STUDY OF THE POTENTIAL AND DEVELOPMENT OF RENEWABLE ENERGY POWER IN INDONESIA : A REVIEW

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Abstract: Energy consumption in Indonesia every year shows an increasing trend, with energy sources from fossils or non-renewable energy dominating renewable energy in the national energy mix. Climate change due to fossil energy emissions and the depletion of fossil energy reserves directly encourages Indonesia to develop and utilize renewable energy, which is abundantly available in Indonesia. The purpose of this study is to examine the development and planning of the contribution of renewable energy in each sector to the national energy mix in the short to long term. Geothermal capacity total installed in 2019 2130.7 MW with a plan 7.2 GW in 2025 and 17.6 GW in 2050, hydropower total capacity in 2019 6283.3 MW with a paln 21 GW in 2025 and 41 GW in 2050, bioenergy total ini 2019 for power generator 2200 MW with a plan 5.5 GW in 2025 and 26 GW in 2050, in solar energy total capacity in 2020 as power plant 17.22 MW with a plan 6,5 GW in 2025 and 45 GW in 2050, in wind energy until 2020 total capcity for electrical energi 153. 83 MW with a plan 1.8 GW in 2025 and 28 GW in 2050, and the marine energy energy sector in Indonesia has not yet been utilized as an energy harvester. In general, the government targets an increase in the percentage of renewable energy in the national energy mix in the short term until 2025 with a 23% contribution, and in the long term until 2050 with a 31% contribution.

Keywords : potential energy, development renewable energy, Indonesian

INTRODUCTION

Global energy demand in general has shown an increasing trend in the last ten years with growth reaching 1.9% from 2010 to 2020. However, energy consumption decrease in 2020 due to the global covid-19 pandemic with a 4.5% decrease in energy consumption compared to the year 2019 (British Petroleum, 2021). Energy consumption from oil currently dominates with a 33.1% contribution to the total energy global consumption in 2019 (Maulana et al., 2021) then energy sourced from coal and natural gas contributed 27% and 24.2%, respectively, while renewable energy contributed 11.4% and nuclear energy 4.3% (British Petroleum, 2020). The trend of increasing energy demand causes dependence on fossil energy sources (oil, coal, and natural gas), but this fossil energy supply contributes negatively to health (Perera, 2017) and environment (Nurdin et al., 2020). Energy sourced from fossils directly contributes to the effect of greenhouse gases that cause global warming and climate change (Sommer, 2016).

The increase in energy demand also spurs the level of exploitation of fossil energy sources which causes depleting reserves, this is feared because fossil energy is non-renewable (Nurdin et al., 2020). In an effort to control climate change globally due to global warming, the United Nations Framework Convention on Climate Change or UNFCCC formulated the 2015 Paris Agreement to reduce carbon emissions globally (Aisya, 2019). The formulation of the Paris Agreement was positively welcomed by the International Renewable Energy Agency or IRENA by planning a long-term plan to increase the capacity of renewable energy to 65% in the energy sector mix, and increase to 86% in the mix of electrical energy sources globally by 2050 (IRENA, 2020). The formulation of the Paris Agreement specifically in Indonesia was accepted by the government by issuing the Law of the Republic of Indonesia Number 16 of 2016 (Aisya, 2019).

In terms of its geographical location, Indonesia is a region that has abundant natural resources (Nurdin dkk., 2021), which includes non-renewable energy sources (including oil, coal, natural gas) as well as renewable energy (Dutu, 2016). In the last 11 years (Table 1), the energy consumption mix mostly Indonesia is dominated by fossil energy sources (oil, coal, gas), while the mix of renewable energy sources shows an increase starting in 2016 (ESDM, 2020). During the last 10 years, reserves of fossil energy sources in Indonesia have tended to decrease, oil reserves from 8.21 billion barrels in 2008 fell to the range of 3.8 billion barrels in 2019 while natural gas reserves in 2008 were 170 TSCF and continued to decrease 77.29 TSCF in 2019. However, it is different from coal which has reserves

of 37.6 billion tons in 2019 or an increase of 5.3 billion tons compared to 2015 (ESDM, 2020).

