

Design and performance evaluation of a 200 Wp portable solar power system for coastal activities

Endri Andrian, Ojak Abdul Rozak*, Lili Solihin, Dwi Anie Gunastuti

Program Studi Teknik Elektro, Fakultas Teknik, Universitas Pamulang

*Corresponding author: dosen01314@unpam.ac.id

ABSTRACT

The need for electrical energy during coastal activities is increasing alongside the use of portable electronic devices; however, limited access to conventional power grids remains a major challenge. This limited access to conventional power grids remains a major challenge. Therefore, this study aims to design and analyse the performance of renewable energy in the form of portable solar power plants (PLTS) as an alternative source to support coastal activities. The designed system consists of a solar panel with a total capacity of 200 Wp, which can produce 160 W, a lithium battery with a capacity of 12 V 60 Ah, and an inverter as a DC-to-AC converter. The experimental methods used include the design stage, device assembly, and performance testing and analysis. Data collection was conducted at Ancol Beach over a 10-hour test period. The results show that a portable solar power plant can produce electrical energy with a load of 64W, which can produce solar radiation of an average of 560 W/m², with energy produced at 160 Watts and a voltage at maximum power (V_{mp}) = 18.80 V, enough to meet the need to charge electronic devices during activities on the beach for 10 hours. Thus, the designed portable solar power plant can be used as a practical, environmentally friendly, and suitable electrical energy supply solution for coastal areas.

Keyword: coastal areas; portable electronic devices; PLTS; sunlight intensity; environmentally friendly

INTRODUCTION

Coasts are areas that must be protected for their natural beauty by maintaining the pattern of the coastline (Saputro et al., 2025). Currently, many people are managing coastal areas by creating tourist attractions on the coast or building in the middle of the sea (Rieder et al., 2025).

When we travel to the coastal area, we often find tourists who have difficulty getting electricity to just meet the needs of mobile phone charging (Sinaga, 2025).

Thus, the best solution is needed to overcome the problem, and based on the condition of the coastal environment that always gets sunlight (Pongoh et al., 2023). The electricity source derived from solar panels is the best alternative solution to meet the needs of electrical energy in the coastal area (Nugroho et al., 2024).

One of the limitations of solar panels is that they do not depend on conventional electricity, relying on the sun to be able to source electricity (Gunawan et al., 2021).

The use of portable solar panels as a small power plant that can

convert solar energy into electrical energy, then store it in batteries. This allows it to use stored energy to meet the electrical needs of various electronic devices (Jackery, 2023).

Previous research has shown that solar power plants can produce voltage and current from solar panels. However, the flexibility still needs to be improved because it is still in the form of a fixed installation and is not yet a portable type of system (Putra, 2025).

Thus, research on the application of portable solar power plants on the coast is very important as a form of exploration of lightweight, easy-to-use, and efficient energy solutions (Terpadu, 2017).

It is hoped that the development of solar panels specifically designed for users can provide many benefits in supporting activities on the beach that are safer and more environmentally friendly (Fauzi et al., 2024).

MATERIALS AND METHOD

Material

In conducting this research, several stages are carried out so that they can be completed immediately. Figure 1 shows the stages in detail.

The following are some of the components, materials, and equipment needed to conduct the research.

