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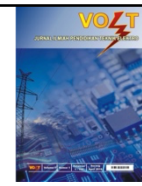

Developing a 6-kilowatt-peak off-grid solar power station (PLTS) at the Az-Zawiyah Foundation in Tanjung Batu, Ogan Ilir, South Sumatra

Imas Ning Zhafarina[1]*

[1]Department of Electrical Engineering, Politeknik Negeri Sriwijaya, Palembang 30128, Indonesia

*Corresponding author: imas.ning.zhafarina@polsri.ac.id

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Abstract

The main problem encountered by the Az-Zawiyah Foundation in Tanjung Batu, Ogan Ilir, South Sumatra is the restricted availability of energy, impeding the foundation's day-to-day operations and educational endeavors. Off-Grid Solar Power Station are installed as a self-sufficient electricity source, eliminating the need for reliance on the PLN power grid. This alternative method helps save costs and supports teaching and learning activities at the foundation. The planning for the building of the Off-Grid Solar Power Station will utilize a capacity of 6 kilowatts peak (kWp). The research technique employed encompasses site assessments, energy demand analysis, and technical and economic calculations in the strategic development of Off-Grid Solar Power Plants. Data was obtained via firsthand observation, interviews with foundation administrators, and measurements of environmental conditions, such as the intensity of sunlight. Technical calculations encompass the estimation of daily energy production, the design of solar PV systems, the selection of crucial components such as solar panels, inverters, and batteries, as well as cost analysis. The calculation results demonstrate that the system has the capacity to produce sufficient energy to meet the electricity requirements of the foundation. Additionally, it has the potential to achieve long-term cost savings and make a beneficial environmental impact by reducing carbon emissions. This planning model is anticipated to be created and serve as a benchmark for foundations or similar institutions in distant regions, with the aim of enhancing energy accessibility and promoting sustainable development for local residents

Keywords: off-grid; solar power station; solar panel; renewable energy

INTRODUCTION

Energy is an essential and fundamental requirement in contemporary life for humans. Due to the expanding global population and economic expansion, there is a growing need for energy. Nevertheless, traditional energy sources like fossil fuels are diminishing and exerting a detrimental influence on the environment. In order to address this issue, it is necessary to find an alternate solution that is both ecologically benign and sustainable. An encouraging approach involves the utilization of sustainable energy sources, such as Photovoltaic Solar Power Plants (Johansson et al., 2012).

A solar power plant is a technological system that harnesses solar energy to produce electrical power. Solar energy is a plentiful and virtually limitless form of renewable energy. Solar panels enable the direct conversion of sunlight into electricity through photovoltaic effects. This technology has had significant advancements in the past few decades and is becoming more efficient and cost-effective (Edenhofer et al., 2011).

The Az-Zawiyah Tanjung Batu Foundation in Ogan Ilir, South Sumatra faces a challenge due to the lack of sufficient access to conventional electrical energy sources. This obstacle hampers the foundation's daily operations and the progress of its many activities and programs. The lack of a sufficient power grid in the area necessitates alternative solutions that can deliver a reliable, efficient, and eco-friendly electricity provision (Byrne et al., 2012).

One of the difficulties in the establishment of solar power plants is the reliance on weather conditions and sunshine intensity, which can impact the consistency of the energy provision (Ghazi & Ip, 2014). Moreover, the significant upfront expenses continue to pose a challenge for numerous developing nations. Nevertheless, as technology advances and the cost of producing solar panels decreases, there is optimism that solar photovoltaic (PV) systems can emerge as the primary answer for generating clean and sustainable energy in the future (Painuly, 2001).