The decreasing reserves of oil and gas energy sources, as well as to control climate change due to carbon emissions, the government issued Government Regulation No. 79 of 2014, one of the contents of the regulation is to increase the contribution of renewable energy to the energy mix in Indonesia until 2050 (Walujanto et al., 2018). Renewable energy sources are sustainable and free of air emissions, so this is a solution in reducing dependence on fossil energy and controlling climate change. Located in a tropical climate and coastal areas, the potential of renewable energy sources in Indonesia is abundant and divided into several sectors as shown in Table 2 (Suharyati et al., 2019).

Table 1. Share of Supply of Primary Energy in Indonesia (%) (ESDM, 2020)

Type of Energy	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gas	25.11	21.73	20.88	22.12	21.97	23.05	21.09	21.39	19.68	28.47	17.44
Coal	26.24	27.74	27.77	24.79	25.9	30.05	27.8	30.53	33.00	37.21	38.46
Oil	43.24	46.77	47.43	48.13	46.77	42.00	44.84	41.42	38.71	35.15	32.82
Renewable Energy*	5.42	3.77	3.92	4.96	5.35	4.09	6.27	6.66	8.61	9.16	11.28

*exclude biomass

Table 2. Availability of Renewable Energy (Suharyati et al., 2019)

Renewable Energy Sector	Availability
Hydropower	94 GW
Geothermal	28.5 GW
Bio Energy	PLT Bio : 32.6 GW
	BBN : 200.000 Bph
Solar	20.8 GW peak
Wind Energy	60.6 GW
Ocean Energy	17.9 GW

The abundant availability of sustainable energy sources in Indonesia encourages the government to increase the contribution of renewable energy to the national energy mix in the long term, as well as reduce dependence on energy sourced from fossils. Based on the presentation of national energy, the focus of the study in this paper is to discuss the development and planning of the contribution of renewable energy in each sector to the national energy mix in the short to long term.

PRIMARY ENERGY SUPPLY

Energy production in Indonesia from 2000 to date has shown an upward trend with a peak reaching more than 1600 Million Barrels Oil Equivalent or BOE in 2019 (ESDM, 2020), but production decreased by almost 100 Million BOE in 2020 due to the covid-19 pandemic (Hilmawan and Sugiyono, 2020). Fig. 1 shows a graph of the energy produced in Indonesia in 2000 – 2009 dominated by fossil energy sources (oil, gas, coal), while renewable energy sources have been utilized hydropower, biomass, and geothermal (ESDM, 2010). Between 2010 – 2020, renewable energy sources from biogas began to be developed in 2015, while solar and wind were developed from 2018 as shown in Fig. 2 (ESDM, 2020).

Based on the final mix of energy consumption in 2010 – 2020, the largest portion of energy is used as fuel oil which is utilized from the transportation and industrial sectors. Meanwhile, the demand for electricity as a household and industry shows an increasing trend every year with a peak in 2020 which reaches more than 18% of all final energy consumption as shown in Table 3 (ESDM, 2020). In 2018, energy in the electricity sector reached 64.5 MW, most of which came from fossil energy generators of coal (50%), natural gas (29%), fuel (7%) and renewable energy (14%) as shown in Fig. 3. The contribution of renewable energy is 14%, hydro energy, geothermal energy, and biomass energy are renewable energy sources that provide the largest portion (Suharyati et al., 2019).

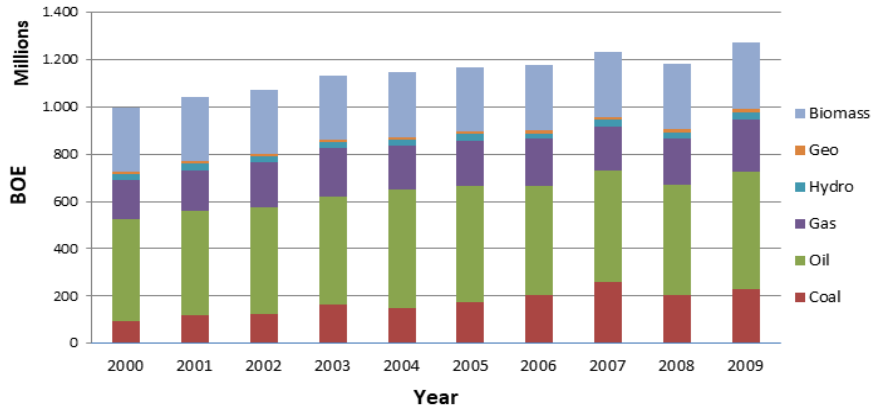

Fig. 1. Primary energy supply 2000 – 2009 in Indonesia (ESDM, 2010)