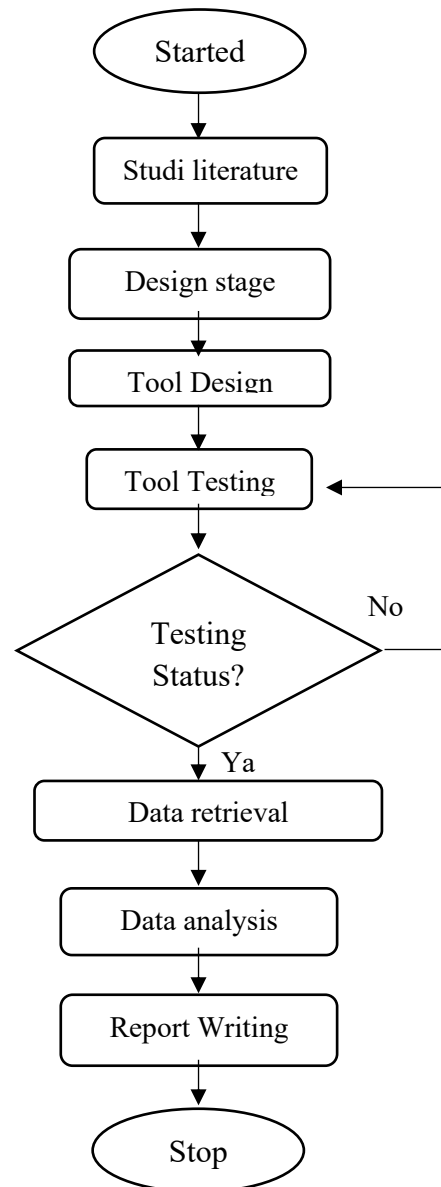


Figure 1. Research Stages.

Table 1. Tools and Materials

No	Components	Specification	Qty
1	Solar Panels	Thin Film Solar 50 wp MPPT 20	4 Un
2	Charge Controller	A 12V USB QC3.0	1 Un
3	Sel LiFePO4	12 Volt 60 Ah	1 Un

4	Inverter	Pure SineWave 300W 12 volts	1 Un
5	LED DC	9 Watt	1 Un
6	Cabel MC4 + DC	MC4 Male-Female Cable 2-4mm ²	1 Set
7	Box	Toll Box	1 Un
8	Voltmeter Digital	12V Digital Panel	1 Un

In coastal areas of Indonesia, solar panels can receive peak sunlight for about 5 hours per day. However, the electrical energy in the battery is not 100% usable, and broadcasting is effective for 5 hours/per day; the battery efficiency is 80%, so it can calculate the capacity of the solar panel used (Fauzi et al., 2024).

$$E = V \times Ah \quad (1)$$

$$E = 12 \times 60 = 720Wh$$

$$E_{Available} = 720 Wh \times 80^\circ = 576 Wh$$

$$E_{Kebutuhan} = \frac{720}{0.8} = 900 Wh$$

$$P = \frac{E}{t \text{ matahari}} \quad (2)$$

$$P = \frac{900}{5} = 180 Wp$$

Because there are no 180 Wp panels, you can use 100 Wp panels for a total of 200 Wp. Specifications that will be used for solar panels:



Figure 2. Solar panels.

Table 2. Specification of solar panel.

Specifications	Value
Model	MS50M-36
Tolerance	50W
Volt at Pmax (Vmp)	18.80V
Current at Pmax (Imp)	2.66A
Open Circuit Voltage (Voc)	22.90V
Short Circuit Current (Isc)	2.88A
Normal Operating Cell Temp (NOCT)	47±2°C
Maximum System Voltage	1500v DC
Maximum Series Fuse Rating	10A
Operating Temperature	-40+85°C
Demension	610x580x35 mm

To determine the charging current needed, namely the Solar Charge Controller (SCC), for safety, we give a margin of about 25-30% of the current, so it can be used as follows:

$$P_{batt} = \frac{P_{panel}}{V_{batt}} \quad (3)$$

$$P_{batt} = \frac{200 W}{12 V} = 16.6A$$

SCC to use is $16.6A \times 1.25 = 20.75 A$. So, what we use is 20.75 A, but it is rounded to 20 A.



Figure 3. Solar charge controller.

Table 3. Specification of solar charge controller (SCC)

Specifications	Value
Normal Voltage	12V/24V
Nominal Current	20 A
Maximum PV	50 V
Output Voltage	12 V

In addition to solar panels, this tool also requires battery components to store electrical energy. The battery's electrical energy is not 100% usable. Broadcasting is effective for 5 hours/per day, and the battery efficiency is 80% (576 Wh). The battery that we will use has a large capacity, so to find out how fast it will fill up with 200 Wp, the calculation is:

$$J (Wh) = V \times Ah \quad (4)$$

If you use a 12 V 60 Ah battery capacity, then:

$$12V \times 60Ah \quad (5)$$

Available Energy

$$720 Wh \times 80\% = 576 Wh \quad (6)$$

To find out the calculation of how long the battery will charge with a load of 60 Watts, the calculation is as follows:

