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Unlocking Renewable Energy Potential in Indonesia: Assessment on Project Viability

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Abstract
Indonesian Government has set an ambitious target to achieve 23 percent of renewable energy share in primary energy mix as well as in term of power sector by 2025. This target is then realized by committing a plan to build 56.4 GW additional power generation until 2028 as stated in the Electricity Supply Business Plan (RUPTL) 2019–2028. However, the deployment of RE power plant seems to be threatened due to untoward pricing policy which is considerably lower than the generation cost of RE-based electricity, resulting in the increase of possibility of future RE projects become unfeasible. Using 242 RE projects documented in 2019–2018 RUPTL, this study aims to examine feasibility of future projects under BPP price and identify other factors which could possibly increase project's viability. The scope of this study includes several technologies such as wind, solar, hydro, mini hydro, biomass, and biogas. Financial model was employed to estimate Net Present Value (NPV) of the project as feasibility indicator. Data for project's cost structure and financial assumption is obtained by literature review, survey and focus group discussion (FGD) to RE developers. The result shows that only less than 50 percent of the samples are feasible, accounting for only 43 per cent by number of projects (103 out of 242 projects) and 42 per cent by capacity (2,452 out of 5,888 MW). Hydro power becomes RE technologies with the highest feasibility followed by biomass. Projects located in Bangka Belitung, Gorontalo, East Kalimantan, Maluku, and North Sulawesi are all feasible, while of which in main islands particularly Java Island are mostly unfeasible due to the lower tariff. In addition to the low feasibility rate, there are several cost components which are considered as Indonesia specific costs such as local content, land acquisition cost, transmission infrastructure cost, and regional adjustment for project location which result in higher project's cost. Finally, it is important for the government to formulate a set of incentive policy for alleviating unfeasible RE projects.

JEL Classification: Q42; Q48; O22

Keywords
renewable energy — project feasibility — power plant — Indonesia

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1. Introduction

Indonesian energy demand is expected to increase strongly driven by raising economic and social development and the growing population. Electricity sector holds an important role for socio-economic development in the country. The demand for electricity has grown at an average 7.1 per cent per year since the end of 2000s from 134.6 Terra Watts hour (TWh) in 2009 to 245 TWh in 2019[1], almost double in just 10 years. Meanwhile, the electrification rate increased rapidly and reached 98.3 per cent in the end of 2018[2], grown more than 30 per cent from 2010 which is recorded as 67.2 per cent.

As a respond to the constant hike of national's electricity demand, the Indonesian Government set an ambitious target to install additional 56.4 Giga Watt (GW) by 2028. Therefore, the government is trying to increase the power supply in the country by setting several fast tract programs (FTP) to achieve the vigorous target providing 137 GW by 2025[3]. However, electricity generation in Indonesia is still predominantly by fossil fuels, particularly coal. Based on data obtained from 2019 Indonesian electricity statistics, installed electricity capacity in Indonesia consisted of 49 per cent coal-fired power plant (CFPP). Indonesia's electricity production dependency on coal makes it one of the ten countries with the largest coal-fired electricity generation in the world based on the UNEP report (2017).

In addition, the dominance of fossil fuel as the main energy source for electricity generation in Indonesia will still continue at least until 2028. Based on National Electricity Supply Business Plan (*RUPTL*) 2019–2028, 54.6 per cent of the national electricity mix in 2025 has been targeted to come from coal combustion. Despite the fact that this percentage shows a decrease from the 2019 coal mix share, which is recorded as 62.7 per cent, this is still slightly higher than the coal mix target documented in the 2018–2027 *RUPTL* which is accounted for 54.4 per cent in 2028. This electricity generation situation in Indonesia is not yet ideal in the long term as it is contrary to Indonesia's commitment to reduce greenhouse gasses (GHG) emissions by 29 per cent (834 million tons of CO_2) by 2030.

As a reference, Nationally Determined Contributions (NDC) were commence actions planned by countries in

[1] National Electricity Supply Business Plan (*Rencana Umum Penyediaan Tenaga Listrik Nasional*/RUPTL) 2019–2028.

[2] The government claimed electrification rate as 98.81 per cent in the end of 2019. https://databoks.katadata.co.id/datapublish/2020/01/10/konsumsi-listrik-nasional-terus-meningkat.

[3] Based on national target stated in National Energy Plan (*Rencana Umum Energi Nasional*/RUEN) 2014.

striving the targets for renewable energy (RE). Under its NDC, China committed to reduce its carbon intensity by 65 per cent from all sectors by 2030 and targeted RE in the primary energy mix to 20% by 2030. India is pledged its commitment to achieve 40 per cent RE in installed electricity power by 2030 (Simamora et al., 2018). While, Indonesia has pledged to lower its GHG by 29 per cent by 2030 against business as usual, therefore the country has set a target to achieve 23 per cent of RE in primary energy mix by 2025. This target is then directly applied to electricity energy mix which aims to provide more than 26 GW electricity from RE by 2025[4].

For the above reason, 30 per cent out of 56.4 GW additional installed capacity will be allocated for RE power plant. Although this number seems high, the realization of this target can be very challenging, particularly in current situation. As of 2019, RE shared 14.8 percent in electricity energy mix amounting to 10.3 GW out of 69.6 GW total installed capacity[5], increased 2.3 per cent from the previous year which is posted as 12.5 per cent. This mean that there is remaining 8.2 per cent to achieve within the next 5 years. Thus, the government has opened opportunity for private sector to invest on RE projects, in particular the power sector.

