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SUSTAINABLE COMMUNITY SERVICE INNOVATION: IMPLEMENTING SOLAR POWER AND WATER FILTERS ON POULTRY FARMS IN TULUNGAGUNG REGENCY

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Abstract

A community service initiative was undertaken at UD. Risky Barokah, an egg-laying poultry farm in Sumberingin Kidul, Ngunut District, Tulungagung Regency. Operating since 2010 on a 7,000 m² site with nearly 10,000 chickens, the farm has faced persistent challenges related to water contamination and high electricity costs. To mitigate these constraints, a solar-powered water filtration system and a 1.1 kWp photovoltaic installation were implemented. The intervention was directed toward improving poultry health and egg productivity through access to clean water, reducing dependence on the electrical grid, and strengthening staff capacity through technical training. Outcomes demonstrated estimated monthly electricity savings of Rp247,500–Rp330,000 and consistent water quality that enhanced flock health and output, while simultaneously lowering the farm's carbon footprint. The project highlights the applicability of renewable energy and appropriate technology in promoting sustainable and cost-effective poultry production.

Keyword: Solar-Powered System, Water Filtration, Poultry Farming, Renewable Energy, Sustainable Technology

INTRODUCTION

The economic structure of Sumberingin Kidul Village, situated in Ngunut District, Tulungagung Regency, has been delineated by a diversified foundation encompassing agriculture, cottage industries, and animal husbandry. Agricultural activity is primarily represented by extensive rice cultivation, facilitated by an integrated irrigation system incorporating both technical and non-technical channels. In parallel, the cottage industry sector has been sustained through the production of construction materials, including bricks and kaolin-based roof tiles, as well as the processing of food commodities such as coconut grater and traditional culinary products. Animal husbandry has likewise constituted a critical component of the village economy, encompassing poultry enterprises (laying hens and broilers), caprine farming (Etawa goats), and aquaculture practices (Desa Sumberingin

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Kidul,2020).

At the broader regency level, poultry farming has been acknowledged as a principal economic sector in Tulungagung, with Ngunut District recorded as holding the second-largest concentration of poultry farmers. In 2023, Ngunut egg production was second only to Rejotangan District, the largest supplier in Tulungagung Regency (Table 1).

Table 1. Distribution of poultry by district and type in Tulungagung Regency, 2023

District	Free Range Chicken	Laying Hen	Broiler	Duck
Besuki	41479	307949	338773	39423
Bandung	57183	67380	728362	82828
Pakel	238457	8780	381120	66536
Campurdarat	132783	61063	550506	27270
Tanggunggunung	145866	27373	1905599	944
Kalidawir	101789	403650	1270399	74577
Pucanglaban	48354	82872	1820906	10893
Rejotangan	223742	1780206	825760	42227
Ngunut	216232	950693	762240	33037
Sumbergempol	118343	695069	211733	40249
Boyolangu	151004	39165	284569	16282
Tulungagung	43072	826	188019	5221
Kedungwaru	258593	495876	684745	5390
Ngantru	187165	691389	995146	42202
Karangrejo	79207	216880	508160	33062
Kauman	141406	6317	127040	40687
Gondang	127703	11709	635200	60075
Pagerwojo	67142	-	804586	2626
Sendang	129676	63327	3091307	5859
Total	**2.509.196**	**5.910.524**	**16.114.170**	**629.388**

Source: Livestock and animal health services Tulungagung regency.

Sumberingin Kidul Village is administratively located within Ngunut District, which, as indicated in Table 1, occupies the second position in Tulungagung Regency in terms of poultry farming population. In 2023, egg production from laying hens in Ngunut District was documented at 950693 eggs, ranking it second after Rejotangan District, which recorded a total of 1,780,206 eggs (BPS Tulungagung, 2023). According to data released by the Tulungagung Regency BPS in 2017, Sumberingin Kidul Village contained 24 registered laying hen farmers, of whom only UD. Risky Barokah has remained active. These small and medium enterprises (SMEs) have subsequently served as a partner in community service initiatives undertaken by a team of lecturers from the State Polytechnic of Malang.

