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Socialization and Training of Solar Power Generation (PLTS) at SD Negeri Tambakharjo Semarang

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Abstract:
SD Negeri Tambakharjo Semarang uses PLN electricity with low installed power. The school is located in an area that has a total photovoltaic output power and solar radiation intensity of 1,486 Mwh/year and 1953.3 Kwh/m²/year. The average output power per day of photovoltaic (solar panels) in October and November 2021 was 4551 Wh and 3778 Wh. Therefore, the purpose of community service is to socialize the use of solar power plants (PLTS) through learning activities (education) and solar pv training for students and school teachers. The methods used in this activity are divided into three stages. In the first stage, field observations were carried out to find problems related to the availability of electrical energy in schools. In the second stage, the implementation of community service includes the delivery of solar panel material with lectures, demos, and solar power plant system designs in schools. In the third stage, it is the stage of evaluation or feedback by providing questionnaires to participants. The results of this service activity provide information data on understanding of solar panels and batteries in the good category. For practical activities, it needs to be improved to be taught for students in grades 5 and 6, so that solar pv props are indispensable in the school.

Keywords: *Solar Radiation; Solar Panels; Batteries; Solar Charge Controller*

Introduction

The source of reserves of fossil or petroleum energy sources has decreased every year. In addition, fossil energy production is also decreasing, while the consumption of fossil energy (petroleum) has increased by 6% every year. This is because the amount of need for fossil energy sources is not comparable to the available energy sources. As a result, Indonesia imports petroleum from other countries to meet energy consumption in the community (Priyohadi Kuncahyo, et all, 2013). To find out the availability of fossil energy sources can be done

by predicting energy sources in Indonesia. One of the ways can be done by the fuzzy logic method. Predictions are made with inputs on the amount of fossil energy production. Predictions based on fuzzy data classification provide information on the depletion of fossil energy sources, so that Indonesia can use other renewable energy sources (Achmad & Heru, 2016). The dependence of power plants in Indonesia in the use of non-renewable energy sources to produce electrical energy as fuel for power plants is still large. Indonesia is a canyon located within the equator, with abundant sources of solar energy. This solar energy source can be obtained every day and the use of this source to produce electricity does not cause environmental pollution (Handoko & Jaka, 2021). In addition to solar energy, the potential of angina energy integrated in microgrid systems has also begun to be widely developed in Indonesia (Adhi Kusmantoro, et all, 2020). The dependence of power plants in Indonesia in the use of non-renewable energy sources to produce electrical energy as fuel for power plants is still quite large. Indonesia is a country located within the equator, with abundant sources of solar energy. This source of solar energy can be obtained every day and the use of this source to produce electricity does not cause environmental pollution (Jaka Windarta, et all, 2018).

The use of solar energy sources using solar panels is widely used for residential electricity needs. Based on field data observations and planning for daily electrical energy needs in type 45 houses, 8,108 watts / day were obtained. The power produced by 8 pieces of PV Monocrystalline 300 Wp with an area of 12.98 m^2 is 2,500 watts. To increase the PV output used *Solar Charge Controller* (SCC) type MPPT 48 V, 60 A generated power 3. 200 watts. For AC loads used Inverter 4. 000 watts, voltage 48 Vdc/220V AC, 60 A. For energy storage used 16 VRLA batteries 12 V, 200 Ah (Renaldy Rahman, 2021). To increase the use of solar panels, an analysis of their output power is carried out. Research was carried out on three solar panels of different capacities. The results showed that the output power of a 10 Wp capacity solar panel at 10.00 is 5.6 watts and a 20 Wp capacity solar panel is 6.33 Watt. While the output power of the 30Wp solar panel is 3.89 Watts. The solar panel output power that has been obtained is influenced by the intensity of solar radiation or weather when data collection is carried out (Ta'Lim Nur Hidayat, 2021). Solar panels, in addition to being able to be used for residential houses, can also be used for electricity sources on

