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Technical Support for Maintaining Solar Power Plants in Plantation Areas, Sajen Village, Mojokerto

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Abstract

Sajen Village is predominantly an agricultural and livestock-based community. However, the lack of sufficient electricity poses a significant challenge to the development of these sectors. Solar Power Generation Technology offers a sustainable solution due to the village's potential for utilizing solar energy. To ensure the successful implementation of solar power plant, it is essential to provide the local community with adequate knowledge and skills in its operation, maintenance, and care. This community service program aims to introduce solar power plant to the residents of Sajen Village while equipping them with the necessary technical expertise. The program consists of several key activities: training on solar power plant operation and maintenance, an introduction to the principles of solar power plant design and installation, and evaluation sessions to assess the community's understanding. These activities are designed to empower participants to independently operate and maintain solar power plant systems. The final stage involves evaluating the program's effectiveness by measuring the participants' comprehension of solar power plant concepts, operations, and maintenance techniques. This initiative is expected to enhance the sustainability of Sajen Village's agricultural and livestock sectors by addressing the electricity shortage through renewable energy solutions. It also promotes community independence in managing solar power systems for long-term benefits.
Keywords: *Renewable Energy; Sajen Village; Solar Power Plant; Training and Maintenance*

Abstrak

Desa Sajen sebagian besar merupakan masyarakat yang bergerak di bidang pertanian dan peternakan. Akan tetapi, kurangnya pasokan listrik yang memadai menjadi tantangan yang signifikan bagi pengembangan sektor-sektor tersebut. Teknologi Pembangkit Listrik Tenaga Surya menawarkan solusi yang berkelanjutan karena desa tersebut memiliki potensi untuk memanfaatkan energi surya. Untuk memastikan keberhasilan penerapan pembangkit listrik tenaga surya, penting untuk membekali masyarakat setempat dengan pengetahuan dan keterampilan yang memadai dalam pengoperasian, pemeliharaan, dan perawatannya. Program pengabdian masyarakat ini bertujuan untuk memperkenalkan pembangkit listrik tenaga surya kepada warga Desa Sajen sekaligus membekali mereka dengan keahlian teknis yang diperlukan. Program ini terdiri dari beberapa kegiatan utama: pelatihan pengoperasian dan pemeliharaan pembangkit listrik tenaga surya, pengenalan prinsip-prinsip desain dan pemasangan pembangkit listrik tenaga surya, dan sesi evaluasi untuk menilai pemahaman masyarakat. Kegiatan-kegiatan ini dirancang untuk memberdayakan peserta agar dapat mengoperasikan dan memelihara sistem pembangkit listrik tenaga surya secara mandiri. Tahap akhir melibatkan evaluasi efektivitas program dengan mengukur pemahaman peserta terhadap konsep, pengoperasian, dan teknik pemeliharaan pembangkit listrik tenaga surya. Inisiatif ini diharapkan dapat meningkatkan keberlanjutan sektor pertanian dan peternakan Desa Sajen dengan mengatasi kekurangan listrik melalui solusi energi terbarukan. Hal ini juga mendorong kemandirian masyarakat dalam mengelola sistem tenaga surya untuk manfaat jangka panjang.
Kata Kunci: Desa Sajen; Energi Baru Terbarukan; Pelatihan dan Pemeliharaan; PLTS

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INTRODUCTION

Sajen Village is one of the villages located in Pacet Subdistrict, Mojokerto, East Java, situated at the foot of Mount Welirang. This village holds strategic potential as the gateway to the Pacet

tourist area from both the Surabaya and Batu-Malang directions. With its abundant natural resources, unique local cultural characteristics, and a community that upholds the values of local wisdom, Sajen Village has significant potential to be developed into a community-based tourism destination. The people of Sajen Village generally live in harmony with nature, embrace a simple way of life, and maintain a culture of mutual cooperation. These characteristics serve as the primary assets in creating an educational and distinctive tourism experience, setting it apart from conventional tourism concepts. By integrating its natural and cultural potentials, the village has the capability to attract tourists seeking an escape from the instant and monotonous urban lifestyle. However, leveraging this potential requires systematic and well-directed management. Community-based tourism aims not only to provide authentic experiences for visitors but also to improve the economic and social well-being of the local community. Therefore, community engagement becomes a strategic step to support the development of Sajen Village as a sustainable tourism destination, with a focus on active participation from the local community.