To address the growing need for electricity and promote the adoption of sustainable renewable energy, it is worth considering the implementation of Off-Grid Solar Power Plants (PLTS). This is particularly relevant in remote regions that lack access to traditional power grids. The Az-Zawiyah Tanjung Batu Foundation in Ogan Ilir, South Sumatra requires an autonomous and enduring energy solution. The Off-Grid Solar Power Plant, with a capacity of 6 kWp, is designed to fulfill the foundation's daily electricity requirements, including lighting, operation of electronic equipment, and other necessities. This planning encompasses a wide range of technical and non-technical factors, including the assessment of energy demand, analysis of solar energy potential, system design, economic calculations, and permit administration. This study aims to offer a thorough analysis of the necessary measures to implement Off-Grid Solar Power as a viable and productive energy solution for the Az-Zawiyah Foundation. Additionally, it seeks to contribute positively to environmental sustainability and the well-being of local communities (Barkhouse et al., 2015).

Solar energy has emerged as a highly promising form of renewable energy in the 21st century. The International Energy Agency (IEA) states that solar energy has immense potential and is capable of satisfying global energy need multiple times over. The use of photovoltaic (PV) technology for converting sunlight into electricity has experienced significant and rapid growth in the past few decades. This technology is characterized by its environmental friendliness, as it does not generate any greenhouse gas emissions. Furthermore, it has become more efficient and cost-effective due to advancements in solar panel production materials and technology (Canton, 2021).

Off-Grid Solar Power offers benefits in terms of achieving energy self-sufficiency, minimizing operational expenses, and delivering electricity to isolated areas. Off-Grid systems typically incorporate batteries to store the energy produced during daylight hours, enabling its utilization at nighttime or periods of cloudy weather. Empirical evidence from several nations demonstrates that Off-Grid Solar Power has effectively enhanced power accessibility in isolated regions and facilitated local economic growth (Khatib et al., 2013).

The design and planning of solar photovoltaic (PV) systems necessitates meticulous deliberation of multiple elements, including energy demands, solar radiation intensity, and local environmental circumstances. Conducting an assessment of energy needs is a crucial initial stage in estimating the necessary capacity of a system. Local meteorological data or solar radiation maps can provide information on the intensity of solar radiation at the project site. Moreover, it is crucial to customize the choice of system components, such as solar panels, inverters, and batteries, according to the individual technological requirements in order to achieve the best possible performance of the system (Duffie et al., 2020).

The consideration of economic considerations is a crucial component in the planning of solar photovoltaic (PV) systems. Although the initial investment cost of solar PV remains relatively high in comparison to conventional energy sources, the declining price of solar panels and advancements in technological efficiency have enhanced the competitiveness of solar PV. An economic viability assessment must be carried out to evaluate the cost-effectiveness of the project, which includes estimating the long-term savings in electricity costs and potential revenue from selling electricity to the grid. A crucial examination is to ascertain if the project is not only technically viable but also cost-effective, considering the original expenses, operational and maintenance costs, and the impact of interest rates on the installation cost of solar PV (Branker et al., 2011).

A comprehensive knowledge of the fundamental elements comprising the Off-Grid Solar PV technology is essential for its implementation. Solar panels are a crucial element that converts solar energy into electrical energy. Solar cell technology has made significant advancements in efficiency through the utilization of materials such as monocrystalline silicon, polycrystalline silicon, and thin films. Every material has its own set of benefits and drawbacks that influence the choice of materials based on the requirements and environmental circumstances at the project location. Silicon-based solar cells are widely utilized and continually improving in efficiency due to extensive research and development efforts. Monocrystalline silicon solar cells have achieved an efficiency of over 26%, however polycrystalline solar cells provide a favorable trade-off between cost and efficiency. Perovskite and tandem solar cells are emerging technologies that have the capacity to enhance efficiency, as demonstrated by García Vera et al., (2021).

Aside from solar panels, inverters are crucial components that serve to transform the direct current (DC) produced by solar panels into alternating current (AC) that can be utilized by household electrical equipment. The efficiency of the inverter is crucial for the overall performance of the solar PV system. Contemporary inverters have been furnished with advanced technology that enables them to function at their best in various working settings, including safeguarding against power surges and other electrical disruptions (Sløk, 2016).

