Journal Renewable Energy & Mechanics (REM)
DOI: 10.25299/rem.2026.26224
Received 2025-05-05; Revised: 2025-09-15; Accepted 2025-09-31

Vol. 09 No.01 2026
E-ISSN: 2614-8315
P-ISSN: 2714-621X

Performance Analysis of 160WP Solar Panels as an Energy Source for 125 Watt Irrigation Pumps

Ojak Abdul Rozak*, Hendrawan Prasetyo, Edy Sumarno, Joko Tri Susilo

Program Studi Teknik Elektro, Fakultas Teknik, Universitas Pamulang
*Corresponding author: dosen01314@unpam.ac.id

ABSTRACT

Solar energy has significant potential as a renewable energy source in Indonesia, especially in areas with prolonged dry seasons. Long, dry seasons that lead to crop failure are among the causes of declining agricultural yields, so appropriate technological solutions are needed to support irrigation systems on difficult agricultural land during the dry season. A water supply is essential, but this system requires an independent electrical power source. The application of Solar Power Plants (PLTS) as a power source for 125W irrigation pumps is an alternative solution. This research aims to design and test a 160 Wp solar power plant system as an energy source. The system consists of solar panels, a solar charge controller (SCC), a 12V 100Ah LiFePO4 battery and an inverter. Tests are carried out to measure the intensity of sunlight, voltage, and current, and to calculate the system's output power and the solar panel's efficiency. The test results showed that the system produced an average solar irradiation of 636,72 W/m², a 13,88V voltage, and a 3.78A current. Meanwhile, the system output power is 51.50 W, resulting in an efficiency of 21,07%. Thus, the solar PV system can charge batteries up to 13,16V; this renewable energy source has been proven efficient for a 125W irrigation pump.

Keywords:Irrigation systems; renewable energy; solar panels; efficiency; irrigation pumps

1. INTRODUCTION

Indonesia, as an agrarian country, has a farming-based livelihood for most of its population (Putranto, 2023). Rich in natural resources, especially in the agricultural sector, it plays an important role in the national economy, and as one of the largest rice-consuming countries in the world (Febriaty, 2016).

Currently, Indonesia is experiencing food security anomalies (Putra & Rahmani, 2025). It is indicated by a 15-year increase in Indonesia's rice imports, from 15.39 million tons in 2005 to 2.75 million tons in 2011, the highest volume. According to the Central Statistics Agency (BPS), Indonesia's rice imports in 2021 will reach 407,741.4 tons, up from 356,286.2 tons in 2020 (Ilmiah & Pertanian, 2023).

The long dry season is the main cause of crop failure. This crop failure has led to a decline in agricultural yields (Minahasa, 2024). These conditions require appropriate technological solutions for irrigation systems on difficult agricultural land during the dry season (Steven Witman, 2021).

Oil-fueled water pumps are considered ineffective. Meanwhile, solar energy has great potential as an alternative source (Gunawan, 2025). Therefore, an alternative solution is needed: a water pump powered by renewable energy. This water pump can increase farmers' productivity (Atthoriq et al., 2022).

One solution to this problem is the Solar Power Plant (PLTS) system. This type of energy includes renewable, environmentally friendly, and non-polluting energy (Syafii et al., 2020). Strengthened by Indonesia's position on the equator, it has great potential to produce electrical energy from sunlight (Fuadiyah & Sudarti, 2022). With the application of appropriate technology that works based on photovoltaic processes to produce energy (Aswar et al., 2022).

The purpose of installing solar power plants is to provide an environmentally friendly electricity supply for agricultural land irrigation pumps that previously used fossil fuels; these now use the main electricity supply sourced from solar PV. Solar panel testing to determine the efficiency of a 160Wp solar panel as an energy source for a 125W irrigation pump.