agricultural land. When the weather is not good, it is necessary to consider the use of batteries, so that the need for electrical energy can be met. In a study to supply a load power of 360 Wh required 1 module of 100 Wp solar panel, while the total need for electrical energy per day was 468 Wh. When the solar panel is at an azimuth angle of 25 ^{0}C can be generated electrical energy 9. 744 Wh. This is sufficient for the needs of 468 Wh of lighting electrical energy every day (Rosalina & Estu, 2019). Solar panels in the solar power plant system can also be used for electricity needs in the livestock business. One of them is community service activities in the broiler farming business in Jakenan District, Pati, Central Java. Solar power plants are used to help improve the results of community efforts in broiler farming. Service activities are carried out by the method of installation, *maintenance*, and expansion of solar power plants in the chicken farming business. In this activity, three 100 Wp solar panels were used for one of the chicken coops. In this activity, it is hoped that the community can increase the results of their efforts in broiler farming (Trias Prima Satya, et all, 2019).

To reduce the electricity load of PLN, solar power plants with an on-grid system can be installed on campus buildings. One of them is the use of on-grid solar panel systems used at STT PLN Jakarta. Based on the results of technical analysis, solar power plants can be used to supply loads with an efficiency of solar panels used at 17.4%. However, based on the performance ratio, it is produced 81%, so that the on-grid solar power plant system can be used in the campus building environment (Rinna Hariyati, et all, 2019). Off-Grid mode solar power plants with a capacity of 1 kWp in STT-PLN are solar power plants designed for renewable energy development activities. This is to determine the optimum potential of electrical energy, *final yield* (YF), performance ratio, and solar power plant efficiency. From the results of the analysis, it is known that before *maintenance final yield* (YF) 1.71343 Wh / Wp.day and the performance ratio is 51.78 %. After *maintenance*, it was generated 3,10121 Wh/Wp.day and 79.29%. In addition, an efficiency of 80.40% was obtained at the 1 KWp solar power plant (Tony & Aas Wasri, 2018). To further provide benefits for the people of Yogyakarta, the use of solar power plants with a capacity of 10 MW with an on-grid mode is carried out. Because the solar power plant capacity is quite large, the first step is to simulate using *RETScreen Clean Energy Project Analysis*. Based on this initial step, it provides an analysis

that the solar power output can be used for the needs ofthe people of Yogyakarta (Sigit & Mohammad Hafidz, 2015). In addition to the STT PLN campus, the Trisakti University campus has also used solar panels to meet electricity needs. Based on an area of 855 m^2 with 312 solar panels of 300 Wp, 5 pieces of 20 Kw inverters are produced by solar power output of 131,232.1 kWh annually. The speaker of this solar power plant requires an initial cost of RP 2,869,777,544 and maintenance costs of IDR 28,697,775 annually. With the calculation of ROI, it produces a *Pay Back Period* within 8 years and 5 months and an NPV of positively valued investments (Ramadhan & Rangkuti, 2016). While in the Rectorate Building of Udayana University, with the installation of 135 solar panels, 2 50 kW inverters and by using the HOMER simulator, the on-grid configuration can distribute electrical energy of 304,772 kWh / year. Meanwhile, grid only distributes electrical energy of 243,555 kWh / year. With the analysis using the HOMER software, an economic value of Rp. 883 / kWh was obtained based on the cost of selling electrical energy from the SOLAR system to PLN (Bagas Maruli, et all, 2020).

In addition to being installed on the campus building, the solar power plant has also been installed in the elementary school building. For example, on the roof of the SD Negeri 5 Pedungan building with the location of Jalan Diponegoro 60 Denpasar. The initial analysis was done with Helioscope software. With this preliminary analysis, information on the potential of solar energy in Denpasar was obtained by 1912.8 kWh / m^2 / year, in a day 5.2 kWh / m 2 was obtained. Solar radiation data was obtained from 07.00 -18.30 WITA. By installing the solar power plant obtained power of 3214.6 KWh, solar panels are attached to the roof with an angle of 30.96^{o}. The potential of electrical energy from the installed solar power plant is 3214.6 kWh with an angle corresponding to the roof angle of 30.96^{o}. When the angular position is set at an inclination of 15^{o} an output power of 3 is obtained. 407 KWh (Kristiawan, et all, 2019).