Energy storage systems, typically in the form of batteries, are an essential element in Off-Grid solar systems. Batteries serve the purpose of storing the energy produced by solar panels during daylight hours, enabling its utilization during nighttime or periods of overcast weather. Parida et al. (2011) conducted research indicating that while choosing battery types, such as lead-acid batteries, lithium-ion batteries, or flow batteries, it is important to take into account aspects such as capacity, efficiency, service life, and cost. The field of battery technology is in a state of continuous evolution, with ongoing advances focused on enhancing energy density and reducing costs. Parida et al. conducted a study where they examined different photovoltaic technologies. They concluded that the Off-Grid Solar PV system is highly efficient for remote areas that lack access to traditional power grids. They recommended implementing an Off-Grid Solar Power Plant at the Az-Zawiyah Foundation (Parida et al., 2011).

The development of Off-Grid Solar Power Plants in rural places has a substantial impact in the social and economic context. According to a study conducted by Byrne et al. in 2014, the implementation of Off-Grid Solar Power Plants enhances the community's quality of life by ensuring reliable power supply and also stimulates local economic growth. An investigation into the notion of a solar city and a technique for evaluating the viability of solar power on rooftops. Solar photovoltaic (PV) systems possess significant capacity to diminish electricity expenses and enhance environmental sustainability. Electricity enhances the efficiency of economic activities such as education, health, and small companies. The findings of these studies indicate that the effectiveness of the Off-Grid Solar Power Plant project relies significantly on the active involvement of the community and the backing of the government and associated organizations (Byrne et al., 2015).

When planning for off-grid solar systems, it is important to take into account the environmental consequences and explore methods to reduce emissions, all while ensuring that the system remains reliable in order to achieve optimal energy efficiency and minimize investment expenses. An ideal integration of battery-based energy storage and backup generators is employed to provide uninterrupted electricity supply (Givler & Lilienthal, 2005). When comparing various configurations of renewable energy systems for off-grid applications in rural areas, it is found that a solar PV system with a sufficiently large capacity can generate enough energy to meet daily needs, even in unpredictable weather conditions like those experienced in the Az-Zawiyah Foundation with varying weather patterns (Buonomano et al., 2018).

The goal of this work is the practical implementation of a substantial contribution towards resolving the issue of restricted electrical accessibility at the Az-Zawiyah Foundation in Tanjung Batu and its vicinity. By conducting a thorough examination and effectively executing the project, the Off-Grid Solar Power Plant has the potential to serve as a sustainable solution, offering enduring advantages to the community in Ogan Ilir, South Sumatra. Furthermore, this study aims to offer practical insights and recommendations for establishing a replicable model in other regions with comparable circumstances. The model will focus on enhancing the efficiency and sustainability of Off-Grid Solar PV systems, benefiting parties involved in their development and implementation.

METHOD

This work employs a descriptive and experimental methodology for constructing an Off-Grid Solar Power Plant (PLTS) with a 6 kWp capacity at the Az-Zawiyah Foundation Tanjung Batu, Ogan Ilir, South Sumatra. Primary data is obtained by directly measuring and simulating using software. Statistical analysis is conducted by comparing performance data to established worldwide benchmarks. The administration and staff of the Az-Zawiyah nonprofit organizations participated in interviews regarding electricity usage data at the foundation. Figure 1 shows the design of a 6 kWp Off-Grid Solar Power Plant (PLTS) system, designed to generate electricity autonomously without being dependent on the primary power grid. The Off-Grid Solar PV system was designed using the AutoCAD tool, with dimensions of 600 cm × 600 cm.

