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Design Micro-Hydro Power Plant Water Resources System for Small Medium Enterprise Rice Mill in Nagari Kamang Hilia Agam

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ABSTRAK

Processing rice products into rice requires further processing, where the grain harvested from farmers is processed into rice. The Nagari Binaan Community Service team from Padang State University will later develop this process. Farmer groups say that the availability of continuous and cheap electricity is their obstacle in producing good and cheap rice products. Counseling and assistance in making civil buildings capture turbulence water micro-hydro power plants is a solution to partner problems offered by the community service team of the Nagari program assisted by Padang State University. The output of the Nagari Fostered Program will be used to build a 5000-watt capacity power plant, supporting the need for free and environmentally friendly electricity. This aligns with the government's renewable energy program for 2030, which aims to produce 25% of the national electricity from renewable sources. This program is planned for 3 (three) stages, where the first year is mapping and detailed engineering design in the form of reports and design drawings. The second year is in the form of civil construction, and the third year's target is the installation of electrical machines and panels for commissioning. There will be training for partners, such as farmers in Kanagarian Kamang Hilia, Agam.

Keywords: *Micro-Hydro; Environmentally Friendly; Turbulence; Renewable Energy; Electrification*

INTRODUCTION

The largest sector in West Sumatra's economy is still the agricultural sector. Over the last five years, the agricultural sector has accounted for 25% of West Sumatra province's Gross Domestic Product (GRDP). It also employs the largest percentage of the working population in West Sumatra, with 37-41% of the total workforce. Access to water for irrigating rice fields and plantations, as well as access to electricity for processing agricultural products, are key factors contributing to the success of the agricultural sector. To ensure a continuous and environmentally friendly electricity supply, the community service initiative is focused on planning and implementing Civil Buildings for Microhydro Power plants in Kamang Ilia District, Agam Regency, West Sumatra, to meet the agricultural needs of the community. [2]-[6].

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The Nagari Kamang Hilia covers an area of 16.31 square kilometers and consists of 17 jorong, including Jorong Koto Panjang, Dangau Baru, Dalam Koto, Batu Baraguang, Bancah, IV Kampuang, V Kampuang, Pintu Koto, Nan VII, and Balai Panjang, followed by Jorong Koto Kaciak, Koto Nan Gadang, Guguak Rang Pisang, Binu, Ladang Darek, and Solok, and Jorong Joho. The total population of Nagari Kamang Hilia is 4941 people, comprising 2451 males and 2490 females. The agricultural sector in the Kenagarian Kamang area contributes to West Sumatran agriculture, focusing on chili, onions, and rice production. Agam Regency, where the average population is involved in agriculture, particularly in Nagari Kamang Hilir, plays a vital role in the region's economic activities, especially in food crop production. The district prioritizes regional development in the agricultural sector, specifically in rice fields, to meet local food requirements and contribute to national food security. The natural conditions in Agam Regency are conducive to rice production, leading to significant harvest, production, and productivity of rice fields in the region from 2012-2016.

Table 1. Area of Harvest, Production, and Productivity of Rice Fields in Agam District in 2012-2016

Year	Harvest Area (Ha)	Production (Tons)	Productivity (Tons/Ha)
2012	56.989	66.151	5,34
2013	57.946	306.410	5,29
2014	58.511	322.621	5,51
2015	60.998	327.567	5,37
2016	66.151	367.535	5,56

The data shows a consistent increase in the harvest area, production, and rice productivity in the Agam Regency each year. In 2016, the highest harvest area was recorded at 66,151 hectares, while the lowest was in 2012 at 56,989 hectares. Likewise, the highest rice production was in 2018 at 367,535 tons, with the lowest in 2012 at 304,321 tons. Regarding productivity, the highest was in 2016 at 5.56 tons per hectare, and the lowest was in 2012 at 5.34 tons per hectare. The rice produced will be sent to rice milling businesses for processing. It's worth noting that in Kanagarian, Kamang Hilia, there are only two rice milling businesses, with one of them allocated for community service as part of the assisted Nagari program. Initial survey results have identified partner problems and proposed solutions to address these issues.