Effective Power = $200 Wp \times 80\% = 160 \text{ Watts}$

$$Ah = \frac{720 Wh}{160 W} = 4,5 \text{ Jam} \quad (7)$$

For the connected use of solar panels
 $4 Hp \times 15 W = 60 W \quad (8)$

$$A_{\text{Battery}} = \frac{60 W}{0.8} = 75 W \quad (9)$$

Solar panel connected charging duration

$$\frac{576 Wh}{75 W} = 8.16 \text{ Jam} \quad (10)$$

For use without solar panels

I also added the load of the 9 W DC lamp because night needs are very suitable if there are activities at night.

Duration without solar panels

$$\frac{576 Wh}{79,6W} = 7.24 \text{ Jam} \quad (11)$$

For an effective power of 160 watts and a charging time of 4.5 hours, with a load size of 75 watts, and a charging time when there is a load of 8.16 hours.



Figure 4. Lithium Battery 12V 60Ah.

Table 4. Lithium Battery 12V 60A

Specifications	Value
Battery Type	Baterai Lithium
Rechargeable	Li-Ion
Battery Type	
Battery Capacity	60 Ah
Voltage	12 Volt

You need not only batteries, but also inverter components that convert DC current to AC current, so you can determine the inverter's capacity

needs. Then you can do the following calculations:

The load is a 4 HP phone charger with a charging power of 1 HP 15 watts. The mobile phone charging power is 60 W, so the inverter power is 75 W. The inverter will be used at 100 watts for power security, with an additional 25% margin (1.25). Specification of the Inverter to be used:



Figure 5. Inverter.

Table 5. Inverter specification.

Specifications	Value
Inlet Voltage	12 Volt
Outlet Voltage	220 Volt
Output Frequency	50Hz
Maximum Conversion Efficiency	90%

Method

Testing of solar power generation systems is carried out using test equipment specific to the quantities being measured, as shown in this method, which is in line with research conducted on the PLTS system in the coastal area of Ancol Beach, which uses the design, installation, and performance testing stages directly to obtain data on voltage, power, and duration of energy supply (Dallaev et al., 2023). In addition, experimental

and direct measurement approaches are also used in research on renewable energy systems in coastal areas, which combine field test data with system performance analysis to determine the efficiency of the energy produced (Di et al., 2025). Measuring parameters such as solar radiation intensity and coastal environmental conditions is also important because these factors greatly affect the performance of solar power plants, as shown in comparative research on energy performance in coastal areas using direct measurement methods for solar radiation and environmental conditions (System et al., 2024).

Table 6. Testing measuring tools.

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

RESULT AND DISCUSSION

The assembly of 200 Wp solar panels as a Portable Solar Power Plant has shown excellent performance after a series of comprehensive experiments on all components, providing convenient phone charging without the need for PLN electrical wiring.

System Creation



Figure 6. The results of the construction of the solar PV system.

This main component consists of a Solar Panel, SCC (Solar Charge Controller), Battery, Inverter, and socket. The SCC (Solar Charge Controller) regulates the supply and disconnects the electricity from the solar panel when the battery is full, allowing the battery to store current from the solar panel and the inverter to convert DC to AC. The inverter converts DC to AC and provides an outlet to distribute electricity.

System Testing

This test must be carried out to determine whether the installation complies with the plan. In this measurement, several measurements will be carried out, namely testing the intensity of sunlight, and also testing temperature, current, and voltage.

We carried out solar radiation intensity testing from 09.00 to 18.00 at a solar radiation intensity of 560 W/m².



Figure 7. Sunlight intensity testing.

Sunlight intensity was measured in stages over 1 month, as shown in Figure 8.

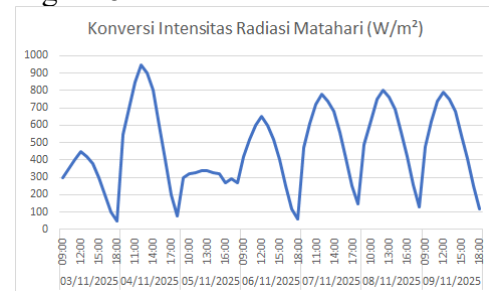


Figure 8. Graph of light and radiation intensity.