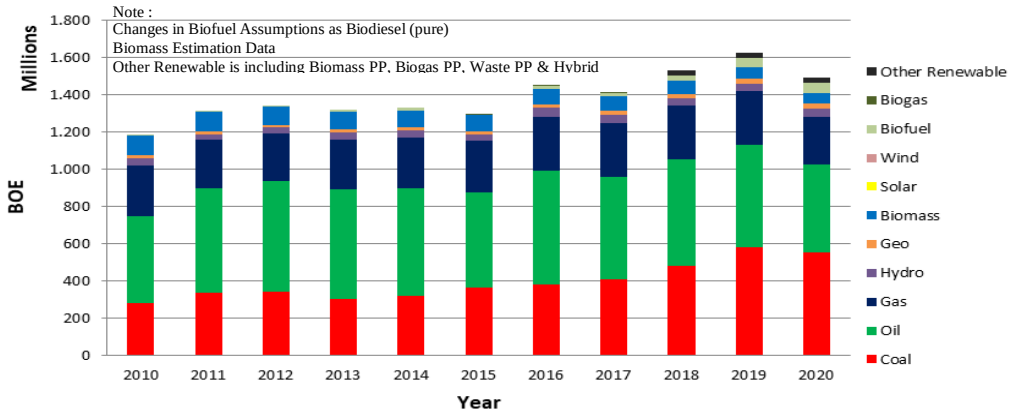

Fig. 2. Primary energy supply 2010 – 2020 in Indonesia (ESDM, 2020)

Table 3. Presentase final consumption mix energy by type (ESDM, 2020)

Year	Biomass	Coal	Gas	Fuel	Bio Gasoil	Biogas	Briquette	LPG	Electricity
2010	13.86%	17.69%	11.19%	37.85%	3.59%	0.00%	0.02%	4.13%	11.67%
2011	12.24%	16.81%	10.96%	38.94%	5.33%	0.00%	0.01%	4.31%	11.40%
2012	10.81%	13.41%	10.63%	42.39%	6.45%	0.00%	0.01%	4.67%	11.62%
2013	11.28%	5.06%	11.67%	44.76%	7.94%	0.00%	0.02%	5.66%	13.61%
2014	10.84%	6.44%	11.39%	42.51%	8.52%	0.00%	0.01%	6.07%	14.23%
2015	10.03%	8.32%	11.29%	38.30%	10.88%	0.01%	0.01%	6.44%	14.73%
2016	9.75%	7.77%	9.47%	40.24%	9.63%	0.02%	0.01%	6.92%	16.19%
2017	8.83%	6.95%	10.52%	39.17%	11.09%	0.02%	0.01%	7.24%	16.16%
2018	7.21%	10.73%	10.21%	34.26%	13.91%	0.02%	0.00%	6.89%	16.77%
2019	6.12%	16.59%	9.38%	26.40%	19.01%	0.02%	0.00%	6.56%	15.92%
2020	5.94%	12.62%	10.85%	24.80%	19.95%	0.02%	0.02%	7.75%	18.05%

RENEWABLE ENERGY DEVELOPMENT

Renewable energy sources in Indonesia began to be seriously managed starting in 2015 and continued to increase until 2019, this is as in Fig. 4 showing an increasing trend renewable energy contribution in the national energy mix from 4.4% in 2015 to 9.15% in 2019. The increasing percentage of renewable energy in the national energy mix is due to the increasing geothermal energy

capacity every year, and the operation of wind power plants in South Sulawesi in 2018 (DEN, 2020). Renewable energy sector capacity from 2015 until 2019 shown at the Table 4 indicates that Geothermal has the largest increase in terms of providing installed capacity of renewable energy plants of 727 MW since 2014, followed by various renewable energies (Solar, Wind, Water) of 554 MW, and Bioenergy of 487 MW spread throughout Indonesia (EBTKE, 2020).

