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Utilization of Solar Panel Energy for Electricity in Seuseupan Village, Sukabumi

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Abstract: Limited public lighting in rural areas remains a significant obstacle affecting community safety, mobility, and socio-economic activities. This Community Service Program aims to improve energy independence in Seuseupan Village, Caringin District, Sukabumi Regency, through the implementation of a solar panel-based public lighting system. Implementation methods included field observations, Focus Group Discussions (FGDs), technical training on solar energy, installation of solar lamps in strategic locations, and monitoring and evaluation of system performance and program impact. Results showed that the solar panel installation improved the quality of lighting in public areas, strengthened people's sense of security at night, and reduced electricity costs by 37%. Furthermore, increased access to lighting contributed to a 23% increase in community economic activity while also increasing community knowledge and participation in the management of renewable energy technologies. This program demonstrates that utilizing solar energy is an effective, economical, and sustainable solution to support village infrastructure development. The program's implementation is based on the goal of achieving energy-independent villages and smart villages, and has the potential to be replicated in other regions with similar geographic conditions and needs. The program's success is measured not only by the technical aspects of installing the solar panel system, but also by the development of community awareness of the importance of utilizing clean energy as an alternative energy source. A participatory approach involving village governments, community groups, and implementers fosters a sense of ownership of the constructed facilities, thereby supporting the continuity of the operational and maintenance systems. Therefore, this community service model can serve as a reference for renewable energy-based community empowerment programs that support the achievement of sustainable development goals (SDGs), particularly in the areas of clean energy, infrastructure development, and improving the quality of life of rural communities.

Keywords: energy independent villages; public lighting; renewable energy; smart villages; solar panels.

1. INTRODUCTION

Technology-based village development is a key strategy for improving energy efficiency and the quality of life for rural communities. Seuseupan Village, Caringin District, Sukabumi Regency, has significant energy potential, particularly solar energy. However, this potential has not yet been optimally utilized due to the dominance of conventional methods, low human resource capacity, and the lack of adequate energy

infrastructure. The lack of public lighting limits nighttime economic activity, increases security risks, and reduces community mobility. At the same time, productivity is hampered by weak land monitoring systems, inefficient water use, and the lack of adoption of appropriate technology. These issues reflect the need for modern technology-based interventions to improve energy production efficiency and the quality of public services.

The application of renewable energy, such as solar panels, is a strategic solution for increasing sustainable energy access in villages (Dirayati et al., 2025). Solar energy offers high efficiency, low operational costs, and the ability to provide lighting in areas not covered by the conventional electricity grid. The integration of these two technologies aligns with the Smart Village concept, which emphasizes the use of digital innovation and clean energy to improve the well-being of rural communities.

The objective of this Community Service Program (PKM) is to address limited energy access in Seuseupan Village through the implementation of integrated appropriate technology. This program aims to improve the provision of solar energy-based public lighting infrastructure to strengthen security and community socio-economic activities at night. In addition, this PKM is directed at increasing the capacity and technological literacy of village communities through training in the use, maintenance, and utilization of solar energy technology (Energi & Issn, n.d.). To ensure the sustainability of the program, this activity also aims to establish a local institution capable of managing technology independently through the Seuseupan Smart Farmers Group (KTCS). Overall, this program is expected to produce a village empowerment model based on the integration of renewable energy technology as a foundation towards the realization of an independent Smart Village (Putra et al., 2022) that can be replicated in other rural areas (Al-Ali et al., 2019).

Electrical energy is a basic human need that plays a vital role in supporting various life activities, including social, economic, educational, and public service activities. The availability of adequate electrical energy is a crucial indicator of regional development because it directly impacts the quality of life of the community. In rural areas, public lighting is a public service that plays a strategic role in creating a safe, comfortable, and productive environment. However, many villages in Indonesia still face limited public lighting facilities due

to limited electricity networks, high operational costs, and limited village government budgets. This situation results in less than optimal nighttime activities, reduces environmental safety, and limits the development of community economic activities.

Seuseupan Village, located in Caringin District, Sukabumi Regency, is an area with significant natural resource potential, yet it still faces various challenges in providing energy infrastructure. Several village roads, public facilities, and public spaces still have low levels of lighting at night. This condition limits community mobility, especially for students, micro-business owners, farmers, and those who continue to engage in nighttime activities. Furthermore, inadequate lighting increases the potential for crime and traffic accidents, as well as reducing public comfort when using public facilities.

