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A Design of Mini Hydro Turbine System at Orang Asli Village, Kg Redig Pos Hau, Gua Musang

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ABSTRACT

This research project investigates the feasibility of implementing a mini-hydro power system in Kampung Redig, a remote Orang Asli village in Pos Hau, Gua Musang, Malaysia, to address the community's ongoing electricity challenges. The village currently relies on a mix of solar panels and diesel generators, both of which are unsustainable due to high maintenance costs and increasing fuel prices. Designed by the Faculty of Bioengineering and Technology at Universiti Malaysia Kelantan (UMK) in collaboration with the Society of Petroleum Engineers Kuala Lumpur Section (SPEKL), and industry experts, the mini-hydro system utilises the kinetic energy of river water to generate up to 101 kW of electricity. This research explores the system's technical design and potential to provide a more sustainable and affordable energy source for the village. Additionally, the project offers economic benefits by involving the Orang Asli community in the installation process, providing them with valuable skills and income. The results demonstrate the positive impact of renewable energy solutions on rural communities, fostering stronger relationships between the Orang Asli, UMK, and external stakeholders while improving living standards through reliable electricity access.

Keywords: Mini hydropower; renewable energy; Orang Asli community

1. Introduction

The Orang Asli village in Kg. Redig Pos Hau, Gua Musang, is located 25 km from Gua Musang town, involving a 2-hour journey by four-wheel drive vehicle (4WD). The Pos Hau area has 10 villages, and Kg Redig is one of the villages in the Pos Hau area, which has a population of 30 houses. As a result of the survey, the electricity supply in this Orang Asli village is minimal. Through assistance from government agencies, electricity supply in this village has been held with the installation of solar panels for the use of every house in this settlement. However, the lack of maintenance and less accurate use have caused damage to the majority of solar panel component units supplied. The residents of this village only depend on diesel electricity generators and have to bear average operating costs of almost RM 400 per month to purchase diesel in the year 2023. For 2024, the cost of the diesel needed to operate the generators is increasing due to a blanket subsidy retracted by the Malaysian government, and it costs 56% of the price, raising diesel from RM 2.15 to RM 3.35 per litre. Hence, this phenomenon will also increase the cost of Kg. Redig Orang Asli's electricity

generator operation. Therefore, in light of the recent surge in diesel prices, it becomes even more prudent to consider alternative energy sources such as hydroelectric power, especially for remote communities such as the Orang Asli community in Kg Redig Pos Hau. Fig. 1 shows an aerial view of Kampung Redig, showcasing the houses of the Orang Asli villagers.

Fig. 1: Aerial view of Kampung Redig, Pos Hau, home to the Orang Asli

Electricity is widely recognised for its vital role in improving living standards, driving economic growth, and enhancing access to education and healthcare. However, rural communities in Malaysia and other developing countries often lack access to modern energy sources such as electricity. While recent years have seen significant expansion in electricity access, inadequate infrastructure for energy sources continues to be a major obstacle to the socio-economic development of these communities.

Electricity demand in Malaysia, primarily met by natural gas and coal, has expanded rapidly, with the total installed capacity now at around 30 gigawatts (GW) [1]. However, most power stations are concentrated in the densely populated and industrialised regions of Peninsular Malaysia. As a result, the reliable energy supply needed to improve living standards in rural communities like Kampung Redig, Pos Hau, Gua Musang, Kelantan, Malaysia, remains insufficient due to cost-effectiveness challenges.

On the other hand, renewable energy is derived from natural resources such as sunlight, rainwater, wind, and tides, which are naturally replenished [2]. For example, hydropower plants convert the potential energy of water into electricity, offering a clean and renewable energy source. It was reported that small-scale hydropower or mini-hydro electric power systems can generate sufficient electricity for homes, farms, or villages [3]. Thus, installing a mini-hydro electric power system provides a sustainable, localised solution to energy needs, reducing dependence on costly non-renewable sources and fostering long-term socio-economic progress in rural communities. However, these systems require control mechanisms to manage the significant variations in water flow that occur in rivulets, ensuring a consistent power supply [4].

Many case studies on the suitability of mini-hydro electric power have been conducted worldwide. For instance, an irrigation project in India was identified as a technically and financially viable site for micro-hydro power generation [5]. In Italy, a mini-hydro installation produced 1.9 GWh/year, supplying energy to 600 households and reducing flood risks in the study area [6]. Similarly, in Indonesia, the potential for mini-hydro power generation in a mountainous region was assessed, revealing that rivers could generate between 17-137 kW, sufficient to provide electricity for 37 to 304 homes [7].

