

## Implementation of Water Filtration Method with Solar Power Plant for Residents of Gomang Hamlet Lajolor Village

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### ABSTRACT

The implementation of water filtration method with solar power plant aims to optimize natural resources through water filtration installations by converting solar power into electrical energy to meet the clean water needs of Gomang hamlet and Lajolor Village residents. The methods used to carry out community service are service and mentoring. Technical implementation is divided into three stages: preparation, implementation, monitoring, and evaluation. At each stage of implementation, instruments that refer to the objectives of the service based on the results of observations in the field are used. The results of this service program are in the form of using PLTS to replace electricity needs for drive pumps and filtration equipment to provide safe, healthy, and clean water for residents of Gomang Hamlet. In the long term, it can also be improved in the form of mineral water packaging to enhance the economy of residents. This program also produces outputs in the form of maintaining a sustainable ecology, especially by supporting the sustainability of spring water sources. The Water Filtration Program with PLTS can optimize the water supply produced from the abundant springs in Gomang Hamlet-Lajolor Village and increase residents' income by cultivating healthy living. The implementation of this program requires assistance and sufficient time. Optimization of limited time has not been able to provide maximum results. Therefore, this program needs to be implemented continuously. Local community groups and related parties enthusiastically followed the community service activities in Gomang hamlet. Nevertheless, the participation of various parties in supporting the program's implementation is needed in the future.

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## INTRODUCTION

The Government of the Republic of Indonesia's encouragement to develop innovative ideas in the new and renewable energy (EBT) utilization sector continues to be encouraged. As stated in the National Energy Policy, which sets a target of 23% use of EBT sources by 2025, Meanwhile, in 2030, the target is 31% (Agustine et al., 2023). This policy is motivated by the factual conditions of energy potential, especially solar energy in Indonesia, which reaches 50% but has only been realized by 7% (Tampubolon & Adiatma, 2019). Logically, various parties must be involved to implement the EBT use program.

In its development, the need for electrical energy has almost become a vital scale for society. In fact, almost all countries need electrical energy, with the exception of Indonesia. This is influenced by human life and lifestyle in the current era, which is always related to the quality of energy use. The Ministry of Energy and Mineral Resources (ESDM) of the Republic of Indonesia released data showing that there was an increase of 2.26% in national per capita electricity use in 2019. This data shows an increase of 1,084 kWh per capita. The increase that occurred in 2020 amounted to 1,089 kWh per capita, and in 2021, there was an increase of 1,109 kWh per capita. This increase is equivalent to 92.22% of the 2021 specified achievement of 1,203 kWh per capita (Dihni, 2021).

Another fact shows that Indonesia's electrification adequacy is 71.2%. Whereas in other countries such as Singapore and Malaysia, it is 100% and 85%, respectively. Based on this data, there are at least 28.8% of Indonesians who have not yet received electricity supply (Adam, 2016). Reflecting on this kind of situation, the use of renewable energy is a relevant alternative solution to be developed. One form of renewable energy uses sunlight with the construction of solar power plants (Huda, 2018), which can produce electrical energy for community needs. The current government is supporting the use of renewable energy (Yuliza et al., 2023) because of the cost of providing expensive electricity (Oh & Park, 2019). Even though the main source of electricity in Indonesia comes from fossil fuels, its supply is diminishing and damaging the environment (Cheng et al., 2020; Ko et al., 2015; Yuliza et al., 2021). Renewable energy itself is energy that can be returned naturally, quickly, and sustainably.

This community service activity is allocated in Gomang Hamlet, Lajolor Village. This area is one of the areas in Tuban Regency that is located in the middle of the forest and on the slopes of the hills along the Kendeng mountains. Geographically, Gomang hamlet is surrounded by forest areas under the management jurisdiction of Perum Perhutani. This condition gives the impression of an isolated area, far from the city center, at a distance of about 48 km. However, behind the appearance of the region, there is tremendous potential that, if developed, will be able to improve the economic level and welfare of the local community.