As energy demand increases, the use of electricity, which is still dominated by fossil fuels, creates various problems, including increased greenhouse gas emissions, dependence on fossil fuels, and high operational costs for energy supply. Therefore, the development of new and renewable energy sources is a national development priority, as outlined in various government policies regarding the energy transition. One renewable energy source with significant potential in Indonesia is solar energy. As a tropical country located on the equator, Indonesia receives an average solar radiation intensity of around 4–5.4 kWh/m² per day, making it highly suitable for use as a source of electricity through solar panel (photovoltaic) technology.

Solar panel technology offers several advantages over conventional lighting systems. In addition to being environmentally friendly, this system has relatively low operational costs because it utilizes sunlight as its primary energy source. Solar panels can also operate independently (a stand-alone system) without relying entirely on the PLN electricity grid, making them highly suitable for rural areas and areas with limited electricity access. In recent years, the price of solar panel system components such as photovoltaic modules, batteries, charge controllers, and LED lights has become increasingly affordable, enabling wider implementation of this technology in various sectors, including village street lighting.

Utilizing solar energy for public lighting not only offers technical benefits but also positively impacts social and economic development. Adequate lighting can improve neighborhood safety by reducing dark areas

that could potentially become crime hotspots. Furthermore, people can utilize nighttime for various productive activities such as trading, studying, religious activities, and other social activities. Thus, the presence of solar-powered public lighting can be a factor in driving local economic growth while improving the community's quality of life.

In addition to providing economic benefits, the use of solar energy also contributes to environmental conservation efforts. Unlike fossil fuel-based power plants that produce carbon emissions, solar panel systems generate electricity without combustion, thus eliminating air pollution during their operation. The implementation of this technology supports the national carbon emission reduction target while also supporting the achievement of the Sustainable Development Goals (SDGs), specifically Goal 7 (Affordable and Clean Energy), Goal 11 (Sustainable Cities and Communities), and Goal 13 (Climate Action). Therefore, the implementation of solar energy not only provides local benefits for rural communities but also contributes to the national and global sustainable development agenda. The success of implementing renewable energy technologies in communities depends not only on technical aspects but also on the level of knowledge, skills, and participation of the community.

2. METHOD

This community service was carried out in accordance with the planning and discussions that had been carried out with the management of Sesuseupan Village, Sukabumi, activity period 26 December to 29 December 2025, to conduct observations and analysis of existing problems to be followed up on in the community service so that the target achievement was clear and appropriate for the village. The implementation method for this community service program uses a participatory action research (PAR) approach combined with participatory mentoring (community empowerment). This approach was chosen so that the community is not merely a beneficiary but also plays an active role in every stage of the program, from problem identification and planning to implementation through to evaluation and program sustainability. This approach is expected to increase the community's capacity to independently manage renewable energy technology.

