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Mini-Micro Hydropower Plants Progress in Indonesia: The Effective and Suitable Projects for Isolated and Remote Communities

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Article Info
Volume 83
Page Number: 1509 - 1514
Publication Issue:
March - April 2020

Article History
***Article Received**: 24 July 2019*
***Revised**: 12 September 2019*
***Accepted**: 15 February 2020*
***Publication**: 15 March 2020*

Abstract

In 2017 Indonesia has reached about 91.16% of national electrification ratio. The most challenging part of increasing the electrification ratio is the ineffective cost and long term revenue of installing long distribution and transmission lines to the isolated and remote areas. To achieve the 100% electrification ratio in 2020, the Indonesian government has constructed more micro hydropower plants (MHPP) scale to supply power to isolated and remote areas. The total hydropower plant that has been installed all around Indonesia since 2016 is about 11% of the total available potency. The projects were economically effective as they normally run with the collaboration among, national government, local authority and local communities. The mini-micro hydropower projects that were running from 2011 to 2015 have been conducted in two main scheme, the private sector or so-called independent power producers (IPPs) and through government funding. The MHPP projects implementation of course was facing in between benefits and short-comings. Some of the benefits of MHPP are low cost project, environment benign and long live operation. However, the drawbacks of MHPP might include specific site requirement, social conflict, non-skilled operator that might harm himself, and operation is depending on the local climate. The win-win solution should be come across for MHPP projects to accommodate between the benefits and the short-comings.

***Keywords**: Electrification Ratio, MHPP, Hydropower Project*

1. Introduction

It cannot be denied that in some developing countries, the electrification ratio is still low due to some classical reasons such as limited economic capability, energy sources, human resources, etc. In Indonesia electrification ratio is increased about 18.21 % since 2011[1], [2]. This indicates that the Indonesian government has achieved the target for electrification equality among the Indonesia population. The 100% of electrification ratio or so-called universal

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access is targeted to be achieved in 2020 [3]. Although electrification ratio target should be achieved maximally, the larger portion of renewable based power plants is a must for a better global environment. Indonesia itself, has declared the use of renewable based power plants about 23% for the total power plants in 2025 [4]. Currently, wind and solar cell become the most popular renewable based power plants that installed worldwide since 2004 [5]-[8]. However, wind and solar have high initial capital cost and long term of cost revenue for isolated and remote areas [9]. Moreover, long conventional transmission and distribution line will not be economically effective for the isolated and remote areas [10]. Therefore, it is pivotal for the government to explore the suitable and effective power plants for these communities.

2. Hydropower Potency in Indonesia

Hydro energy potency in Indonesia is about 75 GW [11] and up to 2016 there are only about 11% has been installed throughout Indonesia [12]. In Indonesia, hydro energy potency almost spread in almost all provinces, the potency of hydro energy can be seen in Figure 1 [11].