Figure 1. Farm Area

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Figure 2 Kamang Hilia mayor's office


Figure 3. Nagari Rice Milling Business


Figure 4. Irrigation of rice fields

Nagari Kamang Hilia has great potential for economic growth through its extensive rice fields. Since Nagari is located far from the end of Tilatang Kamang District, where a constant supply of electricity is vital for rice milling businesses to operate consistently, it is crucial to have

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access to an affordable and sanitary rice milling facility. The availability of water for irrigation and electrical energy to support the processing of agricultural production are essential for the success of the agricultural sector. In order to ensure continuous and environmentally friendly electricity, this community service activity focuses on planning and implementing Turbulence Water Capture Civil Buildings for Microhydro Power plants to meet the agricultural needs of Kenagarian Kamang Hilia, located in Agam Regency, West Sumatra. [2]-[14].

RESEARCH METHODS

Stages of Activities

The community service implementation is carried out by providing technical and expert assistance, training, and counseling and empowering the existing Nagari Kamang Hilia, Tilatang Kamang District community about the process of site selection, calculation, and design of the Microhydro Power Plant Water Capture Civil Building for Community Agricultural Needs in Nagari Kamang Hilia, Agam Regency, West Sumatra.

The implementation process of service activities encompasses several stages, starting with communication and consultation with the community, including village officials such as Walinagari, Nagari Farmer Group, Traditional Leaders, Youth, Culinary Business Activists, Artisans, and Workers in Nagari Kamang Hilia, alongside support from the Agriculture Office and Tilatang Kamang sub-district officials. A crucial step involves the mapping of potential water sources for the turbine drive, conducted by the UNP team and Civil Engineering Students in collaboration with the Head of the Farmer Group, utilizing DJI Phantom 3 Drone and Pix4D Capture for data collection, and analyzing the data with Pix4D Mapper and GIS Applications to create Orthophoto Maps and DSM. Furthermore, an analysis of Nagari Kamang Hilia land suitability for the location of civil buildings essential for micro-hydro power treatment plants is performed, employing GIS and AutoCAD MAP software, alongside all analog map materials and survey results. Following the land suitability analysis, a Civil Building Water Catcher Microhydro Power Plant design is developed, incorporating expert data processing and field data to produce a 2D design and cost budget plan. Additionally, the community receives training and counseling on Microhydro Power Plants, including renewable energy and maintenance aspects. This stage is complemented by field and secondary data analysis to create detailed engineering designs with precise calculations based on theoretical rules. Lastly, the project's visibility is enhanced by creating and distributing leaflets, posters, and online publications, which are shared with the mayor and farmer groups to promote the initiative.

RESULTS AND DISCUSSION

The implementation of devotion to the community of the Construction Nagari Development Programme is carried out following the planning of the implementation of devotion as follows:

Coordination of the activity agenda with the Nagari government

The first realization carried out by the UNP Service team was to communicate and consult with Kenagarian and the community to explore problems and collect initial data that will be used as a basis for determining the location of beneficiary buildings, namely Mitra Tani, rice mills, and locations for the placement of water capture civil buildings later.

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Figure 5. Photo with the Community Service team, Heller Owners, Farmer Groups and Nagari representative

Based on the discussions in the field, it was discovered that the primary issue stemmed from the significant quantity of grain crops being acquired by intermediaries and traders from areas outside of Nagari, such as the Payakumbuh and Tanah Datar Regency, which are neighboring regions of the Kamang Hilia District. It is anticipated that the Nagari Fostered service team will be capable of providing free electricity to partners. This, in turn, will lead to reduced electricity expenses and lower rice milling fees, making it appealing for local farmers to have their rice milled in Nagari Kamang Hilia.

Mapping potential water sources that will be the source of the turbine drive

The next stage carried out by the Community Service Team is to map and measure the existing water discharge and determine the Zero point that will be used as *bench-mark* water-catching civil buildings.

Figure 6. River Water Speed Measurement with Current Meter

A current meter tool determined that the average water velocity is 2 meters per second. At this water speed, generating a maximum power of 15,000 watts is feasible. However, the micro-hydro tool's output capacity is limited to 5000 watts. There is potential to enhance the motor to reach an output of 15,000 watts in the future, leveraging the available river water speed.

