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Update on Geothermal Development Status and Working Areas Potential in Indonesia

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ABSTRACT

Energy are one of the vital aspects to determine countries growth, even energy supply could lead to economic, political and social instability. For many countries, it become an issue especially during economic and political uncertainty today. Indonesia are one of them. To support the average economic growth of 5.4% per year, it is estimated that energy demand needs to increase by 4.3% annually (BPS, 2021).

Indonesia is the world's largest geothermal potential country and should play a very important role in geothermal business in the world. According to Ministry of Energy and Mineral Resources data (2022), There are 351 geothermal potential locations spread throughout the country, most of which are geothermal prospects with high temperatures.

Indonesia's geothermal resources reach 23,356.9 MW and until now utilization in electricity sector has only reached 2,355.6 MW or only 10.1% of all its resources. The geothermal development area currently covers 63 Geothermal Working Areas (GWA) including 19 existing GWAs established before Law Number 27 of 2003 concerning Geothermal and 44 GWAs established after Law Number 27 of 2003, as well as 16 Preliminary Survey and Exploration Assignment Areas. Among those GWA's had been stipulated, there are 16 GWA's has already been able to generate 2,355.63 MW of electricity from geothermal energy. Meanwhile 26 areas have been conducted exploitation and exploration stage.

To attract investors for developing geothermal, some strategies have been taken by the Government. The Government of Indonesia (GOI) has carried out the activity to add subsurface data to the drilling of exploration wells in Cisolok Cisukarame and Nage geothermal fields. The government drilling has also carried out by PT SMI (cooperation with PT Geo Dipa Energi) in the Waesano, Jailolo and Bittuang areas to reduce exploration risks before being offered to business entities. GOI also has reviewed the geothermal electricity price to achieve the economic viability as well as the affordability to the public. GOI has issued the Presidential Regulation No. 112/2022 for renewable energy tariff to create certainty in the RE business scheme. With published price regulation, GOI still continues to encourage investors by offering incentives in exploration activities and lessens the amount of risk by allowing the government to assess exploration activities, using the geothermal fund and others sources of renewable fund. These policies are issued to achieve a forward leap in development

Indonesia has established various national-scale programs to accelerate the development of new and renewable energy. At the end of 2021 at the COP-26 Glasgow event, the Government of Indonesia said that the net zero emission program is targeted to be achieved by 2060 or earlier. Environmental issues that cause climate change have encouraged the Government of Indonesia to carry out an energy transition to open up space for more optimal use of new and renewable energy. This ambition is also Indonesia's commitment conveyed during Indonesia's G20 Presidency. World leaders including Indonesia has been committed to accelerate and ensure a sustainable, equitable, affordable energy transition and inclusive investment. These commitments also called Bali Roadmap in which consist of 3 priorities especially in energy sector that is securing energy accessibility, advancing smart and clean energy technologies, and advancing energy financing.

Lastly, The geothermal business is still very wide open for investors both at local and abroad to contribute in achieving Indonesia's Net Zero Emission in 2060 with an installed capacity target of 12.5 GW.

1. INTRODUCTION

Indonesia has the biggest geothermal potential in the world, and has developed geothermal power plants faster in terms of capacities in the last 5 years. Over 40 years when the first geothermal power plant operated at Kamojang Field, Indonesia has developed 2,355.6 MW or about 10.1 percent of 23,356.9 MW of geothermal potential through the year 2022. The development has proceeded slowly in terms of the national target and is currently facing difficult challenges. The additional capacities from 2015 to 2022 is about 1,056 MW. Another 13 MW are expected to be commissioned at the end of 2023 to produce totally 2,368.6 MW across Indonesia.

Geothermal development in Indonesia is regulated under the Presidential Decree since 1974 but revised by the Geothermal Law No 27 since 2003 and amended by the Law No.22/2014. The growth of geothermal development looks very slow compared to its potential, 29 GW. Even the government has issued the so called President Instruction No.4 Year 2010 to accelerate and develop the electricity sector by mandating PLN to take almost 4000 MW from geothermal in the 10000 MW fast track program phase II in 2014. The supporting regulation shows that the GOI give priority to accelerate the use of geothermal in the National Energy Policy to install 7200 MW of geothermal plants by 2025 to contribute at least 12% of the national electricity needs. The RE target in the national energy road map is 23% of the national energy mix by 2025. Currently Indonesia is the world's 2nd largest geothermal electricity producer after the United States.