This study assessed the feasibility of establishing a 101 kW mini-hydro power system at Kampung Redig, Pos Hau, Gua Musang, Kelantan, Malaysia. It involved analysing hydrological data of the river and rainfall patterns, as well as calculating key parameters such as water head and discharge, alongside the technical design of the turbine to determine the maximum and minimum power that could be generated.

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2. Mini Hydro Turbine Design

The mini hydro design system (community project) installed at Pos Hau, Gua Musang, Kelantan, is illustrated in Fig. 2. The small-scale hydroelectric power generation system utilises the energy of moving water from a nearby river stream. It begins with a water channel, which picks up the water from the river and makes it go into a casing to turn the runner. The pulleys also move by this movement, and then the generator moves.

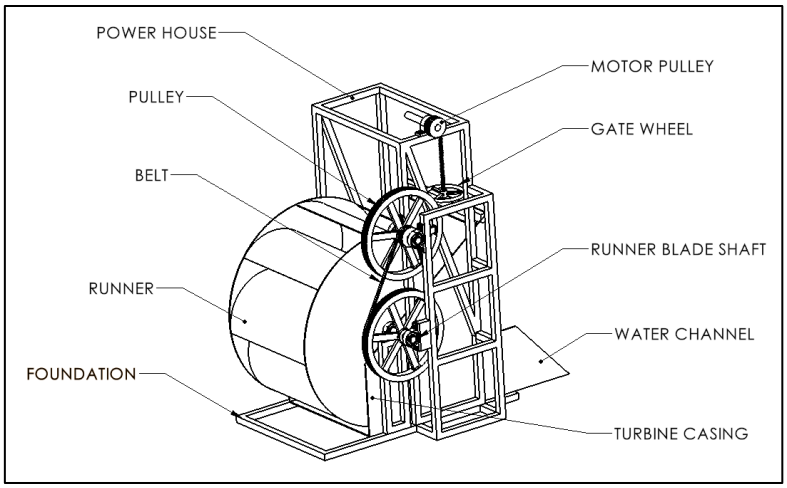

Fig. 2: The drawings of the mini hydro installed at Kg Redig, Pos Hau, Gua Musang

There are several central elements to the mini-hydro system itself. The gate wheel controls water streaming inside the turbine. This is controlled by the gate wheel, which the operator can adjust to set the flow rate, maintain the system's power output, and completely cut off water flow for maintenance or emergencies. The mechanical power from the runner blade transfers to other machine components, including the motor pulley (wherein electrical energy is generated by driving the motor shaft), using an apparatus called pulleys. Pulleys also help manage the system by controlling belt tension. It spins within the runner shaft, holding the turbine and pulley intact with precise placement to align them. The runner transforms the kinetic energy of a moving water flow into mechanical energy.

The foundation gives structural support and stability to the entire setup and bears the weight of the powerhouse and all installed mini hydro components. So, it has a half-cylindrical shape into which the water gets filled, thus preventing any shifting or settling of the structure, absorbing vibration, and evenly distributing the weight to minimize the risk of structural failure. The powerhouse is where the main components that produce electricity are housed, mounted, and protected. Based on the foundation protects equipment from weather, debris, and intruders and contributes to decreasing the turbine and generator noise.

With its ability to regulate water flow, the gate wheel keeps the turbine and generator operating conditions at a level where energy conversion occurs effectively, thus providing a continuous electric output. The foundation and powerhouse combine to keep the system stable, secure, and running optimally. Table 1 shows the function for each of the parts listed in Fig. 2.

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Table 1: Components and Functions of the Mini Hydro Turbine System

Part	Function
Power House	The structure that houses the turbine, generator, and other mechanical and electrical components. It serves as the operational hub of the system.
Motor Pulley	A mechanical component connected to the motor that drives the pulley system, transmitting rotational energy to the turbine.
Gate Wheel	Controls the flow of water into the turbine by adjusting the position of the gate and regulating the amount of water entering the system.
Pulley	Transmits mechanical power from the motor to the belt and other rotating components, allowing the turbine to generate energy.
Belt	A flexible mechanical component that transfers rotational power from the motor pulley to the turbine shaft.
Runner Blade Shaft	The central shaft connects the runner blades to the rest of the turbine assembly, allowing them to rotate as water flows over the blades.
Runner	The part of the turbine that converts the kinetic energy of the water into rotational energy, typically consisting of blades that are turned by the water flow.
Water Channel	The path through which water flows toward the turbine. The channel directs the water to maximise its impact on the turbine's blades.
Turbine Casing	The outer shell houses the turbine components, protecting them from debris and environmental factors while also directing water flow to the runner.
Foundation	The structural base supports the entire turbine system, providing stability and anchoring the system to the ground or bedrock.