The Community Service Team employs drones and theodolite for field mapping. The drone scans yield three-dimensional maps that depict the surroundings of the rice fields and rice mills in the Kamang Hilia Kenagarian area. These are the outcomes of drone-based mapping.

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Processed	2023-09-18 12:26:05
Camera Model Name(s)	FC300X_3.6_4000x3000 (RGB)
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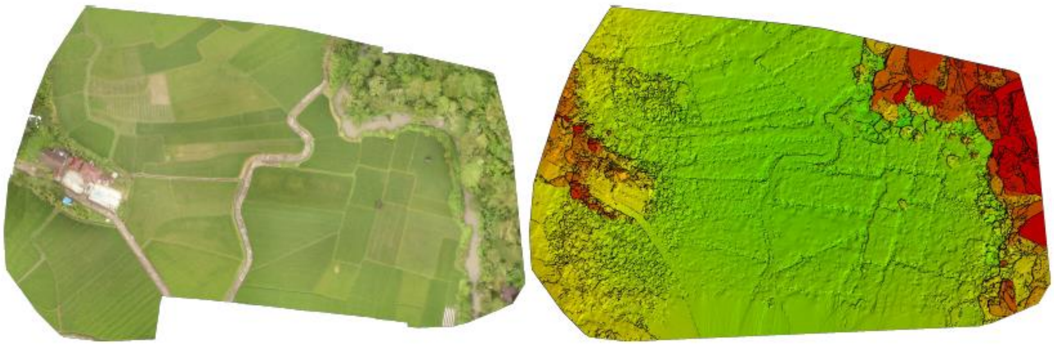
Preview



