An Analysis of the Possibility to Achieve the Specified Indonesian Renewable Energy Development Target: Status and Proposal for the 2020-2024 Medium-Term Development Plan

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Abstract
During the 2015-2019 Medium-Term Development Plan (MTDP), Indonesia's renewable energy showed good growth performances, especially for biofuels. In terms of share, however, there was a large gap between the targets of renewable energy's share and their realizations, due mostly to the growth of fossil fuels which grew higher than expected. The high growth of fossil fuels was caused by large imports of petroleum and LPG and as a result of the "35,000 MW" project implementation. The achievement of developing Indonesia's renewable energy in the next future will not be determined by the sector alone, but also by the growth of other energy sectors, namely oil, natural gas, and coal. For renewable energy to reach its development target in 2020-2024 MTDP (including to achieve 23 percent share by 2025), several strategies and actions were proposed. These include utilizing the increased production of renewable energy to be used to reduce consumption of fossil fuels, linking the development of certain types of renewable energy technologies with development programs and their potential users, establishing a Renewable Energy Development Agency and an Energy Conservation Center, and improving regulations on renewable energy development (particularly on tariff and Renewable Portfolio Standards).

Keywords: Indonesia, renewable energy, energy policy, medium-term development plan

Introduction

Indonesia is one of 169 countries in the world which has set its renewable energy development targets (REN21, 2019), driven by various objectives including reducing dependence on fossil fuels, improving the balance of payments and following international agreements on climate change and sustainable development (Purwanto, 2017; Nugroho, 2018a, 2018b). Like many other Asia's developing countries, Indonesia since the early 1970es has put into practice a Five-Year Development Plan in building various sectors of its national life (GoI, 2015; GoI, 2020). Various strategic plans and sectoral policies, for the ease of coordination and achieving their goals, are consolidated in the Five-Year Development Plan document, later known as the Medium-Term Development Plan (MTDP).

A basically fossil fuels country, Indonesia has experienced various developments in its energy policymaking (IEA, 2008, 2014, 2015; Nugroho, 2011, 2018a). The most recent and basic law on national energy policy is Government Regulations in lieu of Laws number 79 of 2014 (Rep. of Indonesia, 2014), which is based on the Energy Law number 30 of 2007 (Rep. of Indonesia, 2007), and which has been translated into Presidential Regulation on National Energy General Plan (GoI, 2017). Included in the core of the long-term national energy policy is the prioritization of renewable energy development.

This paper examines renewable energy development in Indonesia, in the context of national energy policy and medium-term development plans (MTDP). Discussed mainly the achievement of renewable energy development targets in the 2015-2019 MTDP, as well as proposals for renewable energy development for the 2020-2024 MTDP. Several studies estimate that Indonesia's renewable energy development targets are difficult to achieve (Purwanto, 2017; Bappenas, 2017; Bridle, 2018), the paper tried to confirm this, while the proposal is not limited to 2020-2024 MTDP but also efforts to achieve the renewable energy mix target 23 percent in 2025 as stated by the National Energy Policy (NEP).

Our analysis began by studying the data on renewable energy development targets and their achievements in the 2015-2019 MTDP, then looked at the factors that cause differences between target data and their realization. Several previous studies and theories (Boyle, 2004; Tester, 2005; Brown, 2011; Sovacool, 2012, 2013; IRENA, 2014) were studied to explain the causes of these differences. A better understanding of the theories and problems faced in energy development in Indonesia (Bappenas, 2016, 2017a, 2017b, 2018; 2019d; Irsyad, 2017; Nugroho, 2015, 2018a, 2019;) resulted in our proposals for renewable energy development for 2020-2024 MTDP. Besides, we have access to some limited official data and reports (for example Bappenas, 2017a, 2018, 2019) which help conduct this study.

The paper is structured as follows. Section 2 contains the essence of the national energy policy, renewable energy performances during 2015-2019 Medium-Term Development Plan, and some analysis regarding the difference between the target and realization of the renewable energy development during the period. Following analysis, Section 3 contains Indonesia's considerable potential for renewable energy development, and our proposals regarding renewable energy development for the

2020-2024 MTDP that also intended to meet the target of renewable energy share in 2025. Section 4 summarizes and concludes our study.