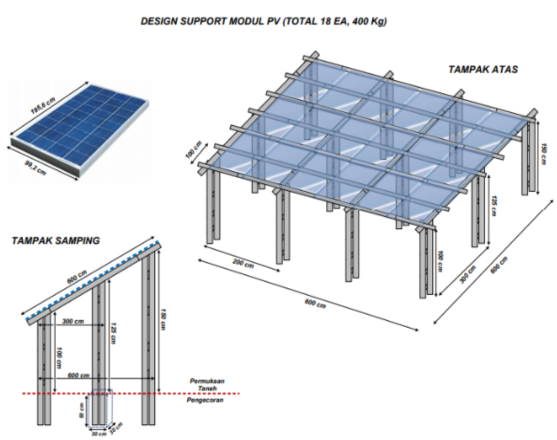

Figure 1. Design of Off-Grid Solar Power Plant System with a Capacity of 6 kWp

In order to construct an Off-Grid Solar Power Plant (PLTS) system, the following materials and equipment are required: 72 polycrystalline solar panels, each with a capacity of 320 Wp; 1 inverter unit with a capacity of 6 kW; 4 lithium-ion batteries with a combined capacity of 400 AH; a solar charge controller for managing battery charging; DC cables, air conditioners, connectors, and other installation equipment; as well as a pyranometer for measuring solar radiation and a multimeter for monitoring electrical parameters.

The parameters measured include daily energy needs to determine daily energy consumption data utilized by the Foundation, daily and yearly average solar radiation data at the location to assess solar energy potential, evaluation of the efficiency of solar panels, inverters, and batteries, and an initial cost analysis encompassing various aspects of the system's components and installations.

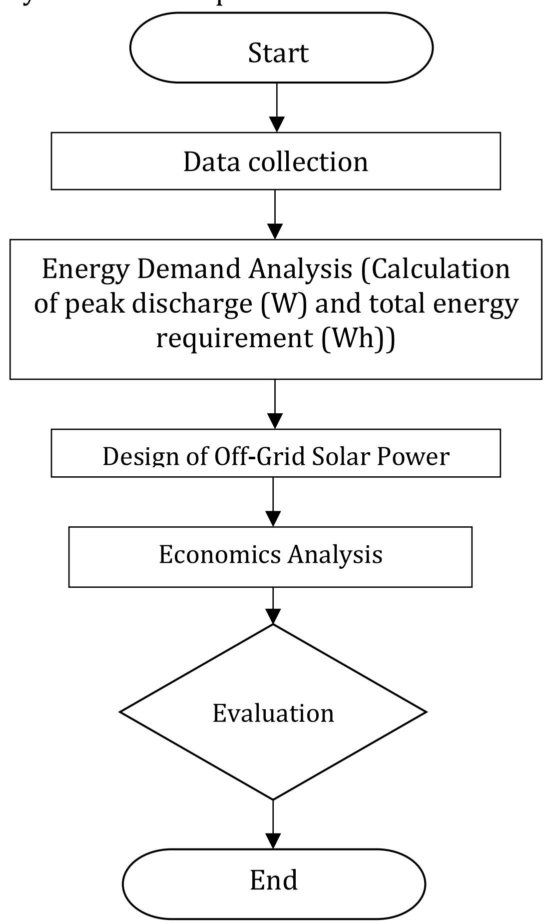

Figure 2. Flow chart of planning for the construction of Off-Grid Solar Power Plants

The stages of each solar PV development planning process must be represented in this flowchart, which delineates a systematic and structured methodology for the construction of Off-Grid Solar PV. This process encompasses data collection, energy needs analysis, system design, economic analysis, and final evaluation to guarantee the success of the planning. Each stage of the design is executed to ensure that the resulting solar PV system can meet the energy requirements of the foundation in an economical and efficient manner.

Interviews with foundation administrators and direct surveys were implemented to accumulate data. The data collected encompasses the operating hours of the apparatus, the type of electrical equipment used, and the daily energy consumption. Furthermore, it acquires data on solar radiation intensity, meteorological conditions, and topography from reputable sources, including the Meteorology, Climatology, and Geophysics Agency (BMKG) and pertinent scientific literature.

