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Country Update: The Fast Growth of Geothermal Energy Development in Indonesia

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ABSTRACT

Indonesia, as the world's largest geothermal potential, should lead in its renewable resources development to become a clean energy producer. The potential of geothermal in Indonesia is about 29 GWe composed of a speculative resources, hypothetical resources, possible reserves, probable reserves and proven reserves. Now, the Geological Agency of Indonesia (GAI - Badan Geologi Kementerian ESDM) and Directorate General of New, Renewable Energy & Energy Conservation of Indonesia points out that the resources and reserves are located in 312 locations across Indonesia.

The current geothermal fields operate from 13 locations (including 3 new geothermal fields in the 3 locations) compared to 10 locations in the year 2015. The total current installed capacity is 1948.5 MW with additional capacities of 510 MW, an increase to those installed of 1438.5 MW in the year 2015 presented in Melbourne. These additional capacities show the fastest growth of geothermal energy development in the last few years. The installed capacities now are coming from geothermal power plants including: Sibayak (12 MW), Kamojang (235 MW), Darajat (270 MW), Dieng (60 MW), Gunung Salak (377 MW), Lahendong and Tompaso (120 MW), Wayang Windu (227 MW), Ulu Belu (Lampung, 220 MW), Patuha – West Java (55 MW), Ulumbu – Flores (10 MW), Mataloko – East Nusa Tenggara (2,5 MW), Sarulla - North Sumatra (330 MW, and Karaha – West Java (30 MW). At least about another 190 MW will be commissioned in 2019 such as Lumut Balai – South Sumatra (55 MW), Sorik Marapi Modular Unit 1&2 (20 & 30 MW each), Sokoria Unit 1 (5 MW), and Muara Laboh Unit 1 – West Sumatra (80 MW). The total capacity by year end 2019 is about 2,138.5 MW respectively.

There is no indication of how fast geothermal direct-use will grow in Indonesia, even after the new geothermal regulation has been issued to attract private companies in this business. In terms of geothermal development and its utilizations, the government of Indonesia (GOI) committed to utilize the biggest geothermal energy resources to become the world's largest geothermal producers in the world. The new road map has been introduced in 2018 to support our National Energy Policy. The total expected capacity of the geothermal energy in the national energy mix policy is 7.2 GWe, to fulfill the portion of geothermal as part of 23% in the renewable energy target by 2025. In addition, with the national renewable energy target and Paris Agreement commitment ahead, Indonesia should also assess the way to achieve the national RE commitment.

To attract investors for developing geothermal, GOI has reviewed the geothermal electricity price to achieve the economic viability as well as the affordability of the low pricing policy to the public utilities. GOI has issued the Ministry of Energy regulation no.50/2017 for renewable energy tariff to create certainty in the RE business scheme. The regulation is revising the geothermal feed in tariff structure number 17/2014. The scheme of the tariff is applied to the new and existing geothermal development. In fact, the development of new geothermal fields in the last two years is almost stagnant. It is likely due to, the unattractive geothermal rate of return, high risk in PPAs, purchase guarantees, and uncertainty in protected and forest conservation areas. The fast growth of geothermal development is mainly coming from the existing power purchase agreement (PPA). Since the progress of geothermal development is behind the expectation, now the target has been revised to a 10,000 MW program by 2030.

Instead, 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.

Finally, it is expected that the installed capacity of geothermal in the year 2025 is about 7,241.5 MW, and 10,000 MW by 2030 which is planned to be commissioned with any effort.

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 a span of 45 years, Indonesia has developed 1948.5 MW or about 6.5 percent of 29,000 MW of geothermal potential through the year 2018. The development has proceeded very slowly in terms of the national target and is currently facing difficult challenges. The additional capacities from 2015 to 2018 is about 510 MW. Another 190 MW are expected to be commissioned at the end of 2019 to produce totally 2,138.5 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 64 existing areas have been targeted for 10,000 MW for the year 2030 through the geothermal development plan. These numbers include the 13 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) and plays 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. The Ministry of Energy has reviewed and revised any obstacles and issued 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.

To support these policies, Indonesia 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 in 2018. The result will be seen in the next few years.