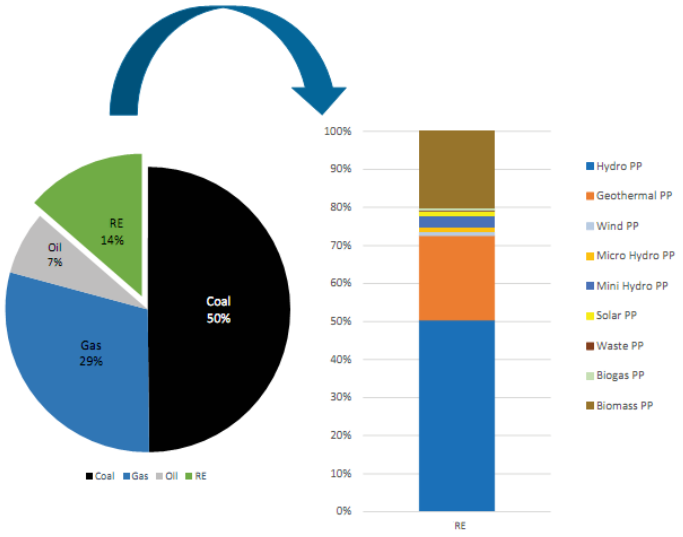

Fig. 3. Capacity electrical energy sector in 2018 (Suharyati et al., 2019)

Through the National Energy General Plan of the Ministry of Energy and Mineral Resources - Republic of Indonesia, the government targets an increase in the contribution of renewable energy to the national energy mix in the short term until 2025 and long term until 2050 (DEN, 2020). In the short term in 2025, the contribution of renewable energy is targeted to reach 23% of the national energy mix, with a capacity of 92.2 Million Tonnes Barrell Oil Equivalent (MTOE). Meanwhile, in the long term, the contribution of renewable energy is targeted to reach 31% of the national energy mix with a capacity of 315.7 MTOE which is divided into 235.3 MTOE as fuel for power plants and 79.4 MTOE as energy sources for other sectors. The target for increasing the use of renewable energy in the national energy mix consists of several types of renewable energy sources such as geothermal, hydropower, bioenergy, solar, wind, ocean, and other renewable energy sources that are planned to be installed and spread throughout Indonesia (BPPT, 2021).

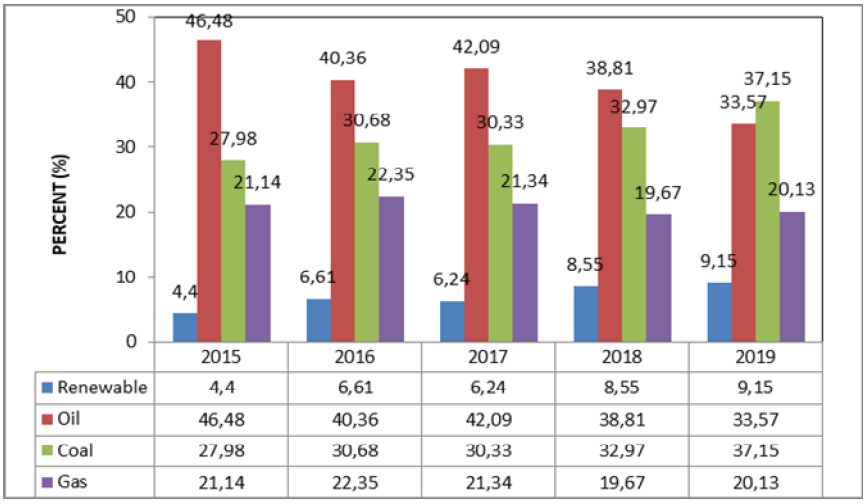

Fig. 4. Renewable energy contribution in mixing energy (DEN, 2020)

Table 4. Renewable energy sector capacity (ESDM, 2020)

Year	Solar, Wind, Micro Hydro (MW)	Geothermal (MW)	Bioenergy (MW)
2014	212.4	1403.3	1402.7
2015	273.7	1438.3	1741.7
2016	351.9	1553.3	1783.1
2017	396.7	1808.3	1856.8
2018	576.3	1948.3	1882.8
2019	753.3 (target)	2138.3 (target)	1881.9 (target)
	766.6 (realization)	2130.7(realization)	1889.8 (realization)