The total daily energy requirement (Wh) and peak demand (W) are determined through the energy needs analysis. This energy demand analysis is beneficial for calculating the value of the foundation's daily operational expenses, which include lighting, electronic equipment, and other requirements. It also aids in the calculation of the number of batteries required, the number of PV arrays, the controller capacity (SCC/BCR), and the inverter capacity. In the interim, the solar energy potential at the project site is assessed by utilizing solar radiation intensity data. The Global Solar Atlas website was employed to perform this calculation. The potential electrical energy generated by photovoltaic solar panels in a single day is 3,613 kWh/kWp, as determined by the location of the panels.

The process of system design involves the selection of components to ascertain the specifications and varieties of components that will be employed. This includes the selection of solar panels, inverters, batteries, and other supporting devices. The components are chosen in accordance with the environmental conditions and energy requirements. The architecture of the solar PV system, which encompasses the location of the solar panel installation, the configuration of the electrical circuit, and the energy storage system, is being designed.

In the interim, the economic analysis was conducted by examining the operational costs associated with the cost of materials, equipment, installation, and delivery services to determine the estimated price of the Off-Grid Solar Power Plant system installation. The evaluation is conducted to guarantee that the system design is in compliance with the energy requirements and economic analysis. The planning process may proceed if the evaluation results indicate that the system is eligible. The planning process is deemed complete upon the completion of all of the aforementioned stages and the evaluation of the system's feasibility.

RESULT AND DISCUSSION

This study demonstrates the viability and efficacy of implementing a 6 kWp off-grid solar power plant at the Az-Zawiyah Tanjung Batu Foundation in Ogan Ilir, South Sumatra. This solution effectively addresses the energy requirements of the foundation. This is evident from the outcomes of precise daily load predictions and an ideal system design, which demonstrate that this system can function efficiently and inexpensively. The daily load calculation of the Off-Grid Solar Power Plant serves to ascertain the required system size and energy storage capacity to ensure the system can adequately fulfill daily electricity requirements (Da Rosa & Ordonez, 2021). Table 1 shows the estimated calculation of daily electricity load at the Az-Zawiyah Foundation.

Table 1. Estimated calculation of daily electricity load at the Az-Zawiyah Foundation

Facility	Sum	Power load (W)	Total power (W)
Junior High School Classroom			
Indoor lighting	3	5	15
Outdoor lighting	1	5	5
Electric socket	2	60	120
Vocational High School Classroom			
Indoor lighting	3	5	15
Outdoor lighting	1	5	5
Electric socket	2	60	120
Teacher Room and Administration			
Indoor lighting	22	5	110
Electric socket	17	60	1020
Air Conditioner 1 PK	1	600	600
Foundation Office and Warehouse			
Indoor lighting	7	5	35
Outdoor lighting	3	5	15
Electric socket	8	60	480
Air Conditioner 1 PK	1	600	600
Total	**71**		**3.140**

The Az-Zawiyah Foundation's estimate of the daily load estimation yielded an energy consumption of 22.270 Watts/Day, assuming an average usage of around 7 hours each day. The determination of the quantity of batteries in an Off-Grid Solar Power Plant is contingent upon various aspects, such as the daily energy consumption, backup energy requirements, and the battery capacity that is accessible. The entire necessary battery capacity can be determined by multiplying the daily energy usage by the number of days of reserve. The calculation of the number of batteries required depends on the individual capacity of the batteries available in the market and the ability to connect them in parallel or series to get the desired capacity. This desired capacity is determined by dividing the total battery capacity by the battery's efficiency. The formula utilized for computing the quantity of batteries is as follows (Masters, 2013):

$$N = \frac{E_{daily} \times \ Number\ of\ days\ without\ sun}{V \times DOD \times \eta} \quad (1)$$