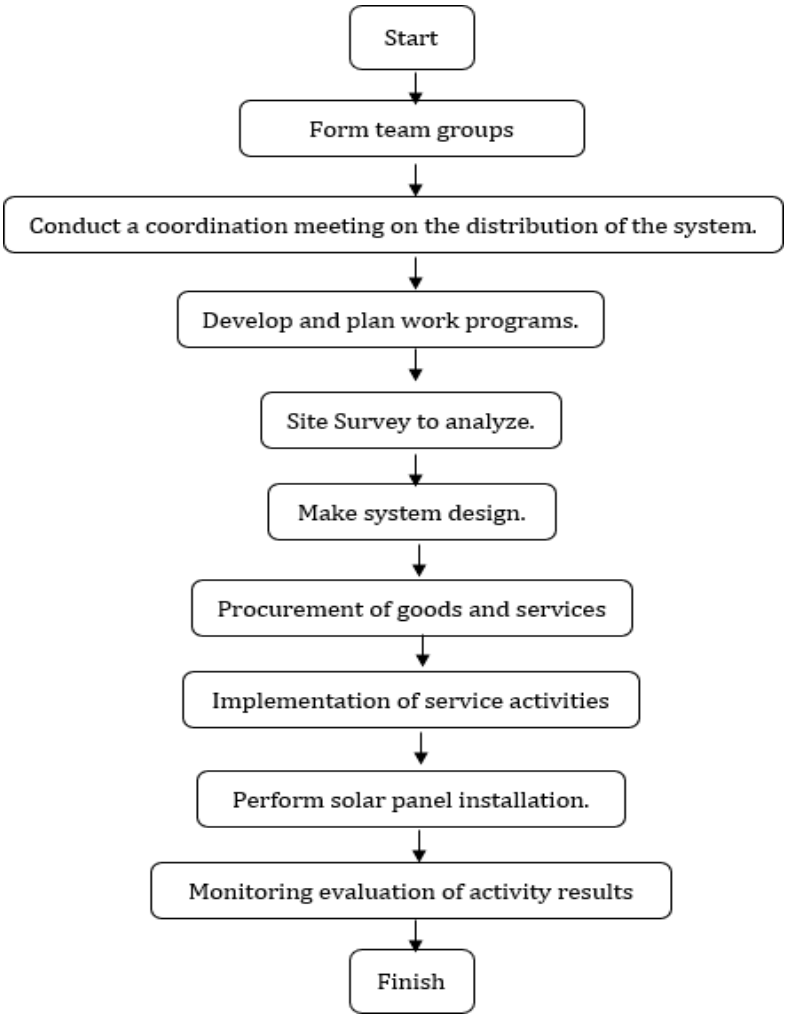

Figure 1. Community Service Implementation Flowchart

2.1 Problem Identification and Needs Analysis

The first stage involved field observations to identify the condition of public lighting in the village. The team surveyed several strategic locations, including village roads, public facilities, places of worship, village halls, and areas of community economic activity. In addition to the observations, interviews were conducted with village officials and community members to obtain information on lighting needs, environmental security conditions, village electricity costs, and the potential for solar energy utilization. The main problems identified included limited public lighting at night, high electricity operating costs, low utilization of renewable energy,

and lack of community knowledge about solar panel technology.

The results of this identification served as the basis for determining the solutions to be implemented. This community service program began in November 2025 with observations in Seuseupan Village, Caringin, Sukabumi. Based on the situational analysis, a priority issue that could be addressed to improve community welfare was the lack of street lighting.

Figure 2. Village Conditions during Field Observation

The activity phase continued with the formulation of solutions and technical planning, which included equipment procurement, work schedule development, and determination of success indicators. Field implementation was carried out according to the established timeline, including the installation of solar-powered lamps at strategic points in the pilot villages (Maheswari et al., 2019; S et al., 2024). Each phase was implemented through a collaborative approach between the community service team, the village government, and the local community to ensure the program's success and sustainability.

2.2 Focus Group Discussion (FGD)

The next stage was a focus group discussion (FGD) involving the Seuseupan Village Government, the Village Consultative Body (BPD), community leaders, youth organizations (Karang Taruna), MSME groups, and the

community service implementation team. The FGD aimed to determine priority locations for solar-powered lamp installation, compile the system's technical requirements, agree on management and maintenance mechanisms, and increase community participation from the beginning of the program. The FGD resulted in agreement on lamp installation locations based on community needs and environmental safety aspects.

2.3 Solar Lighting System Design

Based on the survey and FGD results, a small-scale solar power generation system was designed, consisting of solar panels (solar photovoltaic), a solar charge controller, a storage battery, energy-efficient LED lights, light poles, and an installation system. The design was carried out taking into account solar radiation intensity at the location, lamp power requirements, nightly power-on time, energy storage capacity, and ease of maintenance. This stage aims to produce a system that is efficient, economical, and capable of operating independently without relying on the PLN electricity grid.

2.4 Training and Knowledge Transfer

To ensure the sustainability of the program, the community was provided with training on solar panel technology, covering the working principles of photovoltaic systems; the function of each solar panel component; simple installation techniques; operational procedures; periodic maintenance; fault identification, and simple solutions. The training was conducted in theory and practice, allowing participants to gain hands-on experience in installing and maintaining the system. In addition to improving community competency, this activity also aims to raise awareness of the importance of using clean energy as part of sustainable village development.

2.5 System Implementation

The implementation phase is the process of installing a solar panel-based lighting system at strategic points that have been jointly determined. The implementation phase includes the installation of lampposts, the

installation of solar panels, the installation of batteries and charge controllers, the installation of LED lights,

Figure 3. Implementation of Community Empowerment and Training

testing the functionality of the entire system, and testing the lighting at night. In this phase, the community is directly involved to gain technical experience in system installation.

2.6 Monitoring and Evaluation

Monitoring is conducted during the system's operation to determine its technical performance and impact on the community. Parameters evaluated include:

a. Technical Aspects: solar panel performance, battery voltage, lamp duration, system stability, and installation conditions.

b. Social Aspects: community safety level, comfortability of nighttime activities, community participation level, and user satisfaction level.

c. Economic Aspects, Reduced village electricity costs, increased MSME activity, and increased

community activity at night. The evaluation was conducted using field observations, interviews, documentation, and questionnaires distributed to the community.