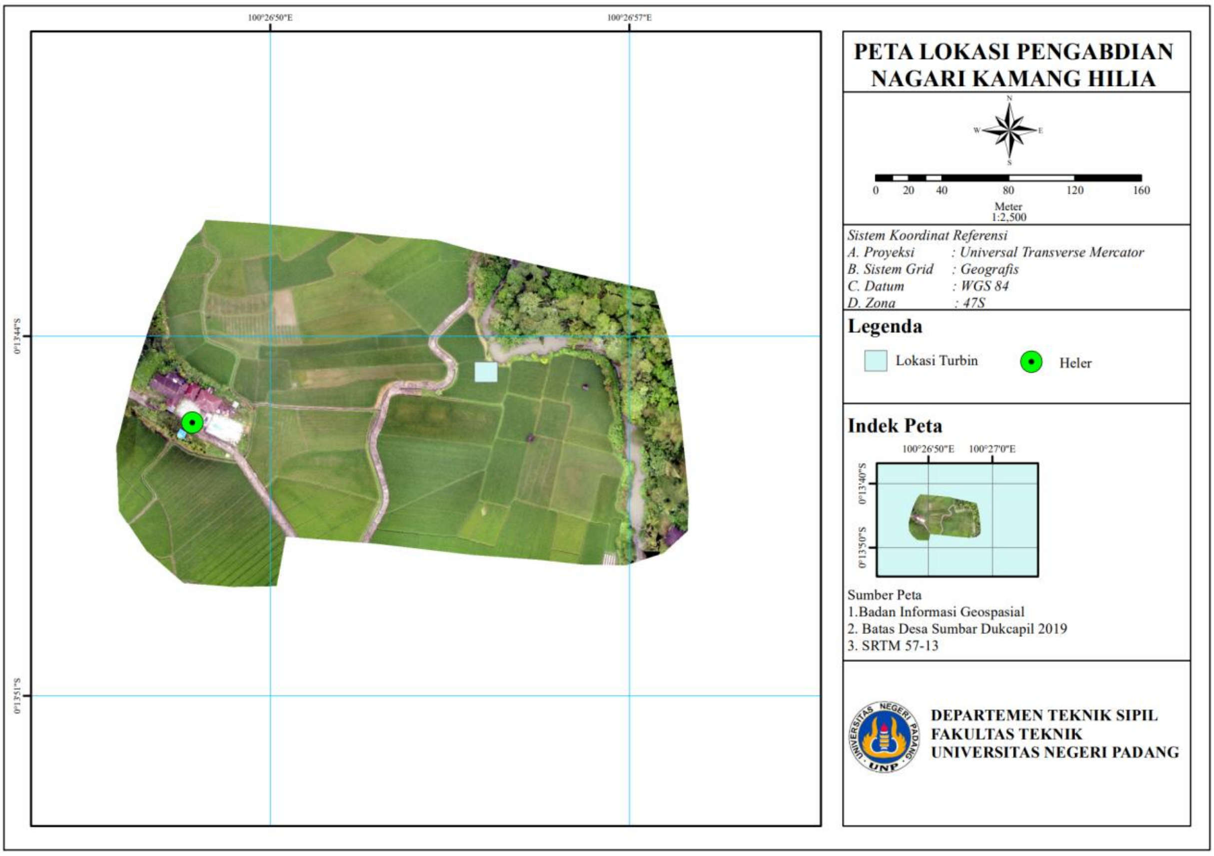


Figure 7. Map of Nagari Binaan Community Service Location, Kamang Hilia

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Analysis of the suitability of Nagari Kamang Hilia land and the location of civil buildings needed for the location of micro-hydro electricity treatment installation.

From the analysis of land suitability located near the flow of the Jorong Binu-Ladang Darek trunk river, where the location of the turbulence water catcher civil building will later be built, it was found that the river flow speed is 2 m / s, where this water speed supports the placement of the water catcher civil building later. This civil building will be built simply with microhydro constituent components expected to produce a minimum power out capacity of 5000 watts. The advantage of this turbulence civil building is that for different levels of water table and small discharge, is the ability to generate greater impact momentum to the turbine due to turbulence flow designed to help generate greater water energy.

Design of civil buildings water catcher micro-hydro power plant

The community service team will calculate the dimensional needs of the building, the minimum output of electrical power to be generated, and the budget plan needed. By conducting on-site measurements and analyzing the needs of civil structures for capturing water to generate micro-hydro power by utilizing water flow patterns to create turbulence, this system can optimize motor efficiency and prolong the lifespan of turbine bearings. The presence of a sluice gate to regulate the volume of water flowing into the turbulence civil building will allow the control of water flow to meet the required electrical power output. The provided details outline the civil design of buildings for capturing water turbulence for micro-hydro power plants that will be constructed in the assisted villages of Kamang Hilia. The physical implementation of this project will be carried out during the second and third stages of the Nagari service program.