Through the National Energy General Plan of the Ministry of Energy and Mineral Resources - Republic of Indonesia, the government targets an increase in the contribution of renewable energy to the national energy mix in the short term until 2025 and long term until 2050 shown at the Table 5 (DEN, 2020). In the short term in 2025, the contribution of renewable energy is targeted to reach 23% of the national energy mix, with a capacity of 92.2 Million Barell Oil Equivalent (MTOE) with details of 69.2 MTOE for the electricity sector or equivalent to 45.2 GW and 23.0 MTOE for the other sectors. Meanwhile, in the long term, the contribution of renewable energy is targeted to reach 31% of the national energy mix with a capacity of 315.7 MTOE which is divided into 235.3 MTOE as power plants and 79.4 MTOE as energy sources for other sectors. The target for increasing the use of renewable energy in the national energy mix consists of several types of renewable energy sources such as geothermal, hydropower, bioenergy, solar, wind, ocean, and other renewable energy sources that are planned to be installed and spread throughout Indonesia (BPPT, 2021).

Table 5. Renewable Energy Capacity for mix energy 2025 and 2050 (BPPT, 2021)

2025				2050			
23 % Renewable Energy capacity from mix energy	69.2 MTOE	Geothermal	7239 MW	31 % Renewable Energy capacity from mix energy	69.2 MTOE	Geothermal	17.546 MW
		Hydropower	20960 MW			Hydropower	45379 MW
		Bio Energy	5532 MW			Bio Energy	26123 MW
		Solar Energy	6379 MW			Solar Energy	45000 MW
		Wind Energy	1807 MW			Wind Energy	28607 MW
		Other	3128 MW			Other	6383 MW
	23.0 MTOE	Biofuel	13,9 Million Kilo Litre		23.0 MTOE	Biofuel	52.3 Million Kilo Litre
		Biomass	8,4 Million Ton			Biomass	22.7 Million Ton
		Biogas	489,8Million m^3			Biogas	1958,9 Juta m^3
		CBM	46,0 MMSCFD			CBM	576,3 MMSCFD

Geothermal Energy

Many countries that are surrounded by a ring of fire with volcanic activity have succeeded in developing it as a power plant. Indonesia is a country with natural volcanic activity with the potential to reach 28,000 MW or the equivalent of 40% of the world's geothermal potential (Hasan dkk., 2012). Geothermal in Indonesia began to be used as a fuel for power plants in 1983 in Kamojang Drajat, West Java, additional capacity in the 1990s, 2000s, and until 2019 has produced an installed capacity of 2,130.7 MW or 8.9% of geothermal resources in Indonesia, which found in 11 Geothermal Working Areas as shown in Table 6 (ETBKE, 2020).

In 2020 there is no additional geothermal generating capacity and it is planned to shift in 2021, this is due to delays in infrastructure mobility from within or outside the country due to regional restrictions during the COVID-19 pandemic. The planned additional capacity of 140 MW comes from the Sokoria Geothermal Power Plant Unit 1 (5 MW), the Orik Marapi Geothermal Power Plant Unit 2 (45 MW), and the Rantau Dedap Geothermal Power Plant Unit 1 (90 MW) (EBTKE, 2020). Geothermal development for electricity is projected at 7.2 GW in 2025 and 17.6 GW in 2050 or 59%

of geothermal potential in Indonesia. This potential can increase along with increased exploration and discovery of new reserves (EBTKE, 2020).

Table 6. Indonesian Geothermal Capacity in 2019 (ETBKE, 2020)

No	Island	Number of Location	Source (MW)	Installed Capacity (MW)
1	Sumatera	101	6979	744.3
2	Java	73	8107	1253.8
3	Bali	6	335	0
4	Nusa Tenggara	31	1363.5	12.5
5	Kalimantan	14	182	0
6	Sulawesi	90	2068	120
7	Maluku	33	1156	0
8	Papua	3	75	0
	Total	351	23965.5	2130.7

Hydropower (Large Scale and Mini/Microhydro Scale)

As a country located in the equator, Indonesia has high rainfall every year so that it has a large enough hydropower source, be it run off rivers or dams, so that it has potential hydropower that can be utilized and developed both for power plants with total potential large-scale hydropower is 75,091 MW. In addition to having hydropower potential that can be utilized as a large-scale hydroelectric power plant (large scale hydropower), Indonesia also has other hydropower potential, namely in the form of small-scale mini-hydro and micro-hydro power plants with a total potential of 19,385 MW (EBTKE, 2020). In contrast to large scale hydropower for the state electricity network, mini/micro hydro development plays a vital role in helping the government provide access to electrical energy for the community in areas that are not able to be reached by the state electricity grid (DEN, 2020). Until 2019, the installed capacity of large scale hydropower is 5,468.2 MW and mini/micro hydro 815.1 MW, bringing the total renewable energy capacity from the hydro energy sector to 6,283.3 MW (DEN, 2020).