2.7 Program Success Indicators

The success of the activity is measured using several indicators as follows:

Table 1. Indicators of Measuring Activity

Indicators	Target
Solar-powered lamps function properly.	≥95%
Community participation in training	≥80% of participants present
Community knowledge increases	≥70% based on pre-test and post-test results
Electricity cost reduction.	±37%
Increase in community economic activity	±23%
Community satisfaction level	≥85%

3. RESULT AND DISCUSSION

A Community Service activity titled "Utilizing Solar Panel Energy for Electricity in Seuseupan Village, Sukabumi Regency" was implemented in Seuseupan Village, Caringin District, Sukabumi Regency, activity period 26 December to 29 December 2025. This program aims to increase productivity and provide an environmentally friendly alternative energy source through the application of solar panel technology.

Table 2. Implementation Results

Activity stages	Execution time	Key Achievements
Field observation & FGD	Month 1	Identify two main problems: low agricultural productivity & lack of public lighting.
Solar Energy Training	Month 2	18 participants understand solar panel installation & maintenance
Solar Powered Light Installation	Month 2	Active solar panel lights at strategic points in the village.
Evaluation and Monitoring	Month 3	28% increase in productivity and 87% energy efficiency
Documentation and Output	Month 3	Draft scientific articles and video documentation prepared

Based on system testing results, eight solar-powered lamps were installed at strategic locations, including the

village's main road, around the village hall, and in the night market area. Each unit features a 100Wp solar panel, a 30W LED lamp, and a 50Ah battery, capable of operating for up to 10 hours at night.

Table 3. Impact of Solar Panel Implementation

Indicator	Before Implementation	After Implementation	Change (%)
Security Level (case reports/month)	5	3	-40%
Monthly Electricity Cost (Rp)	3.200.000	2.000.000	-37.5%
Nighttime Economic Activity (index 1–10)	5	7	+23%

Results and Impacts of this activity are improved nighttime neighborhood safety by 40% (based on a community survey), reduced village electricity costs by an average of IDR 1,200,000 per month, and increased nighttime economic activity (stalls and small markets) by 23%. By measuring the voltage and current produced by solar panels, we can ensure that the components are receiving the energy they need to operate properly. These measurements also help optimize solar energy usage.

4. CONCLUSION

The success of this activity not only has a direct impact on improving community welfare, but also opens up opportunities for program replication in surrounding villages with similar characteristics. Integration of solar energy to support the regional sustainable development vision. With this achievement, the program is expected to be a real contribution of higher education in realizing the Sustainable Development Goals (SDGs), specifically SDG 2 (Zero Hunger), SDG 7 (Clean and Affordable Energy), and SDG 11 (Sustainable Settlements and Communities), towards smart villages that are independent, innovative, and economically and ecologically resilient.

REFERENCES

Pandria, T.M.A, & Prasanti, N. (2021). Penerapan Panel Surya sebagai Sumber Energi Listrik Alternatif pada Gedung Fakultas Teknik Universitas Teuku Umar. *Serambi Engineering*, *6*(4).

Ismangil, A., & Gendam Prakoso, W. (2020). The Effect of Electrical Conductivity of $LiTaO_3$ Thin Film on Temperature Variations. *International Journal of Advanced Science and Technology*, *29*(6), 3234–3240.

Ismangil, A., Gendam Prakoso, W., & Saepulrohman, A. (2021). The Effect of Cerium Doping on $LiTaO_3$ Thin Film on Band Gap Energy. *International Journal of Electronics and Communications System.* http://ejournal.radenintan.ac.id/index.php/IJECS/indexmm20XX

Ismangil, A., Noor, F. A., & Winata, T. (n.d.). The Effect of Niobium and Rubidium Doping on the Energy Band Gap of a Lithium Tantalate ($LiTaO_3$) Thin Film. In *Indonesian Journal of Physics: 20*(10).

Karim, S., Cahyanto, D. (n.d.). *Analisa Penggunaan Solar Cell Pada Rumah Tinggal Untuk Keperluan Penerangan dan Beban Kecil*. https://ojs.uniska-bjm.ac.id/index.php/eeict

Al-Ali, A. R., Al Nabulsi, A., Mukhopadhyay, S., Awal, M. S., Fernandes, S., & Ailabouni, K. (2019). IoT-solar-energy-powered smart farm irrigation system. *Journal of Electronic Science and Technology, 17*(4), 10001 7. https://doi.org/10.1016/j.jnlest.2020.100017

Dirayati, F., Sari, R. A., & Purnomo, R. F. (2025). Perancangan dan Implementasi Sistem Smart Agriculture Berbasis Internet of Things untuk Meningkatkan Produktivitas Pertanian. *Jurnal Media Informatika (JUMIN).*

Ismangil A., Hidayatulah, S., & Saepulrohman, A. (n.d.). (2024). Utilization of Solar Panel Energy for electricity in the AT-Taubah Musholla, West Cilebut Village. *JPMI (Jurnal Pengabdian Masyarakat Inovatif), 2*(2).