The planning to build 44 new geothermal plants by 2014, announced in Bali during the 2010 World Geothermal Congress, is still a far away target. However, the Government of Indonesia never stopped the expansion of these targets. Now, total 63 existing areas have been targeted for 3,355 MW for the year 2030 through the geothermal development plan. These numbers include the 16 new geothermal areas which were assigned to the private companies for geothermal exploration (WSPE). PLN as a state-owned electricity company and Independent Power Producer (IPP) could play a significant role to achieve this target. But the government of course should provide opportunity to the private sector to participate in the development of geothermal power. Government of Indonesia (GOI) has reviewed and revised any obstacles regarding the geothermal price on MEMR Regulation No. 2 year 2011 on the ceiling price policy, MEMR regulation no. 22 year 2012 on the Feed in Tariff as amended by regulation No.17/2017, MEMR regulation no.10 year 2017 and MEMR regulation no.50 year 2017 related to mandated PLN to buy energy from renewables including geothermal and issued Presidential Regulation No. 112/2022 on Acceleration of Renewable Energy Development for the Supply of Electricity, summarized in it is the determination of electricity tariffs for renewable energy sources including geothermal.

To support these policies, GOI also strengthened the financing schemes support through PT. SMI (state owned company) which is financed by the World Bank for exploration of the green geothermal field before it is developed by private companies. As a pilot project, SMI started to drill one exploration well and will be tendered afterward. In addition, MEMR also has been conduct exploration drilling to decrease exploration risk and also lowering generation costs.

Since 2022, the government has reviewed the target of geothermal development for years 2025 and participated in very intensive discussion to formulate a new road map, seeking a financial scheme that will achieve the national target. Based on PLN's general planning of electricity, total capacity projection of the electricity from RE in the period 2022-2031 which included 3,355 MW coming from geothermal. This paper will update and discuss the Indonesian geothermal development status which is rapidly expanding in the installed capacities but still far from the national target due to the economic viability of projects, affected by renewable energy policy.

2. GEOTHERMAL RESOURCES AND RESERVES

Indonesia has abundant geothermal resources throughout the country. This is because Indonesia is in the Himalayan volcanic range that stretches along the islands of Sumatra and Java and the Pacific volcanic range that stretches along Sulawesi, Maluku to Papua. A total of 356 potential locations have been identified by the Geological Agency as having indications as geothermal resources, where the highest number of locations are on the island of Sumatra as many as 101 potential locations followed by the island of Sulawesi as many as 90 locations and the island of Java as many as 75 locations.

The current calculation of the geothermal resources of Indonesia is about 23,356.9 GW (Geological Agency, 2021) in total. It is composed of: 5,8 GW of speculative resources, 3.4 GW of hypothetical resources, 9,3 GW possible reserves, 1,8 GW probable reserves and 3,1 GW of proven reserves. Most of the geothermal prospects are high temperature geothermal systems. Sumatera has the largest geothermal potential, with 9,5 GW, or 40,5% of the total potential. The second largest potential is located in Java (7.9 GW), followed by Sulawesi (3.0 GW). The rest come from Bali – Nusa Tenggara (1.6 GW), Maluku (1.1 GW) and a very small amount comes from Papua (75 MW) and Kalimantan (175 MW).

Table 1. Geothermal Resources and Reserves in Indonesia (Geological Agency, 2022)

No	Island	Location	Resources (MW)				
			Speculative	Hipotetic	Reserves		
					Possible	Probable	Proven
1	Sumatera	101	2,167	1,567	3,624	976	1,126.4
2	Jawa	75	1,259	1,191	3,260	377	1,820
3	Bali	6	70	21	104	110	30
4	Nusa Tenggara	34	215	146	783	121	12.5
5	Kalimantan	14	151	18	6	0	0
6	Sulawesi	90	1,352	342	989	180	120
7	Maluku	33	560	91	485	6	2
8	Papua	3	75	0	0	0	0
Total		356	5849	3376	9251	177	3,110.9
					14,131.9		
			23,356.9				

In 2018, GOI has begun updating resource and reserve data in accordance with the reference to the Indonesian national standard (SNI) number 6009 of 2017 based on the availability and quality of subsurface data to drilling. These current resources and reserve are hundreds less but more reliable than previous year resources which amount to 23,765.5 MW. This shows that in Indonesia the

development of geothermal to prove proven reserves continues to go hand in hand with the emergence of economic weakness in recent years. During 2022, 18 wells have been drilled from Sorik Marapi, DTT Dieng, Patuha and Darajat geothermal fields.

3. GEOTHERMAL UTILIZATION

Based on law number 21 of 2014 concerning geothermal, the utilization of thermal energy from geothermal can be divided into 2 types, namely direct utilization and indirect utilization. Direct utilization is an entrepreneurial activity for the use of Geothermal directly without carrying out the process of converting from thermal energy and/or fluid into other types of energy for non-electrical purposes. Direct utilization activities can be carried out for tourism, agribusiness, industry and other activities that use geothermal energy directly without any change or thermal conversion. Meanwhile, indirect utilization is an entrepreneurial activity for the use of Geothermal through the process of converting from thermal energy and / or fluid to electrical energy. The use of geothermal into electrical energy can be done for its own interests as well as for the public interest.