The method used to create a solar PV system consists of a solar panel, a solar charge controller (SCC), a 12V 100Ah LiFePO4 battery and an inverter. The test method measures the intensity of sunlight, voltage, and current, and calculates the system's output power and the solar panel's efficiency.

2. MATERIALS AND METHOD

2.1 Material

The materials needed for the manufacture of solar power plants are shown in Table 1.

Table 1. Solar PV component requirements

Material	Specification
Solar Panel	160Wp
SCC	10A
Battery	100Ah
Inverter	500W

The type of monocrystalline solar panels used in solar PV systems for agricultural land irrigation pumps is shown in Figure 1.

Figure 1. Monocrystalline solar panels.

The solar panel data used is model ST-Solar Q160W(32), maximum power 160Wp, maximum power voltage 18.24V, maximum power current 8.77A, open circuit voltage 21.80V, short circuit current 9.30A, nominal operating cell temp (NOCT) 47, ± 2°C maximum system voltage 1000V, maximum series fuse 15A, dimension 1040*770*30mm, weight 8.3 Kg.

The solar charger controller to be used in the solar power plant system as an energy source for agricultural land irrigation pumps is shown in Figure 2.

Figure 2. Solar charger controller.

The data solar charger controller used has a PWM-rated voltage of 12V, a rated current of 10A, and a max. PV voltage 50V, max. PV input power (12V) 260W.

The type of battery used in the solar power plant system as an energy source for agricultural land irrigation pumps can be seen in Figure 3.


Figure 3. Battery.

The battery data used is a LifePo4 12V model, battery ampere-hour 100Ah, battery voltage 12V, battery charging & discharging cycles 2000, dimensions 196*131*170 mm.

The type of inverter used in the solar PV system supplying energy to agricultural land irrigation pumps is shown in Figure 4.

Figure 4. Inverter.

The inverter data used is the pure sine wave model 500W, output frequency 50/60Hz, input voltage 12V, low voltage range ±10.5V, high voltage range 15V, overhead range 60°C ± 10°C, dimension 185*105*60 mm.

2.2 Method

Testing of the solar power plant system is performed using testing tools specific to the measured quantity, as shown in Table 2.

Table 2. Solar PV Measuring Equipment

Paramemeter	Measuring Instruments
Solar Radiation	Lux Meter
Temperature Photovoltaic	Thermometer
Voltage	Avometer
Current	Amper Meter

3. RESULTS AND DISCUSSION

The total load power requirement of 375W is the 125W power divided by 100% of the load power capacity, plus 40% of the energy lost. The capacity of the 156.2Wp solar panel is 625W, divided by 4 hours of optimal illumination time. The total battery power requirement of 394W is the total power of 375W divided by 100%

of the load power capacity and 5% of the energy lost (Priska Restu Utami et al., 2022).

System Creation

The design of the solar power plant system, including solar panels, SCC, batteries, inverters, and water pumps as system loads, is shown in Figure 5.

Figure 5. The results of the construction of solar PV.

In this system, the solar panel cannot directly operate the load. The energy generated by the solar panels is first stored in the battery and then converted from DC to AC using an inverter, used to operate the load through the output *port* of the inverter

System Testing

All tests were carried out in an open field area in West Cilandak, South Jakarta, from 09:00 AM–05:00 PM for five consecutive days. The panel's angle of inclination is about 15°, with the ambient temperature ranging from 30–34°C. All measurements were carried out using portable digital measuring instruments, with due consideration of the measurement results.

Measurements of sunlight intensity are taken to determine how much sunlight the solar panels receive. Testing the intensity of sunlight using a lux meter, the measurement results are converted into watts per square meter (W/m^2). The process of measuring the intensity of sunlight is shown in Figure 6.

Figure 6. The process of measuring the intensity of sunlight.

The sunlight intensity measurements were conducted in stages over 5 days; the collected data are shown in Figure 7.