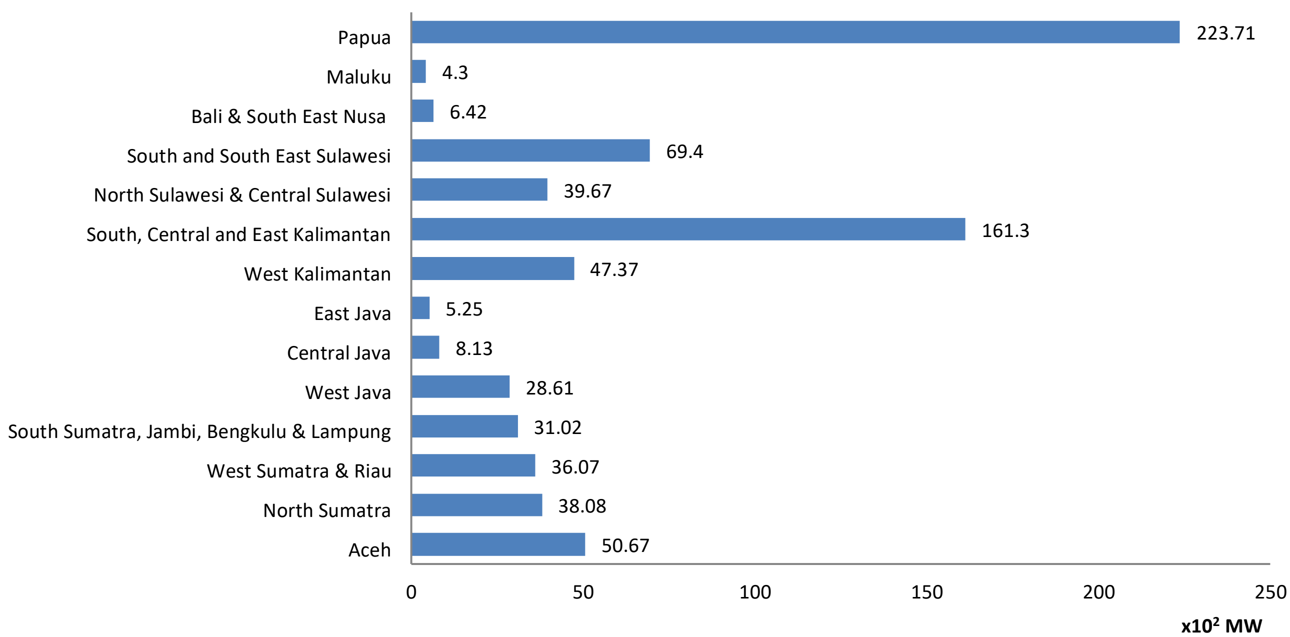

Figure 1: Hydropower potency in most of provinces in Indonesia [11]

As demonstrates in Fig. 1, Papua has the most enormous potency of hydropower in Indonesia, however, Papua are still in electrification rate of less than 50% [13], the most challenging factor that influence the infrastructure development in Papua is regarding social and physical challenges such as mountains, swampy lowlands, great distances, etc [14]. Potency of Mini-Micro Hydropower for each main islands in Indonesia can be seen in Fig. 2.

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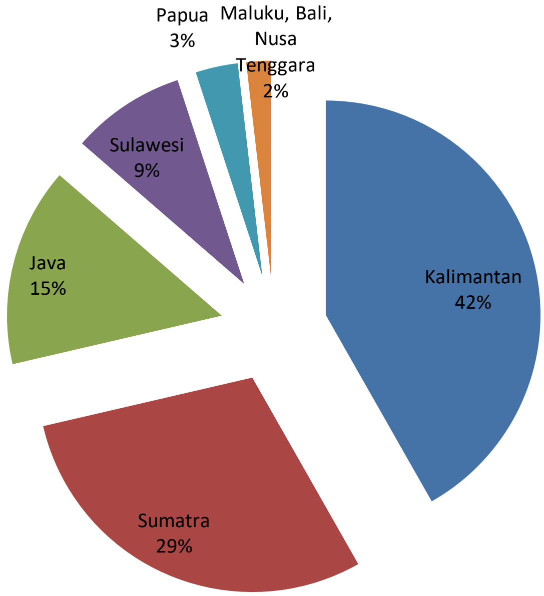


Figure 2: Mini-Micro Hydropower potency in main islands in Indonesia [15]

As reported in [15], the total potency of Mini-Micro Hydropower Plants (M-MHPP) in Indonesia is about 19.38 GW that spread out on the main islands as shown in Fig. 2. Kalimantan, Sumatra, and Java become the top three of islands that have promising for project of Mini-Micro Hydropower Plants. Based on the needs and the potency, the projected M-MHPP projects have been released by the Indonesian Government [15] from 2017-2025 as demonstrated in Figure 3.