3.1. Indirect Utilization

The main utilization of geothermal in Indonesia is indirect use to generate electricity. However, geothermal business for direct use cannot be ignored in order to achieve the national energy mix target which is the goal of the national energy policy launched by the Government.

Table 2. RE Installed Capacity within Five Years in Indonesia (EBTKE, 2022)

RE Power Plant	Actual				Plan	Actual	Plan	
	2018	2019	2020	2021	2022		2023	2024
Wind	143.5	154.3	154.3	154.3	156.3	154.3	154.3	209.3
Solar	65.2	150.6	172.9	204.7	893.3	271.6	430.4	725.1
Biofuel	1874.8	2098.3	2253.2	2284	2327.4	3086.6	3144.9	3331.3
Geothermal	1948.3	2130.7	2130.7	2286.1	2344.1	2355.4	2355.6	2456.6
Water	5791.4	5995.7	6140.6	6601.8	6808.8	6688.9	6825	7341.9

Currently, 2,355.6 MW geothermal power plant has already been installed as of 2022. This number are slightly increase about 69.5 MW than previous year which installed 2,286.1 MW. The total installed capacity that has been generated comes from 48 power plants in 16 Geothermal Working Areas. Most of them are located on the island of Java with an installed capacity of 1,263.8 MW compared to second largest on the island of Sumatra with an installed capacity of 949.8 MW which the most significant increase compared to those only 122 MW in 2015. While the province with the largest total installed capacity is West Java with a total installed capacity of 1,193.8 MW or more than 50% of the total installed capacity.

Star Energy Geothermal is still the top producer by generating 873.8 MW, followed by PT Pertamina Geothermal Energy which generating 672 MW and Sarulla Operation Ltd which generating 330 MW.

3.1.1. Existing Installed Capacity

The installed geothermal power plants are located in 18 geothermal fields. They are: Kamojang, Darajat, Patuha, Wayang Windu, Karaha and Salak in West Java; Dieng in Central Java; Sibayak, Sarulla and Sorik Marapi in North Sumatera, Muara Laboh in West Sumatra; Lumut Balai and Rantau Dedap in South Sumatra; Ulu Belu in Lampung; Lahendong in North Sulawesi; and Ulumbu, Mataloko and Sokoria in Flores.

No	Area, Provinsi	Power Plant	Company/JOC Contactor	Unit Turbine (MW)	Total Capacity (MW)
1	Kamojang Darajat, Jabar	Kamojang	PT. Pertamina Geothermal Energy	1 x 30 2 x 55 1 x 60 1 x 35	235
	Kamojang Darajat (KOB), Jabar	Darajat	JOCC Star Energy Geothermal Darajat II, Ltd	1 x 55 1 x 94 1 x 121	270
2	Cibeureum Parabakti, Jabar	Salak	JOCC Star Energy Geothermal Salak, Ltd.	3 x 60 3 x 65,6	376,8
3	Dataran Tinggi Dieng, Jateng	Dieng	PT. Geo Dipa Energi	1 x 60	60

No	Area, Provinsi	Power Plant	Company/JOC Contactor	Unit Turbine (MW)	Total Capacity (MW)
4	Sibayak Sinabung, Sumut	Sibayak	PT. Pertamina Geothermal Energy	1 x 10 2 (Monoblok)	12
5	Pangalengan (KOB) , Jabar	Wayang Windu	JOCC Star Energy Geothermal Wayang Windu Ltd.	1 x 110 1 x 117	227
	Pangalengan (Patuha Area), Jabar	Patuha	PT Geo Dipa Energi	1 x 55	55
6	Lahendong Tompaso, Sulut	Lahendong	PT. Pertamina Geothermal Energy	6 x 20	120
7	Waypanas, Lampung	Ulubelu	PT. Pertamina Geothermal Energy	4 x 55	220
8	Ulumbu, NTT	Ulumbu	PT. PLN (Persero)	4 x 2,5	10
9	Mataloko, NTT	Mataloko	PT. PLN (Persero)	1 x 2,5	2,5
10	Sibual Buali, Sumut	Sarulla	JOCC Sarulla Operations Ltd.	3 x 110	330
11	Karaha Cakrabuana, Jabar	Karaha	PT. Pertamina Geothermal Energy	1 x 30	30
12	Lumut Balai, Sumsel	Lumut Balai	PT. Pertamina Geothermal Energy	1 x 55	55
13	Sorik Marapi Roburan Sampuraga,Sumut	Sorik Marapi	PT Sorik Marapi Geothermal Power	1 x 42,4 1 x 56,95 1 x 62,8	162,15
14	Liki Pinawangan Muaralaboh, Sumbar	Muaralaboh	PT Supreme Energy Muara Laboh	1 x 85	85
15	Rantau Dedap, Sumsel	Rantau Dedap	PT Supreme Energy Rantau Dedap	1 x 98,4	98,4
16	Sokoria, NTT	Sokoria	PT Sokoria Geothermal Indonesia	2 X 3,29	6,58
TOTAL					**2.355,63**