Unfortunately, the regulations issued by Indonesian Government are not always consistent for improving the business climate of investment to support these commitments to develop RE in the country, in particular the regulations issued since 2017. The current electricity tariff, under average cost of electricity generation (*Biaya Pokok Pembangkitan*/BPP) reference price, is lower than the paid tariff under older regulation. A high tariff obliges PLN to pay extra cost to RE developers, which in turn results in extra costs in PLN's budget. The implementation of BPP and associated tariffs are seen as an attempt to push down the electricity subsidies by the government. Yet, the occurrence tariff is a new barrier to the RE developers since it draws out incentives for them. The low electricity tariff under BPP price is possibly to make RE projects unfeasible due to the high cost of power plants. Consequently, RE deployment in Indonesia is threatened to slow down. In the end, renewable energy policies in Indonesia have not incentivized this sector to develop significantly, notably due to potentially unfair pricing policy[6].

The issue of RE deployment in Indonesia worsened when 5 out of 75 Power Purchasing Agreements (PPAs) signed during 2017–2018 were terminated and 27 of them are threatened to not achieve financial close[7]. Undeniably, pricing regulation is strongly assumed as one of the constraints to financial injection into RE investment (Ragosa & Warren, 2019). There are two major issues behind pricing policy in Indonesia: the policy changed rapidly (mainly in the last 3 years) leading to uncertainty into business environment and the uncompetitive price policy under the latest pricing regulation. Extensively, in fundamental, RE project feasibility does not only depend on the price of energy but also influenced by other factors such as government regulation and support, business climate, technology improvement, and so forth.

On the other hand, amidst the unfavorable situation for RE investment, through *Perusahaan Listrik Negara* (PLN) the government has planned to build hundreds of new RE power plants as stated in the RUPTL. Nonetheless, in respect to the current trend where several RE projects are terminated and more of them are struggling to find financial support, it is likely that most of the targeted projects are in reality do not feasible to execute. This situation will affect the achievement of 23 per cent RE target by 2025, for which the government should take a prevention to avoid failure. Thus, this study is proposed to examine the feasibility of RE projects in 2019–2028 RUPTL under the BPP price. The scope of this study includes several technologies such as wind, solar, hydro, mini hydro, biomass, and biogas. In addition, the study also aims to identify other factors which influence project's viability to see how those factors can be intervened to increase probability of project's feasibility. In the end, we would like to deliver some possible policy recommendations to promote RE development in Indonesia.

2. Literature Review

Global renewable energy cost generation has fallen sharply over the past decade, lower than the cheapest new fossil fuel-fired option. This cost reduction is influenced by technology improvement, economies of scale, competitive supply chains, and better learning experience of developers (IRENA, 2020). Efficient business climate and proper regulation have huge role in encouraging the development of renewable energy market efficiently which can surpass cost of fossil fuel.

Several factors have commonly cited as the barriers of renewable energy investment, such as complex and uncertain policy, unattractive pricing, high upfront cost, imbalance risk allocation, unequal electricity infrastructure across country, and limited access to financing (IESR, 2019; Kennedy, 2018; Maulidia et al., 2019a,b).

In general, project viability is influenced by pricing mechanism, cost structure, and other factors that affect renewable energy (RE) business climate. This price itself is influenced by the regulations and negotiation processes with PLN. However, pricing mechanism has become a big issue in regard to RE development, typically in developing countries such as Indonesia. Inappropriate pricing system could possibly bring some burdens either for government or developer. The current BPP tariff does not support the deployment of RE as it is lower than the previous feed-in

[4] Based on RUEN. Only accounts the committed targets.

[5] Kontan.co.id. (2020, February 9). *Kapasitas pembangkit listrik nasional mencapai 69,6 GW, PLTU masih mendominasi*. https://industri.kontan.co.id/news/kapasitas-pembangkit-listrik-nasional-mencapai-696-gw-pltu-masih-mendominasi.

[6] Based on the Minister of Energy and Mineral Resources (MEMR) Decree No.4 Year 2020, electricity price is pegged 85% of regional BPP if it is higher than national BPP, while the calculation of regional cost include coal-fired power plant (CFPP) which has different business mechanism to majority RE power plants. Moreover, CFPP receives advantage to access cheap coal under domestic market obligation (DMO) arrangement.

[7] IESR. (2019). *Indonesia clean energy outlook 2020: Tracking progress and review of clean energy development in Indonesia progress and review of*. http://iesr.or.id/wp-content/uploads/2019/11/IESR-ICEO-Presentation.pdf. There is an update from MEMR that as per January 2020 there are 3 more projects terminated.

tariffs (FiT) which makes the Indonesian RE investment unattractive (Maulidia et al., 2019a).

Majorly, there are two classes of support mechanism: price-based systems (feed-in tariffs or FiT) and quota or amount-based systems (Gipe, 2006; Vlachos & Biskas, 2014). Recent experience indicates that FiT are the utmost effective policy to stimulate RE deployment and are currently applied in 63 countries (Medonça et al., 2009; Ernst and Young, 2008; Couture & Gagnon, 2010). The principle of a FiT mechanism is to provide a guaranteed payment for electricity generated from RE for a fixed period of time. The mechanism is able to compensate for the risks associated with capital-intensive RE investment.