One of the natural potentials found in Gomang Hamlet is a spring whose water discharge is constant during both rainy and dry seasons. The water produced is relatively abundant but has not been optimally utilized. The majority of local community members utilize the water for daily needs directly without further special treatment. In fact, as is known, the kendeng mountains contain lime substances that do not rule out the possibility of dissolving in the water consumed. Of course, from a health aspect, this condition is not worth recommending because, in the long run, it can affect the level of public health.

Based on the description of the area, at least some problems can be identified in Gomang hamlet, Lajolor Village. These problems include the abundant supply of water from springs in Gomang hamlet, Lajolor Village, but it has not been optimally utilized and has no economic value. Residents also directly consume water without special treatment, which has a negative impact on their health. In terms of technology, there is no use of water filtration technology utilizing PLTS that can reduce residents' expenses and even increase income. The use of solar panels that convert solar energy into electricity is currently widely used in several institutions, both commercial and non-commercial (Boers & Ben-Asher, 1982). By using this method, no combustion is required, so it tends not to cause environmental damage (Nfaoui & El-Hami, 2018).

Furthermore, the condition of plants around springs is still limited, which has the potential to reduce water discharge, even though water is a substance that is needed in human life. The availability of a clean water supply is an essential thing that must always be maintained. Clean water is essential for human life, so irregular consumption can limit its availability (Saragih et al., 2021). In the Gomang hamlet of Lajolor Village, the need for healthy, clean water is very necessary, considering that the sedimentation of lime substances in the soil still tends to dominate. Unraveling this problem also requires collaboration from various parties, so the absence of local wisdom-based synergy to optimize the potential of natural resources available in Gomang Hamlet and Lajolor Village is also a problem that is no less important to note.

On the other hand, the availability of sunlight in the Gomang hamlet area is sufficient because the geographical area is located on a hilly slope. However, this potential still requires a touch of technology. One of them is in the form of conversion into electrical energy that can be used to operate pumping equipment and water filtration. The people of Gomang Hamlet are still dependent on the electricity supply from PLN, which, of course, requires a considerable amount of money.

Based on the description above, the community service team of Sunan Bonang University took the initiative to build a water filtration installation for a solar power plant (PLTS) by utilizing renewable energy from the sun. With the potential possessed by Gomang Hamlet, this innovation is expected to create independent business opportunities that can economically increase the income of the local community. On the other hand, the problem of clean and healthy water sufficiency can be adequately addressed.

## METHODS

This community service activity was carried out in Gomang Hamlet, Lajolor Village, Singgahan Subdistrict, and Tuban Regency through several major stages. These stages include the preparation stage, the implementation stage, and the monitoring and evaluation stage. These three stages in detail can be seen in Figure 1 as follows:

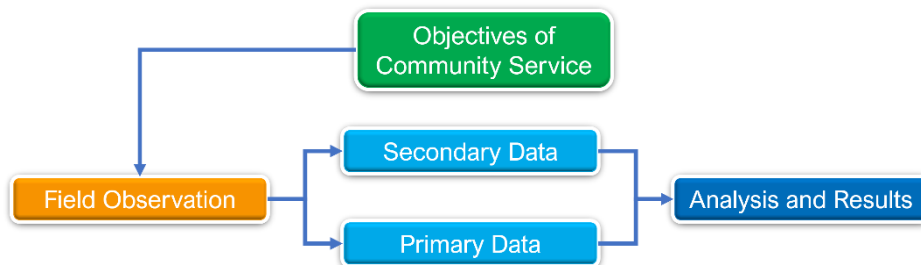


FIGURE 1. Stages of Activity Implementation

Each stage in the implementation of these activities uses instrumental methods that still refer to the objectives of the service. Of course, based on observations in the field. The results obtained from field observation activities are in the form of primary and secondary data, which are then processed through analysis so as to obtain the expected results. The instrument for implementing the stages can be presented in Figure 2 below:



FIGURE 2. Flowchart for Method

The preparation stage was conducted with field studies and supported by secondary data. The field study was intended to find out the real conditions of the area, namely Gomang hamlet, Lajolor village, Singgahan sub-district, and Tuban Regency. The real conditions include village potential, problems, potential activities, and social potential.