The geothermal power is generated from the high temperature geothermal systems mainly dominated by hot water systems except Kamojang and Darajat geothermal fields which are dominated by vapor geothermal systems. Total power generation is increased from 14 million MWh in 2018 into 16.6 million MWh in 2022 (Table 3). The steam productions are increasing from 101.1 million tons in 2018 to 123,6 million in 2022.

Table 3. Total Steam and Electricity Production in 2022

NO	AREA	PRODUCTION	
		STEAM (Ton)	ELECTRICITY (MWh)
1	**SALAK**	3,272,856.44	2,855,017.00
2	**DARAJAT**	13,902,728.64	2,106,062.24
3	**WAYANG WINDU**	13,783,882.51	1,884,115.39
4	**SARULLA**	13,145,716.05	2,032,577.19
5	**DIENG**	2,515,247.80	350,642.48
6	**PATUHA**	3,044,685.07	445,347.54
7	**ULUMBU**	692,252.87	54,036.49
8	**MATALOKO**	-	-
9	**KAMOJANG**	13,146,945.45	1,679,389.66
10	**ULUBELU**	11,191,942.15	1,553,200.97
11	**LAHENDONG**	6,784,560.50	864,222.49
12	**SIBAYAK**	-	-

NO	AREA	PRODUCTION	
		STEAM (Ton)	ELECTRICITY (MWh)
13	**KARAHA**	725,436.53	84,252.67
14	**LUMUT BALAI**	3,191,355.26	448,528.72
15	**SORIK MARAPI**	8,195,928.64	824,290.67
16	**MUARALABOH**	4,718,834.43	723,925.53
17	**SOKORIA**	222,963.84	30,204.42
18	**RANTAU DEDAP**	5,050,839.72	651,966.48
	*** TOTAL 2022**	**123,586,175.90**	**16,587,779.95**

The most interesting action taken during the last few years is from Chinese international manufacturer company KS Orka which owned and operated 2 geothermal areas. Sorik Marapi geothermal area are now operated by KS Orka who has acquired 100% of the shares owned by OTP Geothermal Pte Ltd (OTP) from Origin Energy Geothermal Singapore Pte Ltd (Origin Energy) and Tata Power International Pte Ltd (Tata Power) in 2016 while a year after in 2017, they also has acquired 95% of the shares of PT Sokoria Geothermal Indonesia previously owned by PT Bakrie Power. KS Orka has also been active in some of geothermal area acquisition to increase renewable energy investment in Indonesia.

Sorik Marapi and Sokoria geothermal areas are two of several fields with very fast development progress. Sorik Marapi started the first drilling in October 2016, 2 months after the field was acquired, while Sokoria started the first drilling in October 2017, 9 months after the field was acquired. In addition, KS Orka is also a geothermal developer capable of building and operating a relatively short power plant where Sorik Marapi Unit-1 began commercial operations in 2019, just 2 years after EPC power plant began, while Sokoria Unit-1 began commercial operations in 2022, just 3 years after EPC power plant began. It's all thanks to their massive funding, effective drilling and efficient modular power plant.

As of 2022, Sorik Marapi consists of 3 power plants: Unit-1 42.4 MW operating in 2019; Unit-2 56.95 MW operating in 2021 and Unit-3 62.8 MW (gross) operating in 2022. Currently, Unit-1 of 6.58 MW Sokoria geothermal area has also started operating for commercial purposes.

In addition, there are 2 other power plants planned to be commissioned in 2023, operated by KS Orka in Sokoria (3 MW) and Geo Dipa Energi in Dieng (10 MW). In addition, there are 4 power plants are planned to be installed in 2024, operated by PGE in Lumut Balai (55 MW), Sabang Geotermal Energi in Jaboi will install 2 small scale power plant (5 MW and 10 MW) and Medco in Blawan Ijen (31 MW).