However, FiT was problematic for many developing countries. As the centers of production and energy consumption in Asia, Indonesia and Philippines are able to be a relevant lesson. Aside from the high potential in generating RE sources, both countries are challenged by the political conflicts in developing a FiT mechanism. Consequently, the applied FiT design in both countries failed to reinforce RE investors which led to insufficient production of energy from wind, solar, and biogas sources (Bakhtyas et al., 2013).

Based on the above situation, Indonesian policy makers face a problem in the pricing structures of renewable energy. Unlike other countries which adjusted the FiT (feed-in-tariff) rate based on renewable penetration, Indonesia does not have a policy that adjusts to changes in market conditions. Consequently, the FiT design in Indonesia is inconsistent and this causes RE investment to be less attractive. This issue was worsened as a result of the last pricing structure under the current regulation, which was identified as a barrier to obtain funding for new projects (Simamora et al., 2018).

Previously, the Government of Indonesia released a series of pricing regulations aimed at attracting the attention of investors. The FiT scheme in Indonesia was first introduced under the Presidential Decree No. 45/1991 which obliged Indonesia's utility company, PLN, to purchase high geothermal tariff around US$7¢–10¢per kWh. Unfortunately, due to the Asian Financial crisis and PLN's financial condition, the tariff was dropped rapidly to less than US$5¢per kWh. Hence, it made the projects become unfeasible and most private companies withdrew their RE investment from Indonesia (Van Campen et al., 2017).

In 2002, Ministerial Decree has introduced the purchase agreement on small-scale power. It obliged PLN to purchase electricity generated from RE sources by Independent Power Producers (IPPs) with capacity under 1 MW. This purchase obligation was then increased up to 10 MW in 2006 by amended regulation. Later on, in 2013 the Decree of the Minister of Energy and Mineral Resources (MEMR) No. 17/2013 was introduced to regulate specific RE technology, solar photovoltaic (PV). The regulation set a price rate for solar PV purchase at US$25¢per kWh or US$30¢per kWh if contains local element for at least 40 per cent. Unfortunately, that regulation was not applicable anymore due to a lawsuit from *Asosiasi Pabrikan Modul Surya Indonesia* (APAMSI) that opposed the use of solar panels which manufactured locally for the whole solar photovoltaic (Hamdi, 2019).

Afterward, the regulation was revised into the Decree of the Minister of Energy and Mineral Resources No. 19/2016. According to that regulation, the feed-in-tariff was applied to 22 regions in Indonesia with the range of tariff rate at US$14.5¢–25¢per kWh. The tariff was set above retail price which based on the RE grid installed location. The market welcomed the regulation, which proved by a massive incremental of IPP participation in RE investment. However, the election of new minister of MEMR in 2016 was claimed by most RE developers and activist as a step back in progress of RE policy in Indonesia. The regulation was dismissed by the minister due to the heavy burden of PLN in particular regions to cover the high FiT rate.

The chosen minister then issued Ministerial Decree of MEMR No. 50/2017 which replaced the previous regulation. This new regulation arranged RE tariff based on the existing BPP on the relevant local grid (regional BPP) which sets by PLN's proposal. Fundamentally, this tariff scheme is considered as FiT, yet it has lower price base than the previous one which is set above the average cost of generation. If the regional BPP is lower than the national BPP, the tariff is negotiable between the RE developer and PLN, otherwise if the local BPP is higher than the national BPP then the tariff is pegged 85 per cent of regional BPP at maximum. The latest regulation, Ministerial Decree of MEMR No. 4/2020, as the amendment of MEMR No. 50/2017 remains unchanged in term of pricing mechanism. The notable change of this regulation is about project ownership in the end of period which is previously Build, Own, Operate, Transfer (BOOT) to Build, Own, Operate (BOO). The policy implies that the developer is no longer obligated to transfer the project's assets to PLN in the end of project lifetime.

Indonesia as a country of 17,500 islands has huge challenges in terms of geographic electricity distribution. According to the current regulation, the remote areas are more promising in providing a higher payment to the developer due to the domination of diesel generation, whereas the RE deployment in Indonesia's main islands (Jawa, Sumatera, and Bali) becomes less attractive owing to the domination of cheap coal usage which lead to the lower paid tariff. Even though the policy is slightly supportive for RE development in remote areas, the electricity demand is relatively low and the electricity infrastructure distributed unequally, even PLN considers investing in remote area is not economically feasible (Maulidia et al., 2019a).

The main issue is that the capacity and ability of PLN as the state utility company is limited, so the involvement of the private sector is critical. At present, private sector participation is rapidly increasing in global renewable energy sectors, including the rising contribution of private sources of finance (Kennedy, 2018). PT PLN (Persero)—as the only electricity off-taker in Indonesia—has also estimated that financing support from private investment reaches IDR1.600 trillion or around US$120 billion to achieve the renewable energy mix target of 23% by 2025 (Maulidia et al., 2019a). The risk of limited financial capacity is even considered as the highest risk or extreme category in the 2019–2028 RUPTL. The government has to understand that not providing long-term policy stability would increase the financing costs (Ozorhon et al., 2018). Hence, without transforming the current policy settings, including pricing mechanism, energy infrastructure, and risk allocation (Burke et al., 2019;

Table 1. Roadmap of Renewable Energy Development in Indonesia (MW)