Renewable energy performances during 2015-2019 Medium-Term Development Plan

The essence of national energy policy as stated in GR 79 of 2014 covers two main things; first, the estimated total future energy demand or the amount of energy needs to be supplied nationally (divided for electricity and fuel; both until 2050); and the second, the national energy mix, with the direction of increasing the share of renewable energy. The essence of the policy can be summarized as shown in Figure 1.

It can be seen from Figure 1 that the amount of energy that has to be provided will increase from less than 200 MTOE (million tons of oil equivalent) in 2013, to about 400 MTOE by 2025, and to at least 1,000 MTOE by 2050. Given the increasing demand, the share of renewable energy needs to be increased from around 5 percent in 2013 to 23 percent in 2025, and 31 percent by 2050.

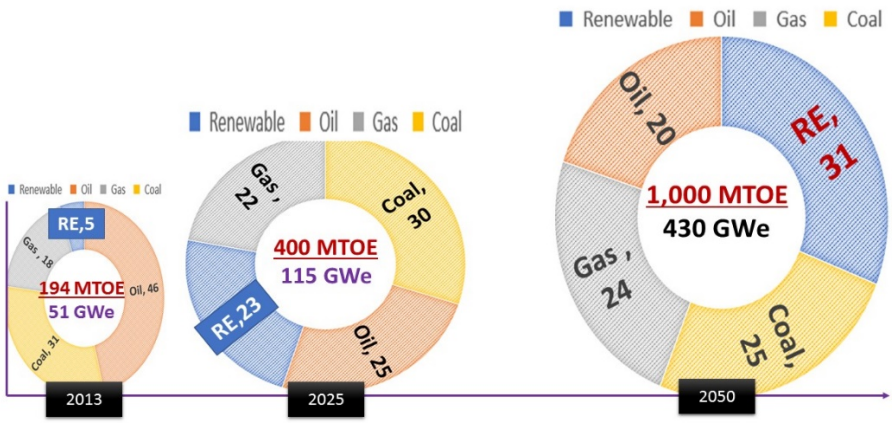

Figure 1: Energy Demand (TPES), Electricity Generation Capacity, and National Energy Mix (according to GR-Law 79/2014)

During the 2015-2019 MTDP, renewable energy showed good growth in production; it was very close to that suggested in the National Energy General Plan (NEGP), which is around 13 percent per year on average. However, this growth was achieved unevenly, and the details differed largely from those predicted in the NEGP. As the Ministry of Energy and Mineral Resources data shows (Dilisusendi, 2019), the growth of renewable energy-based power plants reached by only 7.1 percent per year on average, far below the targets in NEGP or MTDP.[1] Conversely, the growth of non-electricity renewable energy was very impressive, with liquid biofuels grew by 33

[1] Actually, in the initial 2015-2019 MTDP document there were no quantitative targets for renewable energy development mentioned. The NEGP target for renewable energy development was then adopted by MTDP in the middle implementation of the 2015-2019 MTDP.

percent per year on average, and biogas even higher, at 40 percent per year on average (from 25.2 million cubic meters in 2015 to 95.6 million cubic meters in 2019).

Although the growth of renewable energy in the 2015-2019 MTDP was not poor, its share in the national energy mix was still far lower than expected (Figure 2).

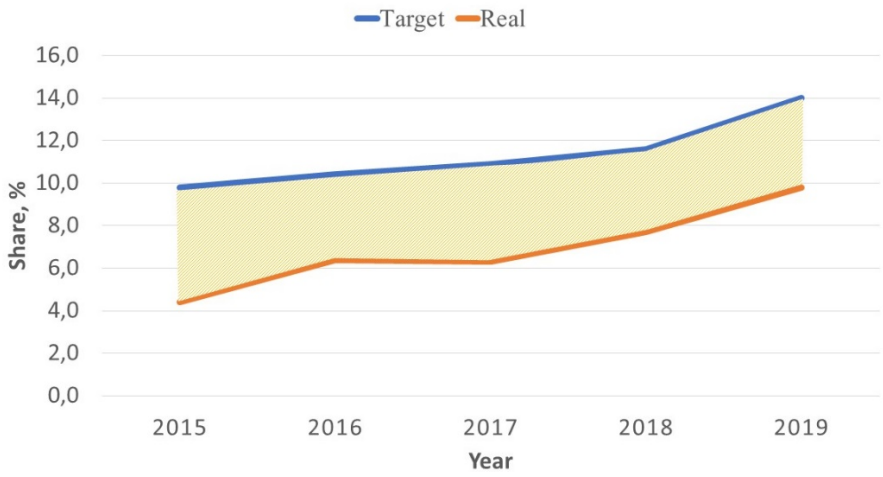

Figure 2: Renewable energy share in national energy mix: targets and realization during the 2015-2019 MTDP