Further, there are also 62 power plants being developed with a total capacity of 2,449 MW. These projects also have been stipulated in National Electricity Plan (RUPTL) PT PLN where geothermal contributes to generation of 3,355 MW by 2031. Therefore, there are about 906 MW of scattered quotas that are still open for development in other prospect areas.

3.1.2. On-Going and Future Project Development

Since President Susilo Bambang Yudhoyono announced a plan to develop 9000 MW of geothermal plants by 2025 at the 2010 World Geothermal Congress in Bali, projecting Indonesia as the world's leading geothermal energy producer, many efforts have been made. The plan to accelerate the use of new and renewable energy was also set by President Joko Widodo to build a 35 GW electricity infrastructure which was strengthened in the Bali Compact declared in the implementation of the G20 Presidency in Bali in 2022 where one of the results was to agree to accelerate and ensure a sustainable, fair, affordable energy transition and inclusive investment..

So far, 63 geothermal working areas (GWA/WKP) have been offered to private companies including 12 GWAs assigned to the state-owned companies (PLN, PGE and Geo Dipa Energi). In addition, GOI has also offered 16 preliminary survey and exploration assignments (PSAE/PSPE) to the private sector.

Of the total GWA that has been offered, 16 GWAs have been produced with an installed capacity of 2.4 GW and a planned field expansion of 1.5 GW. In addition, 6 GWAs are in the exploitation stage with a total development plan of 400 MW and 20 GWAs in the exploration stage with a total development plan of 1.2 GW. In addition, 13 geothermal areas have also been assigned to the private sectors for preliminary survey and exploration with a development target of 886.5 MW. Thus, there are 21 GWAs and 3 PSAEs have not been developed with a total resource and reserve of 2.6 GW.

However due to the un-economic viability of the project, most of them are not realized. Only a few projects are running for exploration and development based on the permit. Only a few projects are moving from the new regulation regime and the rest are projects run by PGE with own operation and or with his partner on JOC scheme as well as PLN. Most of the projects still find it difficult to move forward due to investment uncertainty as the price of electricity is without considering the economic viability of geothermal development cost.

3.2. Direct Utilization

Today, Indonesia needs to review to establish the direct use regulation in addition to indirect purposes such as electricity. The direct utilization (non-electricity) is not only for spa and swimming pools, used for hundreds of years in natural hot springs, but also for other purposes. Other uses include distillation of vetiver, pasteurization of mushroom, brown sugar processing, fish farming, and coffee seed and tea drying. The regulation is under assessment to further involve all stakeholders.

There is no new report of geothermal direct use in Indonesia, since WGC2015. At present, the aquaculture facility that utilizes geothermal fluid is also identified in Lampung. It is a traditional freshwater fishery in Lampung Province, mixing natural geothermal hot water (outflow) with freshwater from a river to grow large catfish. The farmer reported that the fish grow better in the geothermal fluid and freshwater mixture. Total brine use was about 50 tonnes/hour for each field of fish farming. Palm sugar processing using brine produced from Lahendong geothermal field operated by Masarang Foundation is suspended (Figure 2). The more use of geothermal for agriculture such as copra drying in Lahendong, Mataloko and Wai Ratai Lampung, mushroom cultivation in Pengalengan (West Java), tea drying and pasteurization in Pengalengan and also geothermal direct use for large catfish growing in Lampung is running better.

4. DEVELOPMENT BREAKTHROUGH

Indonesia has significantly developed geothermal energy as one of the primary energy in the past 5 years compared to other countries in the world that rely on their energy from new and renewable energy with an additional installed capacity of 547.6 MW. This is driven by a series of targets set by the Government so as to encourage aligned policies and regulations and increase the amount of investment to accelerate the use of geothermal. However, the total installed capacity is only able to generate 2.4 GW or 10.1% of the total resources and reserves. Therefore, a series of efforts are needed to debottlenecking constraints while accelerating geothermal development.

4.1. Regulation regarding Land Use

Several regulations and policies have been set by the Government as an effort to accelerate the development of geothermal energy as well as to attract investment in the geothermal sector. One of them is in the land use issue, especially for prospect areas located in forest areas. The geothermal potential in forest areas is very large, especially the potential with a high enthalpy system that is economical for the use of geothermal as electrical energy. Geothermal resources in forest areas reach approximately 20 GW where the geothermal potential in production forest areas at 4.3 GW, protected forest areas at 9.9 GW and conservation forest areas at 5.8 GW.