No	Renewable Energy	Capacity	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Total
1	Geothermal	MW	190	151	147	455	245	415	2,759	45	145	55	4,607
2	Hydro	MW	154	326	755	-	182	1,484	3,047	129	466	1,467	8,009
3	Mini Hydro	MW	140	238	479	200	168	232	27	20	20	10	1,534
4	Solar PV	MWp	63	78	219	129	160	4	250	-	2	2	908
5	Wind	MW	-	-	30	360	260	50	150	-	-	5	855
6	Biomass/Waste	MW	12	139	60	357	50	103	19	5	15	35	794
7	Marine	MW	-	-	7	-	-	-	-	-	-	-	7
8	Biofuel	Thousand Kilo Liter	520	487	291	167	151	146	154	159	166	175	2,415
	Total	**MW**	**560**	**933**	**1,697**	**1,501**	**1,065**	**2,287**	**6,251**	**199**	**648**	**1,574**	**16,714**

Source: RUPTL 2019–2028

Table 2. Sample Distribution

RE Technology	Total Project	Capacity (MW)	Total Capacity (MW)	Distribution according to island				
				Sumatera	Java	Kalimantan	Sulawesi	Eastern part of Indonesia
Biogas	8	1–5	16.9	75%	13%	13%	-	-
Biomass	19	0.9–50	133	42%	5%	-	-	53%
Mini Hydro	134	1–10	725	49%	21%	4%	13%	13%
Hydro	32	12–510	2,981	34%	19%	9%	28%	9%
Solar PV	30	1.75–100	581	50%	3%	3%	10%	33%
Wind	19	3.8–250	1448	21%	53%	5%	5%	16%
Total	242		5885	109	47	12	31	43

Source: RUPTL 2019–2028
Notes: Eastern part of Indonesia include Bali, Nusa Tenggara, Maluku, Papua, and West Papua

Kennedy, 2018; Maulidia et al., 2019a,b), the existing policy framework is doubtful to support Indonesia in reaching the target of 23% RE in the energy mix.

3. Methodology

The Government of Indonesia through the Decree of the Minister of Energy and Mineral Resources No. 39K/20/MEM/2019 already gave mandate to PLN to carry out electricity supply programs in Indonesia, listed in the State-Owned Utility's 2019–2028 Electricity Supply Business Plan (RUPTL), including the development of renewable energy power plants. The projects planned for renewable energy are estimated reached nearly 400 projects, with the composition of targets for each type of technology as shown below.

The feasibility simulations in this study only cover several RE technologies, namely biogas, biomass, hydro ($>$ 10 MW), mini hydro ($\leq$ 10 MW), solar PV, and wind power plants. To simplify the analysis process, all projects are assumed to be built in 2020. While it should be noted that RE technology is currently growing in the world, especially solar PV and wind, which has led to plunged costs for solar modules and wind turbines. Although on the other hand, financing for hydro and mini hydro tends to be more expensive in the future due to untapped potential project located in remote areas and extreme weather due to climate change which drastically affect the sustainability of water flow (Mukhi et al., 2020).

The data and assumptions used come from various sources, including the list of projects in the power plant construction roadmap listed in the 2019–2028 RUPTL, electricity price based on the average cost of electricity generation[8] (BPP) based on Ministerial Decree No. 55K/20/MEM/2019 concerning the *Besaran Biaya Pokok Penyediaan Pembangkitan PT PLN (Persero) Tahun 2018*, literature study, survey, and in-depth interviews with developers, experts, academics, and policy makers.

Two determinants of project feasibility are revenue and cost components. In general, both determinants are influenced by two aspects, namely regulatory and geographical aspect. The maximum rate of BPP price depends on the location of each project geographically which can be vary for each project[9]. Meanwhile, the factors affecting the cost component are more diverse because they are also influenced by the characteristics of each technology. For instance, the regional adjustment factor, which represents the geographic aspect, may affect the cost of civil works, particularly for hydro and mini hydro power plants which has the largest cost of this component. Meanwhile, solar PV projects are influenced by regulatory factor, known as local content requirement[10], which require solar PV power plant to use at least 40 per cent local content of solar module as regulated in the Ministry of Industry Regulation No. 5/2017. This may affect the cost of solar module as the price difference is quite high, around 27–88 per cent, between local and imported modules (IESR, 2019).

Each type of renewable energy has its own features which can affect the electricity generation cost as well. For instance, it is necessary to replace the inverter for solar PV power plant once every 10 years, while the major overhaul should be carried out for biogas and biomass power plant

[8] Cost-based price which has different tariff structure geographically.

[9] If the regional BPP is less than the national average BPP, the applicable price is negotiable up to 100% of the regional BPP. However, if the regional BPB is higher than national average BPP, then the maximum price applicable in the region is only 85% of the regional BPP.

[10] *Tingkat Komponen Dalam Negeri* (TKDN).

Table 3. Summary of General Parameters

Parameters	
Cost of equity[1]	14.98%
Cost of debt	
Mini Hydro	12.00%
Other RE	7.00%
Debt to Equity Ratio	
Mini Hydro	50:50:00
Other RE	70:30:00
Tax rate	25%
Weighted Average Cost of Capital (WACC) & Discount Rate	
Mini Hydro	10.79%
Other RE	8.17%
Inflation rate	3.50%
Exchange rate	Rp14,000 per USD
OPEX escalation	40% higher than inflation
Regional Adjustment Factor	
Sumatera	1.2
Java	1
Kalimantan	1.3
Bali & Nusa Tenggara	1.5
Sulawesi	1.4
Maluku & Papua	1.6

Source: Author's Database - Deducted From Literature Review, Survey, and FGD- (2020)
Notes: [1]http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/ctryprem.html

every 8 years. Moreover, solar PV power plant has electricity degradation factor which cause the decreasing amount of electricity produced annually. These features have been considered in developing the cost structure.

