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Innovative Solar Water Pump with Automatic Water Level Regulator for Efficiency Rice Field Irrigation

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ABSTRACT

Nowadays, most of human activities are related to the use of technology. The invention of various innovative ideas that simplify human life is essential. One of the uses advancement technologies can applied in agricultural field, especially for irrigation processes since it becomes the critical step in agricultural activity since it ensures that plants receive an adequate water. Due to the importance of irrigation, this community service activity aimed to provide information on how to build a solar pump for irrigation purposes and implement an innovative solar water pump with automatic water level control to improve the efficiency of irrigation of rice fields in Bekiung Village. The system is designed using solar panels as the main energy source, minimizing dependence on conventional electricity and fossil fuels. With the integration of water level sensor and automatic control system, the pump is able to adjust the water supply in real-time based on the actual needs of rice plants. Field tests show that the system is able to provide water consistently and efficiently, reducing water and energy wastage. The implementation of this technology not only improves irrigation efficiency, but also supports environmentally friendly sustainable agriculture. The results of this study are expected to serve as a model for other villages facing similar challenges in irrigation water management.

Keyword: Solar Pump, Automatic Irrigation, Bekiung Village, Agriculture

1. Introduction

Climate change become one of the major threats in agricultural sector, since it related to the proper quantity and quality of water resources [1]. Plants, which is not different from human, are really need proper water for life and produce a good product. In case of that, high temperature, rainfall quantity, water scarcity become a major challenge for agricultural activity. Indonesia, which is very well known as agrarian country, is really concern about the water resources since there are many of rice field that need to provide with fresh water. Extreme weather which causing a harmful effect for water quality can lead to crop productivity loss and threatens global food stability [2].

Aligned with water problem, energy consumption is also growing rapidly and will increasing every day. It can be caused by the invention of technology with always integrated to the electricity system. Concerning to the high world's energy demand, using a renewable energy becomes one stop solution in the future. Renewable energy as unlimited energy source become the best choice for both energy sources and environmental [3]. Among all the energy sources, solar energy is the best one. Recently, there are several technologies that exist and lead a breakthrough improvement in agricultural section. Some of the advancement include smart monitor for pests and diseases, predict the environmental condition or weather for the cultivation and collect the data about moisture for the crops. Not to be overlooked, irrigation remains a key factor for successful agriculture.

Due to the climate change, many farmers in Indonesia often face problems with water resources, especially in rural areas far from the electricity grid. Bekiung village faces problems with erratic water and inefficient irrigation techniques, leading to decreased productivity of rice crops. Solutions may lie in renewable energy technologies such as solar power. Water pumps that use solar energy are an efficient and environmentally friendly alternative. Automatic water level regulation helps optimize water usage by knowing the real-time needs of the plants. Solar energy is a free and eco-friendly resource that is easily accessible during daylight hours. Amorphous, polycrystalline, and monocrystalline types of photovoltaic (PV) panels are used for solar heating, street lights, and household loads. These are the types of photovoltaic panels that effectively utilize solar energy. The aim of this research is to save electricity, reduce water wastage, and help farmers who have problems irrigating fields due to lack of water. Water is pumped into a reservoir from a borehole, and then delivered to the fields through MS and actuators [4]. Farmers require greater attention for manual irrigation operations, resulting in overwatering or drought stress due to negligence and skill limitations [5]. To maintain ideal land conditions for crops and reduce water wastage, smart irrigation systems are the right choice [6]. In particular, a favorable solution to address these issues is to implement solar power-based automatic pumping operations. This will also reduce water wastage and accelerate plant growth [7]. For irrigation systems, solar power is considered better than conventional energy sources as it provides a clean and renewable resource to power irrigation operations [8].