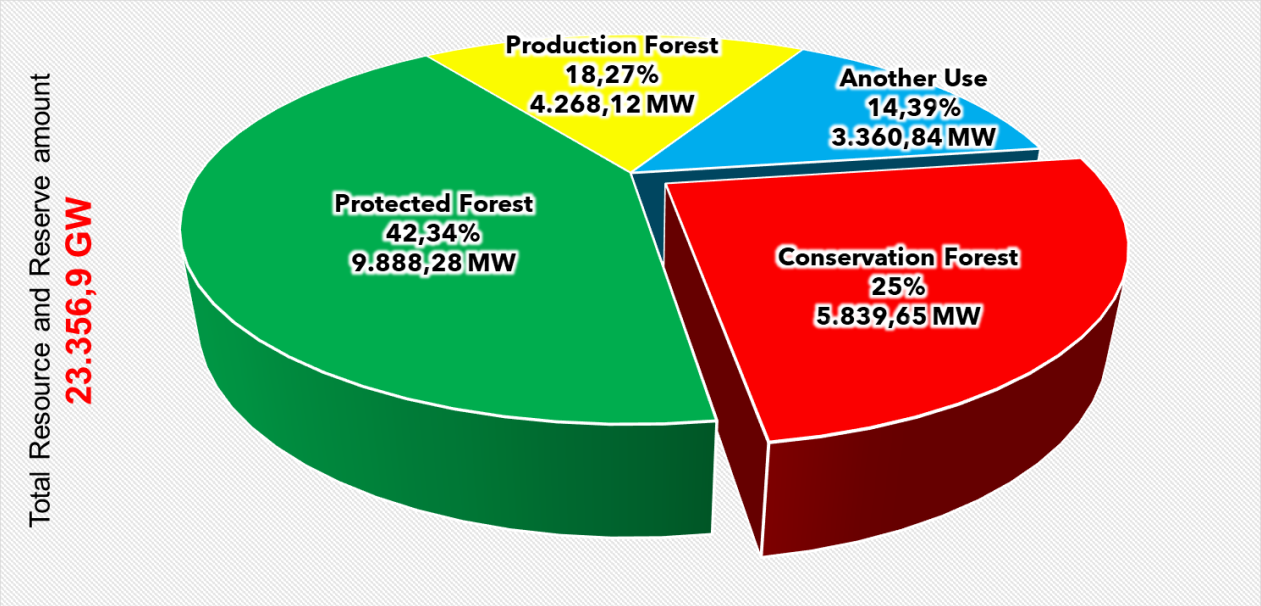

Figure 1. Geothermal Resources and Reserves in the Forest Area

Law Number 21 of 2014 concerning Geothermal has been established by the Government to allow geothermal exploitation in forest areas including conservation forests. Previous laws and regulations still categorized geothermal activities as mining activities where geothermal activities were considered extractive activities that could significantly damage the landscape. However, with the development of technology in geothermal business, the possibility of this impact can be suppressed. In addition, in the long run, the benefits of using geothermal as energy can significantly convert emission production from fossil plants.

4.2. The Latest Price Regulation

One of the causes of low geothermal utilization is the price of geothermal electricity which has not taken into account the economic factor of the costs that geothermal developers have incurred. The determination of geothermal electricity tariffs according to geothermal regulation terminology in Indonesia can be divided into two parts, namely:

1. The phase before the issuance of Law Number 27 of 2003 concerning Geothermal where at the beginning of that period electricity tariffs were very cheap because they had not considered the economy but rather considered business strategies, namely consideration of cross-subsidies between SOEs (between PERTAMINA and PLN)

2. The phase after the issuance of Law Number 27 of 2003 concerning Geothermal where in that phase the determination of geothermal electricity tariffs has begun to take into account the Cost of Generation (BPP) which uses an economic approach from geothermal

However, the geothermal economic approach has not been able to significantly encourage geothermal development because the BPP is still too low compared to the cost of geothermal generation.

Most recently on September 13, 2022, the Government issued Presidential Regulation Number 112 of 2022 concerning the Acceleration of Renewable Energy Development for the Supply of Electricity, summarized in it is the determination of electricity tariffs for renewable energy sources including geothermal. The calculation of PLTP tariffs according to Presidential Regulation 112 of 2022 can be seen in the table below.

Table 4. Geothermal Prices based on Presidential Regulation Number 112 of 2022

No.	**Capacity**	**Highest Ceiling Price (Cent US$/KWH)**	
		Year 1 to 10	**Year 11 to 30**
A.	**Electricity Purchase Price**		
1	Up to 10 MW	9,76 X Location Factor	8,3
2	> 10 - 50 MW	9,41 X Location Factor	8,0
3	> 50 - 100 MW	8,64 X Location Factor	7,4
4	> 100 MW	7,65 X Location Factor	6,5
No.	**Capacity**	**Steam (equivalent Electricity) Purchase Price (Cent US$/KWH)**	
		Year 1 to 10	**Year 11 to 30**
B.	**Steam (equivalent Electricity) Purchase Price**		
1	Up to 10 MW	6,60 X Location Factor	5,60
2	> 10 - 50 MW	6,25X Location Factor	5,31
3	> 50 - 100 MW	5,48 X Location Factor	4,65
4	> 100 MW	4,48 X Location Factor	3,81

4.3. Government Drilling

As an effort to reduce exploration risks and increase the competitiveness of geothermal electricity prices, MEMR will carry out improved geoscience data quality through data acquisition and geothermal exploration drilling, including geological survey activities, geochemical surveys, geophysical surveys (gravity and magnetotellurics), temperature ramp surveys, to the drilling of exploration wells.