Based on information data, the construction of rooftop solar power plants in school buildings, campuses, and even plantations has begun to be carried out, it is necessary that school buildings in the city of Semarang also use solar power plants for electricity needs in schools. SD Negeri Tambakharjo, West Semarang District, Semarang City, Central Java. The electricity source used by SD Negeri Tambakharjo

comes from PLN. Geographically, Indonesia is on the equator, so Indonesia is very rich in solar energy sources with an average solar radiation intensity of around 4.8 kWh / m^2 per day and an average temperature of 34 ºC, so it is very suitable for solar panels to be used. Tambakharjo public elementary school uses PLN electricity with a capacity of 900 VA, so it is not enough to meet the entire load. To meet the needs of electrical loads, use the load interchangeably. Therefore, the purpose of service activities at SD Negeri Tambakharjo Semarang is to socialize the use of solar power plants (PLTS) through learning activities (education) and solar power plant training for students and school teachers. Activities are carried out with counseling, demos or practices using solar power plant components, and solar power plant planning at SD Negeri Tambakharjo Semarang

Result

In accordance with the objectives of community service activities, the method carried out is divided into three stages, namely observation / survey, implementation, evaluation.

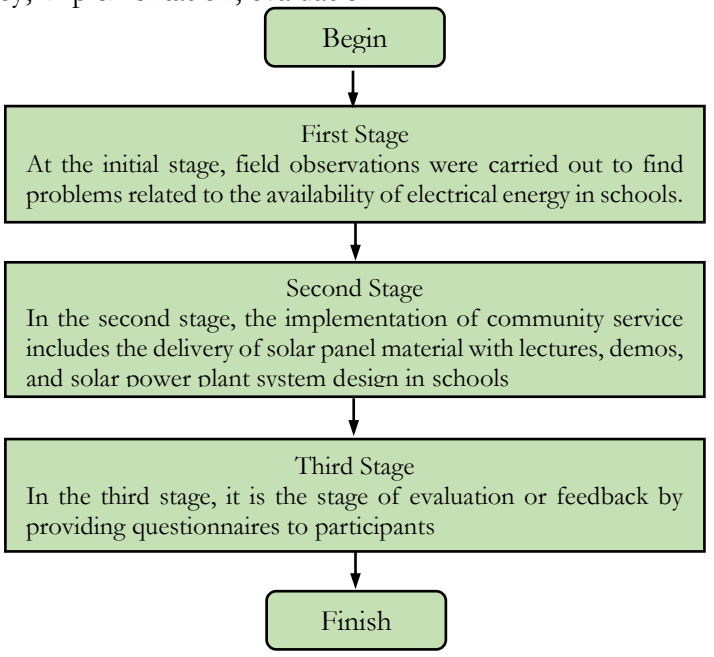

Figure 1. Steps of activity.

In the initial stage, a field survey was carried out, namely at the location of SD Negeri Tambakharjo by conducting discussions with the principal and teachers regarding teaching materials about solar panels. In survey the Community Service Team also looked for information data on the number and capacity of electricity loads in schools. In addition, observations were also made on the intensity of solar radiation at the school site. In this early stage, it can be seen the level of understanding of students and teachers towards solar power plants, electricity needs in schools, and the potential for solar energy at school locations. The second stage is the implementation of community service through the delivery of the theory of solar power plants and their components. In this stage, lectures were carried out in the classroom with teacher participants and school students, conducting solar power plant demos outside the classroom, and question and answer during the activity. In this implementation stage, the community service team also designed a solar power plant with an off-grid system for electricity needs in schools. The third stage is the feedback stage from community service participants. In this stage, a questionnaire is given to determine the level of understanding and interest in solar PV. The three stages can be shown in Figure 1.

