). IA-23. In IEEE TRANSACTIONS ON INDUSTRY APPLICATIONS (Issue 6).

Fitri Andansari, T., Afnan Habibi, M., Alfianto, I., Nur Maharani, S., Yazid, M., & Wibawa, A. (2022). INSTALASI PLTS HYBRID UNTUK AKUAPONIK SENGKALING. http://ejournal.uniramalang.ac.id/attamkin/

Hidayat, A. A. N. (2022). PLN Petakan Potensi Program Elektrifikasi di Sektor Pertanian, Hemat hingga 80 Persen - Bisnis Tempo.co. https://bisnis.tempo.co/read/1619945/pln-petakan-potensi-program-elektrifikasi-di-sektor-pertanian-hemat-hingga-80-persen

Mokeddem, A., Midoun, A., Kadri, D., Hiadsi, S., & Raja, I. A. (2011). Performance of a directly-coupled PV water pumping system. Energy Conversion and Management, 52(10), 3089–3095. https://doi.org/10.1016/j.enconman.2011.04.024

Nurman, F. A., Arofat, A. H., Saifullah, A., Sastya, P. D., & Rosyadi, F. (2014). Comparative Analysis of Approaches to Consider Rationale of use of Solar Panel Plants for Power Supply of Off-Grid Consumers.

Oliver, J. S., David, P. W., Balachandran, P. K., & Mihet-Popa, L. (2022). Analysis of Grid-

Interactive PV-Fed BLDC Pump Using Optimized MPPT in DC–DC Converters. Sustainability (Switzerland), 14(12). https://doi.org/10.3390/su14127205

Putra, D. F. U., Wibowo, R. S., Aryani, N. K., Penangsang, O., & Soeprijanto, A. (2022). Implementasi Greenhouse Terintegrasi dengan Pompa Air Berbasis Photovoltaic untuk Menunjang Kebutuhan Pangan Sayur. Sewagati, 7(2), 214–221. https://doi.org/10.12962/j26139960.v7i2.467

Rahman, R., Karim, S., & Elekro, P. T. (n.d.). Analisis Perencanaan Pembangkit Listrik Tenaga Surya Offgrid Untuk Rumah Tinggal di Kota Banjarbaru.

Rimbawati, R., Siregar, Z., Yusri, M., & Al Qamari, M. (2021). PENERAPAN PEMBANGKIT TENAGA SURYA PADA OBJEK WISATA KAMPUNG SAWAH GUNA MENGURANGI BIAYA PEMBELIAN ENERGI LISTRIK. Martabe : Jurnal Pengabdian Kepada Masyarakat, 4(1), 145. https://doi.org/10.31604/jpm.v4i1.145-151

Setiawan, B., Hidayat, G., & Yulian Candra, A. (2017). RANCANG BANGUN DC SUBMERSIBLE PUMP SISTEM PHOTOVOLTAIC BATTERY COUPLED DENGAN PANEL SURYA TIPE POLYCRYSTALLINE SKALA LABORATORIUM.

Shao, H., Tsui, C. Y., & Ki, W. H. (2009). The design of a micro power management system for applications using photovoltaic cells with the maximum output power control. IEEE Transactions on Very Large Scale Integration (VLSI) Systems, 17(8), 1138–1142. https://doi.org/10.1109/TVLSI.2008.2001083

Sinaga, H. H., Permata, D., Soedjarwanto, N., & Purwasih, N. (2021). Pompa Air Tenaga Surya untuk Irigasi Persawahan bagi Masyarakat Desa Karang Rejo, Pesawaran, Lampung. Wikrama Parahita : Jurnal Pengabdian Masyarakat, 5(1), 22–26. https://doi.org/10.30656/jpmwp.v5i1.2633

Syafrianto, D., Banjar-Nahor, K. M., & Hariyanto, N. (2020). Optimized design of renewable energy, firm capacity and stable operation power plant for serving off-grid commercial load in Indonesia. EECCIS 2020 - 2020 10th Electrical Power, Electronics, Communications, Controls, and Informatics Seminar, 21–26. https://doi.org/10.1109/EECCIS49483.2020.9263446

Syofiadi, R. (2022). Listrik Hadir di Sektor Pertanian, 193.058 Petani dan Peternakan Rasakan Manfaatnya - PT PLN (Persero). https://web.pln.co.id/cms/media/siaran-pers/2022/12/listrik-hadir-di-sektor-pertanian-193-058-petani-dan-peternakan-rasakan-manfaatnya/

Yunus, M., Abbas, H., & Sardju, A. P. (2022). Journal of Science and Engineering PERENCANAAN PLTS OFF GRID DI DESA TOLONUO SELATAN KECAMATAN TOBELO UTARA KABUPATEN HALMAHERA UTARA.