Converting sunlight intensity to solar radiation intensity showed that all tests averaged 560 W/m². The output voltage of a solar panel is measured during solar charging.

For temperature measurement, the aim is to ensure operational efficiency and also to extend the service life of the solar panel system by using a thermometer. This tool measures the system temperature, as shown in Figure 8.



Figure 8. Temperature measurement

The temperature measurements were carried out in stages over 1 month, as shown in the graph in Figure 9.

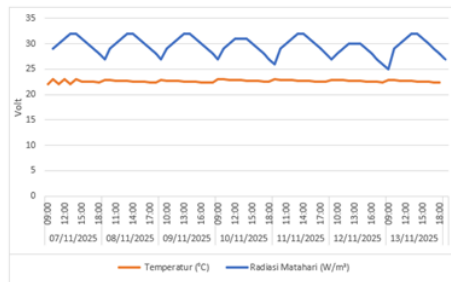


Figure 9. Graphic temperature

Over the measurement period, the average solar panel temperature was 30 °C.

For the no-load solar panel battery charging test, it is important to determine whether the solar panel battery charging matches the design based on measurements taken over a month. To determine this, see the graph in Figure 10.

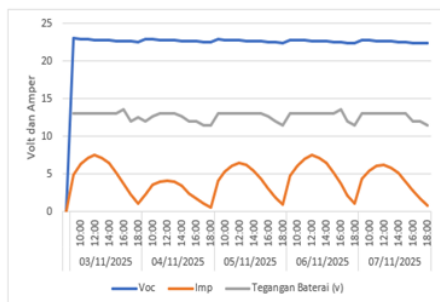


Figure 10. Load-free solar panel battery charging test.

Load-free solar panel battery charging tests show 1-month measurements, with an average highest peak VOC of 22.95 volts and a lowest of 22.5 volts.

Measuring solar panel battery charging with a load is also important to determine whether it is in accordance.



Figure 11. Charging a solar panel battery using a load.

The design was not met during the 1-month measurement period, as shown in the graph in Figure 11.

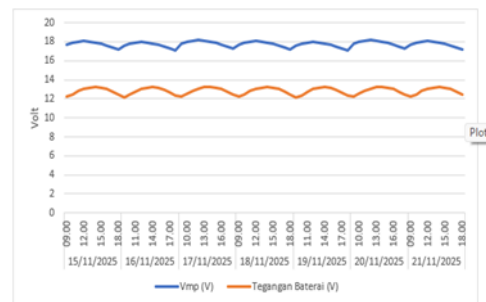


Figure 11. Charging solar panel battery using load.

Testing solar panel battery charging with a load provides 1 month of measurements that meet the specification requiring an average Vmp of at least 15 V.

The 1-month results show that the highest peak Vmp was 18.1 V, produced at the highest point in sunlight, and the lowest was 17 V, produced at low sunlight. Table 7 shows the solar panel battery tested with a load for 1 day without solar panel assistance.

Table 7. Testing the battery using a load.

Time	Used Energy (Wh)	Energy Residue (Wh)	Battery (%)
09.00	60	651	90
10.00	138	582	81
11.00	207	513	71
12.00	276	444	62
13.00	345	375	52
14.00	414	306	43
15.00	483	237	33
16.00	552	168	23
17.00	621	99	14
18.00	690	30	4

CONCLUSION

The research results show that a 200 Wp portable solar PV system can generate an effective power of approximately 160 W, assuming a system efficiency of 80%. Charging a 12 V 60 Ah battery is estimated at about 4.5 hours under optimal solar intensity, while the system can supply about 64 W to charge electronic devices for about 10 hours.

These results align with research by Gunawan et al. (2021), which shows that portable solar PV systems are effective as independent energy sources for low-power electronic devices. Similarly, Fauzi et al. (2024) indicate that a portable solar PV system with a capacity of

approximately 200 Wp can meet electricity needs in locations off the PLN grid, operating for several hours depending on battery capacity and lighting conditions.