N : Number of batteries needed
Edaily : Daily energy needed (Wh)
V : Battery system voltage
DOD : *Depth of Discharge* baterai (%)
η : Battery efficiency (%)

A study conducted by Ma, Yang, Lu, and Chen (2014) demonstrates that including optimization algorithms in the design of solar photovoltaic (PV) systems can enhance efficiency and decrease the need for batteries. The study employs a mathematical methodology to enhance the arrangement of solar photovoltaic (PV) systems in rural regions of China. By implementing ideal configurations, it is possible to decrease the number of batteries needed by as much as 20% while maintaining system performance at its highest level. This demonstrates that the utilization of optimization technologies can have a substantial impact on the design of a solar photovoltaic (PV) system, making it more efficient and cost-effective (Yang et al., 2009). According to a study conducted by Akinyele, Belikov, and Levron (2017), economic analysis plays a crucial role in the planning of off-grid solar PV systems. This study demonstrates that the optimal number of batteries may be determined by taking into account technical factors as well as economic factors such as upfront expenditures, ongoing expenses, and interest rates (Akinyele et al., 2018). Prior studies highlight the significance of optimizing and doing economic analysis while planning solar photovoltaic (PV) systems. Both of these methods can enhance system efficiency and decrease the quantity of batteries needed. Implementing these strategies in future planning can yield substantial advantages in terms of energy efficiency and cost-effectiveness.

The determination of the quantity of photovoltaic (PV) solar panels that can be deployed in an Off-Grid solar power facility is contingent upon the daily energy consumption of each individual device that will be linked to the system. Once the daily energy consumption is determined, the subsequent task involves computing the overall energy output generated by a solitary solar panel within a 24-hour period. This calculation hinges on both the efficiency of the solar panel and the quantity of solar radiation received at the specific geographical location. Next, by dividing the overall daily energy usage by the energy generated by a single solar panel, one may determine the number of solar panels needed. Furthermore, it is crucial to take into account the total efficiency of the system, including the efficiency of the inverter and battery, when determining if the intended number of solar panels is adequate to satisfy daily energy requirements (Messenger & Abtahi, 2018).

Peak Sun hour (PSH) = 5 hours
PR (Performance Ratio)/FF(Fill Factor) from PV = 0.8
DF (Dissipation Factor) PV work = 0.8
Pm PV= 370
Required PV output energy = 22,270
Maximum PV voltage at STC (Vmpp=17,8V) = 15.13 V
Total energy output 1 Ea PV/day = 1535.5 WH
Total energy output 1 Ea PV/day at operational temperature = 1228.4 WH
Actual array PV capacity required = 5366.265 Watt Peak
Minimum PV = 18 Ea
Solar Power Plant Capacity = 6707.831 WP

The calculation of controller capacity, also known as Nominal Current Rating (NCR), in Off-Grid Solar Power is essential for accurately sizing the controller required to regulate the energy flow from the solar panel to the battery. It also controls the charging and discharging of the battery to maintain the appropriate balance and prolong the battery's lifespan. In order to determine the capacity of the SCC, the initial step involves calculating the maximum current output of the solar panels (Hankins, 2010):

$$I_{max} = \frac{P_{PV}}{V_{PV}} \qquad (2)$$

I_{max} = Maximum current generated by solar panels (A)
P_{PV} = Total power from solar panels (W)
V_{PV} = Nominal voltage of solar panel (V)

Setelah menghitung arus maksimum dari panel surya, perlu memperhitungkan faktor keamanan. Rumus untuk menghitung kapasitas SCC:

$$I_{SCC} = I_{max}\ x\ Safety\ factor \qquad (3)$$

I_{SCC} = SCC current capacity (A)
Safety factor = 1.5 (W)

Dari rumus (3) didapatkan perhitungan:
Isc PV (Short Ciruit current) = 3.17 A
Isc array PV = 86.205 A
PV controller current limit = 80 A
Maximum current of DC load (battery current) = 460 A
Load controller current limit (battery) = 120 A
Battery Charging Time = 0.76 jam

