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Approaches to Sustain Microhydro Power Plants (MHPP) Operation in Rural Areas of Gorontalo Regency, Indonesia

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Abstract. Electrification is one of the driving factors for improving the life quality of a country. Currently, Indonesia electrification is borne solely by Perusahaan Listrik Negara (PLN), which aren't sustainable and eco-friendly due to its main energy source is fossil fuel. Gorontalo, which is endowed with abundant renewable energy resources has installed many renewable power plant energies, but some of them have stopped operating due to an inability to maintain the operation. In South Dulamayo Village, which its energy supply has already dominated by PLN, there is still a renewable energy power plant. The microhydro power plant project (MHPP) in South Dulamayo has operated for more than seven years old. It currently struggles to maintain its sustainability. This study focused on capturing how the microhydro power plant in South Dulamayo maintains its sustainability. It is possible to keep The MHPP South Dulamayo working together (hybrid) with PLN for several customers, mainly manage by the intervention of UNG researchers.

INTRODUCTION

Ensuring access to affordable, reliable and modern energy for all by 2030 has come one step closer as a result of recent progress in increased access to electricity, in particular in the least developed countries, and improvements in industrial energy efficiency while also furthering an interest in the role of Information and Communication Technologies (ICTs) [1]. Enhanced knowledge is required for the development of user-friendly and long-term viable solutions [2]. Increasing electrification can improve many factors in a rural area's life quality; for example, in rural KuwaZulu-Natal it improves income, political participation, and women's career [3]. The task of improving access to energy is widely recognized as important issues [4]. However, national priorities and policy ambitions to deliver energy for all continue to be needed to put the world on track to meet the energy targets for 2030 [5].

Energy consumption has always been a key issue in sustainable urban planning and assessment. Different forms of energy research can provide different perspectives on the development of energy policy [6]. Based on prospective scenario analysis, the long-term configuration of the vehicle fleet, ultimate energy demand, and associated carbon dioxide emissions can be used until 2050 [7]. The total final energy consumption escalates from 427 Mtoe in 2015 to 1,046 Mtoe in the business scenario, 856 Mtoe in AMS targets scenario, and 771 Mtoe in Asean progressive scenario in 2040. The increase is driven by industry, transport, and residential sectors. These sectors provide opportunities for potential energy savings and efficiency gains [8].

Ambitious government plans to extend electricity access have yielded fruit in Indonesia, where the number of people without access declined from around 100 million in 2000 to about 23 million in 2016, even with a population increase of almost one-quarter. Therefore, Indonesia alone was responsible for 55% of the net decrease in the number of people without access across Southeast Asia since 2000 [9]. In India, despite the large-scale attempts to electrify after independence, over 45 million households are still without access to electricity [10]. In Ghana, The high rate of access to electricity is the product of the combined efforts of the National Electrification Scheme (NES) and the Ghana

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Energy Development and Access Project (GEDAP). The National Master Plan on Electrification was established under the NES, which proposed plans for expanding access to electricity to cover the entire country by 2020 [11]. An empirical study examines the introduction of the Kenya Slum Electrification Program in Kibera, one of the most deprived areas of Nairobi, and the regularization of energy supplies encouraged under the project in many African cities marked by rapid urbanization and high levels of poverty [12].

Electrification is one of the driving factors for improving the life quality of a country. Currently, Indonesia's electrification is borne solely by Perusahaan Listrik Negara (PLN), which aren't sustainable and eco-friendly due to its main energy source is fossil fuel [13]. In accordance with the national energy policy objectives to realize an optimal (primary) energy in 2025, there are role of each type of energy on national energy consumption. Those role are : 1) petroleum becomes less than 20%; 2) natural gas becomes more than 30%; 3) coal becomes more than 33%; 4) biofuel becomes more than 5%; 5) geothermal becomes more than 5%; 6) other new and renewable energy, specifically, Biomass, Nuclear, Small Scale Water Power, Solar Power and Wind Power to be more than 5%; 7) Other fuels derived from melting coal to more than 2% [14].

Renewable energy systems can create more jobs per invested dollar than conventional energy supply projects. However, there is some doubt about their long-term sustainability. Although many programs have been implemented, the rate of success (ensuring a long-term sustainable program) is low [15].

The general problem of electricity is quite complicated indicated by the frequent rotation of blackouts as in Gorontalo Province. Thus, efforts are needed to find other alternative sources that still consider the technical, economic, and environmental aspects. Gorontalo, as an expansion province from North Sulawesi, currently consists of 5 (five) districts and 1 (one) city, namely Pohuwato Regency, Boalemo Regency, Gorontalo Regency, Bone Bolango Regency, North Gorontalo Regency, and Gorontalo City. Until 2017 the electrification ratio in Gorontalo province has reached 86.56% [16].

METHOD

We used survey and direct observation techniques to obtain data on the geographical, social, and technical conditions of the villages, its inhabitants, and the MHPP project. Several pieces of information, such as a study on electrical energy in the area, were obtained from the literature.

