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Training on Solar Cell Technology as a Solar Power Plant in Graha Citra Mas Housing Estate Kaliwates, Jember

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Abstract. Energy needs are increasing but on the other hand the availability of petroleum reserves as conventional energy is running low, this forces humans to look for alternatives to energy. Indonesia as a country with a relatively good tropical climate in the duration of the sun shines. This matter is a potential to answer the need for alternative energy to replace petroleum, namely solar light or the sun. By utilizing solar panels, solar cells simply consist of a connection of p and n type semiconductor materials which when exposed to sunlight will occur electron flow, from this flow is referred to as electricity or converting solar radiation into electricity. In an effort to educate and serve a number of lecturers from the Department of Mechanical Engineering, University of Jember, held a service located in RT 04 / RW021 Graha Citra Mas Housing, Tegal Besar Village, Kaliwates District, Jember Regency, with the aim of understanding the community regarding Solar Cell Technology as a Solar Power Plant (PLTS). The service runs with the delivery of material and continued by emphasizing discussion and question and answer. With the results of the service felt illustrated and enlightened from the material and answers that the speaker conveyed.

Keywords: Solar PV, Training, Education, Society Devotion.

1. INTRODUCTION

The increasing need for energy and the depletion of petroleum reserves force humans to look for alternative energy sources [1]. Developed countries have also competed and competed to make new breakthroughs to find and explore and create new technologies that can replace petroleum as an energy source [2]. Therefore, an alternative source of electrical energy is needed, namely, by utilizing solar panels [3]. Solar cells are composed of a p-n *junction semiconductor*, wherein p and n type semiconductor materials are interconnected. When these solar cells are exposed to sunlight, the incident photons induce electron movement, resulting in the generation of electric current. A solar cell is a functional component that transforms solar radiation into electrical energy, a renewable and ecologically sustainable resource [4]. The fundamental principle underlying the production of solar cells involves harnessing the photovoltaic effect, a phenomenon capable of directly converting sunlight into electrical energy [5]. The discovery of this principle can be attributed to Bacquere, a French physicist, who first identified it in 1839. When a metal is exposed to photons of a specific frequency, the photons transfer their kinetic energy to the metal atoms, causing the atoms to become excited and subsequently emit electrons. The conduction of a specific amount of current is facilitated by the presence of these free electrons.

The characteristics of solar cells can be obtained based on three parameters, namely open voltage series (*Voc*), short circuit current (*Isc*) and fill factor (*Ff*). The amount of content factor can be known from equation 1, [3].

$$Ff = \frac{Vmp \; x \; Imp}{Voc \; x \; Isc} \qquad (1)$$

Ff = Fill factor
Imp = Maximum current (Ampere)
Vmp = Maximum voltage (Volt)
Isc = Short circuit current (Ampere)

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Voc = Open circuit voltage (Volt)

Radiation parameters and ambient temperature influence, the maximum power output (PMPP), voltage magnitude (VMP) when PMPP and current (IMP) when PMPP is reached from the solar panel. Similarly, in the unloaded solar panel, a short circuit current (*Isc*) can be found from a characteristic point of the solar cell.

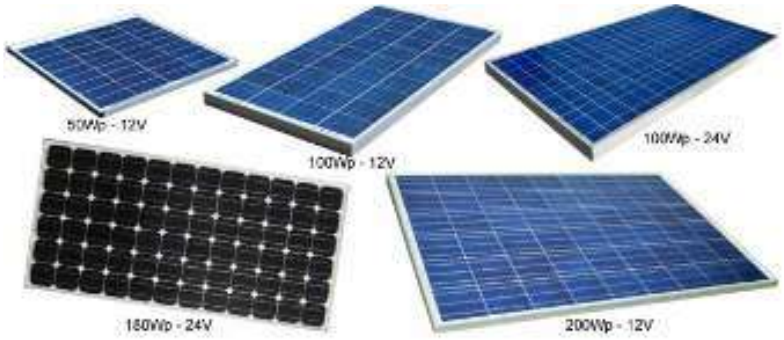

Figure 1. Types of Solar Panels on the Market

When given a large load, there is no current passing through it, this condition is the same as breaking the connection on the ammeter and the result of the voltmeter designation is the no-load voltage (***Voc***), [4]. In a state without irradiation, the condition of the solar cell is like a rectifier diode, and when it gets irradiated, a current will flow opposite to the direction of the current in the diode. Figure 1 shows the types of solar panels, which can produce voltage and current from solar cells under irradiation conditions. [7]. Conversion efficiency is the ratio of the power that a solar cell can obtain to the power received from the sun. The power density of sunlight that reaches the outside of the earth's atmosphere is about 136 m.W/cm² but after passing through the atmosphere it is partially dissipated, while the power density of the sun that reaches the earth's surface during clear daylight is about 100 m.W/cm². The equation for conversion efficiency is formulated as equation 2:

$$\eta = \frac{V \,.\, I}{P \,.\, A} \quad \% \qquad (2)$$

where:
η = voltage efficiency
V = voltage generated
I = solar cell current
P = power density hitting the cell
A = solar cell cross-sectional area

Solar Power Plant (PLTS), can be applied as follows:

a. Solar power for home lighting.
b. Solar power for street lighting (PJU)
c. Solar power for garden lighting
d. Solar power as a power source for CCTV cameras.
e. Solar power as a power source for wireless installations (WIFI), radio transmitters, communication devices.
f. Solar power for train signal devices, ships.
g. Solar power for swallow houses, irrigation, water pumps.
h. Solar power as a portable power supply
i. Solar power as a heater to drive turbines as a solar power plant like in Nevada America.
j. Solar cell as power source for satellite devices.