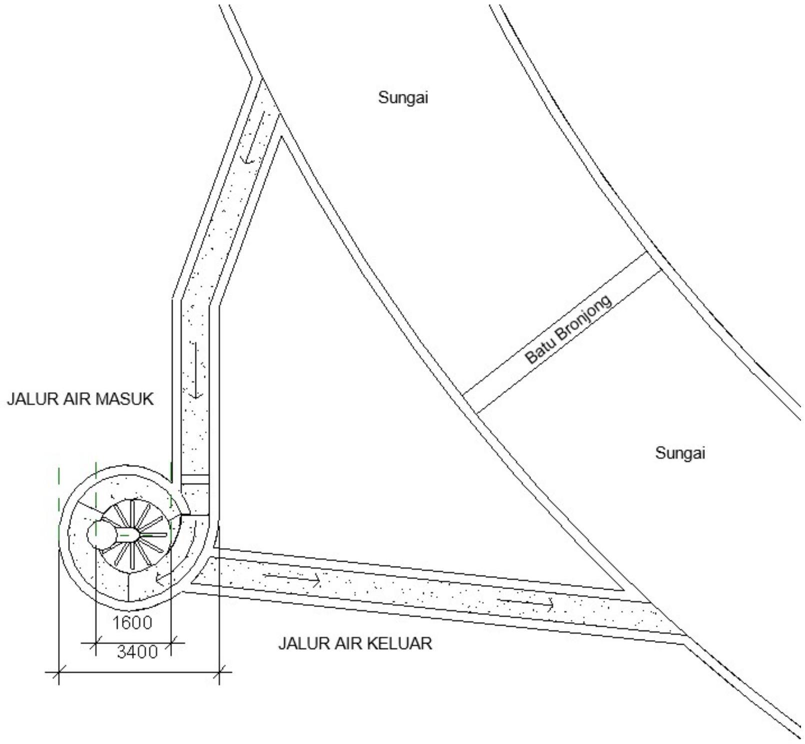

Figure 8. Turbine Installation Plan

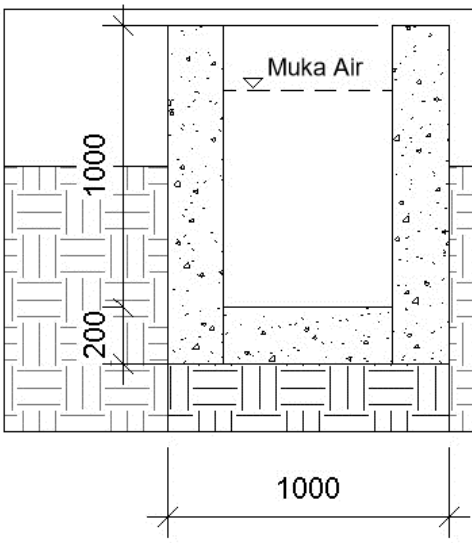

Figure 9. Water flow images

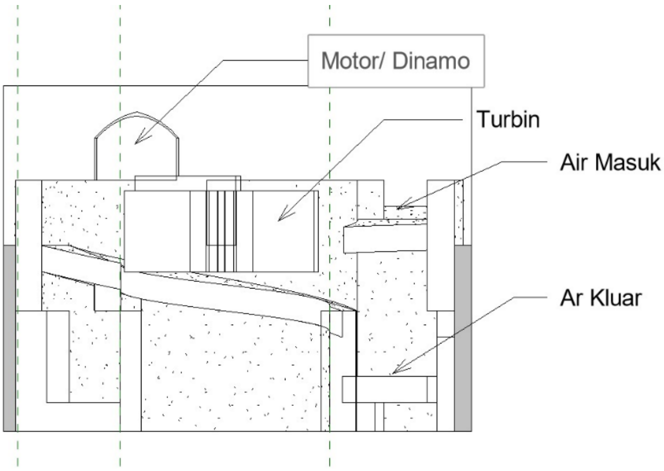

Figure 10. Detail Turbin

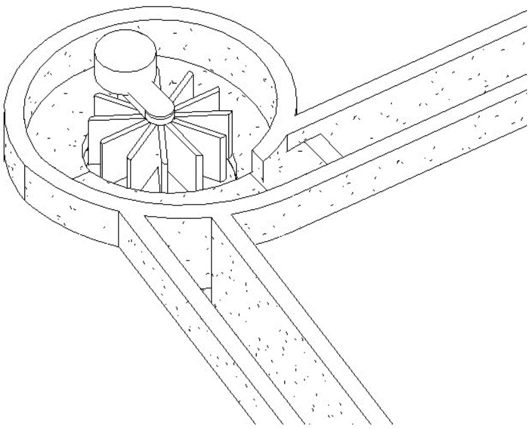

Figure 11. 3D View Turbine Image

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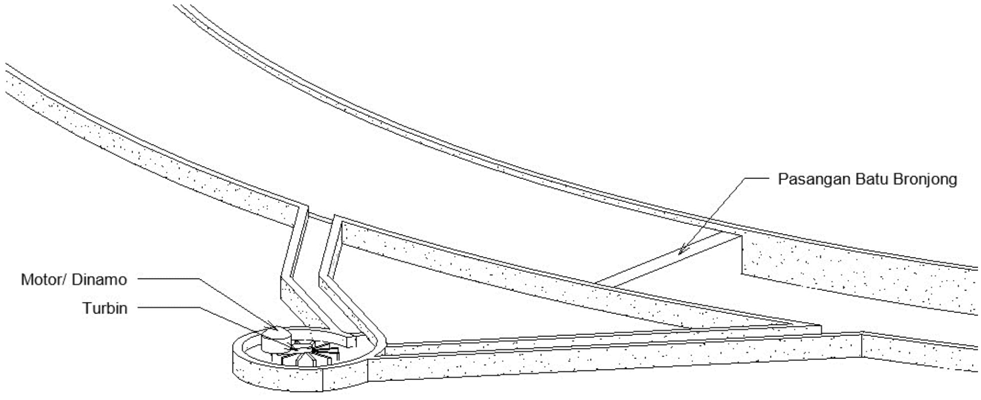
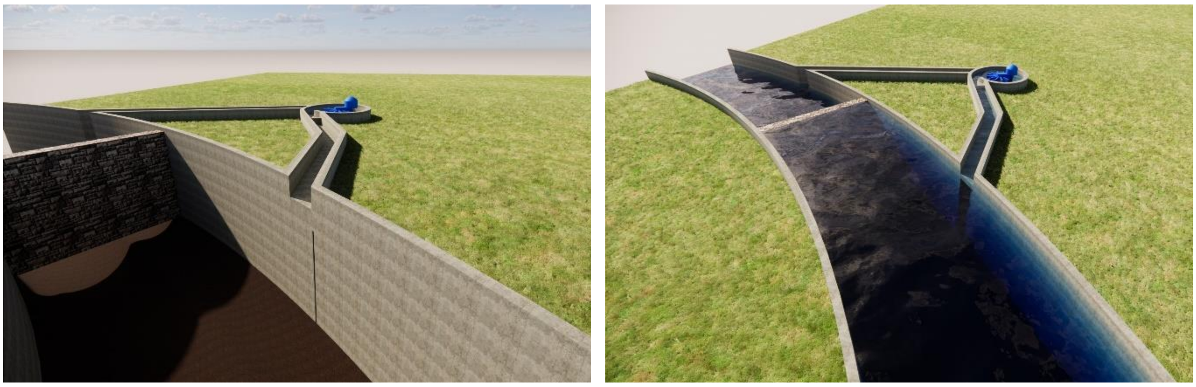
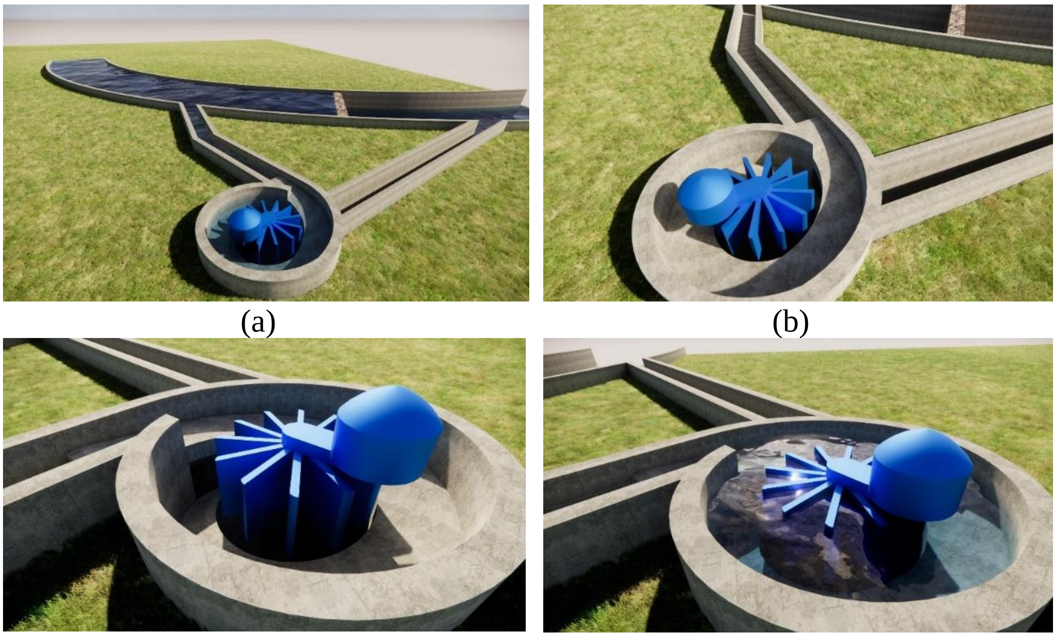


Figure 12. 3D View Image of Turbine Flow



(a) (b)

Figure 13. 3 Dimensional Design of civil buildings capturing microhydro turbulence water



(a) (b)

(c) (d)

Figure 14. Design of turbines and turbulence civil buildings

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Electrical Design

After the design of the civil building is completed, the next realization is that the UNP Assisted Nagari Service Team will design electrical panels and other electrical instruments that will channel power from turbines into electrical energy. Here is the electrical design.