Furthermore, research by Dallaev et al. (2023) explains that flexible solar panel performance is influenced by solar radiation intensity and ambient temperature. This aligns with this study's results, which found that solar panel output increases when solar radiation intensity reaches its highest value, resulting in faster battery charging.

Overall, the results confirm that a 200 Wp solar panel combined with a 12 V 60 Ah battery is an adequate configuration for portable solar power plants (PLTS) in coastal areas. The system is capable of providing sufficient electrical energy for charging electronic devices while maintaining efficiency and ease of mobility, achieving comparable performance to previous studies

REFERENCES

- Dallaev, R., Pisarenko, T., & Papež, N. (2023). *Overview of the Current State of Flexible Solar Panels and Photovoltaic Materials*.
- Di, P., Pesisir, K., Tondano, D., Nursalam, M. Z., Ramchie, A. A. S., Aror, V. F., & Kimbal, A. A. (2025). *Optimalisasi Pada Sistem Pembangkit Listrik Hybrid*. 04(02), 21–32.
- Fauzi, M. W., Ariansyah, M. L., & Wahyuni, E. S. (2024). *Pembuatan Portabel Energi Berbasis Panel Surya Sebagai Sumber Energi Listrik Alternatif Saat Darurat Bencana untuk*

- Bandan Penanggulangan Bencana Daerah Yogyakarta (BPBD DIY).* 5(1), 43–57. <https://doi.org/10.20885/jattec.vol5.iss1.art6>
- Gunawan, L. A., Agung, A. I., Widyartono, M., & Haryudo, S. I. (2021). Rancang bangun Pembangkit Listrik Tenaga Surya portable. *Jurnal Teknik Elektro*, 10(1), 65–71.
- Jackery. (2023). *Cara Memilih Pengisi Daya Surya Portabel Untuk Hiking*. Jackery Global. https://www.jackery.com/blogs/buying-advice/portable-solar-charger-for-hiking?srsId=AfmBOoorW3LZpPEK_fGSMf-N0AZLask3fgdBxvuv2KQEMHZzIYy8-kF0
- Nugroho, B. A., Setyawan, F. X. A., & Yudamson, A. (2024). *Perancangan Pembangkit Listrik Tenaga Surya Dengan Sudut Panel Optimal Sebagai Sumber Energi Listrik Pada Area Keramba Jaring Apung Padang Cermin*. 14(1), 1–8.
- Pongoh, J., Langie, M., Tuwongkesong, S., Pasek, W., Tampemawa, J., & Manado, P. N. (2023). *Central publisher*. 1, 289–294.
- Putra, A. E. (2025). *Literature Review : Study on the Utilization of Solar Power Plants (PLTS) as an Effort to Increase Electricity Access in Rural and Remote Areas*. 5(1), 31–44.
- Rieder, D., Louis, J., & Elmenreich, W. (2025). *Life cycle assessment of portable charging technologies — a case study of a solar charger and a power bank*. 906–927. <https://doi.org/10.1007/s11367-025-02453-8>
- Saputro, C. J., Wenno, L. A., Doringin, F. J., Sundah, J., Elektro, J. T., Manado, P. N., & Malalayang, P. (2025). *Pembangkit Listrik Tenaga Surya Sebagai Sumber Energi Pada Rakit Rumah Apung Di Kawasan Pesisir Pantai Malalayang Kota Manado*. 04(02), 40–48.
- Sinaga, S. H. (2025). *Perbandingan kinerja pembangkit listrik tenaga angin dan tenaga surya di kawasan pesisir 1,2. 5*, 63–71.
- System, A., Lama, R. K., & Jeong, H. (2024). *Design and Performance Analysis of Foldable Solar Panel for*.
- Terpadu, J. T. (2017). *Received : Accepted: Published : 2(April), 1–4*.
- Warjoto, R. E., Canti, M., & Hartanti, A. T. (2018). Metode komposting Takakura untuk pengolahan sampah organik rumah tangga di Cisauk, Tangerang. *Jurnal Perkotaan*, 10(2), 76–78.
- Yunus, M. (2011). Teknologi pembuatan asap cair dari tempurung kelapa sebagai pengawet makanan. *Jurnal Sains dan Inovasi*, 7(1), 53–61.