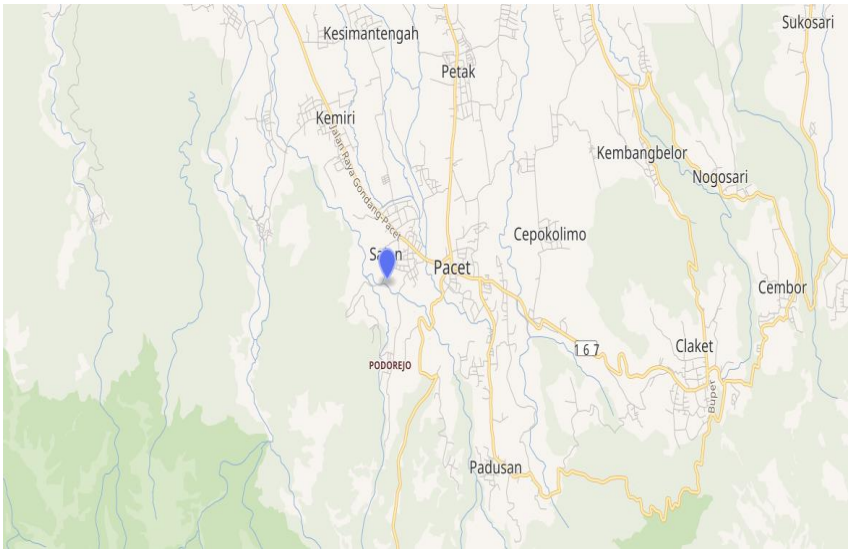

Figure 1. Map of Sajen Village Area, Mojokerto

Solar photovoltaic (PV) technology, commonly known as solar panels, is an innovative solution for converting solar energy into electrical power (Widagdo et al., 2023). This technology utilizes photovoltaic cells, typically composed of semiconductor materials like silicon, to perform the energy conversion. When sunlight strikes these cells, the light energy is absorbed, releasing electrons and generating an electric current (Widagdo et al., 2023). A solar panel is essentially a collection of interconnected photovoltaic cells, forming a module that can be scaled up into larger photovoltaic systems to supply electricity for homes, businesses, or even the main power grid. Over the years, solar PV technology has advanced significantly, becoming one of the most popular, clean, and sustainable sources of renewable energy (Sartika et al., 2023). Its primary benefits include being environmentally friendly, reducing reliance on fossil fuels, and offering a reliable renewable energy option (Sujito et al., 2022). Despite these advantages, solar panels can encounter various issues over time. Common problems include reduced efficiency, mechanical damage, connection issues, degradation of solar cells, battery storage malfunctions, and inverter failures. Additionally, external factors such as shading from trees, animal interference, or damage caused by extreme weather conditions can further affect solar panel performance (Nugraha et al., 2021).

One practical application of solar PV technology can be seen in the plantation area of Sajen Village, where solar panels are utilized to support daily operations. However, a significant challenge faced by farmers and village officials is their limited knowledge of maintaining solar panels or solar power systems. To address this issue, it is essential to provide comprehensive training for the

villagers. This training aims to enhance their understanding of solar panel systems, including their operation, maintenance, and repair processes. By equipping the villagers with the necessary skills and knowledge, they can ensure the efficient operation and longevity of their solar power installations, ultimately fostering a more sustainable energy future for the community.

METHOD

The Community Service activity focused on providing technical assistance for the installation of Solar Power Plants was carried out from November to December 2024 in Sajen Village, Pacet, Mojokerto. This activity involved 24 local residents working in agriculture and livestock, the Sajen Village officials, as well as lecturers and students from the Electrical Engineering Program at Universitas 17 Agustus 1945 Surabaya. This program was chosen because Sajen Village has attractive tourism potential supported by its agricultural and livestock products, such as fresh milk production. Moreover, the villagers are open to new information and knowledge, and the village officials are welcoming to external parties conducting community service activities in the area.