Many farmers around the world use water pumping in their irrigation systems. The technology is evolving rapidly, moving from traditional irrigation methods that were largely dependent on farmers to modern farming methods that utilize various machines and systems for the plantation process and water pumping [9]. Livestock are usually watered and irrigated using water pumps. Irrigation is a large area that focuses on the supply of water to grow crops and maintain landscaping features such as trees, shrubs, grass, and flowers [10,11]. To supply the required amount of water to a specific area with the right pressure and flow rate, water pumping is an essential component of irrigation systems [12]. Farmers usually use fossil-fueled or diesel water pumps or electric pumps for their conventional irrigation systems. However, fossil and diesel-fueled water pumps are detrimental to the environment as they pollute the air and contribute to the problem of climate change, which is a major issue worldwide [13]. This is because burning diesel and fossil fuels releases carbon dioxide, which causes global warming, the greenhouse effect, and harm to humans [14]. As a result, to provide the necessary energy for agricultural activities, it is imperative to utilize renewable energy resources. Solar energy is a great alternative to irrigation systems for agricultural activities [15]. It is especially beneficial for farmers in rural areas as it can reduce the amount of electricity used and the amount of fossil fuels consumed [16].

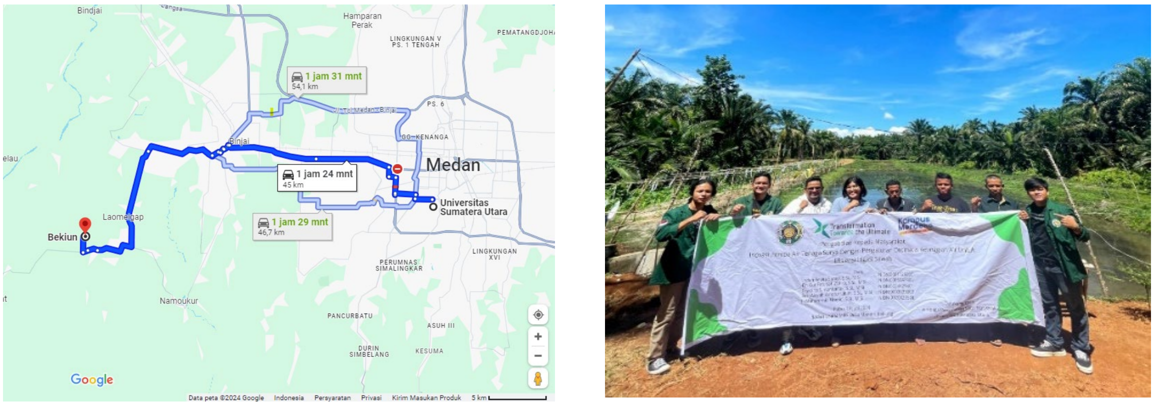
2. Implemetation Method

2.1 Tools and Materials

The tools used in making solar water pumps are solar panels, water pumps, solar charger controllers, inverters, lithium batteries, and cables. In addition, the tools used to perform the installation are multimeter, screwdriver, cutting pliers, knife, scissors, and hammer.

2.2 Community Service Location

Community service is carried out in Bekiung Village, Kuala District, Langkat Regency, North Sumatra. the partner location is 45 km from the University of North Sumatra with a travel time of about 1 hour 24 minutes by car via the road as shown in **Figure 1** below.

