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Renewable energy transformation using solar panels in the Red Tilapia Intensive System community

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ABSTRACT

The transition to renewable energy is a strategic response to the global energy crisis and climate change. A community service project was conducted to promote energy independence for the Red Tilapia Intensive System (REDTIS) community by installing solar panels. Utilizing the Asset-Based Community Development (ABCD) method, the initiative involved installing two solar panels with a total capacity of 200 WP, a 100 AH battery, a 30 A solar charge controller, and a 500 Watt inverter to power a 100-Watt aerator. The project began with community asset identification, renewable energy analysis, system design, installation, and performance monitoring. The solar panel system generated an average of 1 kWh daily, covering approximately 41.3 percent of the aerator's 2.4 kWh daily energy requirement. This reduced reliance on conventional energy, lowering electricity costs and carbon emissions. While the solar panels did not fully meet the aerator's energy needs, the initiative demonstrated significant potential for scalability. Enhancing energy production, storage, and management is expected to achieve complete energy independence. This project serves as a replicable model for other communities seeking sustainable energy solutions.

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1. INTRODUCTION

The transformation of renewable energy is recognized as one of the strategic efforts to address the global energy crisis and climate change challenges (Panagoda et al., 2023). Among various types of renewable energy, solar panels or photovoltaic cells have gained increasing attention due to their significant potential and the abundant availability of sunlight in many parts of the world, including Indonesia (Hariyanto et al., 2023). The utilization of smart solar panel technology has been identified as an effective and efficient solution to achieve energy independence in various sectors, including the fisheries sector (Muntini et al., 2024).

The partner community in this program is the REDTIS (Red Tilapia Intensive System) community located in Slilir Village, Indonesia. This community focuses on intensive red tilapia farming, which requires consistent and reliable energy support for operating essential devices such as aerators, water pumps, and water treatment systems. However, access to electricity from the main grid is often limited, especially in remote areas, posing a significant challenge to the sustainability of their operations (Saleh et al., 2020).

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This challenge highlights the urgent need for innovative solutions, such as the adoption of solar panels, to sustainably meet their energy demands (Sunaryono et al., 2023).

Solar panels offer several advantages, including the ability to optimize sunlight absorption and higher energy conversion efficiency compared to conventional photovoltaic technologies (Corkish, 2014). These systems are integrated with monitoring and automatic adjustment mechanisms that allow real-time performance optimization based on environmental conditions and energy requirements (da Costa et al., 2024). Therefore, the use of solar panels is expected to enhance energy efficiency, reduce operational costs, and increase energy independence in intensive red tilapia farming systems.

The ABCD (Asset-Based Community Development) method has been applied in this study to identify and utilize the assets available within the REDTIS community (Rinawati et al., 2022). This approach emphasizes community empowerment by optimizing local potential and enhancing the community's capacity to independently manage renewable energy resources (Bagas et al., 2024). Through the ABCD method, sustainable energy management that is highly competitive is expected to be achieved, supporting the development of the intensive aquaculture sector.

This service program aims to improve the energy independence of the REDTIS community in Slilir Village through the implementation of solar panel technology. The objectives include providing a reliable renewable energy solution to support intensive aquaculture operations, reducing dependence on conventional energy, and enhancing the community's capacity to manage renewable energy independently. Thus, the program not only delivers economic benefits but also contributes to environmental sustainability and the well-being of the community.

2. METHODS

The Asset-Based Community Development (ABCD) approach was used in this study. The ABCD method focused on empowering the Red Tilapia farming community by leveraging local assets and resources to achieve sustainable development goals. With the ABCD approach, this project is expected to significantly contribute to increasing the energy independence of the Red Tilapia farming community and provide a model that can be adopted by other communities facing similar challenges.