Implementation Method

Every successful activity must begin with thorough planning. This includes the careful preparation of work plans, defining the specific activities to be carried out, setting the timeline for implementation, selecting the appropriate locations, and identifying the individuals involved. These elements must be carefully thought out and meticulously planned. In the case of the community service activities in Sajen Village, the approach involves both socialization and training methods to engage and educate the community. To ensure the accuracy of the data collected, interviews and questionnaires are employed, providing valuable insights and updates on the progress of the activities. The chosen methods are tailored to meet the specific needs of the community service initiative. Below, we outline the design and procedures for carrying out these activities:

a. Location Survey

The people of Sajen Village have long lived as farmers and ranchers, with most of the population depending on the agriculture and livestock sectors for their livelihoods. In addition, this village also has tourism potential that is increasingly well-known. The agricultural and livestock activities carried out have been directed at efforts to support the sustainability of the local economy. One of the challenges faced by residents is the limited energy in supporting agricultural and livestock activities. Energy sources such as generators are often used to support daily activities, but limited fuel stocks are often an obstacle. The adequate potential for solar energy in the Mojokerto area can be a promising alternative to overcome this limitation. By utilizing the Solar Power Plant, Sajen Village can reduce dependence on fossil fuels and create more environmentally friendly energy sources to support various productive activities of residents, including in the agriculture, livestock, and tourism sectors. In addition, it is important for the community to understand how to maintain the solar power plant system in order to extend its service life and support the sustainability of energy management effectively. Furthermore, training programs should be provided to equip local residents with the necessary skills for proper maintenance and troubleshooting of the system. This initiative could also open up new employment opportunities for residents, contributing to the village's economic growth.

Figure 2. Training is Conducted at the Location where the Solar Power Plant is Installed

b. Social Approach

Community service activities in Sajen Village are specifically tailored to meet the needs of the residents. It is crucial to approach these initiatives in a way that helps the community recognize the importance of their involvement, especially when facing challenges that require collective action. Building awareness is key, as it fosters a mindset where solving problems becomes a shared responsibility and a way to improve their quality of life. Direct socialization was conducted with each farmer group, with assistance from village officials, including the village head, secretary, and farmer group leaders. The outcome of the socialization revealed that the installation of solar power plants would be most effective in areas between agricultural and livestock zones. One of the main challenges identified was the limited knowledge of renewable energy options and the high cost of using generators for electrical energy on boats. This community service initiative is perfectly aligned with addressing these issues. Moreover, it supports the government's agenda of promoting renewable energy, particularly given the vast potential in the Mojokerto region. By providing practical information on the proper installation of solar power systems, the project is expected to significantly benefit the community. The Farmers group of Sajen Village have enthusiastically embraced this initiative, recognizing its potential to enhance their livelihoods.

Figure 2. Social Approach to Sajen Village Residents during the training

c. Training Success Indicators

The success indicators of this community service are as follows: First, the location of the participants is highly suitable for the training program being conducted. Second, there is an increase in the farmers group knowledge about the importance of environmental conservation and health, particularly through the utilization of Solar Power Systems. Third, the farmer group skills in the installation and maintenance of Solar Power Plant have improved, indicating success in the practical aspects of the training.

d. Evaluation Methods

Evaluation activities serve as a means to assess and monitor the progress of community service initiatives. Monitoring involves determining whether residents are effectively utilizing and maintaining the solar power systems. This process includes direct inspections of the Solar Power Systems components and interviews with residents. Effective coordination plays a crucial role in ensuring smooth execution of these activities, as it facilitates continuous communication about the condition of the provided equipment.

RESULT AND ANALYSIS

Throughout the training process, all participants actively engaged in every stage of the program. During the theoretical session, participants were provided with an explanation of fundamental concepts, covering both on-grid and off-grid electrical systems. In addition to theoretical knowledge, participants gained hands-on experience. In the final session, all participants were taken to the location of the solar panels within the building for a review. The closing activity involved preparing a report, which included an evaluation of the training process. The report also assessed the effectiveness of the training to monitor its outcomes. To measure this, a set of 10 short questions was administered both before and after the training. The pre-test and post-test consisted of identical multiple-choice questions.