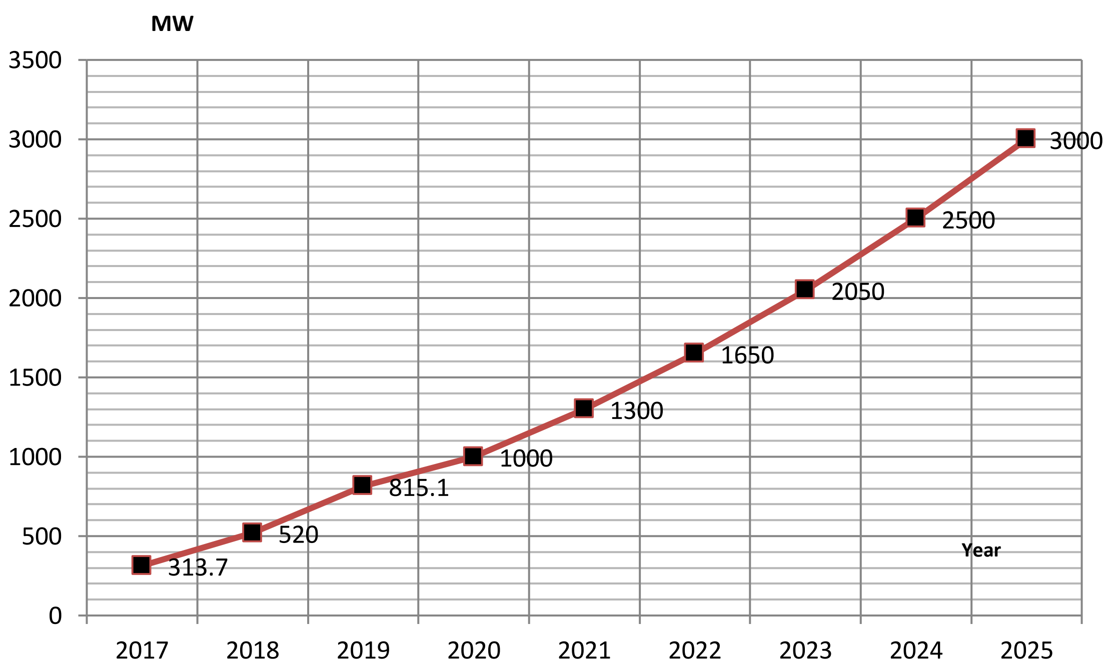


Figure 3: Mini-Micro Hydropower projected installing capacity in main islands in Indonesia [15]

Mini-Micro Hydropower Progress 2014-2015

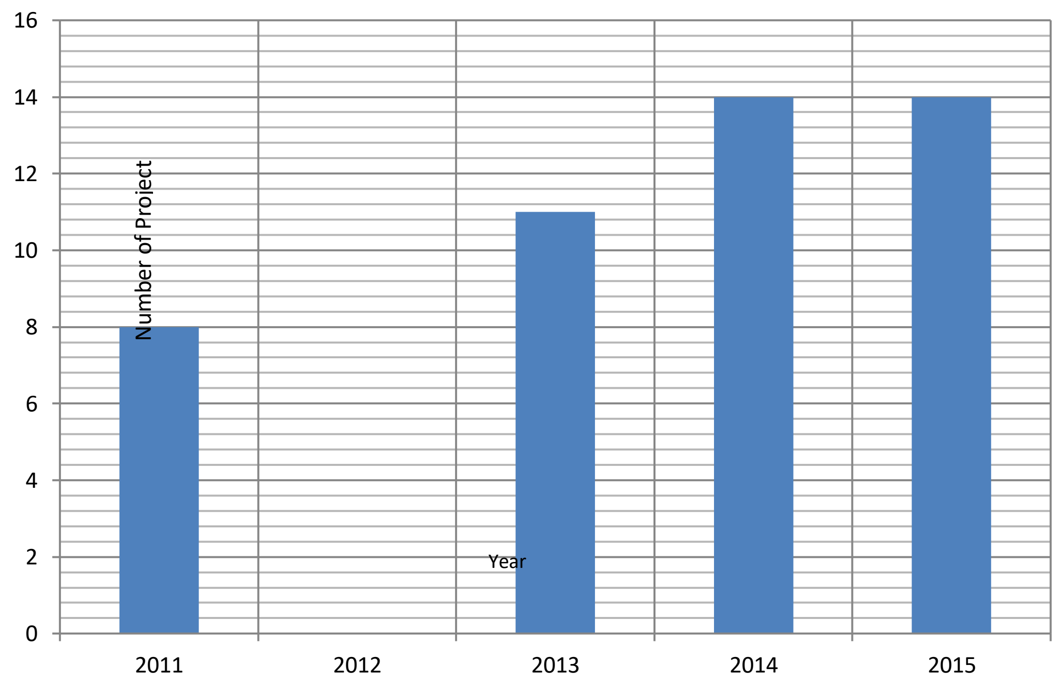
To fulfil the electrification ratio and in the same time maintain the economic visibility, a cheap, simple and small scale based power plants is required particularly to electrify the isolated and remote areas. The progress of Mini-Micro Hydropower Plants projects for independent power producer (IPP) in Indonesia is shown in table 1[16].

Table 1: Mini-Micro hydropower projects in 2011-2015 for IPP [16]

Main Island	Total Capacity (MW)	Number of Projects
Java	39.98	18
Sumatra	50.43	10
Sulawesi	33	11
West Nusa Tenggara	10.8	2
Total	134.21	59

It shown in Table 1, within 2011-2015 there are about 59 projects of mini-micro hydropower spread around Indonesia. Number of projects in Java Island is the largest within that period of time but smaller in total capacity if compared with Sumatra. Sumatra Island has only 10 number of projects but has the largest total capacity of nearly 50.5 MW due to some of mini hydropower with capacity more than 5.0 MW have been constructed. Sulawesi Island has 11 projects with total capacity of 33 MW. The dominant range of each capacity varies within 2.0-3.0 MW with one project with 7.5 MW in Luwu District, South Sulawesi [16]. There were two projects of mini-micro hydropower plants have been established in West Nusa Tenggara with about 10.8 MW. The number of mini-micro hydropower plants projects in Java Island is larger based on the number of population in Java Island is the larger within others islands in Indonesia.