Why did the difference between the share of renewable energy targeted for 2015-2019 MTDP and its realization was quite large?

While many studies focus on barriers/challenges in analyzing Indonesia's renewable energy prospects (Bridle, 2018; IRENA, 2016; Purwanto, 2017), we also consider the development of non-renewable energy, namely oil, natural gas, and coal. Our examination of growth data for all types of energy found that during the 2015-2019 period: (i) oil had grown higher than expected/ the target, (ii) the use of gas grew higher than projected, and (iii) coal even grew very rapidly compared to its projection.

The growths that were above the estimate, can be traced due to the following reasons. First, Indonesia, to some degree, is not successful yet in realizing its old agenda to reduce its large dependence on petroleum as the main source for fulfilling the country's energy needs (IEA, 2007, 2015; Nugroho, 2018; BP, 2019). No longer a net petroleum exporting country, during 2015-2019 MTDP Indonesia met about half of its petroleum needs by importing both crude oil and oil products (MEMR, 2018), be a burden on Indonesia's balance of payments (Bappenas, 2019b). However, the growth of petroleum imports showed a downward trend.

Secondly, as a long impact of Indonesia's energy policy a decade earlier to replace kerosene with LPG for household energy, while its domestic LPG production capacity is limited (Nugroho, 2011), LPG imports continued to increase during the 2015-2019 MTDP (Budiarti, 2019). The high growth of LPG imports during the period (close to 12 percent per year averagely) could partly be a result of the slow development of

Indonesia's natural gas infrastructure, specifically, that serve households (Nugroho, 2018a; Bappenas, 2019c).

Thirdly, the "35,000 MW" program implemented in the 2015-2019 MTDP (GoI, 2015) although only part of it had been built, had led to an increase in domestic coal consumption, specifically for electricity generation (Bappenas, 2016; Tampubolon, 2018). Driven mainly by power generation, coal consumption in that period increased by around 10 percent per year on average (Bappenas, 2019c.)

Within renewable energy itself, we look at the differences in growth that occurs due to the following things. Renewable energy-based power plants that grew by only 7.1 percent on average per year was due to poor tariff policies implemented during the second half of the 2015-2019 MTDP, and this was due particularly to the implementation of Minister of Energy & Mineral Regulation 50 of 2017 (MEMR, 2017; Rahma, 2017).[2]

On the other hand, the impressive growth of non-electric renewable energy is evidence of the effective mandatory policies for the use of biofuels in particular during the period. Taking advantage of its position as the world's largest CPO (crude palm oil) producing country, and in attempt to decrease dependence on fossil fuels, Indonesia since 2008 has developed biodiesel blends and implemented a mandatory use of biodiesel (Rahmanulloh, 2019), the last based on the Minister of Energy and Mineral Resources Regulation No. 12 of 2015 which requires the use of B-20. So far Indonesia's pioneering work in implementing mandatory biodiesel has been quite successful (Hadiyanto, 2018; Rahmanulloh, 2019).

Proposals for the 2020-2024 MTDP and to meet the target of renewable energy share in 2025

Learning from the 2015-2019 MTDP experience, we consider that to achieve the renewable energy share in the future (DEN, 2019; GoI, 2020) two main strategies must be implemented: (i) increasing the capacity of renewable energy development, and (ii) controlling the growth of other types of energy, namely oil, natural gas, and coal. It should also be noted that to achieve the target of 23 percent renewable energy share by 2025, the supply of renewable energy in the 2020-2024 MTDP must grow faster than that in the 2015-2019 MTDP period.