Furthermore, community service initiatives conducted by lecturers from the State Polytechnic of Malang were implemented in collaboration with a small and medium enterprise (UKM) partner, UD. Rizky Barokah. The poultry facility, operational since 2010, occupies approximately 7,000 m² and comprises 11 coops constructed initially to accommodate up to 30,000 chickens. However, as a consequence of the COVID-19 pandemic, the current flock size has declined to approximately 10,000. An intensive housing system has been adopted, wherein each coop, measuring roughly 15 m × 18 m, is designed to enhance egg productivity and maintain avian health.

Despite the farm's considerable production potential, several operational constraints have been identified, notably concerning the suboptimal quality of drinking water, dependence on electrically powered water distribution, and elevated energy expenditures. Exposure to contaminated water has been associated with adverse health outcomes in poultry, including gastrointestinal disturbances, diminished feed consumption, and heightened vulnerability to infectious diseases (Raut et.al., 2024). There are signs that the groundwater quality at the coop has declined, which may be caused by its closeness to the chicken manure collection site, as shown in Figure 1.

Figure 1. Chicken manure waste pond located near a water source

The poultry farm at UD. Risky Barokah encounters significant challenges related to water quality and electricity consumption from the national power grid (PLN). Contaminated drinking water is known to induce various diseases in poultry, leading to a decline in productivity and an increase in healthcare expenses. Additionally, disruptions in the electricity supply, particularly during power outages, can impede the functioning of the water pumping system, which in turn affects the poultry's access to water and, consequently, their overall health. Moreover, the substantial electricity costs incurred for lighting, water pumping, and heating equipment significantly raise operational expenses, thereby diminishing profitability.

To mitigate these challenges, the implementation of a solar-powered water filtration system offers a viable solution, capable of lowering electricity costs, stabilizing water supply, and ensuring water quality. The adoption of this renewable technology can reduce reliance on external resources, enhance operational sustainability, and decrease long-term operational expenses, while simultaneously improving poultry health and productivity. This strategy also supports the economic and environmental sustainability of poultry farming.

IMPLEMENTATION METHOD

A. Flowchart of Community Service Implementation

Community service (CS) initiatives were undertaken at the UD. Risky Barokah laying hen farm, involving the installation of a solar power generator and a dedicated poultry water filtration system. These installations were completed on August 23, 2025. The effectiveness of these activities is directly tied to the use of proper, efficient, and sustainable methods.

Consequently, a rigorous focus on the implementation methods of the CS project is essential, particularly regarding the solutions developed by the project team. To ensure the smooth and successful execution of the project, a detailed technical description of the methodology is also required to complement the overall framework. The implementation of the community service project follows several key stages, as illustrated in the flow chart in Figure 2.