Figure 3. Provision of Solar Power Plant Maintenance Materials

Solar Power Plant Maintenance

Maintenance of solar power systems is essential and quite simple due to their stationary nature. The maintenance requirements are minimal, as the lack of movement of the solar panels significantly reduces the potential for physical damage (Roihatin et al., 2022). However, maintenance should be carried out regularly and carefully to ensure the longevity and durability of the solar panels. The key to maintaining a solar panel system is ensuring it remains strong,

functions optimally, operates efficiently, and has an effective structure. Solar panels are known to be durable, as their effectiveness remains around 92% even after twenty years of use, but they still require attention to extend their usability. For the utilization of solar power systems, residents are expected to carry out regular maintenance. This is important for the following reasons:

a. Solar Panels Get Dirty Quickly

Being placed in open areas makes solar panels prone to accumulating dirt. Common contaminants include dust, dry leaves, and bird droppings. If left unchecked, this dirt can block sunlight from reaching the silicon layer of the solar panel. When the silicon layer is not exposed to sunlight, no electricity is generated. This phenomenon is commonly referred to as shading.

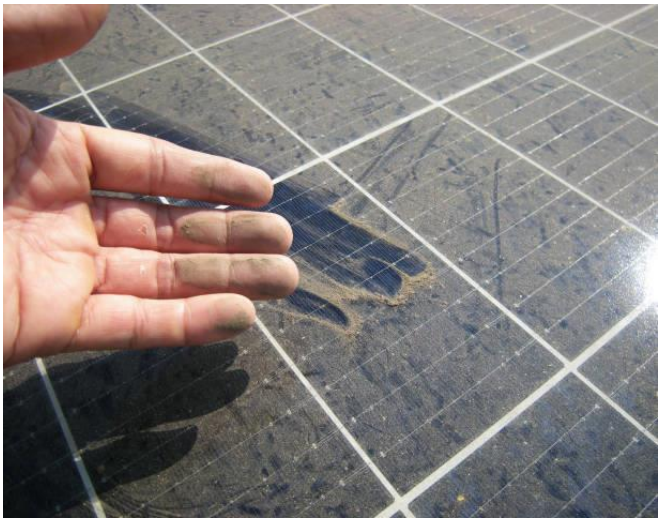

Figure 4. Dusty condition of Photovoltaics

b. The Electrical System Needs to be Checked Periodically

It is also important to check the solar panel circuit to ensure it is still generating electricity according to its specifications. If it is not performing as expected, the cause can be investigated by checking for issues such as broken cables, dirty panels, or even damaged panels.

c. Condition of the Solar Panel Mounting Brackets

There are various conditions for installing solar panels, including on flat ground, sloping roofs, flat roofs, or even mounted on a single pole. Each installation type has its own characteristics. For instance, when installing on a flat roof of a ship, the solar panels are bolted to the roof. However, during installation, they may be exposed to heat and rain, which could cause the bolts to loosen or the roof construction to deteriorate over time. Such issues need to be checked periodically, ideally every three months, to prevent the solar panels from becoming loose and potentially damaged.

d. Other External Factors

Other external factors that may affect the solar panels include damage from rocks, impact from debris, nests built by wild animals, or other unforeseen circumstances. These issues may not be immediately visible, but they require careful inspection to identify potential damage. Regular maintenance schedules should include inspections for such external factors to prevent long-term efficiency losses. Additionally, installing protective measures like guards or covers can minimize the risk of physical damage to the panels.

Figure 5. Cleaning Inverter Panels from Wild Ant Nests

To ensure the continuous generation of electrical energy from the solar power plant, proper maintenance of the system is crucial. Farmers group are taught the necessary steps for maintaining the solar power system, which include:

a. Solar Panel Cleaning

To clean solar panels, it is important to use clean water. Avoid using hot water, as it evaporates too quickly. If using liquid soap for cleaning, it is best to mix the soap with the water beforehand, rather than applying it directly to the solar panels (Kusuma et al., 2023). Direct contact with liquid soap may leave behind hazardous substances that can create marks, which are difficult to remove. It is also crucial to avoid using hard-bristled brushes, as they can scratch the panels and shorten their lifespan, affecting their efficiency in absorbing sunlight (Mulyono et al., 2022). When cleaning solar panels, ensure that water does not dry on the panels naturally. Instead, immediately dry the panels with a clean, soft cloth before the water evaporates. This will help prevent water marks that can reduce the panel's ability to absorb sunlight (Kustanto et al., 2024).