Based on the proportions of investment cost or capital expenditure (CAPEX) and operating expenditure (OPEX), each power plant can generally be divided into two groups. The first group is the type of power plants with a proportion of CAPEX costs far higher than OPEX, otherwise it will be classified as the second group. Several types of power plants, such as hydro, mini hydro, solar PV, and wind are included in the first group, where OPEX costs are around 1–2 per cent of CAPEX costs. Meanwhile, biomass and biogas include in the latter group, with OPEX cost reaching 10 per cent of the first year CAPEX costs. This OPEX cost is also assumed to increase 4.90 per cent annually. This aspect is also noteworthy to estimate period of cash disbursement along the project lifetime, which affect the source of financing, as well.

The approach used to evaluate project feasibility is the Discounted Cash Flow (DCF) valuation method which is the process of comparing the cost of initial investment with the present value of potential income over the project lifetime, which will result the Net Present Value (NPV). Another indicator commonly used is the project Internal Rate of Return (IRR), defined as the rate in which NPV equal to zero. In this level, entire revenue is allocated to bear the entire cost along the project lifetime and left the project developers without any margin.

$$NPV = \sum_{t=0}^{n} \left(\frac{Free\ Cash\ Flow_t}{(1+r)^t} - \frac{Initial\ Investment_t}{(1+r)^t} \right) \quad (1)$$

The calculation of initial investment, operating, and maintenance cost, as well as the preparation of income statements, balance sheets, and cash flow statements precede the calculation of NPV and Internal Rate of Return (IRR). The incorporation of BPP price component into the financial model is part of the feasibility evaluation process. If the NPV generated is positive and the project internal rate of return (IRR) higher than the weighted cost of capital (WACC), than the project categorized as feasible.

4. Result and Discussion

The only renewable energy has been long developed is hydro power plant that can already reach economies of scale and compete with CFPP (Tang et al., 2019). The results show that feasible projects are still dominated by hydro and mini hydro, followed by biomass and solar PV. However, the amount of capacity from feasible projects for solar PV is still small compared to the number of feasible projects, not even reaching 20 per cent of the total capacity to be installed. This shows that feasible projects are small-scale projects and located in areas with high levels of solar irradiance, such as Nusa Tenggara, Sulawesi, and Aceh. But the comparison of the two, the percentage of projects that are feasible both in terms of the number of projects and the relative capacity of the same, around 43 per cent and 42 per cent, respectively.

When viewed from the distribution of Net Present Values (NPV), mini hydro and biogas has small distribution of NPV due to its relatively small capacity compare to other REs. Meanwhile, the NPV of wind is the most scattered, but unfortunately no project is feasible across the country. While hydro, as the most common source of renewable energy, has the most outliers compared to other plants due to its project location geographically. Several factors are predicted to have an impact on the total NPV, including Indonesian specific cost, such as local content, regional adjustment factor due to project location, and regional average cost of electricity generation (BPP) as project's source of revenue.

As shown in Figure 2, hydro power plant still dominates as the most feasible project in all regions, except Sulawesi which only reaches 1 per cent due to undetermined location made the assumption used is the lowest BPP, even for the

Table 4. Feasibility rate based on type of RE

RE Technology	Feasibility Rate	
	Number of Projects	Capacity (MW)
Biogas	0 out of 8 0%	0 out of 17 0%
Biomass	14 out of 19 73%	68 out of 133 51%
Hydro	23 out of 32 72%	1,953 out of 2,981 66%
Mini Hydro	55 out of 134 41%	365 out of 725 50%
Wind	0 out of 19 0%	0 out of 1,448 0%
Solar PV	12 out of 30 40%	110 out of 581 19%
Total	103 out of 242 43%	2,452 out of 5,888 42%

Source: Author's Calculation (2020)

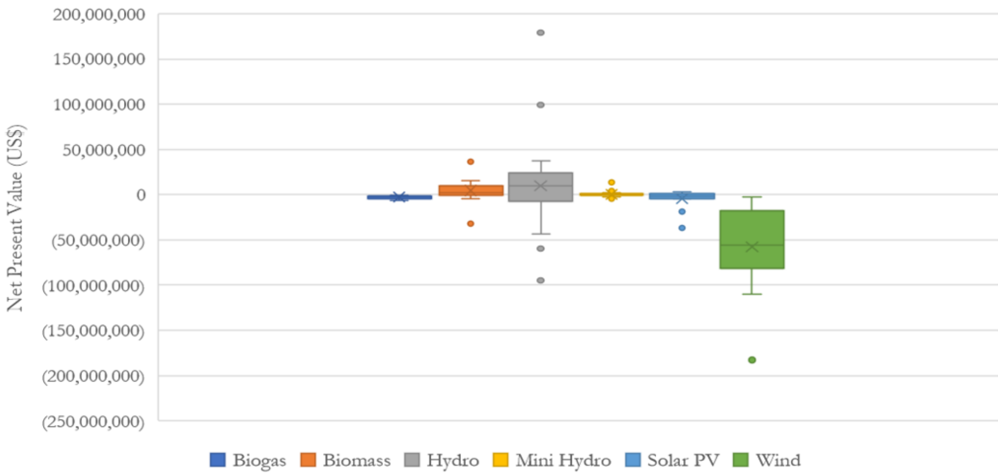

Figure 1. Distribution of Project NPV
Source: Author's Calculation (2020)

Java region with low BPP tariff. However, no other RE is feasible for Java. Meanwhile, it is more diverse in Sumatra and Eastern part of Indonesia[11]. The domination of hydro followed by biomass, mini hydro, and solar PV. Biomass is one of the potentials that can be developed in the Sumatra region due to its abundant of feedstock sources, such as oil palm plantations, woodchips, also pulp and paper industry.