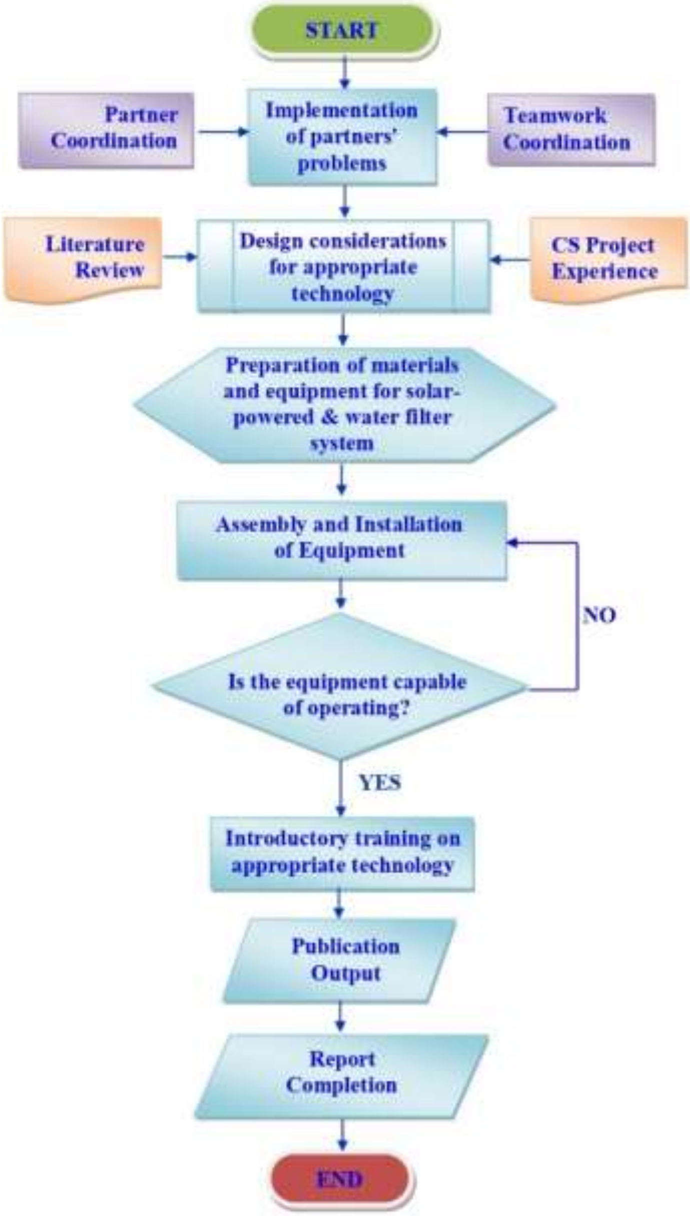

Figure 2. Community service implementation flowchart

The flowchart presented in Figure 2 delineates the structured process for executing a CS project at the UD. Risky Barokah laying hen farms. The process initiates with a phase focused on teamwork and coordination, wherein the project team collaborates to address the specific challenges encountered by the partner farms, ensuring that the solutions align with their particular needs. It is followed by a comprehensive literature review, which serves as the foundation for the design considerations regarding appropriate technology.

Based on previous community service projects, the team will prepare the necessary materials and equipment for installing the solar power and water filtration systems. The systems will then be assembled, installed, and evaluated for functionality. Once confirmed as operational, training will be provided on the use of the technology. Finally, the project outcomes will be documented and published to contribute to the body of knowledge on sustainable livestock management.

B. Overview of Solar Energy Applications in Community Service

The incorporation of solar photovoltaic (PV) systems into community service initiatives in Indonesia from 2021 to 2024 has demonstrated notable progress, primarily through programs conducted by lecturer teams from the State Polytechnic of Malang (Polinema). Early activities concentrated on basic electrification, such as providing stable lighting and reducing reliance on the national power grid (PLN). Over time, however, the scope of applications expanded to agriculture, aquaculture, education, public safety, and religious facilities. These developments illustrate both the growth of technical expertise and the role of renewable energy as a driver of practical solutions that enhance productivity, operational efficiency, and community resilience. Consequently, solar energy has come to be recognized not only as a technological innovation but also as a significant force in socio-economic transformation across rural and urban areas.

From 2021 to 2024, the adoption of solar photovoltaic (PV) systems in Indonesian community service programs advanced markedly, with lecturer teams from the State Polytechnic of Malang (Polinema) playing a central role. These initiatives reflect the growing adaptability of PV technology to address rural electrification, agriculture, aquaculture, religious institutions, and public safety, underscoring the role of renewable energy as both a technological innovation and a catalyst for socio-economic resilience.