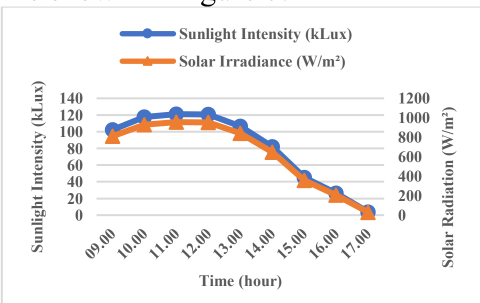

Figure 7. Graph of the conversion of light intensity to solar radiation.

The conversion of sunlight intensity to solar radiation intensity showed the same trend across all tests, with an average of 636,72 W/m².

The solar panel output voltage is measured at the solar charge controller (SCC) to determine the voltage before it is delivered to the battery. In general, the purpose of voltage measurement after SCC is to ensure a stable, safe, and optimal charging process. The measurement of the incoming voltage at the solar charge controller using a digital Avometer is shown in Figure 8.

Figure 8. Voltage measurement process.

The SCC voltage measurements were carried out in stages over 5 days; the collected data are shown in Figure 9.

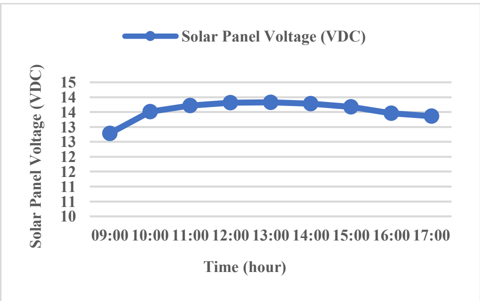

Figure 9. Voltage measurement graph.

The lowest SCC voltage measurement results were 12.79V at 09:00, and the highest was 13.83V at 13:00 with an average of 13.88V at solar radiation 636,72W/m^2. This condition can be declared good because it is ready for battery charging.

The current generated by the solar panel is measured by the solar charger controller (SCC) to determine the current used during battery charging. Overall, the purpose of the current measurement after SCC is to ensure that the battery charging process takes place safely, stably, and in accordance with the specifications of the solar PV system. The process of measuring current on a solar charge controller using digital amperemeter pliers is shown in Figure 10.

Figure 10. Current measurement process.

The results of the SCC current measurement, carried out in stages over 5 days, are shown in Figure 11.

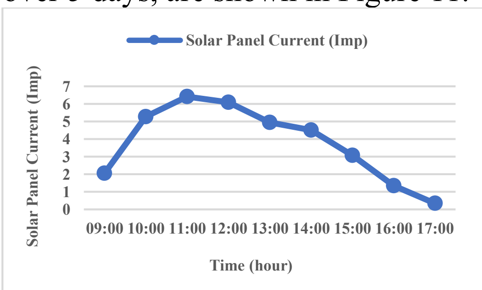

Figure 11. Current measurement graph.

Based on the current measurement, the solar panel produces an average of 3.78A and shows the same trend as the voltage measurement results. The current value is the result of the battery charging process.

Based on the SCC voltage and current measurements, the solar panel power output can be calculated. The results of solar panel power production are shown in Figure 12.

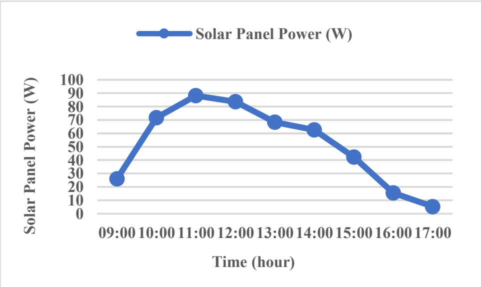

Figure 12. Power production graph.

The average solar panel power output of 51.50W can be corroborated by the battery voltage required for the irrigation pump's energy supply. With a total solar PV power of 141W, it can supply 125W of pump operation for 3 hours. The efficiency of solar panels, based on power output, is 21.07%.