Since 2019, 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. PLN's general planning of electricity targeted to about 6.42% per year, slightly smaller than the previous target of 8.68% in 2012. Total capacity projection of the electricity from RE in the period 2018 – 2025 is 6251 MW which included 4362 MW coming from geothermal. This paper will update and discuss the Indonesian geothermal development in the last five years 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. GEOLOGICAL BACKGROUND

Geological Agency of Indonesia (GAI, 2016), reported that Indonesia is composed of more than 312 geothermal potential locations (Figure 1). They are located along Sumatra, Java, Bali and the islands of eastern part of Indonesia, which is known as 'the ring of fire'. The geothermal potential lies between the eastern end of the Mediterranean Volcanic Belt and the western side of Circum Pacific Volcanic Belt and is blessed with abundant volcanic activities. Indonesia now becomes a second largest geothermal producer but has the biggest geothermal energy potentials in the world.

3. GEOTHERMAL RESOURCES AND POTENTIAL

Current calculation of the geothermal resources of Indonesia is about 29 GW in total. It is composed of: 6.6 GW of speculative resources, 4.4 GW of hypothetical resources, 11.9 GW possible reserve, 2.5 GW probable reserve and 3 GW of proven reserve (GAI,2017). Most of the geothermal prospects are high temperature geothermal systems.

Sumatera had the largest geothermal potential, 12.8 GW or 44% of the potential is there. Now only 562 MW geothermal power plant capacity were installed, a very significant increase compared to those only 122 MW in 2015. The second largest plant is located in Java (9.8 GW), followed by Sulawesi (3.2 GW). The rest come from Bali – Nusa Tenggara (1.9 GW), Maluku (1 GW) and a very small amount comes from Papua (75 MW) and Kalimantan (145 MW).

The geothermal development road map targeted in the National Energy Policy-NEP that released in 2014 is planned to install geothermal power plant about 7241 MW by 2025. However, the realization is still low and quite far from the target and looks hard to achieve. Due to the high demand for low carbon emission energy development a new road map was established for geothermal use in Indonesia through 2030, peaking at 10.000 MW total installed capacities.

4. GEOTHERMAL UTILIZATION

The main utilization of geothermal in Indonesia is indirect use to generate electricity. However, direct use of geothermal has been important for all of human history. The modern use of geothermal can be used to support the nation.

Currently, 1948.5 MW power plants from geothermal energy have been installed as of 2018 (Table 1 and Figure 2). It is an increase of about 510 MW from its installed capacity of 1438.5 MW in 2015 and almost double from 1187 MW in 2009. The installed geothermal power plants are located in 13 geothermal areas. They are: Kamojang, Darajat, Patuha, Wayang Windu, Karaha and Salak in West Java; Dieng in Central Java; Sibayak and Sarulla in North Sumatera, Ulu Belu in South Sumatra, Lahendong in North Sulawesi, and Ulumbu and Mataloko in Flores. In addition, there are another 190 MW worth of projects undergoing will be commissioned in the year 2019, i.e.: Sorik Marapi geothermal field (50 MW), Lumut Balai (55MW), and Muaralabuh (80 MW), and Sokoria (5 MW).