Plans to increase the installed capacity of large scale/ mini-micro hydro the additional installed capacity of large scale/ mini-micro hydro in Quarter I-III of 2020 is 131.57 MW, with details of 80.15 MW for large scale hydropower and 51.42 MW for mini-micro hydro. In Quarter IV, there were 3 additional power plants, namely mini-micro hydro Bojong Cisono 1.6 MW located in Banten, mini-micro hydro Pesantren I 1.6 MW in West Java, and mini-micro hydro Lau Gunung 10 MW in North Sumatra. There are a total of 14 projects operating in 2020 with an installed capacity of 144.97 MW. Of the 14 projects, 12 of them are large scale/mini-micro hydro which are not targeted to operate in 2020 (EBTKE, 2020). Large scale hydropower development for electricity is projected at 18.0 GW in 2025 and 38 GW in 2050 or about 51% of all large scale hydropower potential of around 75 GW. Meanwhile, mini/micro-hydro power development for electric power is projected at 3 GW in 2025 and 7 GW in 2050 or 37% of the mini/micro-hydro potential of around 19 GW (EBTKE, 2020).

Bioenergy

Bioenergy potential is spread throughout Indonesia with various types and uses, such as biomass, municipal waste as a power plant, as well as biofuel (biodiesel – bioethanol), biogas as non-electricity. Utilization for biomass generators uses raw materials from waste from the palm oil industry, pulp-paper industry (black liquor), sugar cane industry (bagasse), food industries such as rice processing, corn, and rice. As well as for municipal waste generation, the raw material used is municipal waste which is in the final disposal site of each region. Meanwhile, the use of bioenergy for non-electricity is biofuel (biodiesel and bioethanol) using raw materials derived from the palm oil industry (CPO) and the sugar industry (molasses), while for household/communal scale biogas, the raw material used is livestock waste (ESDM, 2020).

Based on a study conducted by the Indonesian Directorate of Biomass in 2012, the potential for biomass that can be converted into electricity in Indonesia is 32 GW with a distribution as shown in Table 7 (ESDM, 2020). Until 2019, the installed capacity of biomass power plants is 2200 MW, further development of biomass for electricity is projected at 5.5 GW in 2025 and 26.0 GW in 2050 or 80% of the bioenergy potential of 32.7 GW (EBTKE, 2020).

Table 7. Biomass Potency in Indonesia (ESDM, 2020)

No	Potency	Suma-tera	Kali-mantan	Java-Madura-Bali	Nusa Tenggara	Sula-wesi	Ma-luku	Pa-pua	Total (MW)
1	Palm Oil	8812	3384	60	-	323	-	75	12654
2	Sugar-cane	399	-	854	-	42	-	-	1295
3	Rubber	1918	862	-	-	-	-	-	2780
4	Coconut	53	10	37	7	38	19	14	178
5	Rice Husk	2255	642	5353	405	1111	22	20	9808
6	Corn	408	30	954	85	251	4	1	1733
7	Cassava	110	7	120	18	12	2	1	270
8	Wood	1212	44	14	19	21	4	21	1335
9	Animal Waste	96	16	296	53	65	5	4	535
10	City Trash	326	66	1527	48	74	11	14	2066
Total (MW)		15589	5061	9215	635	1937	67	150	32654

Biofuel from palm vegetable oil began to be applied in Indonesia in the transportation sector in 2006 as a mixture of diesel fuel oil (biodiesel) as much as 2.5% or called B2.5, then B7.5 in 2013, B10 in 2014, B15 in 2015, B20 starting in 2016. The level of this biofuel blend in diesel oil exceeds the government's minimum target, as shown in Fig. 5 (Silalahi and Simatupang, 2020). Began January 2020, the level of biofuel mixing in diesel fuel will increase by 30% or B30 and is targeted to reach 2050. In 2021, palm oil biofuel production as a diesel fuel mixture is targeted to reach 9200 million liters, this biofuel is produced by palm oil companies in Indonesia, as shown in Table 8 (USDA, 2021).