Risk factors for geothermal development are influenced by several aspects, namely resources, work completion, off-taker, supply-demand, geothermal prices, operations and regulations. The risk of geothermal development at the end of the exploration stage includes detailed geoscience surveys ranging from 90-95% and at the end of the exploration stage (including geoscience surveys and exploratory drilling) may decrease by up to 50% (ESMAP, 2012). The implementation of geoscience survey activities up to the exploration drilling stage is estimated to reduce the price of geothermal electricity by 0.42-2.53 cents USD/kWh.

Government exploration activities will be carried out in 2021-2022 at 2 GWAs, namely Cisolok-Cisukarame in West Java Province and Nage in East Nusa Tenggara Province.

The first drilling of slim hole exploration wells by the Government was carried out at GWA Cisolok Cisukarame in 2021 where the implementation was in the conservation area of Mount Halimun Salak National Park. The purpose of implementing exploration drilling at GWA Cisolok Cisukarame is not only to reduce exploration risks, but also to facilitate the development of geothermal prospects in conservation areas that are classified as not easy for the private sector to implement. The drilling of the CKK-01A exploration well at GWA Cisolok Cisukarame was able to penetrate to a depth of 821.5 meters with a temperature at a total depth of 58oC.

The drilling of the NGE-01A slim hole exploration well reached a final depth of 1500 mMD (total depth) and the NGE-02 well reached a final depth of 600.3 meters. The claycap is estimated to be at a depth of 600m.

The results of pressure and temperature measurements (PT Logging) in the NGE-01A well show a maximum well pressure of 1793 psi and a maximum well temperature of 267.96 oC which is included in the high temperature. Meanwhile, the results of pressure and temperature measurements (PT Logging) in the NGE-02 well showed a maximum well pressure of 758 psi and a maximum well temperature of 144.38 oC with a gradient temperature of 19 oC / 100 m. The results of the NGE-01A well completion test showed that the well pressure was stable at a pressure of 1487 psi with a temperature of 278 oC to a temperature of 284 oC.

In addition to being implemented by MEMR through the Geological Agency, a few numbers of the government drilling project of 280 MW located in Wae Sano (NTT, 151 MW), Jailolo (North Maluku, 75 MW), and Bittuang (South Sulawesi, 54 MW). The exploration of the project uses a geothermal fund through PT. SMI, is an infrastructure company created by the government to support geothermal drilling, done by government.

5. FUTURE DEVELOPMENT

Based on the last few years, the growth rate of electricity demand is about 7% annually. In the National Energy Policy (NEP), geothermal is one of the first priorities to support the 23% renewable energy target in 2025 and 31% by 2050, respectively. This might accelerate development of geothermal to achieve the target since the sector has not been able to make adequate investments in the power supply capacity, thus far. Now, The government has drawn up a new, more ambitious roadmap in geothermal development to support government programs related to Net Zero Emissions that are targeted to be achieved by 2060. The future development and power plant installation expected is shown in Figure 3.