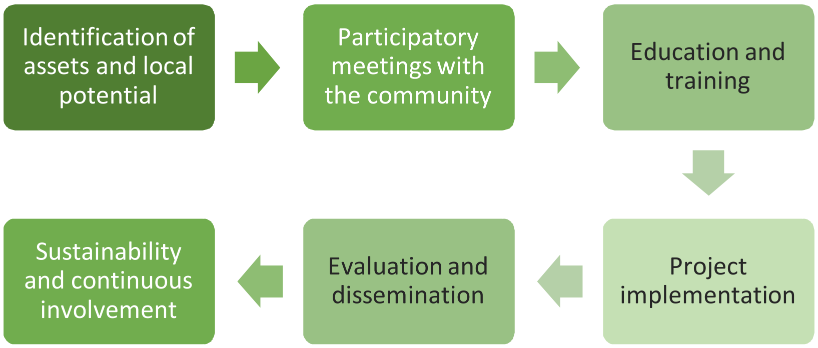

Figure 6. Methods applied in community service

The implementation of this method for the solar panel energy independence project in the REDTIS farming system was carried out through the following stages (Cholily et al., 2024).

Identification of Community Assets

In the first stage of the ABCD method, community assets were identified. This process involved mapping the physical, socio-economic, and environmental assets within the REDTIS community. The activities included: (1) Surveys and Interviews. Data were collected through surveys and interviews with community members to identify available resources; (2) Field Observations. Physical assets such as land, farming facilities, and other natural resources were identified by conducting direct observations at the Red Tilapia farming location in Slilir village, Bakalan Krajan, Malang; (3) Asset Mapping. A community asset map was developed, covering human resources, local organizations, infrastructure, and renewable energy potential.

Needs and Potential Analysis

In the second stage, an analysis of the renewable energy needs and potential within the REDTIS community was conducted. The activities included: (1) Energy Needs Assessment. The energy requirements for operating aerators in the Red Tilapia farming system were identified; (2) Renewable Energy Potential. The potential for solar energy at the farming site was analyzed, including sunlight intensity, duration of exposure, and available areas for solar panel installation; (3) Gap Evaluation. A gap assessment was performed between energy needs and the availability of conventional energy sources to determine the contribution solar panels could provide.

System Planning and Design

In the third stage, the solar panel system was planned and designed according to the community's needs and potential. The activities included: (1) Technical Design. The technical design covered the number and type of solar panels, battery capacity, and automatic control devices; (2) Implementation Plan. An implementation plan was developed, including the installation schedule, budget, and required resources; (3) Training and Capacity Building. Training was conducted to improve the community members' capacity to operate and maintain the solar panel system.

Implementation and Installation

In the fourth stage, the solar panel system was implemented and installed at the Red Tilapia farming site. The activities included: (1) Equipment Installation. Solar panels, inverters, batteries, and control systems were installed at the designated location; (2) System Testing. The system was tested to ensure that all components functioned properly and according to the planned design; (3) Technical Adjustments. Technical issues encountered during the installation process were resolved to ensure the system was fully operational.

Monitoring and Evaluation

In the fifth stage, the performance of the solar panel system and its impact on community energy independence were monitored and evaluated. The activities included: (1) Performance Monitoring. The system's performance was monitored for 30 days post-installation and periodically thereafter to ensure efficient operation and to meet the community's energy needs; (2) Impact Evaluation. The impact of the solar panel implementation on energy independence, cost efficiency, and sustainability for Red Tilapia farming was evaluated; (3) Community Feedback. Feedback was gathered from community members regarding their experiences using the solar panel system and suggestions for improvements.

Reporting and Dissemination of Results

In the final stage, the results of the study were reported and disseminated to stakeholders and other relevant parties. The activities included: (1) Final Report. A final report was prepared covering the entire process and outcomes of the ABCD method implementation in this project; (2) Publication. The research results were published in scientific journals and conferences as a means of sharing knowledge and experiences with the academic community. Additionally, publications were made through social media and local news platforms.