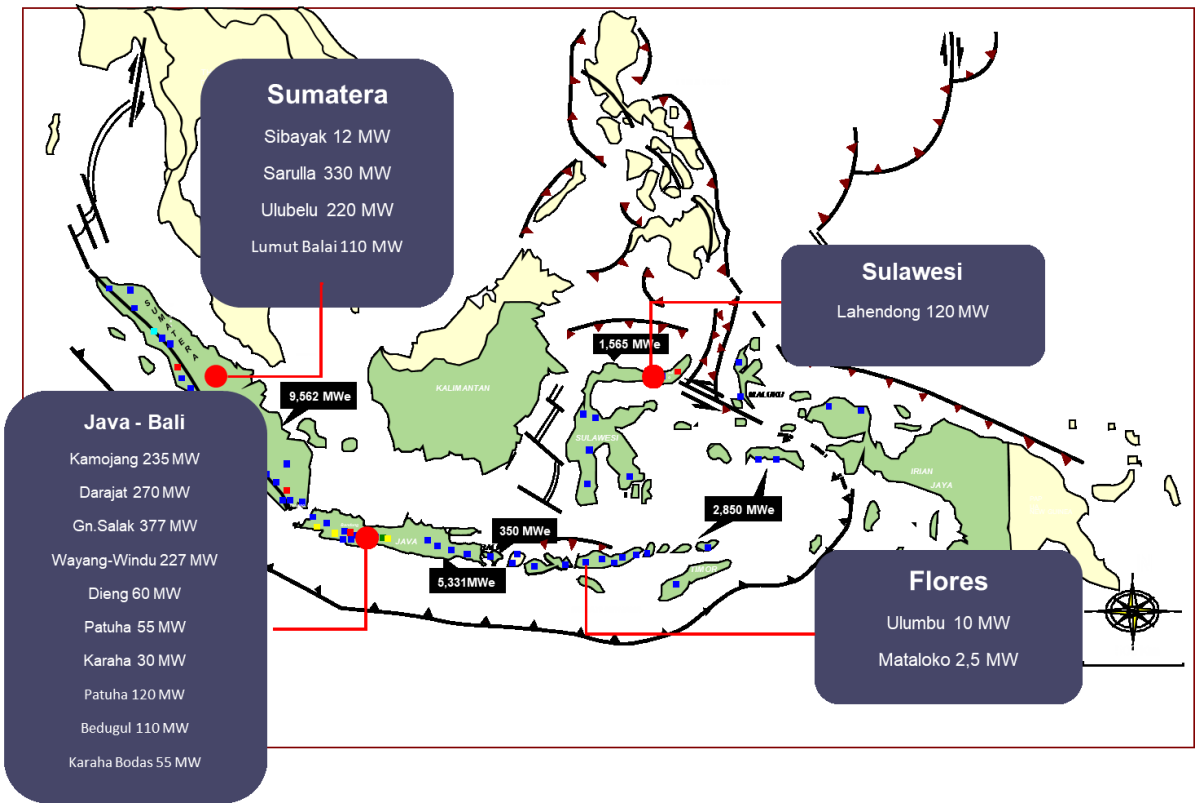

Figure 1: Location map of Indonesian geothermal resources and its installed capacity. The resources are 29 GW.

4.1. Installed Power and electric generation.

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. From those geothermal plant installed capacities, most have been in operational condition beginning in 1982 for Kamojang as the oldest power plant and Karaha geothermal plant as the latest project operated since 2018. Total power generation is increased from 9.6 million MWh from 2014 into 14 million MWh in 2018 (**Table 1**). The steam productions are increasing from 74.6 million tons in 2014 to 92.1 million tons in 2017 and 101.1 million tons in 2018.

Table 1. Present and planned production of electricity

	Geothermal		Fossil Fuels		Hydro		Nuclear		Other Renewables (specify)		Total	
	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr	Capacity MWe	Gross Prod. GWh/yr
In operation in December 2019	1948.5	14,011	49,447		5,124	12,425	none	none	2,001		60,789	262,661
Under construction in December 2019	190				294		none	none	165			
Funds committed, but not yet under construction in December 2019	151				564		none	none	127			
Estimated total projected use by 2020	2,289				6,182		none	none	2,293		63,000	

4.1.1. Existing geothermal operation area.

Some of the existing geothermal power plants have been uprated such as Darajat (from 260 to 270 MW) and another is also in process of repair, such as Sibayak 12 MW from a 2 MW monoblock and the 2 units of 5 MW of condensing power plant. The others are well operated. They are: Dieng (60 MW), Kamojang (235 MW), Gunung Salak (377 MW), Lahendong (120 MW), Wayang Windu (227 MW), Ulumbu (10 MW), Mataloko (2.5 MW), Patuha (55 MW), Ulu Belu (220 MW), Sarulla (330 MW) and Karaha (30 MW) as shown in the Table 2.

The most interesting action taken during the last few years is from Chevron Geothermal, the biggest geothermal player in the country who operated Darajat and Salak geothermal field in Java. Salak geothermal and Darajat geothermal are now operated by Star Energy who also operate Wayang Windu geothermal field under Joint Operating Contract (JOC) with PGE. Another JOC scheme is Sarulla, which is operated by Sarulla Operation Ltd (SOL, the Consortium of Medco Power, Kyushu Electric, Ormat Power and Itochu).

In addition, there are four other power plants that will be commissioned in 2019, operated by PGE in Lumut Balai (55 MW), KS Orka in Sorik Merapi (45 MMW) and Sokoria (5 MW) and Supreme Energy in Muaralabuh (80 MW).

Further, there are also 51 areas being developed. These are 10 working areas undergoing project for drilling and development, 21 working areas under exploration status and 13 other areas for geothermal development. Out of those fields mentioned, there are also 22 additional working areas to be tendered. Total power plant capacity from geothermal are predicted to be 10 thousand MW in 2030. Those geothermal fields operate using the existing geothermal rule, i.e. Presidential Decree (PD) No.45 Year 1991 and the Geothermal Law No.272003 as amended by Law No21/2014.