The initial phase in 2021 focused on community-scale electrification. Asrori et al. (2021) introduced a solar DC system at TPQ Al-Murtadho, Malang, enabling lighting through 12 V LED lamps while demonstrating the capacity of PV systems to sustain pumps and aerators, thereby reducing dependence on the national grid. In parallel, Gumono et al. (2021) installed three solar streetlights at the Aisiyah Dau Orphanage, which not only enhanced neighborhood security and supported nighttime activities but also improved residents' technical skills in assembling and maintaining PV-based lighting.

In 2022, applications diversified to aquaculture and rural infrastructure. A notable example was the installation of a 600 Wp micro-solar power plant for koi aquaculture in Tulungagung (Asrori et al., 2022). The system, comprised of four 150 Wp panels, an 850 VA hybrid inverter, and a 100 Ah VRLA battery, powered a 75 W pump with a filtration capacity of 26,000 liters per hour, generating operational savings of approximately IDR 108,352.5 per month. Simultaneously, Polinema extended PV use to rural safety infrastructure through solar-based street lighting and lighting for tourist facilities around Malang ((Nurhadi et.al, 2023). Evaluations confirmed adequate illumination at strategic points, improving nighttime mobility and reinforcing PV's role in rural security and tourism support.

The year 2023 marked further expansion into agriculture and public facilities. Asrori et al. (2023) implemented a 600 Wp mini-scale PV system in a poultry farm in Blitar. The installation generated 3.6 kWh per day, resulting in electricity savings of IDR 162,000 per month while securing continuous heating for day-old chicks (DOCs), a critical factor for livestock sustainability. Concurrently, Witono et al. (2023) developed PV-powered warning lights for rural roads in Tulungagung, using 100 Wp monocrystalline panels, a 10 A MPPT controller, a 12 V 65 Ah battery, and a 40 W LED unit. In the same period, Polinema teams installed solar streetlights at the Baitul Ummah Mosque and in Klandungan Hamlet, improving community safety, lowering dependence on PLN power, and fostering awareness of renewable energy (Ridzki et al., 2023; Novfowan et al., 2023).

By 2024, PV applications demonstrated significant diversification and refinement. In Tulungagung, Asrori et al. (2024) deployed a 540 Wp a hybrid system to power a high-pressure water sprinkler in cattle farming, effectively reducing humidity and temperature within barns while lowering operational costs. Similarly, Adiwidodo et al. (2024) applied a 100 Wp PV system to support koi spawning ponds by ensuring continuous aeration, thereby promoting sustainability and productivity in aquaculture. At the same time, Hidayat et al. (2024) upgraded the PV power plant at the Al-Ikhlas Islamic Boarding School in Malang, improving its capacity from 600 Wp to 1,000 Wp and achieving a performance ratio of 0.809 with an efficiency of 18.8% (15.47% in field trials). Meanwhile, Junus et al. (2024) extended applications to the Imam Bonjol Mosque and additional PV-based streetlights, further embedding solar energy in community safety systems and public infrastructure.

Overall, the progression of photovoltaic solar initiatives undertaken by Polinema's academic community between 2021 and 2024 demonstrates not only the widening scope of applications across diverse sectors but also their strategic contribution to socio-economic transformation, as reflected in cost savings, capacity-building at the community level, and the enhancement of local resilience through renewable energy adoption.

RESULTS AND DISCUSSION

The implementation of the community service program produced notable outcomes, reflected in the successful installation of a solar-powered water filtration system, the establishment of a hybrid solar power unit, and the delivery of technical training. Together, these components contributed to improved operational efficiency and sustainability within the poultry coop environment. The detailed results of these activities are presented in the following discussion.

A. Installation of Water Filtration System

At UD. Rizky Barokah farm, the installed water filtration system was equipped with an 800 W centrifugal pump delivering a flow rate of approximately 30–50 liters per minute, with an operational mean of 40 liters per minute. Under these parameters, the 5,000-liter storage tank could be filled within 2–3 hours, accounting for pressure losses across the filtration stages and ultraviolet (UV) disinfection unit.