The location of the school has a great radiation potential, so using solar panels in the solar power plant system as a source of electrical energy can reduce dependence on PLN electricity. The service participants were 10 teachers and students in grades 5 and 6 of SD Negeri Tambakharjo Semarang, totaling 40 students. After the completion of the activity or after the third stage, monitoring is also carried out every month for one year to find out the benefits of community service activities that have been carried out.

In the implementation of this activity, preliminary observations were carried out on October 6, 2021. The data obtained includes information data on electricity load, PLN electrical power capacity, solar energy potential, as well as data on the absence of material delivery about solar panels or solar power plants (PLTS) to students, especially grade 5 and grade 6 students. SD Negeri Tambakharjo Semarang is located -06°58'38" LS and 110°21'57" BT. Figure 2 shows the solar azimuth location of SD Negeri Tambakharjo Semarang. The total output power of photovoltaic/solar panels and solar radiation intensity is 1486 Mwh/year and 1953.3 Kwh/m^2/year. The average output

power per day of photovoltaics (solar panels) in Oktober and November 2021 is seen in Table 1. Meanwhile, the average output power of the photovoltaic for a year is seen in Figure 3.

Table 1. Profile of the average photovoltaic output power (Wh).

Hour	October (Wh)	November (Wh)
0-1	-	-
1-2	-	-
2-3	-	-
3-4	-	-
4-5		-
5-6	10	13
6-7	132	121
7-8	309	272
8-9	466	413
9-10	575	511
10-11	633	556
11-12	637	558
12-13	599	505
13-14	506	411
14-15	378	288
15-16	223	163
16-17	80	63
17-18	3	3
18-19	-	-
19-20	-	-
20-21	-	-
21-22	-	-
22-23	-	-
23-24	-	-
Total	4.551	3.877

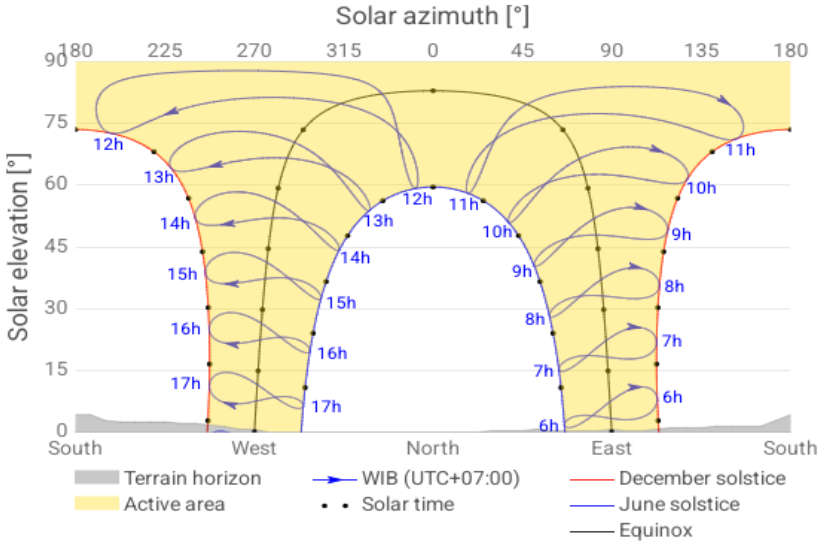

Figure 2. Horizon and sunpath.