Furthermore, the implementation stage is carried out by forming groups and building infrastructure, in this case, using the service method. Next, training and mentoring are carried out based on the mentoring method, involving community members of Gomang hamlet in Lajolor village and related stakeholders.

The monitoring and evaluation stage is carried out with reference to the process of activities that have been carried out. This monitoring and evaluation also involved several parties, including residents, management groups, partner stakeholders, and a team from Sunan Bonang University.

## RESULTS AND DISCUSSION

### Identification of Potential and Problems

Demographically, the population of Gomang hamlet is 177 families. The economic level of the majority of the community is middle- to lower-class. In the midst of such community conditions, there is an educational institution in the form of the Wali Songo Gomang Islamic Boarding School, which has been established since 1977 with a total of 1,248 male and female students.

The geographical condition of Gomang hamlet in Lajolor village is in the middle of the forest and on top of the hills. The administration area is located in Lajolor Village, Singgahan Sub-district, Tuban Regency, East Java Province. Located in the middle of a teak forest under the management of Perum Perhutani, Gomang hamlet has natural potential in the form of a water supply that never runs out, even in dry season conditions. A satellite portrait of Gomang Hamlet can be seen in Figure 3 below:



**FIGURE 3.** Satellite photo of the Gomang Hamlet area of Lajolor Village

Most people in Gomang hamlet use springs to meet their daily water needs. The water taken also does not receive further treatment. In this case, the community directly uses the water for daily purposes. In fact, the sedimentation of lime substances dissolved in water in Gomang hamlet is relatively high and has a negative impact on health.



**FIGURE 4.** Photograph of a water source in Gomang Hamlet, Lajolor Village

The existence of the Islamic Boarding School is a unique attraction that certainly has enough influence on the pattern of life of the people of Gomang hamlet. The character of the Kyai (the caretaker of the Islamic Boarding School) is still central to the community. Therefore, the sociological contours of the residents of Gomang hamlet can be relatively directed by collaborating with local community leaders.



**FIGURE 5.** Photo of some sides of Wali Songo Gomang Islamic Boarding School

Based on the results of field observations, the potential and problems that exist in the Gomang hamlet of Lajolor village are as follows:

- The water supply generated from springs in Gomang hamlet - Lajolor village is abundant but has not been utilized optimally and economically;
- Residents directly consume the water without special treatment, and it has a negative impact on health;
- There is no use of water filtration technology by utilizing solar power plants that can reduce residents' expenses and even increase income;
- The condition of plants around the springs is still limited, potentially leading to a reduction in water discharge, even though residents need it;
- There is no local wisdom-based synergy to develop the potential of natural resources in Gomang hamlet - Lajolor village.

The adoption of water filtration techniques to make use of excess water supply to meet the needs of the people of Gomang Hamlet and Lajolor village for clean and healthy water is one of the solutions suggested in reference to the possible issues in Gomang Hamlet of Lajolor village listed above. Water treatment methods that utilize filter media—such as sand, silica, anthracite, or other types of media—as well as chemical or mineral compounds like lime, zeolite, activated carbon, resin, ion exchange, membranes, biofilters, and others are referred to as filtering methods. (Adminira et al., 2023).

Ideally, water should not be consumed directly without further treatment. The goal is to purify the water so that it is suitable for consumption (Halim et al., 2023). Therefore, renewable innovations are needed that are able to produce processed water ready to drink with good quality at relatively low operational costs.

The following alternative solution is to utilize solar power as a solar power plant to operationalize the spring infrastructure. In this case, the need for water filtration still requires a pump. The pumping equipment requires electrical energy from PLN, which has a significant cost. The use of PLTS can be a solution so that cost overruns can be overcome.

The use of PLTS as an energy source is in line with the Electricity Supply Business Plan (RUPTL) of PT PLN (Persero) for 2021–2030, where the government plans to encourage the sufficiency of electricity with the 35 GW program and the policy of developing new renewable energy (EBT)(Nurjaman & Purnama, 2022).

These problems cannot simply be shouldered and resolved by one party. Empowering stakeholders based on local wisdom is necessary to support productivity and save available resources, including the

reforestation of plants around springs. Collaboration between stakeholders is needed so that the program can run optimally.