Meanwhile, some MHPP (not include the mini hydropower plants) projects were funded by Indonesian government within 2011-2015 as can be seen in Figure 4 [16].



(a)

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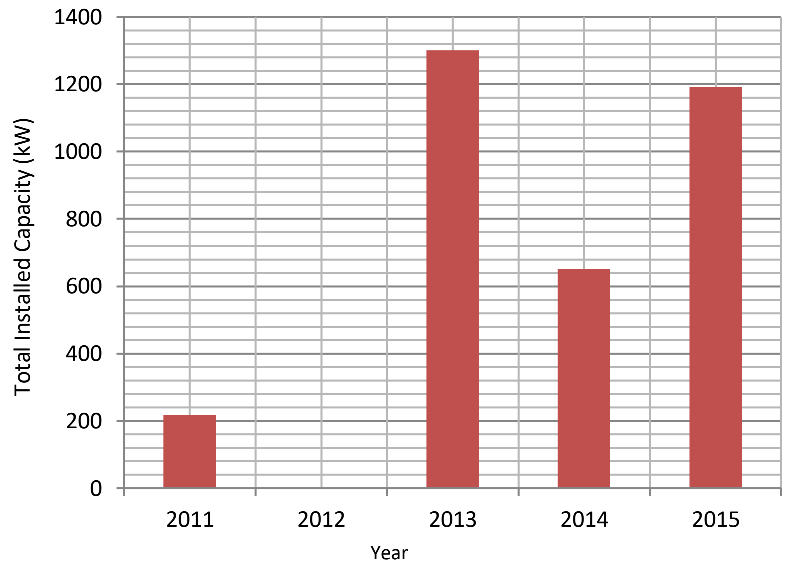

(b)

Figure 4: Project of government funded MHPP in 2011-2015; (a) Number of MHPP Project, (b) Total installed capacity of MHPP [16]

Within 2011-2015, some MHPP projects were funded by Indonesian government except in 2012, no budged were allocated for MHPP projects as shown in Figure 4(a). The total installed capacity throughout Indonesia per year is demonstrated in Figure 4(b). Although number of projects is smaller in 2013 compared with the number of projects in 2014 and 2015, but the total installed capacity is larger than in 2014 and 2015 due to some projects in 2013 are in scale that larger than 100 kW.

Common Applied Technology of MHPP in Indonesia

In developing countries, MHPP technology normally used just to achieve the fundamental functions of the facility to reduce the cost. The cross-flow turbine type is the common turbine type used for small scale hydropower plant in Indonesia due to its suitability for low heads, accommodates large water flows, more tolerant of sands and other particles [17], [18]. To generate power, an induction generator is employed due to its robustness, simple construction, no synchronisation problem and absence of DC excitation system [19]. Rather than control the water input, to stabilize the frequency and the output voltage, an electronic load controller (ELC) is employed. ELC controls the connection or disconnection of the output generator with the dummy loads to maintain the nominal frequency and voltage [18]. Dummy loads might vary from one MHPP to another, it might be in the form of water heaters, incandescent lamps, air heaters, etc.

3. General Benefits

The reasonable option for rural electrification that fulfils low cost and environment concern requirements is micro hydropower plants, as long as the water discharge from the nearest rivers is available. For small islands, however, solar and wind might be the viability option with their certain drawbacks as aforementioned above.

Several benefits of MHPP that could be mentioned are listed as follows:

- Cost effective due to its type mostly “Run-off Rivers”, without big dam and water storage [18].
- Environment benighted as no combustion part involved.
- Much more concentrated energy source compared to wind and solar [18].
- Low operation and limited maintenance required [20].
- Live operation can last for 50 years [21].

4. Challenges and Barriers

Although progress of mini-micro hydropower plants has shown the promising development, there are still yet some of challenges and barriers in the following points:

- It is site-specific technology, as the rivers located specific and might not close to the rural communities [21].

- Social conflicts might the main challenge and barrier. Most of rivers are used also for other purposes such as drinking water, irrigation, etc. The existence of MHPP might reduce the quantity and quality of the river's water which in turn could trigger the social conflict.
- Most of MHPP operators are non skilled persons. There are many cases in developing countries that operators loss their live due to insignificant knowledge and less working attitude in operating the MHPP.
- Rapid climate change might lead to the inconsistent water sources from time to time.
- Lack of information for rainfall, catchment area, climate and other data site become also a big challenge and barrier for developing MHPP in developing countries [22].

Acknowledgments

Authors would like to appreciate Research, Technology and Higher Education Ministry of Indonesia for funding the research through research scheme of Applied Strategies Research for Higher Education Institutes in 2018.

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