RESULTS

South Dulamayo is one of the villages in Telaga Jaya District, Gorontalo Regency, Gorontalo, Indonesia, coordinated at 0.704665, 123.038580 (Fig.1a). This village is located in the upper reaches of the watershed, with altitudes ranging from 700-1100 meters above sea level (asl), the slope is dominated by 25% to 40%. Most of the administration (23.45% or 487.67 ha) is a protected forest area and partly (76, 55% or 1592.02 ha) as agricultural cultivation areas. It also has a strategic function as a buffer zone of the Limboto Watershed and Bone Bolango Watershed in Gorontalo Province, which has a large hydro-energy potential [17].

(a) (b)

FIGURE 1. (a) Location of the study site; South Dulamayo, Gorontalo, Indonesia; (b) MHPP Generator; Marelli Generators MJL 200 SA4

Land use practices to protect biodiversity have been performed by local communities in Indonesia for a long time. The agroforestry practices are called Ilengi. Ilengi Agroforestry is a stretch of mixed gardens, managed from generation to generation to form a vegetation structure that resembles natural forests, which are in the Gorontalo area, especially in Dulamayo Selatan Village. This inspiration is the primary source of income for rural communities and functions as a source of food, medicine, building materials. Its utilization puts forward the aspects of preservation and diversity of cultural values by paying attention to and protecting traditional values and customs that exist in society.

Approaches to Maintain Sustainability

Since 2012, The MHPP South Dulamayo already lost more than 70% of its costumers. Extreme weather conditions that happen frequently disturb project productivity. Besides, inadequate maintenance is affecting the power plant longevity and its durability. Breakages frequently happen on the belt and ball bearing that cost more than 69.44 USD. With the electricity tariff around 1.38-1.73 USD per month, it's hard for the project to handle its debt. More than 50% of its management staff has left their job, that leaves two remaining staffs. With the increase of electrical power needs, it is clear that PLN will expropriate the role of the electricity supplier.

It is possible to keep The MHPP South Dulamayo working together (hybrid) with PLN for several customers, mainly the management by the intervention of UNG researchers. Three schemes for maintaining the MHPP Dulamayo were proposed. The advantages of the proposed approach compared to general and PEU is shown in Table 1.

Standalone MHPP Dulamayo

The biggest problem is great difficulties in economic sustainability, as the project has no financial scheme in place. The issue concerning sustainability that needs to be improved is the electricity tariff [13].

In this scheme, the MHPP Dulamayo will be operating as its current situation, where about 20 customers will paying their monthly contribution of about IDR300,000,- (USD 20.90). The contribution will be used to maintain any cost related to breakages and leaving the technician/staff without salary (but their monthly contribution is free). In this condition, there has not been an improvement in the services, but at least the MHPP can operate as long as there is enough water supply, and there are no breakages. The problem of maintaining the operation MHPP is the lack of economic sustainability, as the project has no financial scheme in a place like in Rimba Lestari and Mendolo village, Gorontalo [13]. The University students can use the facility (MHPP) as a laboratory of the power generator, while society can use it as a learning community.

MHPP Dulamayo hybrid with PLN

The hybrid scheme is utilizing MHPP Dulamayo when it is operating and using PLN service when MHPP Dulamayo is down. The monthly contribution for both MHPP and PLN should be paid by the community, where kWh meter is only one (placed in the MHPP facility building). The staff of MHPP, in this case, will do extra work (distributing the PLN power using the existing grid of MHPP). The advantage of this scheme is less blackout, meaning there is a higher satisfaction on services. The customers will be happy to pay the monthly contribution compared to the first option.

MHPP Dulamayo hybrid with PVPP

The last option is utilizing another renewable energy such as PV, which is planned to install in the South Dulamayo village. This option is fully renewable means but needs more preparation on the implementation, whether the company installing the PVPP would like to use the existing grid of MHPP or to promote their own.

TABLE 1. Comparison of general and PEU, and complementary approaches between the university and local community

	General and PEU approach	Complementary approach with University
Financial scheme for maintenance	• MHPP is mainly maintained by the ta-riff earned from local beneficiaries • Electricity from the existing MHPPs is applied to community businesses, which cover the maintenance fee of the MHPPs	• University uses the facility as a laboratory for learning the technology. • The community service program will cover the maintenance fee of the MHPPs owned by the local community.
Characteristics	• Electricity generated by MHPPs in a remote area is generally limited, and they cannot afford to supply toward PEU. • The cost of repair (un-exceptional cost) is too high for the local community to cover, and they must rely on external donors. • PEU covers it, and traditional livelihoods should be changed to more modern counter-parts (I.e., following market supply and demand forces).	• The university and local community complement each other • Modern technology (MHPPs) is self-maintaining

CONCLUSION

The analysis of the MHPPin South Dulamayo proves to be unsustainable without action from Universities. The biggest challenge is to keep the MHPP of South Dulamayo working as a hybrid with PLN. A further study is needed to investigate and understand the driving factors for the sustainability of an electrification project deeply.

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