Eastern part of Indonesia is dominated by three types of electricity sources, namely hydro, mini hydro, and biomass, and then followed by solar PV. Hydro and mini hydro are relatively scattered, while biomass is mostly located in East Nusa Tenggara because the price is high and the feedstock varied from wood pellet, felling trees, forest residues, plantation pruning, and other biomass categorized as waste. As for the solar PV projects mostly located in West Nusa Tenggara, where the potential of solar irradiance is among the highest for the territory of Indonesia, followed by Maluku, and East Nusa Tenggara. Meanwhile, Kalimantan is dominated by hydro, followed by mini hydro. There are no biogas, solar PV, and wind projects feasible in this region. Meanwhile, the Sulawesi region is dominated by solar PV, which also has high solar irradiance potential, followed by mini hydro.

As seen from the distribution of feasible projects, there are five areas where all projects fall into the feasible category, namely Bangka Belitung, Gorontalo, East Kalimantan, Maluku, and North Sulawesi. East Nusa Tenggara, Aceh, and West Nusa Tenggara which incidentally have low electrification ratios also have a percentage of feasible projects reaching 87 per cent, 80 per cent, and 75 per cent, respectively. However, in areas such as Papua, there are only 9 per cent of projects that are feasible. Some regions do not even have feasible projects, such as Central Java, Riau Islands, South Kalimantan, South Sulawesi, and West Papua.

4.1 Project Feasibility Factors: Indonesia Specific Costs

It has been mentioned that electricity price serves as the main component which determines power plant project feasibility. Current state in Indonesia, electricity tariff is regulated by MEMR Regulation No. 4/2020 which uses the regional BPP as a reference for price setting to IPPs. However, the problem with BPP is that the value composed by all power plant technologies operating in the region which is mainly dominated by CFPP. As the backbone of national electricity, CFPP has been developed in massive scale and receive various incentives such as continuous and cheap supply of coal mandated by Ministerial Decree of MEMR No. 261 K/30/MEM/2019 about domestic market obligation (DMO). The regulation obligated coal producers to supply

[11] In this study, Eastern part of Indonesia includes Bali, Nusa Tenggara, Maluku, Papua, and West Papua.

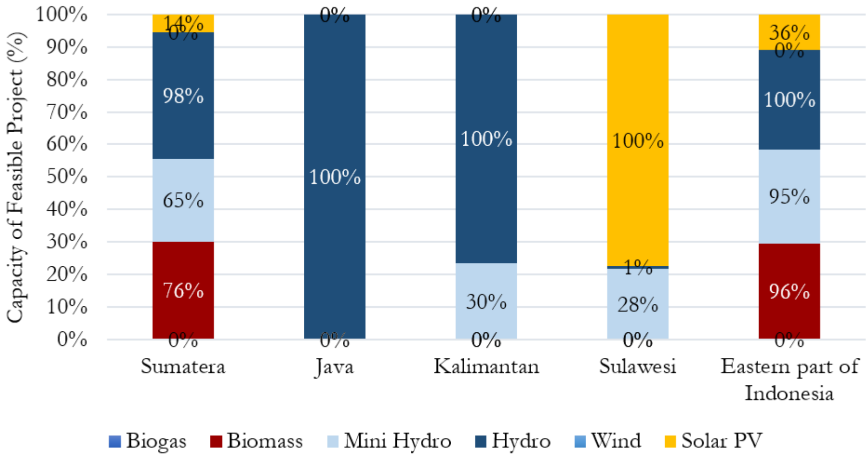

Figure 2. **Capacity of Feasible Project in Each Region (%)**
Source: Author's Calculation (2020)

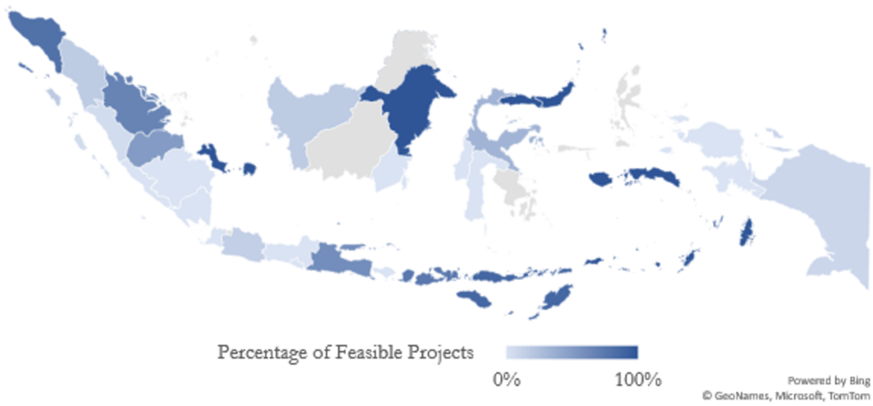

Figure 3. **Distribution of Feasible Project by Project Unit**
Source: Author's Calculation (2020)

domestic market as much as 25 per cent of total production and capped coal price for CFPP at the maximum of US$70 per metric ton. Thus, CFPPs are able to generate lower cost for producing electricity –much lower since the external cost is exempted- than other technologies and results in low BPP tariff. Meanwhile, it is known that RE-based electricity still high in cost both for initial overly and operational costs (OPEX), particularly in Indonesia in which several RE technologies development are still in the beginning stage (IESR, 2019). Thus, except hydro power, other RE power plants are mostly built in small scale project which probably leads to inefficiency and are not comparable to CFPP. These all situations then become disincentive for investors and developers to take part in Indonesia's RE business.