b. Do it in the Morning or Evening

During the day, solar panels can become very hot as they absorb the sun's heat. This can make cleaning difficult. The best time to clean solar panels is in the morning or evening, when the panels are cooler and the electricity generation is lower. If cleaning must be done during the day, ensure that the weather is relatively cool to prevent overheating the panels (Gunadhi et al., 2023).

c. Turning Off the Electrical Circuit from The Solar Panel

Before checking or cleaning the solar panels, always turn off the safety switch. This is essential to prevent any current from entering the system during maintenance.

d. Monitoring the Performance of Solar Panel Systems

Installing a monitoring system to track the performance of solar panels can be extremely helpful in assessing the condition of the solar power system. This tool allows for precise, real-time tracking of the energy produced by the panels. Additionally, the monitoring system provides comprehensive data on the environmental impact of the solar panels, including the reduction of carbon dioxide levels and other emission gases (Fitriana et al., 2022).

Activity Evaluation

Based on the assessment indicators conducted before and after the activity, the results indicated that the community service activities led to an increase in understanding and skills related to the use of solar power systems in agricultural areas. This improvement was evident in the participants' knowledge of the solar power systems, their understanding of the electrical operating system within solar power systems, and their ability to repair and maintain the solar power systems. The results from the questionnaire were analyzed using the Wilcoxon test, which demonstrated a statistically significant improvement in participants' knowledge and skills. These findings highlight the effectiveness of the training program in enhancing the community's ability to utilize and manage solar power systems for agricultural applications.

The Wilcoxon test results revealed a comparison of participants' knowledge of the solar power systems before and after the training. One individual showed lower knowledge after the training compared to before, eight individuals maintained the same level of knowledge, and fifteen individuals demonstrated improved knowledge. The statistical results in Table 1 indicate a significant value of 0,001 ($p < 0,05$), confirming a significant difference between the pre-training and post-training assessments.

The Wilcoxon test results showed a comparison of participants' knowledge of the solar power plant electrical operating system before and after the training. Two individuals maintained their previous knowledge level, while twenty-two participants demonstrated improved knowledge. The statistical results in Table 2 reveal a significant value of 0,001 ($p < 0,05$), indicating a significant difference between the pre-training and post-training assessments.

Similarly, the Wilcoxon test results comparing knowledge of the solar power systems before and after training showed that two individuals had lower knowledge after the training compared to before, ten people remained the same, and twelve people showed better knowledge. The statistical results in Table 3 indicate a significant value of 0,007 ($p < 0,05$), confirming a significant difference between the pre-training and post-training assessments.

Table 1. Knowledge of Solar Power Systems

	n	**Median (Minimum-Maximum)**	***p***
Knowledge of solar power plant electrical system before training	24	4 (3-5)	0,001
Knowledge of solar power plant electrical system after training	24	5 (4-6)	

Table 2. Knowledge of Solar Power Plant Operating System

	n	**Median (Minimum-Maximum)**	***p***
Knowledge of solar power plant electrical operating system before training	24	4 (3-5)	0,001
Knowledge of solar power plant electrical operating system after training	24	5 (4-6)	

Table 3. Ability to Perform Repairs and Maintenance

	n	**Median (Minimum-Maximum)**	***p***
Ability to perform repairs and maintenance prior to training	24	4 (3-5)	0,001
Ability to perform repairs and maintenance after training	24	5 (4-6)	

CONCLUSION

The training activities for the installation and maintenance of solar power plants for residents, especially farmer groups in Sajen Village, went well. This activity is a form of introducing environmentally friendly solar power plants, and helping the community in overcoming the need for electrical energy in agricultural areas. The use of solar power plants can be used properly, without leaving out the technical aspects in the form of maintenance and correct use for safety and comfort in carrying out daily activities.

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