Utilizing specialized SCCs designed for lithium-ion batteries can offer numerous notable advantages in the development of the

Off-Grid Solar Power Plant at the Az-Zawiyah Foundation (Raghavendra & Padmavathi, 2018). Utilizing the CC-CV approach, SCCs may optimize the charging process of lithium-ion batteries, ensuring both efficiency and safety. This is essential for improving battery lifespan and overall system functionality. Efficient and economical SCC design is crucial for small to medium-sized systems, like the 6 kWp solar power plant at the Az-Zawiyah Foundation. Implementing advanced safety features, such as overcharge and over-voltage protection, can effectively safeguard investments in lithium-ion batteries. These features assist prolong the battery's lifespan, which is typically more costly compared to other battery types (Karim et al., 2013).

The relevance of cost-effective and efficient SCC design lies in its ability to minimize the entire project cost. Cost efficiency is crucial in an off-grid system to effectively manage the budget and make it more financially sustainable for the Az-Zawiyah foundation (Afroze et al., 2015). Utilizing microcontrollers enables more convenient and efficient modifications based on the precise requirements of the site and operational circumstances. It is particularly crucial under fluctuating weather conditions, which is frequently observed in South Sumatra (Islam & Sarkar, 2015). By incorporating modern SCC technology with robust protection and exceptional efficiency features, a steadfast dedication to the utilization of cutting-edge and environmentally-friendly green technology may be ensured.

Accurately calculating the capacity of the inverter on the Off-Grid Solar Power Plant is crucial to ensure that the chosen inverter can effectively manage all the electrical loads connected to the system and adequately supply sufficient power to fulfill daily energy requirements. Having knowledge of the overall load can serve as a means to select an inverter that possesses adequate ability to effectively manage said load. Furthermore, it is crucial to take into account other factors such as the efficacy and capacity of the inverter to manage power surges (Dunlop, 2011). Utilizing high-efficiency inverters to optimize the utilization of electricity produced by solar panels. An inverter of high quality has the ability to minimize power losses that occur during the process of converting direct current (DC) to alternating current (AC) (Yongheng Yang et al., 2016). The gathered data on the capacity of the inverter is as follows:

Inverter output voltage= 220 VAC

Maximum continuous DC current = 460 A

Estimated Surge of inductive load starting current = 8,640 W

Inverter capacity = 33,405 W

Load limiter of inverter capacity = 1,200

At the Az-Zawiyah Foundation, a crucial aspect of planning and implementing Off-Grid Solar Power Plants is to accurately ascertain the appropriate inverter capacity. By considering factors such as peak load estimation, inverter efficiency, and battery compatibility, the system can be fine-tuned to deliver consistent and dependable electricity for the foundation.

The estimation of the cost for Off-Grid solar equipment requires identifying all the necessary components in the system, selecting the suitable specifications, and calculating the cost for each of these components. The aforementioned items encompass solar panels, inverters, batteries, solar charge controllers, cables, and other electrical apparatus. (Ramadhan & Naseeb, 2011).

Tabel 2. Estimated Cost of Solar Power Plant Equipment

Equipment	Amount	Price (Rp)	Total (Rp)
Polycrystalline solar module 320 Wp 72 celss	21 EA	4,135,000	86,677,758
Inverter off grid- Solar inverter pure sine	1 EA	30,500,000	30,500,000
Power Cables & Solar Power off-grid Accessories	7 kWp	1,800,000	12,600,000
1000 VDC Combiner Box Electrical Panel	1 Unit	4,200,000	4,200,000
DC Connection Box Electrical Panel	1 Unit	7,350,000	7,350,000
AC Connection Box Electrical Panel	1 Unit	13,355,000	13,355,000
Mechanical Battery Support	1 Set	2,540,000	2,540,000
Support Module-Ground Mounted	1 Set	27,650,000	27,650,000
Door to Door Expedition Services	1 Lot	5,800,000	5,800,000
Total			**190,672,758**

Table 2 shows the expenses associated with acquiring and setting up the system. This will aid in strategizing the appropriate financial allocation for the acquisition and installation of an Off-Grid solar PV system that aligns with your specific requirements and financial resources.