The multi-stage filtration process consisted of three principal components: (i) a large fiber-reinforced plastic (FRP) tank (145 cm × 10") containing with silica sand and activated carbon for the removal of suspended solids and chemical contaminants; (ii) a cartridge sediment filter housed in a blue casing for turbidity and fine particulate reduction; and (iii) a 60 W UV lamp for microbial inactivation. Water distribution was supported by PVC piping integrated with semi-automatic three-way valves and corrosion-resistant fittings, ensuring consistent delivery throughout the poultry enclosures. The performance outcomes of the filtration system at the UD. Rizky Barokah's facility is illustrated in Figures 3 and 4.

Figure 3. Placement of water filters below water reservoir buildings

Figure 4. Filtration system for drinking water in poultry houses

The multi-stage filtration system has been shown to significantly enhance the quality of drinking water, thereby mitigating the risk of waterborne diseases such as Salmonellosis, E. coli infections, and Cholera. As a result, the need for veterinary medications is diminished, leading to improvements in the health and productivity of laying hens. These results align with prior research that emphasizes the importance of a clean water supply in curbing pathogen outbreaks and reducing antibiotic usage in poultry farming (e.g., Anderson et al., 2021; Fatima et al., 2022; Li et al., 2023). Therefore, the adoption of effective water filtration technologies in this initiative not only confirms its technical viability but also underscores the broader significance of water quality management in promoting sustainable poultry farming practices.

B. Installation of Solar Power Systems

A solar power generation system, integral to this community service initiative, was installed utilizing two 550 Wp monocrystalline photovoltaic panels positioned atop a water reservoir. To optimize solar energy absorption in accordance with the local latitude, the photovoltaic array was oriented toward geographic north at an inclination of 10°–15°. The installation site was strategically selected to maximize direct solar exposure and mitigate efficiency reductions caused by potential shading from adjacent structures or foliage, as depicted in Figure 5.

Figure 5. Positioning of solar panels above the water reservoir building

Upon completion of the solar panel installation, the solar power system is configured and interconnected, comprising an inverter, battery, MCB breaker, and auxiliary electrical components, as illustrated in Figure 6. The solar energy harvested by the installed panels is subsequently directed through a 1,500 VA hybrid inverter for storage in batteries, with the option of hybridization to the local electricity grid. Through inverter management, the utilization of solar energy is maximized, grid dependency is reduced, and supply continuity is maintained. A 100 Ah/12 V deep-cycle VRLA battery provides an energy capacity of approximately 1.2 kWh, ensuring operation of the pump and filtration unit during nighttime or reduced solar exposure. With an average effective solar irradiance of 5–6 hours daily, the system is projected to generate 5.5–6.6 kWh per day. This energy yield enables sustained operation of an 800 W pump for 2–3 hours, sufficient to replenish a 5,000-liter storage tank, while excess capacity may be allocated to agricultural loads or additional charging. In conditions of temporary solar input loss, the battery alone can supply pump operation for approximately 0.5-1.5 hours.

Figure 6. Supporting apparatus within photovoltaic energy systems

Installation of a 1.1 kWp photovoltaic system, capable of producing approximately 5.5–6.6 kWh per day, yields projected monthly electricity savings between Rp 247,500 and Rp 330,000, thereby constituting a substantial economic advantage for poultry producers. Such financial relief may be reallocated toward enhancing feed quality, improving flock health, or investing in modernized housing infrastructure. Beyond direct economic returns, solar energy utilization contributes to operational efficiency, environmental sustainability, and energy autonomy, while also providing contingency power during outages, ensuring long-term resilience for poultry enterprises. The technical performance of the system applied to drinking water filtration in poultry houses, along with its associated financial implications, is presented in Table 2.