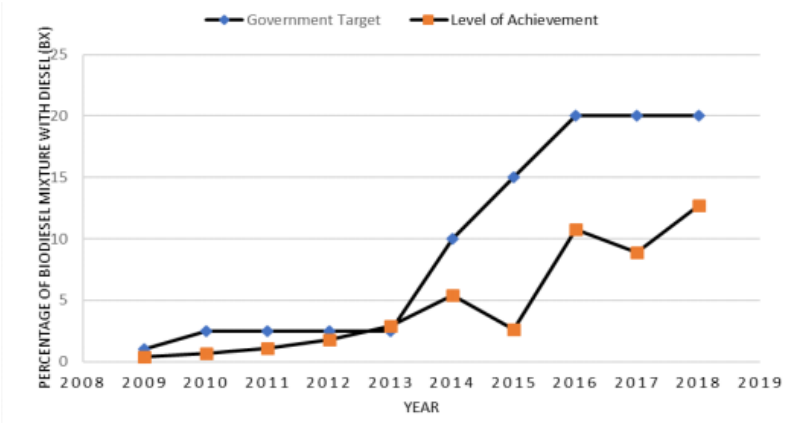

Fig. 5. Biofuel Palm Oil Blend at Diesel Fuel (Silalahi & Simatupang, 2020)

Table 8. List of Biofuel Producers for 2021 (USDA, 2021)

No	Biofuel Producers	Volume (million liter)	No	Biofuel Producers	Volume (million liter)
1	Batara Elok Semesta Terpadu	273	11	Multi Nabati Sulawesi	393
2	Bayas Biofuels	349	12	Musim Mas	883
3	Cemerlang Energi Perkasa	483	13	Pelita Agung Agrindustri	485
4	Ciliandra Perkasa	260	14	Permata Hijau Palm Oleo	397
5	Dabi Biofuels	174	15	Sinar Mas Bio Energy	338
6	Darmex Biofuels	117	16	Smart Tbk	353
7	Energi Unggul Persada	319	17	Sukajadi Sawit Mekar	262
8	Intibenua Perkasatama	288	18	Tunas Baru Lampung	342
9	Kutai Refinery Nusantara	399	19	Wilmar Bioenergi Indonesia	1330
10	LDC Indonesia	387	20	Wilmar Nabati Indonesia	1369
				TOTAL	9200

Solar Energy

As a country located in the equator, almost all year round Indonesia gets enough sunlight, so that solar energy has the potential to be utilized and developed as a power plant or for other purposes. Overall, Indonesia has a total solar energy potential of 207,898 MWp which covers 34 provinces, with 135.01 MWp of which has been utilized until 2019 (ETBK, 2020).

The additional installed capacity of solar energy plants in 2020 is 17.22 MWp with details of rooftop solar energy generation of 15.29 MWp from State Electricity Company customers, and ground mounted solar energy plant of 1.93 MWp owned by State Electricity Company. Ground mounted solar energy plants that are already in operation are located in the provinces of East Nusa Tenggara with a capacity of 1.68 MWp, and East Java with a capacity of 0.25 MWp. Meanwhile, for rooftop solar energy plants, the additional 15.29 MWp installed capacity is obtained from the use of rooftop solar energy generators from State Electricity Company customers from the government, industrial, household, or social sectors based on Presidential Regulation No 22 2017 about National Energy General Plan (RUEN). The growth of rooftop solar energy customers based on tariff groups is dominated by customers from households, namely 2,526 customers from a total of 3007 customers throughout 2020, while the total installed capacity of rooftop solar energy plants connected to the PLN network from the beginning of 2018 to the end of 2020 of 21.404 MWp. The development of solar power for electricity is projected at 6.5 GW in 2025 and 45 GW in 2050 or 22% of 207.9 GW the solar power potential (DEN, 2020).

Wind Energy

Wind energy based on its placement is divided into two types, namely onshore wind energy, and offshore or oceanic wind energy. Until 2020 the total installed capacity of onshore wind energy connected to the state electricity grid is 153.83 MW, the growth of wind energy capacity from 2010 is shown in Table 9 (ESDM, 2020) (IRENA, 2021). The addition of a large enough wind energy capacity in 2018 to 2020, after operation of the wind farm concept Sidrap South Sulawesi with a capacity of 75 MW (ESDM, 2019), and in Tolo Jeneponto with a capacity of 72 MW (ESDM, 2019). The development of wind power for electricity projected 1.8GW in 2025 and 28.0 GW in 2050 or 46% of the wind potential of 60.6 GW (DEN, 2020).