The advantages of solar panels as solar power plants are:

a. Able to supply electricity for locations that have not been reached by the PLN electricity network so that it can be used for remote areas.
b. Solar electricity is a quick solution, due to the relatively quick installation process to generate electricity for lighting etc.
c. Solar power is considered a highly environmentally friendly source of energy due to its inherent characteristics. It possesses the ability to efficiently capture ultraviolet (UV) radiation emitted by

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sunlight, thereby facilitating the generation of electricity. Notably, solar power exhibits a remarkable absence of emissions, noise pollution, and the need for daily fuel procurement.

d. Solar power systems have demonstrated their reliability for over five decades in the context of space programs, where they have exhibited superior resilience compared to other energy sources, including nuclear power, which are unable to endure the harsh environmental conditions prevalent in outer space.

The solar panel is a device that harnesses the potential energy of solar radiation, which is estimated to be 4.8 Kwh / m2 / day according to data from BPPT in 2005. This power potential is significant and remains largely untapped in Indonesia. This service aims to provide an understanding of the community, especially around the University of Jember, about Solar Cell Technology as PLTS so that it can apply and be utilized for daily electricity needs.

2. METHODOLOGY

2.1 Place and Time

Based on the request for filling out the material submitted by RT 04/RW021 Perum graha citra mas, tegal besar Village, Kaliwates sub-district, Jember Regency, this community service will be carried out in February 2023 at one of the houses of Perum graha citra mas residents, tegal besar Village, Kaliwates sub-district, Jember Regency.

2.2 Target Audience

This socialization was aimed at the residents of RT 04 / RW 021 Perum graha Citra Mas, Tegal Besar Village, Kaliwates sub-district, Jember Regency.

2.3 Methods

The method used in this community service activity is the material provided is how knowledge and understanding of Solar Cell Technology as a Solar Power Plant (PLTS). In this activity more emphasis is placed on discussion so that the material can be better understood [6].

2.4 Activity Schedule

Problem identification, material preparation, training activities, evaluation, and report preparation. This activity was held in early to late February.

3. RESULTS AND DISCUSSION

3.1 Results

The service activity was carried out on Saturday, February 18, 2023. The service started at 15.30. Participants who attended were teenagers and young people from Graha Citra Mas housing complex and surrounding areas.

Figure 2. Introduction by Dr. Muh. Nurkoyim Kustanto

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This service activity was opened by Dr. Muh. Nurkoyim Kustanto, who gave an introduction, that Indonesia has great potential for new and renewable energy, especially in solar energy (**Fig. 1**). Indonesia is located on the equator so that the level of sun exposure received is large in the territory of Indonesia. The potential of sunlight received in Indonesia will be very useful if it can be used as a source of electricity. Converting solar energy into electrical energy can be done by utilizing solar panels. Utilization of solar energy sources by the community will be able to be done by installing solar panels on the roof of the roof of the house.

Figure 2. Service Participants

Therefore, this activity was held to provide education to the general public regarding the utilization and installation of solar panels, so that the hope is that the community knows how to utilize solar energy and convert it into electrical energy by utilizing solar panels. After the opening, continued to the core event, namely material about the components of home-scale solar power plant components with off-grid schemes and how to install solar panels. This material was delivered by Dr. Nurkoyim Kustanto and assisted by Muhammad Dimyati Nashrullah, M.Eng. and Dr. Nasrul Ilminnafik.

In this service presentation, Dr. Muh. Nurkoyim Kustanto. explained that to be able to use solar power plants in a home scale, at least several components are needed, namely:

a. Panel Surya
   Solar Panel is a component that functions as a converter of solar energy into lsitrik energy. Solar panels are the main component in solar power plants. Solar panels utilize photovoltaic components to convert sunlight energy into electrical energy. Solar Panel specifications are usually expressed using units of watt-peak capacity.
b. Battery
   In power plants with off-grid schemes, batteries are mandatory. The battery will function to store electrical energy. So that when the main electricity goes out, activities that require electrical energy will not be interrupted because the battery can supply electricity. Batteries are the most expensive component in the installation of solar power plants with off-grid schemes.
c. Charge Controller
   This tool is useful for regulating the electrical energy captured by solar panels to the battery. With this tool, the battery will be able to avoid excess charging so that it will extend the life of the battery.
d. Inverter
   An inverter is a device that functions to convert DC electric current into AC. The current from the battery must be converted into AC current so that the electrical equipment in the house can function.