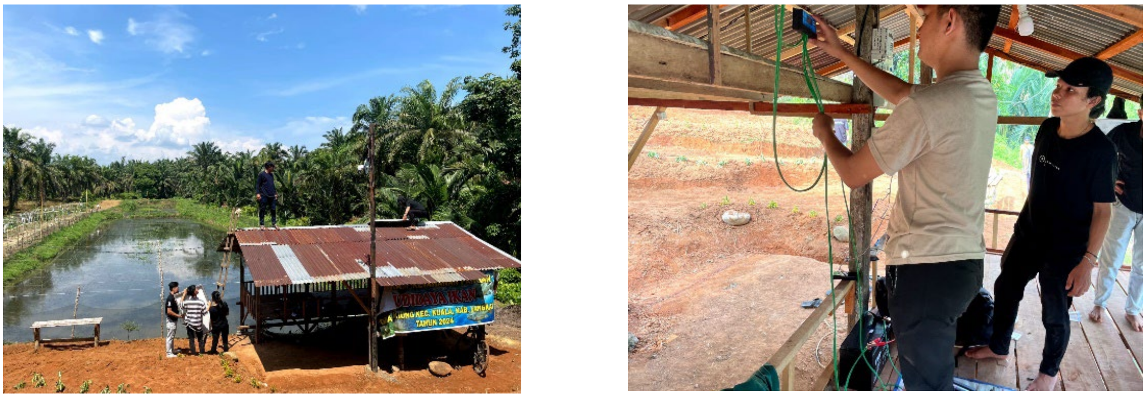


(a) (b)

Figure 1. (a) Location map of the partner network of the University of North Sumatra (b) Bekiung Village.

2.3 Assembly Process of Solar Panel and Water Pump System

It starts with the installation of solar panels and electronic components such as solar heating controllers, inverters, batteries, and water pumps in a safe place and secure from bad weather. To ensure that there are no installation errors that could lead to system failure, all cables and connections are checked, as shown in **Figure 2**. Once all components are properly installed, the system is tested to ensure that it operates according to plan. This solar water pump system, which has an automatic water level regulator, offers a sustainable and efficient solution for irrigating paddy fields in rural areas such as Bekiung Village, where conventional sources of electricity are not available and water availability is erratic.



(a) (b)

Figure 2. (a) Solar Panel Installation in Bekiung Village (b) Electronics Component Installation Process

3. Results and Discussion

The test results of the solar water pump system with automatic water level control in Bekiung Village show that the solar panels produce an average power of 300 Wp (watt peak) every day (**Figure 3**). This is enough to operate the water pump for 6-8 hours each day, depending on weather conditions. When compared to conventional irrigation methods, the reduction in water wastage is more effective. This is achieved by using a timer, which automatically regulates crop water flow according to crop needs and prevents over- or under-watering. In one growing season, the productivity of the rice crop increased, as measured by comparing the yields before and after the implementation of the system. Due to more consistent water supply, farmers reported improved crop quality and more even growth. Farmers were also very satisfied due to better yields and lack of manual work as the system was automated. Although the system is environmentally friendly and has low operational costs after the initial investment, issues include high installation costs and weather variability. Development of battery capacity and Internet of Things technology can improve efficiency. To improve agricultural productivity and irrigation efficiency in rural areas with limited power sources, this innovation offers a workable and long-lasting solution.

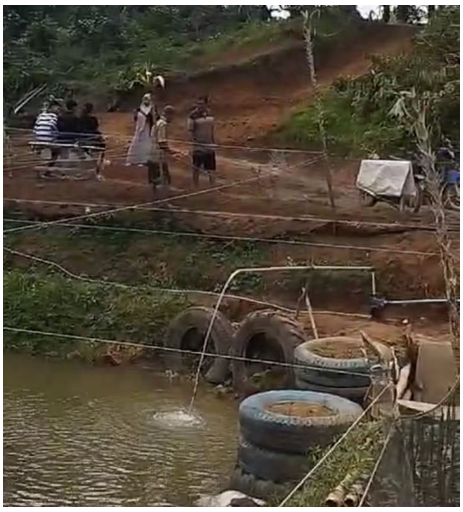


Figure 3. Pump on after all components have been assembled.

4. Conclusion

The development of water pumps with the solar power has been successfully carried out in Bekiung Village, Kuala sub-district, Langkat Regency, North Sumatra. It becomes one of the ways to promote water conservation. The solar water pump system produces sufficient and stable power, demonstrating that solar energy is a reliable option for irrigation systems. This solution also offers additional advantages such as eliminating the need for fuel and reducing pollution. Although cost and weather variability are still issues, the system increases farmer satisfaction, reduces manual labor, and offers an environmentally friendly rural irrigation solution. Through this community services, we educate the farmers and also the villagers in Bekiung village about renewable energy and provide the assistance in assembling the solar pumps to help them irrigate the rice field.

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6. Conflict of Interest

The author declares there is no conflict of interest.

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