### Activity Implementation

The targets of this community service activity include (1) community groups of Gomang hamlet, Lajolor Village; (2) Santri of Wali Songo Gomang Islamic Boarding School; and (3) Campus II students of Sunan Bonang University. The selection of this target group is also based on the mapping of areas that allow for collaboration. The forms of activities are assessment, socialization, and the establishment of management units; PLTS infrastructure development; water filter infrastructure development; operational and maintenance training; reforestation; and education and coordination with stakeholders.

The implementation of this activity refers to several previous problems and solutions. The description of problems and solutions is a reference for determining the type of specific activities carried out. In detail, the flow of activity implementation can be presented in the chart in Figure 6 below:

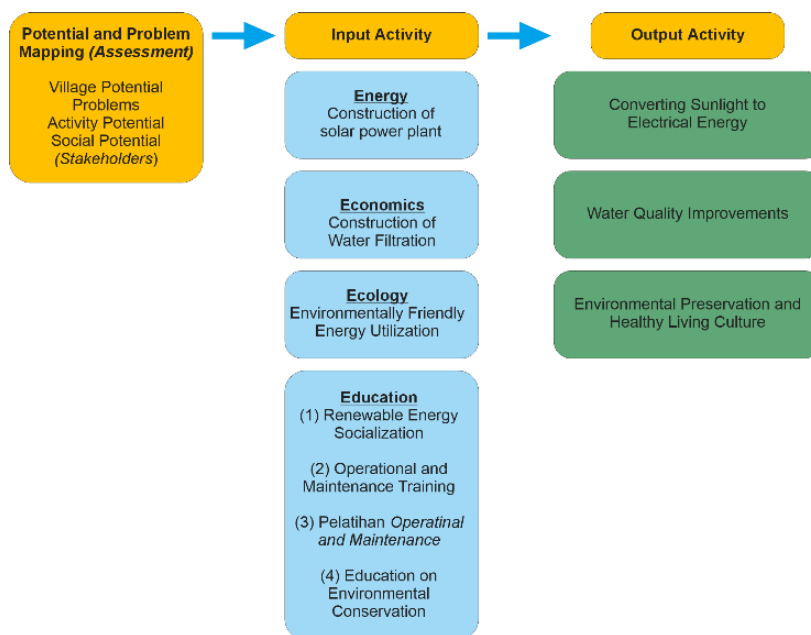


FIGURE 6. Flow of Activity Implementation

The use of PLTS as an electrical energy producer is used to operationalize jet pumps to lift water from the surface to reservoirs and filtration devices. The next series is the installation of water collection and filtration equipment. The location of the equipment installation is around the spring in Gomang hamlet, Lajolor village. An overview of the water pump and water collection and filtration circuit is presented in Figures 7 (a) and (b).



FIGURE 7. (a) Water Pump in Gomang Hamlet, Lajolor Village (b) Water collection and filtration circuit.

Water collection and filtration are done with a simple mechanism, utilizing available resources at a modest cost. Although there are modern and more sophisticated water filtration devices available, they require significant budgeting.

The next step is to save the springs through reforestation. The reforestation around the spring was carried out collaboratively with Kebun Bibit Rakyat (KBR) Sido Makmur in Gomang hamlet. An overview of the spring location and reforestation seedlings is provided in Figures 9 (a) and (b).



**FIGURE 8.** (a) Overview of Greening Plant Location (b) Seedlings of Kebun Bibit Rakyat (KBR) Sido Makmur

Factually, the number of trees available around the springs is not so many that concrete steps are needed in the form of planting varieties of trees that are able to store water supplies to save the existence of the springs. The embryo of saving the spring in Gomang Hamlet ecologically can actually be done by cooperating with the People's Seedling Garden (KBR), Perum Perhutani, and the Wali Sembilan Forestry Vocational School.