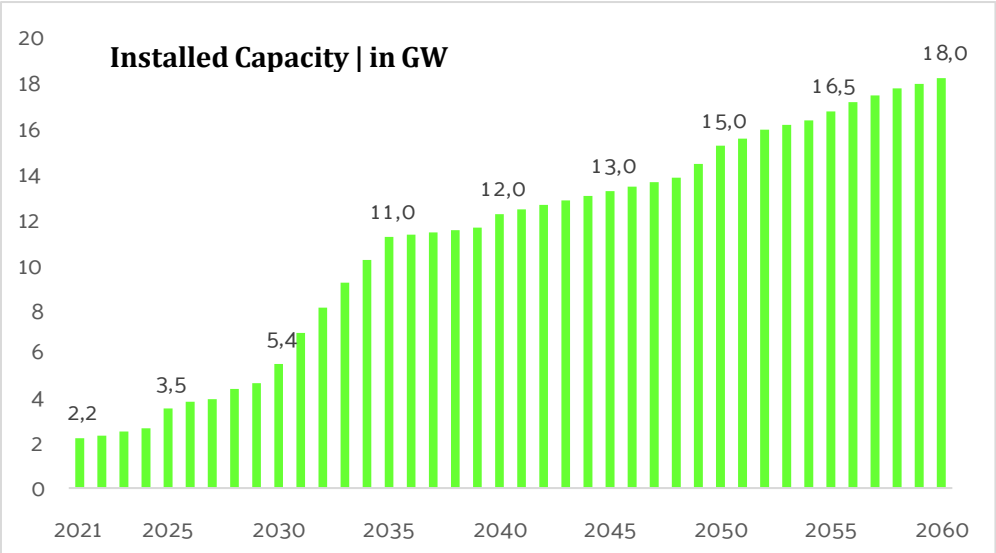

Figure 2. Roadmap of Geothermal Development for Net Zero Emission Targets

In the roadmap, the government targets installed capacity of 3.3 GW (cumulative) or an average addition of 0.3 GW per year until 2030 and installed capacity of 12.5 GW (cumulative) or an average addition of 0.4 GW per year until 2060. The target is expected to require an investment of USD 16.2 billion for capacity addition until 2030 and USD 60.9 billion for additional capacity until 2060.

6. DISCUSSION

In the last five years, only 547,6 MW additional geothermal power plants have been installed and commenced through 2017. The program has been set by government, was failed to attract massive investment in geothermal. It is likely due to the fact that geothermal energy has unique attributes which pose challenges to its development. The issues are caused by the pricing of the energy to achieve the economic viability of the project, bankability of the PPA scheme and negotiation, location of the project in the conservation forest and or national park, government guarantee of the project, obligation of PLN to buy the energy from project companies, lack of human resources, social treatment issues, permit, financing, etc. However, in the past ten years, there have been rewards for 63 areas to the private and state own companies to develop geothermal power plant as part of ten thousand MW respectively by 2030 with the total potency is about 13,571 GW. Out of these areas, there are also 16 area of preliminary survey and exploration assignment of private companies of 2,197 MWe potencies respectively. The following factors are part of the solution to achieve the national energy policy target for geothermal such as: pricing policy, human resources preparation, legal certainties, business attractiveness, shorten time and certainties in permit process and procedure, and of course the financing scheme and support as well as the government support and commitment.

This kind of support aims to reduce and mitigate the high exploration risk of geothermal development and will encourage the private and state-owned companies to develop geothermal in Indonesia. The finance support consists of: Clean Technology Fund (CTF) to be used for exploration drilling, Global Environment Facility (GEF) for technical assistance, and Government Support Fund from Infrastructure Financing for Geothermal Sector (Pendanaan Infrastruktur Sektor Panas Bumi - PISP).

The fund might be used as a grant with the conditions: the winner of the auction of GWA will replace the Exploration Fund plus Premium Risk to guarantee that a revolving fund is running. The time limit for the grant is 15 years: in the first five years, only those funds used will be a revolving fund. Unused funds will be withdrawn, the next ten years, the unused funds at the end of the 15th year will be withdrawn by CTF. PT. SMI is pointed as the project owner for these funds, while MEMR, MoF and PT.SMI will establish a Steering Committee. This support is using Geothermal Resource Risk Mitigation (GREM) through a blended soft loan which comes from PISP, International Bank for Reconstruction and Development (IBRD), World Bank, and Green Climate Fund (GCF) to support state owned companies.

Additionally, exploration programs by the Government to drill 3 exploration wells to prove reserves both implemented through PT SMI and MEMR must be carefully prepared for the purpose of reducing exploration risks, especially in green fields to reduce generation costs. In addition, the results of the program are expected to be able to attract financing interest with more certain reserves.

7. CONCLUSIONS

In the last five years, there has been a significant increase in geothermal installed capacities as well as a significant use of brine for direct use of geothermal. However, all parties, both central and regional governments, enterprises and communities need to provide support in geothermal development to minimize uncertainty in the project development and increase the economic viability of the projects to guarantee certainty and increase attractiveness. In addition, GOI should educate developers and lenders on guaranteeing the viability of the project and provide a development of electricity from geothermal to achieve government targets in net zero emission through 2060.

Other business opportunities in geothermal sector are geothermal direct use, low temperature geothermal potential, small scale power plants, services companies to support the core business of geothermal and human resources for the country. To achieve the targets, international supports are needed in terms of finance, technology, human resources and Technical Assistance. Indonesia with high geothermal potential has a significant challenge to attract private power.

Funding and technology are playing important role in order to accelerate the progress of power plant construction. This also answers some parties' doubts about the amount of the basic price of geothermal generation that has been set by the Government.

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