It needs to demonstrate first that Indonesia has enormous renewable energy potential that can be developed (Nugroho, 2014; Bappenas, 2017b; DGNRE&EC, 2019). As Table 1 shows, the development of renewable energy for electricity in Indonesia is still very small compared to its potential. For example, the country, which is currently

[2] In the middle of the 2015-2019 MTDP, the Minister of Energy & Mineral Resources issued Ministerial Regulation No. 50 of 2017 concerning the use of renewable energy sources for the supply of electricity. The Ministerial Regulation stated that the purchase of electricity from power plants which utilizes renewable energy sources by PLN (The State-Owned Electricity Company) will be determined based on the PLN's Cost of Electricity Supply. Because PLN's costs are considered too low, many prospective electricity providers had withdrawn from the power purchase agreement (Rahma, 2017). It can also be seen that the production of electricity from renewable energy sources, such as geothermal energy, was the result of electricity power purchase agreements made in the previous period, where the principle of "feed in tariff" (Mendonca, 2007) was used in determining electricity purchase agreement.

the world's second-largest producer of electricity from geothermal, has only utilized 7.5 percent of its geothermal potential (NS Energy, 2020; IGA, 2020;). In total, Indonesia has only utilized 2.4 percent of its potential renewable energy sources for electricity utilization. Besides, Indonesia also has a large potential for renewable energy from forests, palm oil, and various other plants that can be utilized as fuel (liquid, solid, or gas), with palm oil being a large source and economically feasible to develop into various types of energy (DGNRE&EC, 2019; Bappenas, 2019d).[3] These renewable energy sources, both for electricity and other uses are unevenly distributed across the archipelago.

RE Resources	**Potential**	**Developed**	**% (D/P)**
Hydro (GW)	75.0	5.3	7.1
Geothermal	25.4	1.9	7.5
Bioenergy (GW)	32.6	1.8	5.5
Solar (GWp)	207.8	0.1	0.0
Wind (GW)	60.6	1.1	1.8
Ocean (GW)	17.9	0.0	0.0
Total	**419.3**	**10.2**	**2.4**

Table 1: Indonesia's renewable energy for electricity: potential and developed (2019)

Learning from the 2015-2019 MTDP experience, we consider that to achieve the renewable energy share in the future (DEN, 2019; GoI, 2020) two main strategies must be implemented: (i) increasing the capacity of renewable energy development, and (ii) controlling the growth of other types of energy, namely oil, natural gas, and coal. It should also be noted that to achieve the target of 23 percent renewable energy share by 2025, the supply of renewable energy in the 2020-2024 MTDP must grow faster than that in the 2015-2019 MTDP period.

We propose that a portion of the additional renewable energy production can be used to replace fossil fuels (oil, natural gas, and coal) in a number of applications (Boyle, 2004; Tester, 2005; Sovacool, 2013).

The growth of coal consumption can be reduced (though not much) by implementing a co-firing program, where coal is blended with pellets resulted from the rehabilitation of palm oil plantation, energy forests, city waste, etc. As the technology is ready (IEA-ETSAP & IRENA, 2013), and negotiation with the state-owned electricity company is in good progress, the co-firing program could be deployed once the pricing system is encouraging (Husaini, 2019; KESDM, 2017). Another one is to develop renewable energy to reduce the use of natural gas and LPG imports by expanding the application of biogas that has been developed so far, for example, that by the BIRU program (FAO, 2014), and adding to it by developing new programs, for instance, the Bio-CNG (compressed natural gas) one (GGGI, 2019). There are grasses, reeds and bushes in Indonesia that potentially could be developed into methane or biogas programs (Supriyanto, 2016; DGNRE&EC, 2019).

[3] Since 2006, Indonesia has been the world's largest producer of crude palm oil, produced 43 million tons of CPO (crude palm oil) in 2018 (GAPKI, 2019). There are also fuel potentials from forests, plantation, paddy field, etc. that can be developed in Indonesia (DGNRE&EC, 2019).

Developing renewable energy to reduce fossil-based fuel will be the main program for the development of non-electric renewable energy. Indonesia's previous success in developing the B-10 biodiesel program needs to be increased by developing the B-20 program and so on (KESDM, 2019). In addition to the biodiesel program which has proven successful, the development of the Green-Fuel program that is being initiated is important to be supported.[4] The success of the two programs later will greatly contribute to the success of the renewable energy development program, in terms of increasing renewable energy production, reducing the growth of fuel (fossil-base) consumption and improving Indonesia's balance of payments.