This activity is carried out on the principle of collaboration. In this case, it establishes partnerships with related stakeholders. The stakeholders who are partners in implementing this activity are:

- Wali Songo Gomang Islamic Boarding School;
- Lajolor Village Government;
- Perum Perhutani;
- Campus II Sunan Bonang University;
- Sido Makmur Seedling Farm (KBR);
- LMDH Rimba Utama Gomang hamlet;
- SMK Kehutanan Wali Sembilan.

In order to succeed in the implementation of activities, mentoring and training agendas were also carried out. This is intended to provide technical knowledge for the target activities so that they can continue to carry out these activities in the future. Apart from being a medium for coordination, mentoring is also a mechanism for reflection and evaluation of several stages of activities that have previously been carried out.



**FIGURE 9.** Assistance with USB Campus II Students

## Sustainability Overview

The results of the construction of the solar power plant and the installation of water filtration equipment will be utilized by the local community in the long term and can increase community income. In the initial stage, the program will focus on the conversion of electricity from solar power plants and water filtration. Next, the water filtration program can be developed into mineral water packaging that can be marketed commercially to the general public. Of course, with an integrated pattern and production system. The number of people who compete for the use of clean water for various household purposes has led to the loss of proper access to clean water for some people (Wicaksono et al., 2019).

From the perspective of renewable energy utilization, it is possible that PLTS can be developed on a large scale. The development of PLTS can help meet the needs of the community, apart from the element of paid electricity, as well as maintain the need for stable electricity flow voltage. Given that the Gomang hamlet of Lajolor Village is an area with an end voltage, the electricity voltage is not stable. Solar cell activity can produce an unlimited amount of electrical energy directly taken from the sun, according to the capacity of the installed equipment to meet the needs of the community (Purwanto, 2020), so that it can reduce costs. The technology used today is still essential; this can actually be developed by reducing minimal maintenance costs using rooftops. As described in BPPEN (National Energy Management Blueprint), which is targeted at 400 MW by 2024 (Sugirianta et al., 2016).

Humans have long known solar cell technology to capture the heat brought by sunlight to be converted into a source of electrical energy (Haryanto et al., 2021). The thermal utilization of solar energy is currently back in demand due to the spread of solar cooling and as part of PV/T systems to increase their efficiency. It is critical to understand how solar thermal systems operate in specific locations and under specific climatic conditions to maximize efficiency (Vig et al., 2021).

Nevertheless, at least the use of solar power plants has represented the government's program. As stated by the President of Indonesia in the G20 Presidency Forum, Indonesia has introduced to the world Indonesia's scenario to achieve net zero emissions (NZE) by 2060 or sooner. The scenario is outlined in the Grand National Energy Strategy (GSEN), which includes a plan to transition energy from fossil fuels to new and renewable energy (Felani et al., 2023).

This program is supported by the existence of local wisdom in the form of Pondok Pesantren Wali Songo Gomang, adjacent to Campus II USB Tuban. Therefore, the range of program sustainability can be ensured to be sustainable and simultaneous.

## CONCLUSION

The Gomang Hamlet-Lajolor Village Water Filtration Program with PLTS can maximize the water supply from the several springs there and raise the standard of living for the locals. The Water Filtration Program with PLTS can provide households with clean, safe water that meets their needs. By generating new jobs through water purification, the Water Filtration Program with PLTS can raise citizens' incomes and lessen their reliance on electricity. Ecologically speaking, by utilizing cutting-edge technology, the Water Filtration Program with PLTS encourages community members to actively participate in preserving natural conditions around the spring in an integrated manner. Building synergy based on local wisdom can be accomplished through collaborating with partner stakeholders through the Water Filtration Program with PLTS.

## LIMITATIONS AND FURTHER STUDIES

The obstacles to the implementation of this activity lie in the availability of supporting resources. The main one is the lack of a time limit for implementation. In program development, the availability of sufficient time is one of the determining factors for this innovation to be carried out optimally. Nevertheless, this activity was successfully implemented according to the initial plan.

Based on the above, it is necessary to conduct a follow-up study as a form of refinement of the initial studies and applications that have been carried out. The involvement of several partner stakeholders also needs to be expanded. Given that this type of activity is a program that must be carried out continuously.



## ACKNOWLEDGEMENTS

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