3. RESULTS AND DISCUSSION

Assets Identification and Requirement Analysis

The results of the assets identification and requirement analysis for the Red Tilapia Intensive System (REDTIS) community have been compiled. The identification of assets, utilizing the Asset-Based Community Development (ABCD) method, revealed that the REDTIS community possesses numerous resources that strongly support the development of renewable energy based on solar panels. First, the community has adequate land space, which allows for the installation of a sufficient number of solar panels to meet the energy needs for operational purposes. Additionally, the site receives optimal sunlight throughout the day, making it ideal for maximizing energy production from solar panels. In terms of human resources, the REDTIS community is predominantly composed of young and productive individuals, indicating the community's potential to engage in training and adapt to new technologies. The community manages more than 30 farming ponds, demonstrating a significant economic potential and substantial energy needs. Therefore, renewable energy solutions are deemed highly relevant and strategic for enhancing energy efficiency and community independence. Figure 1 illustrates the survey and asset mapping activities in the REDTIS community.

Figure 1. Implementation of survey and community asset mapping in the Redtis community

System Design

Figure 2 presents the design of the solar panel system intended for implementation at the REDTIS community site. The system, as designed, generates electricity from 200 WP solar panels, which convert sunlight into direct current (DC) electricity. The electricity produced by the solar panels is passed through an ACS712 current sensor, which measures the current flow from the panels before it is routed to a 30A solar charge controller. This controller plays a crucial role in regulating the flow of electricity to charge the batteries and prevent overcharging or over-discharging, both of which could shorten the lifespan of the batteries. A 12V 100Ah battery is used to store the energy generated by the solar panels, allowing it to be utilized when sunlight is unavailable, such as during nighttime.

The system is also equipped with an INA219 voltage and current sensor to monitor the voltage and current flowing to or from the battery. These measurements are transmitted to an ESP32 microcontroller, which serves as the monitoring and control center for the system. The ESP32 collects data from the ACS712 and INA219 sensors and enables wireless monitoring through a Wi-Fi network.

For energy consumption from the battery, the system is equipped with a 500W inverter, which converts DC electricity from the battery into alternating current (AC) electricity, required by AC-powered devices such as the 100W aerator. This aerator is the primary device powered by the electricity generated by the system. The inverter supplies the necessary AC power to operate the aerator by drawing energy from the battery.

Overall, the system was designed to harness renewable energy from solar panels, manage energy storage in the battery, and provide electricity for devices that require alternating current. With the integration of current and voltage sensors into the ESP32, the system can be monitored and controlled in real-time to ensure operational efficiency and reliability.

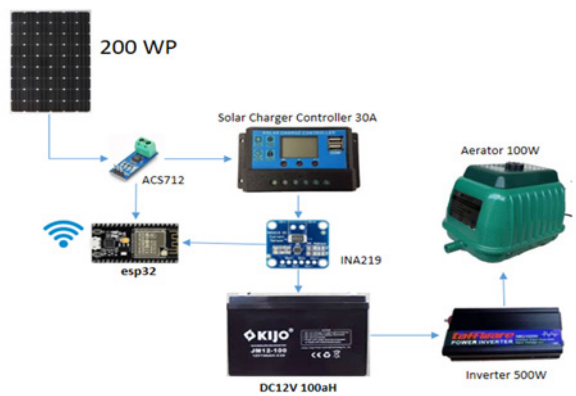

Figure 2. Solar panel system design

Solar Panel Implementation Results

The community service project has been completed with the installation of two solar panels, totaling 200 WP capacity, along with a 100Ah battery, a 30A solar charge controller, and a 500W inverter at the REDTIS community. The installation involved community members, who were provided with explanations and hands-on experience in the implementation of this solar panel system. The system was designed to meet the energy needs of a 100W aerator that operates within the intensive farming system. Figure 3 shows the system installation process at the REDTIS community site.

Figure 3. Solar panel system installation

System capacity and performance

The installed solar panels have a total capacity of 200 WP, which, under optimal conditions, can generate approximately 1 kWh of energy per day (assuming 6 hours of effective sunlight per day). The 100Ah battery, at 12V, provides an energy storage capacity of 12 kWh. The 30A solar charge controller regulates the charging and discharging of the battery, while the 500W inverter enables the conversion of DC to AC power for electrical equipment.