The battery voltage generated during the test from the charging process is shown in Figure 13.

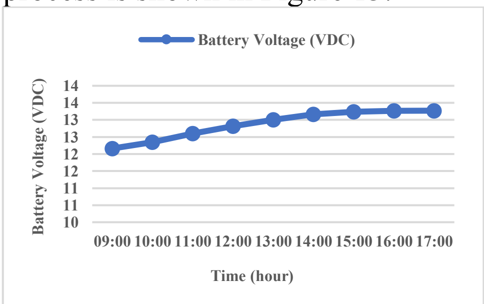

Figure 13. Battery voltage measurement chart.

Based on Figure 13, it can be concluded that the solar power plant system can charge batteries during periods of high solar intensity, as indicated by the trend in the battery charger results, which increase during charging. Thus, the battery is ready for use as an energy source for an irrigation pump.

4. CONCLUSION

The intensity of solar radiation follows the same trend as the other test processes, with an average of 636.72 W/m². The voltage and current measurements generated by the solar panels averaged 13.88V and 3.78A. The average solar panel power production is 51.50W. The efficiency of solar panels, based on power output, is 21.07%. Thus, the battery is ready for use as an energy source for an irrigation pump.

REFERENCES

Aswar, M. B. A., Mahmuddin, F., & Lestari, A. D. (2022). Perancangan Automatic Transfer Switch (ATS) Pembangkit Listrik Hybrid Panel Surya dan Generator untuk Bagan Apung. *Jurnal Penelitian Enjiniring*, *25*(2), 141–148. https://doi.org/10.25042/jpe.112021.09

Atthoriq, A. M., Sumarjo, J., & Anjani, R. D. (2022). Perancangan Sistem Pompa Air Tenaga Surya Terhadap Produktivitas Pertanian Padi (Sawah). *Jurnal Ilmiah Wahana Pendidikan Https://Jurnal.Unibrah.Ac.Id/Index.Php/JIWP*, *8*(3), 178–183.

https://doi.org/10.5281/zenodo.6420819

Febriaty, H. (2016). Analisis Perkembangan Impor Beras Di Indonesia. *EKONOMIKAWAN: Jurnal Ilmu Ekonomi Dan Studi Pembangunan*, *16*(2), 134–141. https://doi.org/10.30596/ekonomikawan.v16i2.941

Fuadiyah, T., & Sudarti, S. (2022). Potensi Pemanfaatan Sel Surya untuk Mendukung Energi di Bidang Pertanian. *Jurnal Teknologi Pertanian Gorontalo (JTPG)*, *7*(2), 75–79. https://doi.org/10.30869/jtpg.v7i2.960

Gunawan, I. N. (2025). *Perancangan Pembangkit Listrik Tenaga Surya 160 WP untuk Pompa Air Submersible*. *5*(1), 731–738.

Ilmiah, J., & Pertanian, M. (2023). *Jurnal Ilmiah Mahasiswa Pertanian, Volume 8, Nomor 3, Agustus 2023 136*. *8*, 136–151.

Minahasa, K. (2024). *3 1,2,3*. *24*(7), 28–42.

Priska Restu Utami, Widyastuti, & Marliza. (2022). Analisa Perhitungan Pembangkit Listrik Tenaga Surya Untuk Taman Markisa Di Wilayah Rt 01/ Rw 08 Kelurahan Mampang, Pancoran Mas, Kota Depok. *Jurnal Abdi Masyarakat Multidisiplin*, *1*(2), 42–49. https://doi.org/10.56127/jammu.v1i2.198

Putra, A. R., & Rahmani, Z. (2025). *Membangun Indeks Ketahanan Pangan Berkelanjutan di Provinsi Kepulauan Bangka Belitung*. *5*(6), 1395–1402.

Putranto, A. H. (2023). *Pjeb: Perwira Journal of Economy & Business Analisis Impor Beras Di Indonesia*. *03*, 90–96.