From this study's output, majority of feasible RE projects are located in the remote area such as Gorontalo, Maluku, Nusa Tenggara, and some other provinces which incidentally has lower electricity rate than national average[12]. This happened due to higher BPP in those regions caused by the high use of diesel power plants. The situation might be good for incentivizing IPPs and achieving target of 100 per cent electrification by 2020. Nonetheless, deploying power plant in those areas can be very challenging and expensive because of geographical constraint, limited infrastructure, and low in electricity demand. Hence, support from the government is highly necessary to bring a better electrification in the mentioned regions.

In term of project cost structure, Indonesia currently faces several specific costs which only incur on project deployment within the country. This means, in other countries these expenses can be exempted so that average generation cost will be lower. Data collected from the survey and FGD, many developers, especially solar PV and wind, are facing high cost for land acquisition. This cost does not take in to account social conflict, time for acquisition process and legal permits which will make it even higher. In other countries, project area is sometimes provided by the government as incentive or part of government-private partnership. This scheme has been proposed in Indonesia but supposed to have some obstacles in the implementation.

Furthermore, developers are now confronted with ambitious regulation of local content requirement (*Tingkat Komponen Dalam Negeri*/TKDN), especially for solar PV. This policy is listed in the Ministry of Industry Regulation No. 5/2017 which requires solar PV developer to use locally manufactured solar module at the minimum of 40 per cent in 2017 and continues to increase to 60 per cent in 2019. However, MEMR holds the requirement at 40 per cent until further notice (IESR, 2019). This policy is considered to hamper the deployment of solar PV in Indonesia because the price of local solar modules is more expensive with lower quality compared to imported modules, while it has a sizable proportion of the project's investment cost. In fact, the global market of solar module has developed rapidly,

[12] Based on the National Electricity Statistic 2019.

which results in price of solar module plummeted more than 80 per cent compared to 10 years ago (IRENA, 2020). Another issue is related to land acquisition because solar PV requires large land area, while it is challenging to acquire land where located in high levels of solar irradiance at reasonable prices, exempted from social issues, and relatively close to the PLN grid (IESR, 2019).

Committing with limited infrastructure notably in the remote area, PLN obligates IPPs to build their own transmission line from project site to the nearest PLN's grid. This situation demands a specific budget which results in higher investment cost, mainly for small scale power plant where it will significantly increase average cost of generation. In addition to this, as a geographical consequence, project located outside Java Island has higher price for machinery and other equipment resulted from a stiff transport or shipping cost. The geographical adjustment then commonly named as logistic index used in this study are as follows: 1 for Java, 1.2 for Sumatera, 1.3 for Kalimantan, 1.4 for Sulawesi, 1.5 for Bali and Nusa Tenggara, and 1.6 for Maluku and Papua. Thus, infrastructure development support is strongly needed, notably for interconnection line. Moreover, PLN's grid system and infrastructure should be improved adequately, which is currently still being a problem particularly in connection to highly intermittent resources such as solar and wind (Maulidia et al., 2019b). As an update, PLN has initiated to build smart grid and smart micro grid for renewables to advance the gird system, for example in Sulawesi and Mandalika[13].

4.2 Renewable Energy Potential and Its Progress

Fundamentally, Indonesia has various potential renewable energy sources. However, solar PV is projected to dominate RE mix in 2025, partly due to the simplicity of technology installation, so that it can reach the outer regions of Indonesia (Kennedy, 2018). But unfortunately, the development of solar PV has been sluggish compared to other countries. Around 2013, the government regulated the arrangement of reverse auction mechanism for 140 MW of solar PV projects in Indonesia. However, the project is still considered expensive due to the maximum capacity of only 5 MW and the limitation of foreign investors' ownership of the project, which eventually made the MEMR closed the project (Burke et al., 2019). Furthermore, between 2015 to 2016, many international investors and developers once again notice the potential of the solar PV market in Indonesia, mainly because the government introduced the Feed-in-Tariff (FiT) mechanism through MEMR Regulation No. 19/2016 to encourage the development of solar PV projects (Kennedy, 2018). However, this has stopped due to changes in pricing mechanism in 2017.

Until now, the policy governing the wind power plant in Indonesia has not been published, even though the discussion has been started since 2016, particularly related to the FiT mechanism. Lesson learned can be taken from Sidrap power plant as the first commercial wind farm in Indonesia (Maulidia et al., 2019b). The project is funded by foreign investors through a public-private partnership scheme. Investors consider that strong government support and government guarantee is significant in encouraging the development of renewable energy in Indonesia. Another issue is that the electricity demand in Sulawesi region is not yet high and the growth rate is low, which leads to electricity surplus in the region. The cost of wind turbines also continue to decline at the global level, up to 50 per cent since 2007 (IRENA, 2020). However, both the solar PV and wind power plants face intermittency issues, where PLN's transmission line capabilities have not been able to compensate for that (Burke et al., 2019; Maulidia et al., 2019b).