Energy needs of the aerator

A single 100W aerator requires a total of 24 kWh of energy per day (100W x 24 hours) if it operates continuously. The installed solar panel system is expected to meet a portion of this energy demand, reducing reliance on conventional energy sources. The current solar panel capacity provides a partial contribution to the aerator's total daily energy needs.

System performance analysis

Based on the monitoring and evaluation conducted over several months of operation, the following key findings related to the performance of the solar panel system were observed.

Energy Production and Consumption

The solar panels successfully generated an average of 1 kWh of energy per day, which was stored in the battery to power the aerator. The aerator consumed 24 kWh of energy per day, meaning the solar panel system provided approximately 41,3 percent of the aerator's total daily energy needs.

Figure 4. Duration of power usage

To validate the credibility of these findings, a comparison with previous studies and initiatives is essential. Sunaryono et al. (2023) implemented a similar solar panel system for aquaculture in another community, achieving an average daily energy production of 1.2 kWh with a slightly larger solar panel capacity (250 WP). While their system covered a higher percentage of energy needs (approximately 50 percent), their setup also required higher initial investment and maintenance costs.

Similarly, a study by Hariyanto et al. (2023) highlighted the use of photovoltaic technology in rural energy systems, reporting a 40 percent reduction in grid dependency. However, their study did not integrate automated energy management systems, which are a key feature of the system used in this project. This distinction underscores the importance of integrating advanced technologies to optimize energy utilization in aquaculture operations.

Efficiency and sustainability

The solar panel system demonstrated good efficiency in generating and storing energy. However, due to the large energy demand of the aerator, the contribution from the solar panels needs to be increased to achieve full energy independence. With the solar panel system, the REDTIS community was able to reduce its dependence on electricity from the main grid, which not only lowered operational costs but also enhanced sustainability and long-term energy independence.

Economic and Environmental Benefit

The implementation of solar panels has provided economic benefits by reducing electricity costs for operating the aerator. Based on the data in Figure 4, the average power generated by the solar panel system can run the aerator for 9 hours a day. To calculate the cost of running a 100 Watt aerator for 9 hours with an electricity cost of 1 kWh at 1600, the calculation can be done as in Equation 1.

$$\text{Energy (kWh)} = \text{Power (kW)} \times \text{Time (hours)}$$
$$\text{Energy} = 100 \text{ Watts } (0.1 \text{ kW}) \times 9 \text{ hours} = 0.9 \text{ kWh}$$

So, the total energy used to run the 100 Watt aerator for 9 hours is 0.9 kWh. The cost incurred if using electricity from PLN at a rate of 1 kWh rounded to Rp 1600 can be calculated using the Equation 2.

$$\text{Cost (in Rupiah)} = \text{Energy (kWh)} \times \text{Cost per kWh}$$
$$\text{Cost} = 0.9 \text{ kWh} \times \text{Rp}1600 = \text{Rp}1{,}440$$

Thus, the cost incurred to run a 100 Watt aerator for 9 hours is Rp 1,440 x 30 = Rp 43,200. The results of this activity also show a positive environmental impact. Use of renewable energy from solar panels has contributed to reducing carbon emissions and the environmental impact associated with the use of fossil fuels (Dwisari et al., 2023).

By reducing dependence on fossil energy, this program contributes to reducing carbon emissions and preserving the environment. Previous research indicates that the transition to renewable energy can yield significant environmental benefits, including reducing air pollution and improving people's quality of life (IPCC, 2021). Thus, this community service is not only beneficial economically but also aligns with global efforts to address climate change.

The community previously relied heavily on electricity supplied from the main grid for 24-hour aerator operations in the ponds. Operating one aerator requires 100 watts of power. The total energy consumption for the aerator over 24 hours amounts to 2.4 kWh. With an electricity rate of Rp1,600 per kWh, the total daily cost is Rp3,840. Over one month, the average expense for a single aerator is calculated as 30 x Rp3,840 = Rp115,200, imposing a significant economic burden on the community.