Steven Witman. (2021). Penerapan Metode Irigasi Tetes Guna Mendukung Efisiensi Penggunaan Air di Lahan Kering. *Jurnal Triton*, *12*(1), 20–28. https://doi.org/10.47687/jt.v12i1.152

Syafii, S., Mayura, Y., & Muhardika, M. (2020). Strategi Pembebanan PLTS Off Grid untuk Peningkatan Kontinuitas Suplai Energi Listrik. In *Jurnal Rekayasa Elektrika* (Vol. 15, Issue 3). https://doi.org/10.17529/jre.v15i3.14793

Aswar, M. B. A., Mahmuddin, F., & Lestari, A. D. (2022). Perancangan Automatic Transfer Switch (ATS) Pembangkit Listrik Hybrid Panel Surya dan Generator untuk Bagan Apung. *Jurnal Penelitian Enjiniring*, *25*(2), 141–148. https://doi.org/10.25042/jpe.112021.09

Atthoriq, A. M., Sumarjo, J., & Anjani, R. D. (2022). Perancangan System Pompa Air Tenaga Surya Terhadap Produktivitas Pertanian Padi (Sawah). *Jurnal Ilmiah Wahana Pendidikan Https://Jurnal.Unibrah.Ac.Id/Index.Php/JIWP*, *8*(3), 178–183. https://doi.org/10.5281/zenodo.6420819

Febriaty, H. (2016). Analisis Perkembangan Impor Beras Di

Indonesia. *EKONOMIKAWAN: Jurnal Ilmu Ekonomi Dan Studi Pembangunan*, *16*(2), 134–141. https://doi.org/10.30596/ekonomikawan.v16i2.941

Fuadiyah, T., & Sudarti, S. (2022). Potensi Pemanfaatan Sel Surya untuk Mendukung Energi di Bidang Pertanian. *Jurnal Teknologi Pertanian Gorontalo (JTPG)*, *7*(2), 75–79. https://doi.org/10.30869/jtpg.v7i2.960

Gunawan, I. N. (2025). *Perancangan Pembangkit Listrik Tenaga Surya 160 WP untuk Pompa Air Submersible*. *5*(1), 731–738.

Ilmiah, J., & Pertanian, M. (2023). *Jurnal Ilmiah Mahasiswa Pertanian, Volume 8, Nomor 3, Agustus 2023 136*. *8*, 136–151.

Minahasa, K. (2024). *3 1,2,3*. *24*(7), 28–42.

Priska Restu Utami, Widyastuti, & Marliza. (2022). Analisa Perhitungan Pembangkit Listrik Tenaga Surya Untuk Taman Markisa Di Wilayah Rt 01/ Rw 08 Kelurahan Mampang, Pancoran Mas, Kota Depok. *Jurnal Abdi Masyarakat Multidisiplin*, *1*(2), 42–49. https://doi.org/10.56127/jammu.v1i2.198

Putra, A. R., & Rahmani, Z. (2025). *Membangun Indeks Ketahanan Pangan Berkelanjutan di Provinsi Kepulauan Bangka Belitung*. *5*(6), 1395–1402.

Putranto, A. H. (2023). *Pjeb: Perwira Journal of Economy & Business Analisis Impor Beras Di Indonesia*. *03*, 90–96.

Steven Witman. (2021). Penerapan Metode Irigasi Tetes Guna Mendukung Efisiensi Penggunaan Air di Lahan Kering. *Jurnal Triton*, *12*(1), 20–28. https://doi.org/10.47687/jt.v12i1.152

Syafii, S., Mayura, Y., & Muhardika, M. (2020). Strategi Pembebanan PLTS Off Grid untuk Peningkatan Kontinuitas Suplai Energi Listrik. In *Jurnal Rekayasa Elektrika* (Vol. 15, Issue 3). https://doi.org/10.17529/jre.v15i3.14793