Ocean Energy

Ocean energy is energy generated from the sea and ocean areas. As an archipelagic country, Indonesia has about 17,805 islands and a total area of around 5,455,675 km2 with 2/3 of its territory (3,544,744 km2) is ocean and has a coastline of about 81,000 km. So this condition places Indonesia as a country with the largest marine energy potential in the world. In general, there are three types of ocean energy, namely gaut wave energy originating from kinetic energy (wind movement) that causes ocean waves, tidal energy from tides caused by the gravitational force of the sun and moon, and

OTEC (Ocean Thermal Energy Conversion) which is the conversion of the ocean's thermal energy from the temperature difference between the warmer surface and the colder ocean floor (DEN, 2020).

Research results from the Center for Research and Development of Marine Geology show the potential for ocean currents of 18 GW, ocean waves of 2 GW, and OTEC of 41 GW, so the total potential is 61 GW. However, marine energy is a renewable energy source that is the slowest in development, this is due to the large investment required, and in many cases its location is far from the country's electricity grid, besides the corrosive and rapidly changing ocean conditions cause operating and maintenance costs of marine energy facilities to increase. Several national institutions have researched the use of marine energy, but its utilization has not yet reached the commercial stage due to the rapid change in policy direction from research to electrification/commercial (DEN, 2020).

Table 9. Wind Turbine capacity growth until 2020 (ESDM, 2020)(IRENA, 2021)

Year	Capacity connected	Tahun	Capacity connected
2010	0.34	2016	1.46
2011	0.93	2017	1.46
2012	0.93	2018	143.03
2013	0.63	2019	153.83
2014	1.12	2020	153.83
2015	1.46		

CONCLUSION

The final target of increasing the contribution of renewable energy sources in the national energy mix aims to reduce the impact of emissions that result in climate change, while also aiming at the depletion of domestic fossil energy reserves except coal. The government targets an increase in the percentage of renewable energy in the national energy mix in the short term until 2025 with a contribution of 23%, and in the long term until 2050 with a contribution of 31%. The development of renewable energy in Indonesia in each type is shown as follows:

1. In geothermal energy sector, until 2019, the total installed capacity of geothermal energy as electrical energy reached 2130.7 MW or 8.9% of geothermal resources in Indonesia. Geothermal utilization for electricity is projected at 7.2 GW in 2025 and 17.6 GW in 2050 or 59% of the current geothermal potential in Indonesia.
2. In hydropower sector, until 2019 the installed capacity of large-scale hydropower is 5468.2 MW and mini/micro hydro 815.1 MW, so that the total capacity of renewable energy from hydropower is 6283.3 MW. Large scale Hydropower development is projected at 18 GW in 2025 and 38 GW in 2050. Meanwhile, mini/micro hydro is projected at 3 GW in 2025 and 7 GW in 2050.
3. In bioenergy sector, until 2019 the capacity of bioenergy as a power generator installed is 2200 MW, then it is projected to be 5.5 GW in 2025 and 26.0 GW in 2050 or 80% of the bioenergy potential of 32.7 GW. Meanwhile, for non-power plants, starting in January 2020, the mixing rate of biofuel in diesel fuel will increase by 30% or B30 and is targeted to reach 2050. In 2021, palm oil biofuel production as a diesel fuel mixture is targeted to reach 9200 million liters.
4. In solar energy sector, until 2020 capacity of solar energy plants in 2020 is 17.22 MWp. he development of solar power for electricity is projected at 6.5 GW in 2025 and 45 GW in 2050.
5. In wind energy sector, until 2020 the total installed capacity of onshore wind energy connected to the state electricity grid is 153.83 MW. The development of wind power for electricity is projected to be 1.8GW in 2025 and 28.0 GW in 2050 or 46% of the potential 60.6 GW.
6. The marine energy sector in Indonesia has not yet been utilized as an energy harvester, this is due to the large investment required and in many cases the location is far from the state electricity grid, in addition to the corrosive and rapidly changing ocean conditions causing the operating and maintenance costs of energy facilities the sea is increasing.

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