After the implementation of solar panels, the available electricity capacity increased with a contribution of 0.9 kWh per day. This reduced the reliance on grid electricity by 37.5 percent, directly lowering the monthly electricity cost to approximately Rp115,200 – Rp43,200 = Rp72,000. In addition to the economic benefits, the community also reported a reduction in aerator operational disruptions, which were previously frequent due to power outages. This success reflects improved stability and operational efficiency in the intensive red tilapia farming system.

Challenges and solutions

The main challenge faced by the system was the insufficient energy production capacity of the solar panels to meet the aerator's entire energy demand. Potential solutions include increasing the number of solar panels and expanding the battery storage capacity (Harahap et al., 2022). Moreover, the use of a more advanced energy management system could help optimize the distribution of energy generated by the solar panels (Wati, 2020). For example, adjusting the aerator's operating time to align with peak solar energy production could improve overall energy efficiency (Arifin et al., 2022).

Potential for Further Development

This community service project has highlighted the significant potential of using solar panels to support energy independence in the Red Tilapia farming community. Future research could explore the integration of grid technologies that combine various renewable energy sources and enhance energy management efficiency (Supari, 2022). It is crucial to base such efforts on a deep understanding of the local context and the community's needs, with the primary goal of providing tangible and sustainable benefits, transitioning from conventional technologies to more efficient and environmentally friendly solutions (Nova et al., 2023).

The asset-based approach applied in this community service has proven effective in empowering the community. By leveraging existing strengths and resources, this program has successfully created a strong social network among community members. These results support the understanding that development focused on local assets can enhance community resilience in facing challenges (Kretzmann & McKnight, 1993). Through strengthening social networks, the community is not only able to manage the solar panel system but also develop other business potentials that can improve their well-being.

4. CONCLUSION AND RECOMMENDATIONS

The application of solar panels in the REDTIS community has significantly contributed to supporting energy independence and operational sustainability in Red Tilapia farming. Although the current energy contribution from the system has yet to fully meet the energy needs of the aerator, it marks a positive initial step toward renewable energy transformation within the community.

However, a key limitation of this study is the battery capacity, which is currently limited to 100 Ah. This capacity is insufficient to store enough energy to support 24-hour operations. Therefore, it is recommended to increase the battery capacity to 300 Ah to provide adequate energy storage and ensure uninterrupted system operation throughout the day. With improvements in battery capacity, energy production, and energy management optimization, the system has the potential to achieve full energy independence, reducing reliance on conventional energy sources and lowering operational costs. Furthermore, the successful implementation of this system offers a replicable model for other communities facing similar challenges, demonstrating its broader applicability and impact. Future initiatives should focus on addressing this limitation and scaling up the solution to maximize its benefits for sustainable aquaculture practices.

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REFERENCES

Arifin, Z., Saroso, B. A., Kurniawan, A., & Ageftry, F. D. (2022). Pemanfaatan energi surya sebagai energi alternatif aerator untuk meningkatkan kualitas air kolam ikan hias berukuran kecil. *Elektrika*, *14*(2), 66-75. http://dx.doi.org/10.26623/elektrika.v14i2.5752

Bagas, M. C., Sholikhah, R. A., Faroha, S., & Rahmawati, V. (2024). Implementasi asset based community development dalam menumbuhkan modal sosial, ekonomi dan budaya pada masyarakat pesisir Desa Branta. *Community Development: Jurnal Pengembangan Masyarakat Islam*, *7*(2), 168-188. https://doi.org/10.21043/cdjpmi.v7i2.22509

Cholily, Y. M., Effendy, M., Indrawan, R. F., Subairi, S., Hakim, R. R., & Suwandayani, B. I. (2024). Diseminasi pakan mandiri pada budidaya ikan berbasis teknologi Resirculating Aquaculture System (RAS) berbantuan solar cell di Desa Parangargo. *Community Development Journal: Jurnal Pengabdian Masyarakat*, *5*(5), 10252-10260. https://doi.org/10.31004/cdj.v5i5.36270