Table 2. Performance evaluation of the installed Solar-PV system

Parameter	Value
Water pump power consumption	800 W (0.8 kW)
UV-Lamp on Filtration System	60 W
Water flow rate	30–50 L/min (avg. 40 L/min)
Filtration tank/ reservoir capacity	5,000 L
Solar panel capacity	1100 Wp (2 x 550 Wp panels)
Hybrid Solar Inverter	1.5 kVa
Battery capacity	100 Ah/12 V (1.2 kWh)
Daily solar energy production	5.5–6.6 kWh
Daily pump operation duration	~2–3 hours
Estimated annual electricity saving	Rp 3,011,250 – 4,015,000

Therefore, energy autonomy is further enhanced through the implementation of solar panels, reducing reliance on external power sources and ensuring the smooth operation of farm infrastructure during power outages. When the state electricity supply (PLN) is disrupted, the solar photovoltaic system serves as a supplemental power source, supporting critical poultry housing components such as lighting, ventilation, and water supply systems. Furthermore, the adoption of solar energy facilitates environmental sustainability by mitigating the farm's carbon emissions through the use of renewable solar energy. This commitment to environmental stewardship not only promotes ecological wellbeing but also strengthens the farmer's position as a sustainable producer, which can appeal to a highly environmentally conscious consumer demographic.

C. Technology Transfer and Handover to Poultry Farmers

This community service (CS) initiative not only provides technical solutions but also empowers farmers with the necessary competencies to operate and maintain solar power and water filtration systems, promoting greater independence in livestock management. The initiative includes comprehensive instruction and orientation on the principles of solar energy and filtration systems, followed by system trials to ensure full operational functionality. Upon successful testing, the equipment is formally transferred, as documented in Figures 7 and 8, ensuring a smooth technology transfer from the service team to the partner beneficiaries. This process guarantees that the partners acquire the essential knowledge and skills to independently operate and maintain the systems, with continued technical support available when required. Post-transfer monitoring and evaluation are expected to enhance system performance, ensure long-term benefits for the farmers, and boost their competitiveness in the agricultural market. As a result, this CS initiative has made a significant impact on poultry farmers in Tulungagung, leading to improved economic outcomes, increased productivity, and enhanced sustainability of their operations.

Figure 7. The equipment handover ceremony at UD. Rizky Barokah poultry farm

Figure 8. The handover of solar water filtration equipment to CS partners

The integration of a solar-powered water filtration system at UD. Risky Barokah has been established as a viable approach for rural electrification and sustainable water resource management. System performance reflected in consistently stable water flow, efficient filtration, and dependable solar energy generation has fulfilled operational demands while yielding appreciable economic savings. The initiative further exemplifies effective technology transfer, as infrastructure development has been combined with community capacity-building efforts to secure long-term operational sustainability and resilience. Dependence on unstable and costly grid electricity is thereby reduced, supporting environmental objectives through a lower carbon footprint, in alignment with national policies promoting renewable energy and rural advancement. Implementation challenges persist, particularly regarding initial capital outlay and ongoing maintenance, most notably for batteries and inverters, which necessitate continual oversight to ensure system longevity. Nonetheless, with adequate training and post-installation supervision, such obstacles can be successfully mitigated. In summary, this project offers a replicable framework for the incorporation of renewable energy technologies in agricultural settings, thereby enhancing productivity, reducing operational costs, and advancing environmental sustainability.

CONCLUSION

The implementation of a solar-powered water filtration system at UD. Rizky Barokah poultry farm was found to deliver notable operational, health, and financial benefits. The system, which included a 1.1 kWp photovoltaic array, supplied continuous electricity for a multi-stage filtration process that improved water quality and, as a result, enhanced poultry health and productivity. This technological implementation resulted in substantial monthly electricity cost savings, demonstrating the economic viability of solar energy. Future enhancements were recommended, including employee training, consistent performance monitoring, and the potential for system expansion to further improve efficiency and long-term sustainability.

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