The study conducted by Kaldellis et al., in 2009 regarding the choice of effective energy storage setups can significantly contribute to the cost optimization of solar PV systems. Foundations can utilize economic and technological analysis to determine the best appropriate energy storage option (Kaldellis et al., 2009). In their study on the worldwide photovoltaic economy, Timilsina et al. (2012) demonstrated that solar PV can yield substantial long-term profits, particularly due to the decreasing costs of solar panels and improved efficiency. This study indicates a speedy return on investment, consistent with the findings of Timilsina et al., which indicate that solar photovoltaic (PV) is a cost-effective and environmentally friendly alternative (Timilsina et al., 2012).

Prior studies on energy efficiency enhancement methods and audits of electricity, thermal, and solar applications have demonstrated that solar PV systems have the potential to substantially decrease energy consumption from traditional sources. Utilizing photovoltaic systems can significantly decrease electricity expenses and mitigate carbon emissions. The results align with the research conducted by the Az-Zawiyah Foundation, which concluded that off-grid solar PV systems can decrease reliance on traditional power networks and decrease annual running expenses (Ibrik & Mahmoud, 2005).

A recent study has examined the capacity of solar photovoltaic (PV) systems to substantially decrease energy expenses and enhance electricity availability in isolated regions. Additionally, they demonstrate that solar photovoltaic (PV) systems possess significant potential to enhance quality of life through the provision of a dependable and environmentally friendly energy source. This study corroborates the findings of the Az-Zawiyah Foundation, which demonstrate that off-grid solar PV systems have the capability to offer sustainable and cost-effective energy solutions (Adaramola et al., 2014).

Assessment of current scenarios for the deployment of solar photovoltaic (PV) systems in isolated rural communities. The evaluation results indicate that the solar PV system is both cost-effective and has a positive impact on reducing carbon emissions and enhancing energy sustainability. This study is pertinent to the research conducted at the Az-Zawiyah Foundation, as it demonstrates that solar PV systems can have comparable beneficial outcomes (Chauhan & Saini, 2015).

CONCLUSION

This study effectively planned and constructed an Off-Grid Solar Power Plant (PLTS) with a 6 kWp capacity at the Az-Zawiyah Tanjung Batu Foundation, located in Ogan Ilir, South Sumatra. The study's primary findings indicate that the designed solar PV system can sustainably and independently fulfill the foundation's electrical energy requirements. It demonstrates a high level of efficiency and operates at cheap costs. The simulation of the system's performance demonstrates that this solar power plant has the capacity to generate sufficient energy to fulfill the foundation's daily requirements, hence offering the possibility of substantial reductions in electricity expenses.

Compare the findings of this study with those of other studies that assess several established photovoltaic technologies and determine that the Off-Grid Solar PV system is very efficient for remote regions. The findings of this study corroborate the results and offer more empirical proof that the development of an Off-Grid Solar Power Plant at the Az-Zawiyah Foundation can be effective and align with expectations.

This planning further validates earlier theories regarding the efficacy and financial viability of off-grid solar systems, as well as the significance of assessing energy requirements and solar energy capacity in the process of optimal system planning. This project utilizes cutting-edge scientific knowledge and technology in the realm of renewable energy to create an effective and environmentally friendly solar photovoltaic (PV) system. Additionally, it aims to significantly enhance energy accessibility and foster economic growth in remote regions. The findings of this study not only give practical solutions for the Az-Zawiyah Foundation, but also present a model that may be used in other locations with similar conditions. This enhances the significance and usefulness of these findings in a wider context.

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