Corkish, R. (2004). Solar cells. In C. J. Cleveland (Ed.), *Encyclopedia of energy* (pp. 545-557). Elsevier. https://doi.org/10.1016/B0-12-176480-X/00328-4

da Costa, T. P., da Costa, D. M. B., & Murphy, F. (2024). A systematic review of real-time data monitoring and its potential application to support dynamic life cycle inventories. *Environmental Impact Assessment Review*, *105*, 107416. https://doi.org/10.1016/j.eiar.2024.107416

Dwisari, V., Sudarti, S., & Yushardi, Y. (2023). Pemanfaatan energi matahari: Masa depan energi terbarukan. *OPTIKA: Jurnal Pendidikan Fisika*, *7*(2), 376-384. https://doi.org/10.37478/optika.v7i2.3322

Harahap, P., Adam, M., & Oktrialdi, B. (2022). Optimasi kapasitas rooftop Pv off grid energi surya berakselerasi di tengah pandemi covid-19 untuk diimplemtasikan pada rumah tinggal. *RESISTOR (Elektronika Kendali Telekomunikasi Tenaga Listrik Komputer)*, *5*(1), 31-38. https://doi.org/10.24853/resistor.5.1.31-38

Hariyanto, W., Utama, S. N., & Fatchurrohman, F. (2023). Implementation of renewable energy using smart light solar cell system for mosque energy efficiency. *Abdimas: Jurnal Pengabdian Masyarakat Universitas Merdeka Malang, 8*(4), 538–548. https://doi.org/10.26905/abdimas.v8i4.11173

Muntini, M. S., Rahayu, L. P. P., Fatimah, I., Faridawati, F., Suyatno, S., Yuwana, L., & Indrawati, S. (2024). Implementasi pemanfaatan Pembangkit Listrik Tenaga Surya (PLTS) untuk peningkatan produktivitas budidaya ikan dan pertanian di Kalurahan Sumbersari. *PESARE: Jurnal Pengabdian Sains dan Rekayasa*, *2*(2), 188-199. https://doi.org/10.24815/pesare.v2i2.38943

Nova, N., Parwati, N. M. S., & Fera, F. (2023). Analisis kendala budidaya ikan nila dengan metode bioflok di Desa Karawana Kec. Dolo Kab. Sigi. *Transformasi: Journal of Economics and Business Management*, *2*(1), 257-263. https://doi.org/10.56444/transformasi.v2i1.525

Panagoda, L. P. S. S., Sandeepa, R. A. H. T., Perera, W. A. V. T., Sandunika, D. M. I., Siriwardhana, S. M. G. T., Alwis, M. K. S. D., & Dilka, S. H. S. (2023). Advancements in Photovoltaic (Pv) technology for solar energy generation. *Journal of Research Technology & Engineering*, *4*(3), 30-72.

Rinawati, A., Arifah, U., & Faizul, A. H. (2022). Implementasi model Asset Based Community Development (ABCD) dalam pendampingan pemenuhan kompetensi leadership pengurus MWC NU Adimulyo. *Ar-Rihlah: Jurnal Inovasi Pengembangan Pendidikan Islam, 7*(1), 1-11. https://doi.org/10.33507/ar-rihlah.v7i1.376

Saleh, J., Budi, S., & Salam, S. (2021). *Pengembangan budidaya ikan nila*. Pusaka Almaida.

Sunaryono, S., Diantoro, M., Taufiq, A., Susanto, H., Najmi, M. I., & Yuliana, F. (2023). Pemanfaatan teknologi sel surya untuk optimalisasi budidaya ikan lele berbasis sistem biofloc-aquaponic. *DEDIKASI: Jurnal Pengabdian Masyarakat*, *5*(1), 51-57. https://doi.org/10.32332/d.v5i1.5684

Supari, S., Pinandita, S., Pratama, S. Y., & Abimanyu, L. B. (2022). *Optimalisasi listrik tenaga surya dalam mobilitas perahu: Metode dan analisanya*. PT. Literasi Nusantara Abadi Grup.

Wati, E. K. (2020). *Aplikasi manajemen & efisiensi energi*. LP_UNAS.