We also propose that renewable energy development, especially for electricity, to be more focused on linking the types of electricity generation with development programs and potential users that are specific to the 2020-2024 MTDP. The hydropower plant must be given priority to meeting the demand for electricity by industrial estates that are built nearby (Bappenas, 2018) by not immediately building coal-fired power plants because of its low cost or easier to construct, for example. It will also important to continue the development of small hydro to meet rural villages' demand (Bappenas, 2017b). Because many of the islands in eastern Indonesia are still experiencing shortages of electricity supply (PT PLN, 2019), while the geothermal potential is located on some of these islands (Bappenas, 2014; Nugroho, 2015), it is appropriate to build (small-scale) geothermal power plants to increase electricity supply on these small islands.

The huge biomass potential in Indonesia can be developed by planting energy forests whose products can be used for cooking fuel, even electricity generation. Development of biomass for electricity potentially could be carried out in plantation areas (especially oil palm plantations) and, in addition to for own use, its utilization can be connected to the surrounding community (Bappenas, 2019d). The use of solar power in tropical countries Indonesia which has been too low (Table 1) needs to be expanded by installing photovoltaic units in remote areas, as much as possible to reduce the use of diesel fuel. Conversely, urban areas also need to develop regulations that require the use of solar power by luxury housing/apartments (including by building rooftop solar power), government offices, and commercial buildings to meet the NEGP targets (GoI, 2017; Burke, 2019).

Beyond the technical matters as previously described, we also propose about institutions and regulations to be established during the 20120-2024 MTDP period. This is considering that the development of renewable energy in Indonesia will continue going forward, therefore a strong institutional and regulatory foundation needs to be established to sustain this large work. Regulations, institutions and tariff policies that support the development of renewable energy need to be strengthened or in place (IEA, 2015; Nugroho, 2018b; Burke, 2019; Purwanto, 2017).

Government organizations responsible for developing renewable energy must be strengthened with greater expertise and ability to carry out their duties, including

[4] Green fuel refers to fuels that are processed in a refinery with treated crude palm oil, called refined bleached deodorized palm oil (RBDPO) through a treatment called coprocessing. There are three types of green fuel, namely gasoline, diesel, and aviation turbine oil. The processing method is different from a 20 percent biodiesel blend, where the CPO material called FAME (fatty acid methyl ester) is blended only after the crude oil becomes fuel (KESDM, 2019).

strengthening cooperation between the central and regional governments on these matters (Nugroho, 2018b). Not only stop at strengthening renewable energy organizations within the government but also forming state-owned enterprises doing renewable energy business, equivalent to those already established for the oil, natural gas, and coal industries. IREDA (Indian Renewable Energy Development Agency) of India and the country's several State-Owned Enterprises engaged in the field of renewable energy are worth emulating to accelerate the development of Indonesia's renewable energy (Burke, 2018; IESR, 2018; IREDA, 2019, Nugroho, 2011, 2018a).

Another proposal on the institution is to establish an Energy Conservation Center. Influencing the growth of oil, natural gas and coal so that they are not too far above the projections as in case of the 2015-2019 MTDP could be carried out partly for example by developing public transportation in major cities of Indonesia, and so on (Bappenas, 2019a; Nugroho, 2018a). However, we consider that the establishment of an Energy Conservation Center could encourage more programmatic and massive efforts to conserve energy consumption, which will have a major impact on conserving fossil fuel consumption. The proposal that the Energy Conservation Center be immediately formed in MTDP 205-2019 also after studying several previous reports which stated that Indonesia's energy conservation potential is quite large in various sectors (IEA, 2015, 2017). However, until now there has been no agency having the responsibility to do jobs such as energy audits, provide soft credit as an incentive to undertake energy conservation projects, or foster the growth of energy management/service companies as the agency's main tasks (Nugroho, 2018a). The model we propose to emulate is the Japanese Energy Conservation Center, whose development has been imitated, for example, by Thailand (Nugroho, 2012; ECCJ, 2018).