The four components are assembled into a power plant scheme with solar energy as shown in **Fig. 3**.

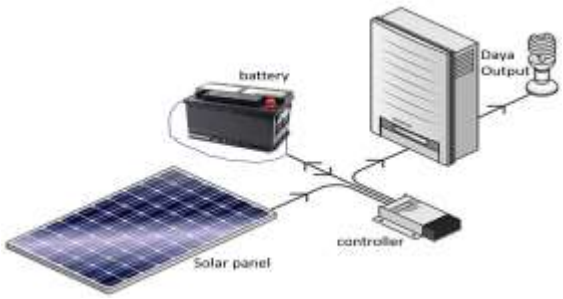

Figure 3. Schema of Power Generation with Solar Energy

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3.2 Discussion

Figure 4. Solar Panel Installation Exposure Session

Dr. Muh. Nurkoyim Kustanto, an esteemed academician hailing from the Department of Mechanical Engineering at the University of Jember, not only orchestrated a comprehensive instructional session on the installation of solar panels but also placed significant emphasis on imparting fundamental electrical safety knowledge to the eager participants (refer to **Figure 4**). This holistic approach to the dissemination of information aimed to equip attendees not only with the technical know-how of solar panel installation but also with essential precautions to ensure their safety in dealing with electricity. Within the ambit of electrical safety, Dr. Kustanto elucidated the critical aspects related to the prevention of electric shock, shedding light on the potential hazards associated with mishandling electrical equipment. Moreover, he delved into the intricate realm of electrical voltage variations and their profound impacts on human physiology. This comprehensive understanding was pivotal in nurturing a sense of responsibility and mindfulness among the participants when dealing with electrical components, particularly in the context of solar panel installation.

Following the didactic segment of the event, an engaging session of questions and answers ensued, as illustrated in **Figure 5**. The participants, evidently invigorated by the wealth of knowledge imparted by Dr. Kustanto, displayed remarkable enthusiasm in seeking clarification on various facets of solar power plants, with a particular focus on the intricacies of solar panel installation. Many inquiries revolved around the practicalities of the installation process, including the nuances of placement, wiring, and maintenance protocols for solar panels. The discussion session provided an invaluable opportunity for participants to engage directly with an expert in the field, facilitating a dynamic exchange of ideas and insights. Dr. Nurkoyim’s erudite responses not only addressed the queries but also enriched the participants' understanding of solar technology, leaving them enlightened and better equipped to embark on solar panel installation projects.

As the event drew to a close, the participants departed with a heightened sense of knowledge and confidence, fortified by the comprehensive material and expert guidance provided by Dr. Kustanto. This holistic learning experience encompassed both the technical and safety aspects of solar panel installation, empowering attendees to not only harness solar energy effectively but to do so in a secure and responsible manner. In summary, Dr. Muh. Nurkoyim Kustanto's educational intervention transcended mere technical instruction, embracing a pedagogical approach that prioritized safety and holistic understanding. Through the blend of theoretical knowledge and practical insights, participants were not only enlightened but also inspired to embrace solar energy solutions with a profound sense of responsibility and competence. Such pedagogical endeavors represent a pivotal step towards fostering a more sustainable and informed society, driven by renewable energy alternatives.

Figure 5. Discussion Session

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4. CONCLUSION

The impactful service initiative spearheaded by a dedicated team of lecturers from the esteemed Department of Mechanical Engineering at the University of Jember has yielded remarkable outcomes. Through their unwavering commitment and expertise, these educators have not only enhanced the understanding of their service participants but have also ignited a profound enthusiasm for renewable energy solutions. The service sessions orchestrated by this exceptional team have proven to be transformative experiences for those involved. By offering vivid examples and compelling demonstrations, they have effectively broadened the horizons of the community, shedding light on the intricate world of Solar Cell Technology and its pivotal role in the creation of Solar Power Plants (PLTS).

These interactive and informative sessions have not merely disseminated knowledge; they have sown the seeds of curiosity and awareness. Participants have emerged with a newfound appreciation for the potential of solar energy as a sustainable power source. Moreover, the practical insights gained from these engagements have ignited a sense of empowerment, as individuals now recognize the feasibility of harnessing solar energy for various applications, from meeting household energy needs to powering larger facilities like offices and other communal spaces. The ripple effect of these services is profound and far-reaching. As community members become more attuned to the possibilities of renewable energy, a broader shift towards alternative energy sources becomes increasingly feasible. This awareness and understanding are crucial steps toward fostering a more sustainable future. It is anticipated that, as this momentum continues to build, the community will not only embrace but actively participate in the ongoing transition to alternative energy sources. In essence, the efforts of the Department of Mechanical Engineering at the University of Jember have not only imparted knowledge but have sowed the seeds of change. They have illuminated a path towards a cleaner, more sustainable energy future, where solar power becomes an integral part of everyday life, powering homes, businesses, and the collective vision of a greener, more environmentally conscious community. This service initiative serves as a beacon of hope, inspiring others to join in the journey towards a brighter and more sustainable tomorrow.

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