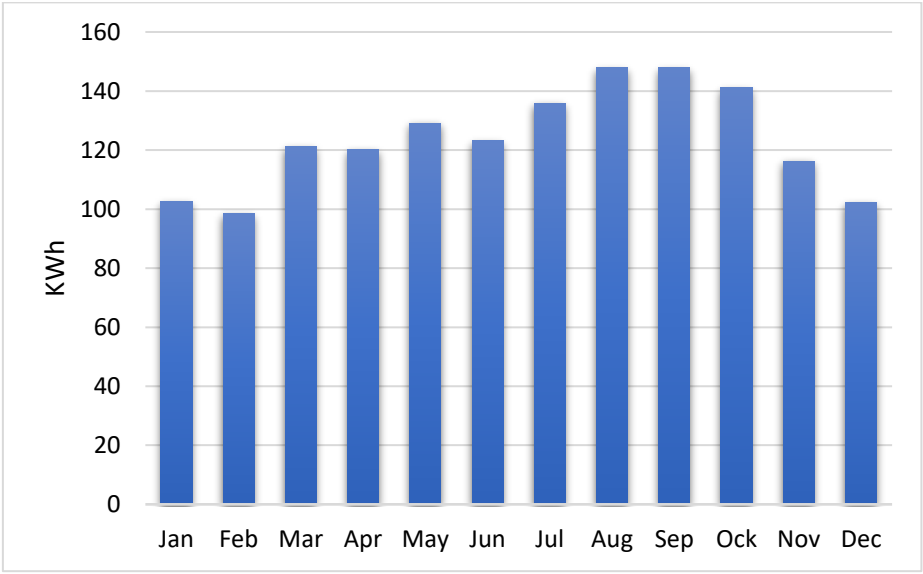

Figure 3. Total photovoltaic output power/ month.

In the implementation stage on December 14, 2021, a lecture was held in the classroom which was attended by all teachers and elementary

school students. In this stage, an understanding of the process of converting from solar radiation to DC electricity using solar panels is given. The explanation was given using power point material and simulation using Solar Pro 4.8 software. In addition, an explanation of other components used in solar power plants is given.

Discussion

The explanation of the material in the classroom is seen in Figure 4. To show how the solar power plant works in addition to using software is done with demos or hands-on practice outside the classroom. In this demo activity, 50 Wp solar panels, 30 Ah batteries, 1000 watt Inverters, 10 A SCCs, and 20 watts of lamp loads were used. This hands-on activity with students is shown in Figure 5, with the teacher shown in Figure 6. This activity also occurred in response to the participants of the community service, seen in Figure 7. Based on data on the electricity load in schools, the use of electrical energy is 3300 Wh. Therefore, to use solar power plants, there are 8 solar panels with a module capacity of 100 Wp. For the energy storage system, 100 Ah, 12 V batteries are used as many as 6 pieces. Other components are inverters with a capacity of 2000 watts and SCC 60 A. Designs that have been made by the Service Team can be used as a reference for the school in using solar power plants.

Figure 4. Delivery of material in class.

Figure 5. Practical activities with students.

Figure 6. Practical activities with teachers.

Figure 7. Ask answer with Participants.

In the evaluation stage, a questionnaire was given to the service participants, to find out the interest and level of understanding of solar power plants (PLTS). The feedback provided becomes information data for the Service Team to evaluate the activities that have been carried out.

Table 2. Evaluation of the results of activities.

Category	Percentage (%)
Understanding solar panels	85
Battery understanding	79
Understanding inverters	65
Solar Pv Practices	48

After this activity, monitoring is carried out every month to follow up on the use of solar power plants in schools. The success of the activities that have been carried out can be seen from the results of the evaluation and the amount of interest of students to learn about solar power plants and schools to start using solar energy as a source of electricity. This is very beneficial for students as the younger generation to develop renewable energy as a source of electricity in Indonesia.

Conclusion and Suggestion

Based on the results of the implementation of community activities, it provides information on understanding of solar panels and batteries in the good category. For practical activities, it needs to be improved to be taught for students in grades 5 and 6, so that solar pv props are indispensable in the school. It can be concluded that the interest of schools, especially to find out more about solar power plants with great interest for students as a younger generation, it is very important to develop renewable energy as a source of electricity in Indonesia. After this activity, monitoring is carried out every month to find out the sustainability of schools in using solar power plants.

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