On regulation, we support to continue the regulation regarding the mandatory use of biodiesel which is mixed with diesel fuel from petroleum, even developing the regulations for higher biodiesel content, to B-30 or even B-40 if its technology and economic development can be achieved during the 2020-2024 MTDP. This is the case for biodiesel developed from FAME process. For green fuels project made from RBDPO (Refined, Bleached, and Deodorized Palm Oil) we suggest that once the development is successful, regulations that oblige their use in the country are immediately issued, similar to that of FAME biodiesel (KESDM, 2015).

We also propose that in the 2020-2024 MTDP period the government issues regulations regarding the "Renewable Portfolio Standards" (Martin, 2009; Nugroho, 2018b), intended for the first time for state electricity companies, to fulfill the obligation to develop renewable energy in various working areas of the company. This is important as the state electricity company is a major player in the supply of electricity in all regions of Indonesia (IEA, 2015; ADB, 2016) while the renewable energy share in the company's power mix in 2019 is only around 12 percent, contributed mainly by hydro and geothermal power (PT PLN, 2019). The final regulatory support we propose is regarding tariffs for purchasing electricity generated by renewable energy sources, by re-implementing the "feed-in tariff" policy that was enacted in the previous period and proven to stimulate renewable energy development. Our overall proposal for renewable energy development to meet its goals in the 2020-2024 MTDP including to support the 23 percent renewable energy share in 2025 is summarized as shown in Table 2. Our preliminary simulations show that by

implementing the proposal described above, it will not difficult to meet such targets of renewable energy development as mandated in the NEGP and 2020-2024 MTDP documents (GoI, 2017, 2020).

1. Renewable energy to replace/reduce fossil fuels consumption	
Program	Action
1.1 Reduce coal consumption in power plants	Co-firing, blending coal with biomass pellets.
1.2 Reduce LPG imports	Continue biogas program; implement Bio-CNG.
1.3 Reduce the growth of oil consumption and petroleum imports	Expand the B-20 with B-30 (FAME), implement the green fuels program.
2. Linking renewable energy (RE) technology with development program and potential users	
Type of RE technology	Action
2.1 Hydropower	Hydropower to meet industrial estates demand and small hydro for rural villages.
2.2 Geothermal	Small geothermal for Eastern Indonesia's islands.
2.3 Biomass	Biomass for plantation and local community.
2.4 Solar power	Photovoltaic for rural villages and urban's luxury houses.
3. Energy institution	
Coverage	Action
3.1 Renewable energy	Establish a Renewable Energy Development Agency.
3.2 Conservation Center	Establish an Energy Conservation Center.
4. Regulation	
Topic	Action
4.1 Biofuels	Continue mandatory for biodiesel, issue the one for green fuels
4.2 Renewable Portfolio Standards	Establish RPS for the state-owned energy companies
4.3 Renewable Energy Prices	Re-implement the FIT (feed-in-tariff) approach.

Table 2: Summary of proposals

Summary and conclusion

During the 2015-2019 MTDP, Indonesia's renewable energy showed a good growth performance as it was very close to that suggested in the National Energy General Plan (NEGP). However, in terms of share in the national energy mix, there was a large gap between the targets of renewable energy's share for 2015-2019 MTDP and their realizations. The gap was caused more by the growths of fossil fuels (oil, natural gas and LPG, and coal) which grew higher than expected. The growth of fossil fuels was caused by large imports of petroleum and LPG and as a result of the implementation of the "35,000 MW" projects. The growth of renewable energy for electricity was much lower than the growth of renewable energy used for fuel, especially for biodiesel and biogas.

The Indonesian archipelago has enormous renewable energy potential that can be developed both as electricity as well as fuels. However, the achievement of the development of renewable energy in the future will not be determined by this sector alone, but also by the growth of other energy sectors, namely oil, natural gas, and coal, that also must be controlled.

In order for renewable energy development to reach its development target in 2020-2024 MTDP (including achieving a 23 percent share of renewable energy by 2025), we propose a number of strategies and actions to be taken. These include utilizing the increased production of renewable energy to be used to reduce consumption of fossil fuels, linking the development of certain types of renewable energy technologies with their potential users, establishing a Renewable Energy Development Agency and an Energy Conservation Center, and improving regulations on renewable energy development (particularly on tariff and Renewable Portfolio Standards).

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