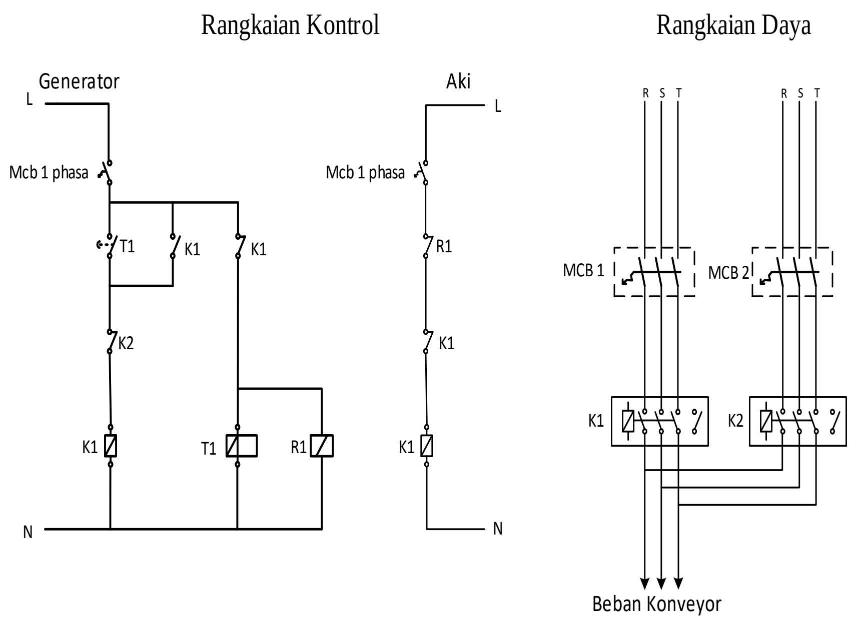

Figure 15. ATS Network Diagram

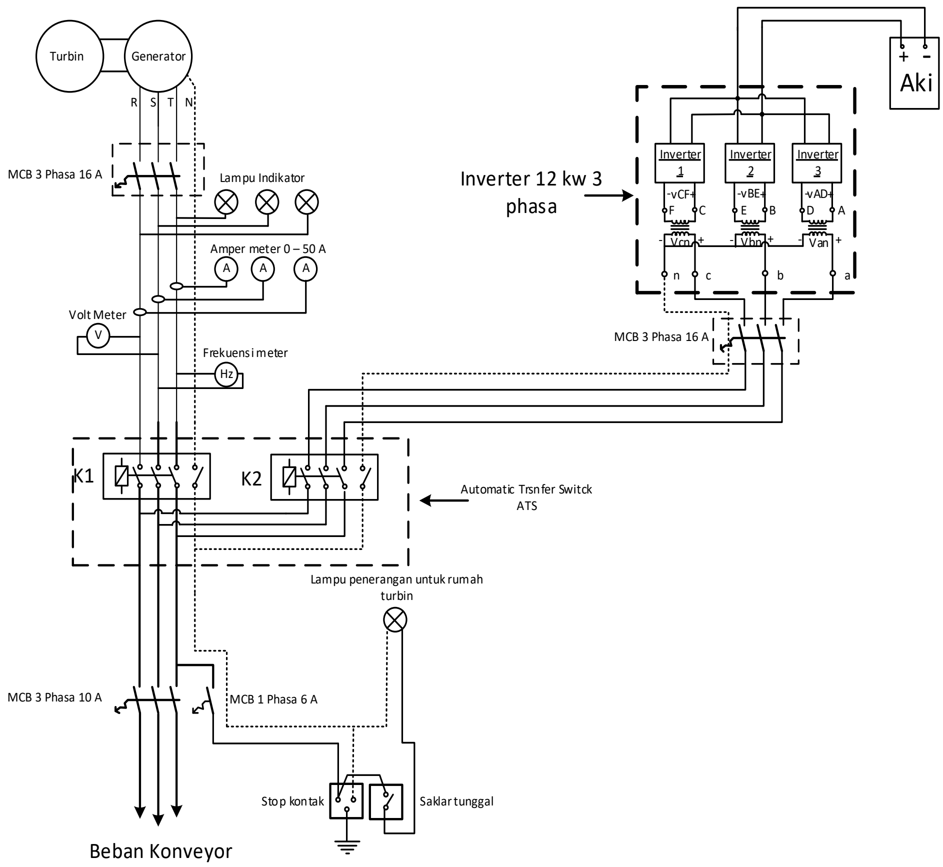

Figure 16. The circuit uses battery back up

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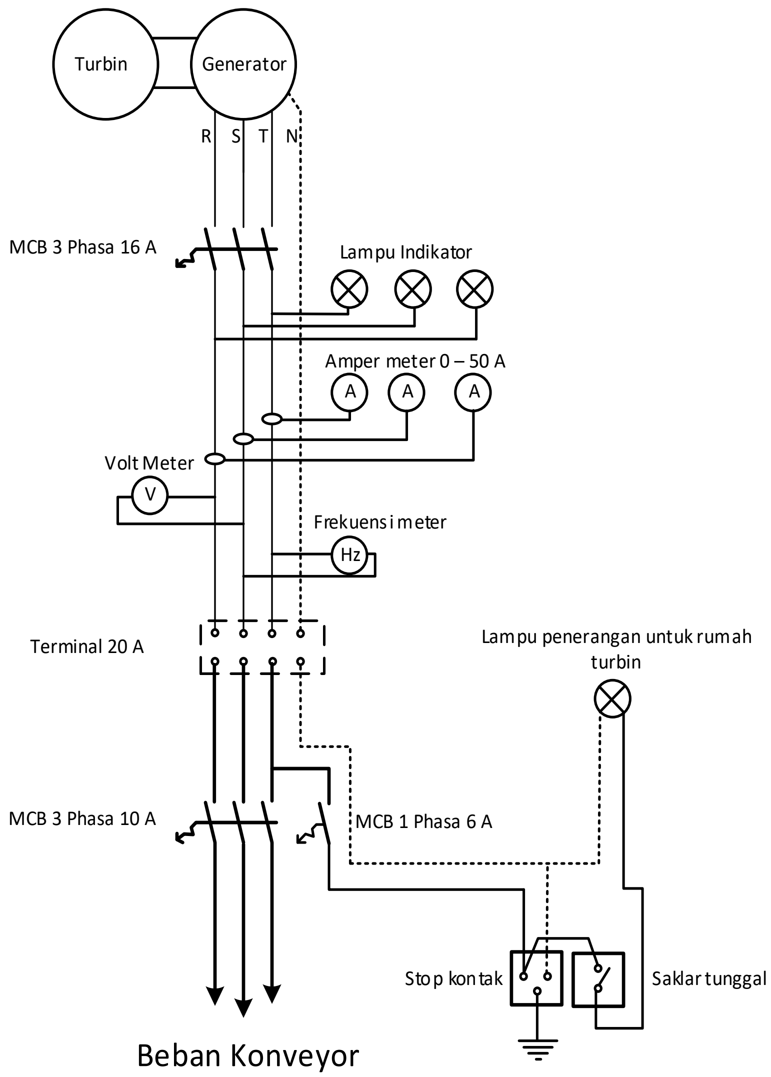

Figure 17. Circuit from generator to conveyor load without battery back up

CONCLUSION

Based on the results and discussion in the previous section, the findings indicate that with a 50% assumption for the degradation of water efficiency due to weather factors, the potential water discharge stands at 6.3 m3/second. It is necessary to enhance the Automatic Transfer Switch (ATS) Circuit to ensure the proper circulation of the electric current generated and effectively cut off the flow in rice milling operations. Additionally, micro-hydro power relies on the pattern of water circulation in the form of turbulence, and this system proves to be more efficient in motor movement and contributes to the durability of turbine bearings. These efforts in community service activities are aimed at assisting rice mill farming partners and the inhabitants of Kamang Hilia Nagari in using Detailed Engineering Design (DED) to construct micro-hydro power plants, highlighting the practical implications of these findings for sustainable energy solutions in agricultural practices.

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