Companies that have resources for biogas and biomass power plants will generally use these resources to meet internal electricity needs or to carry out excess power cooperation with PLN. But in the last few years, IPPs have been increasing in bioenergy investment. The main issue related to biogas and biomass is the sustainability of supply of feedstock as fuel for electricity generation. These plants are usually located within the factory, so transportation costs can be eliminated. However, operational costs per year are quite high compared to other types of power plants, which can reach 10 per cent of the total initial investment cost. Another potential type of biomass, which is still stagnant, is fueled with waste or commonly known as Waste to Energy (WtE) plant. This power plant is very potential to overcome the waste problems in the region level and reduce the adverse impact of waste on the environment.

Hydro potential, both large and small scale, has long been used by the state as main renewable energy source which can compete with coal. Even for remote areas, the potential for mini hydro will be preferred to meet local energy demand compared to other energy sources. This energy source is also distributed throughout the country, with the amount of potential that can be utilized around 34,000 MW of 75,000 MW of the total potential (Tang et al., 2019). However, due to its geographical features, cost of civil works is the biggest component of hydro power plant, which even has the potential for cost overrun to reach 30 per cent. Unlike other power plants, hydro tends to be more expensive because the location of the untapped project is increasingly challenging and the installation cost has steadily increased since 2010, particularly in Asia (IRENA, 2020). Furthermore, it is important to pay attention to the sustainability of water flow, by developing natural infrastructure to ensure water availability in the long run.

To reinforce RE development in Indonesia, one of the utmost crucial factor is an appropriate and reliable regulation (Simamora et al., 2018). As elaborated in the literature review, RE regulation in Indonesia changed rapidly which led to negative business climate for Indonesia's renewable sector. Not only disadvantage developer, uncertain regulation is also seen by investors and lenders as a risk and will hinder them from investing their capital (IESR, 2019). In respect to that, the government is expected to set a strong and supportive policy.

In current situation, the COVID-19 pandemic has sharpened investors' interest in sustainable and resilient assets, including renewables. Institutional investors have been paying increasing attention to companies' environmental, social

[13] Kontan.co.id. (2019, March 19). *PLN Gandeng TSG Perancis untuk Kembangkan Smart Grid di Sulawesi dan NTB*. https://industri.kontan.co.id/news/pln-gandeng-tsg-perancis-untuk-kembangkan-smart-grid-di-sulawesi-dan-ntb.

and governance practices, recognizing their impact on long-term profitability and future value creation. As they review their portfolio strategies, larger investment in renewable energy assets can be expected. This can be a very good opportunity to leverage RE impact as a new strategy to reshape the economy towards more sustainable. For that reason, RE stakeholders, mainly the government, should be able to establish positive business climate for RE, particularly in Indonesia.

Despite the uncertainty caused by the pandemic, foreign direct investment in renewable energy reached an all-time high in the first quarter of 2020, while investments in fossil fuels plummeted. According to fDi Markets (2020), foreign investors have already announced over US$23 billion of cross-border renewable energy investment this year, the highest quarterly performance recorded over the past decade. Placing renewable energy at the core of green recovery plans can signal long-term public commitment to the industry, boosting investor confidence and attracting private capital.

5. Conclusion

The future of RE power plant development in Indonesia should be paid more attention from various stakeholders. The result of this study indicates that less than 50 percent of the samples are feasible, accounting for only 43 per cent by number of projects (103 out of 242 projects) and 42 per cent by capacity (2,452 out of 5,888 MW). As the only renewable energy which has been long developed, hydro power -together with mini hydro- still dominate as the most feasible RE to build in Indonesia, followed by biomass and solar PV, constituting of 66 per cent, 51 per cent, and 19 per cent by capacity respectively. Hydro power plant can already reach economies of scale and compete with CFPP. In addition, most of feasible projects are located in Bangka Belitung, Gorontalo, East Kalimantan, Maluku, and North Sulawesi, while in contrast projects in main islands particularly Java Island are mostly unfeasible due to the lower tariff paid to IPPs under BPP scheme regime. In addition to the low feasibility rate, there are several cost components which are considered as Indonesia specific costs such as local content, land acquisition cost, transmission infrastructure cost, and regional adjustment for project location which result in higher project's cost and possibly turnout the project become unfeasible.

In view of these results, we recommend two policy strategies which can be implemented mainly by the government to support RE business typically for power sector in Indonesia. First, the current electricity tariff -under the BPP price scheme- should be re-evaluated. As has been mentioned in the previous discussion, the use of regional BPP as the reference of RE tariff may result in dispute since it is seen as a disincentive for RE developer due to unfair calculation mechanism. The BBP calculation predominantly consists of CFPP which basically have much lower generation cost than majority RE power plants due to the massive scale and cheap coal incentive, where this is not comparable to most REs which are considerably as new technology in Indonesia. Notwithstanding the low generation cost of CFPP, it will be drawn higher if the external cost is included. Secondly, it is essential for the government to support RE project in purpose of increasing project's viability. This situation can be achieved by establishing an appropriate and reliable regulation for RE, particularly in pricing scheme, and enforcing a comprehensive support for RE business environment such as delivering tax incentive, setting a reasonable local content requirement, easing of doing business, technology improvement, project development facility, and some others.

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