Fig. 3 shows the location of the mini hydro turbine system (squared red box), installed at the side of the river. The system is strategically placed to harness the flowing water, utilising its kinetic energy to generate electricity for the nearby Orang Asli community. The river's natural flow provides a sustainable energy source, making it an ideal site for this renewable energy solution.

Fig. 3: Location of Mini Hydro Turbine System Installation

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Fig. 4 shows the installation of the mini hydro turbine system, where the key components, including the water channel, turbine casing, and generator, are set up near the riverbank. This configuration enables the system to harness the kinetic energy of the flowing water to generate electricity for the surrounding community.

Fig. 4: Mini Hydro Turbine System Installation

The design of the mini hydro turbine system for Kampung Redig effectively integrates renewable energy technology with the community's needs. By utilising the river's natural flow, the system provides a sustainable and reliable source of electricity, reducing dependency on costly diesel generators. This design not only ensures an environmentally friendly solution but also fosters local involvement and skill development, paving the way for long-term socio-economic benefits for the Orang Asli community.

3. Conclusion

The Orang Asli village of Kampung Redig, located in Pos Hau, Gua Musang, has long faced significant challenges in accessing reliable electricity. Despite initial efforts by the government to install solar panels in the village, the lack of proper maintenance and limited use have led to the failure of most of the solar systems. As a result, the villagers have had to rely heavily on diesel generators, which are not only costly to run but also becoming increasingly expensive due to rising fuel prices. With the recent increase in diesel costs, the village is facing even higher electricity bills, making it clear that a more sustainable solution is urgently needed.

This is where the mini-hydro power project comes in. Led by the Faculty of Bioengineering and Technology at Universiti Malaysia Kelantan (UMK), in collaboration with SPEKL (Society of Petroleum Engineers Kuala Lumpur Section), industry experts, and with permission from JAKOA (Jabatan Kemajuan Orang Asli), this project aims to provide the villagers of Kampung Redig with a reliable and affordable source of energy. The mini-hydro system, which uses the power of flowing water from a nearby river, will generate enough electricity to meet the needs of all 30 households in the village, reducing their dependence on costly diesel generators and providing a sustainable alternative.

In addition to the technical aspects of the project, one of the most important benefits is the involvement of the Orang Asli community in the setup and installation of the mini-hydro system. During the installation process, members of the village had the opportunity to work alongside experts, gain hands-on experience, and earn a salary. This has not only provided the villagers with valuable skills but also helped to strengthen their connection to the project, as they have

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played an active role in its development. This involvement in renewable energy projects opens up new job opportunities for the community and lays the foundation for future employment prospects. Fig. 5 shows the Orang Asli community members are actively engaged in the construction of a water dam near the mini hydro turbine. They are being compensated for their work as part of the project's efforts to involve the local community in the development process.

Fig. 5: Orang Asli community members constructing water dam near mini hydro turbine

The project also serves as a powerful example of collaboration between the Orang Asli community, UMK, government agencies, and industry professionals. By working together, these groups are not only addressing the immediate energy needs of the village but also building lasting relationships that can lead to further community development initiatives. The trust and collaboration established through this project will hopefully inspire future partnerships aimed at improving the lives of rural communities across Malaysia.

Beyond the immediate benefits of providing electricity, this mini-hydro project has the potential to transform the lives of the Orang Asli in Kampung Redig. With a consistent power supply, the village will have access to better education, healthcare, and opportunities for economic growth. This project isn't just about power—it's about empowering a community, giving them the tools they need to improve their lives, and showing them that they don't have to rely on expensive and harmful alternatives like diesel. It's a step toward self-sufficiency and a brighter future for Kampung Redig and its people.

However, implementing this project in a rural area has proven costly, primarily due to transportation challenges. The cost of renting a 4WD vehicle to access the remote village has doubled since the diesel price markup last year. Previously, it cost about RM 400 per vehicle, including a driver, but now the price has increased to RM 800 per vehicle, adding significant logistical expenses. Despite these challenges, the project remains a crucial step towards improving living standards in Kampung Redig, providing long-term access to affordable, renewable energy.

In the end, this mini-hydro project is a testament to what can be achieved when people from different sectors come together to solve real-world problems. It's more than just about energy; it's about community, collaboration, and building a sustainable future.

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