Table 2. Utilization of geothermal energy for electric power generation as of 31 December 2019

Locality	Power Plant Name	Year Com-missioned	No. of Units	Status[1)]	Type of Unit[2)]	Total Installed Capacity MWe[3)]	Total Running Capacity MWe[4)]	Annual Energy Produced 2019 GWh/yr	Total under Constr. or Planned MWe
Kamojang, West Java	KMJ Unit 1-5	1983,1987,1987,2008,2015	1		*D*	235	345	3,022	55
Lahendong. North Sulawesi	LHD Unit 1-6	2001,2007,2009,2011,2016,2016	1		*1F*	120	120	1,051	65
Ulu Belu, Lampung	UBL Unit 1-4	2012, 2016, 2017	1		*1F*	220	220	1,927	40
Karaha, West Java	KRH Unit 1	2018	1		*1F*	30	30	263	20
Sibayak, North Sumatra	SBY Monoblock	1996	1	R	*O (Back Pressure)*	2	-	-	-
Sibayak, North Sumatra	SBY Unit 1-2	2008	1	N	*1F*	10	-	-	-
Gunung Salak, West Java	Gunung Salak	1994-1997	6		*1F*	377	377	3,018	70
Darajat, West Java	Darajat	1991, 2000, 2007	3		*D*	270	270	1,975	
Wayang Windu, West Java	Wayang Windu	2000 & 2009	2		*1F*	227	227	1,902	
Dieng, Central Java	Dieng	1998	1		*1F*	60	60	346	265
Ulumbu, Flores	Ulumbu	2013 & 2014	4		*1F*	10	10	39	40
Mataloko, Flores	Mataloko	2013	1		*1F*	2.5	2.5	-	20
Patuha, West Java	Patuha	2014	1		*1F*	55	55	437	170
Sarulla, North Sumatra	Sarulla	2017 & 2018	3		*1F*	330	330	2,114	260
Muaralbuh, West Sumatra	Muaralabuh								80
Sorik Marapi, North Sumatra	Sorik Marapi								45
Lumut Balai, South Sumatra	Loumut Balai								55
Sokoria, Flores	Sokoria								5
Total						**1,948.5**	**2,047**	**16,095**	**1190**

1) N = Not operating (temporary), R = Retired. Otherwise leave blank if presently operating, 2) 1F = Single Flash. D = Dry Steam, 3) Electrical installed capacity in 2019

4.1.2. Expansion of the existing geothermal operation area.

From thirteen existing operated geothermal fields, there were plans to expand the field capacity by another 1005 MW for the 2030 road map program, consisting of Ulubelu 40 MW, Salak 70 MW, Kamojang 55 MW, Dieng 265 MW, Patuha 170 MW, Lahendong - Tompaso 65 MW and Ulumbu 40 MW, Mataloko 20 MW, Karaha 20 MW, and Sarulla 260 MW.

4.2. Ongoing project and Field Development Status

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. So far, 64 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, 13 geothermal working areas have also been assigned to the private sectors for preliminary survey and exploration. This would lead to around 10,000 MW installed capacity by 2030 to achieve renewable energy target in the national energy mix policy.

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 set by GOI is without considering the economic viability of geothermal development cost.

GOI now works more realistic in supplying electricity in addition to increasing the electrification ratio but also toward the energy transition era. MEMR established the new road map of 10,000 MW geothermal projects for the year 2030.

In total PGE, Chevron, Star Energy, Supreme Energy, KS Orka, Medco Energy (Sarulla Operation Ltd), Sejahtera Alam Energy and PLN have drilled more than 187 wells (**Table 3**) in the last 5 years in addition to 510 wells drilled by PGE, Unocal, Chevron, HCE, PPL, MNL, BEL, PLN, GAI and Yala Teknosa before the year 2015. The wells are drilled in the 33 geothermal areas. Total proven and probable reserves of geothermal in Indonesia is 13,413 MW.

The total wells drilled for electricity-generating capabilities of each area exist and being developed are 697 wells composed of exploration wells, production wells, monitoring wells and re-injection wells. The depth of the wells varied from a few hundred meters up to 4000 meters. The wells drilled in the last five years are tabulated in Table 3.

Table 3. Wells drilled for electrical, direct and combined use of geothermal resources from January 1, 2015 to December 31, 2019 (excluding heat pump wells)

Purpose	Wellhead Temperature	Number of Wells Drilled				Total Depth (km)
		Electric Power	Direct Use	Combined	Other (specify)	
Exploration[1)]	(all)	24	0	0	0	48
Production	>150° C	140	0	0	0	286
	150-100° C	0	0	0	0	0
	<100° C	0	0	0	0	0
Injection	(all)	23	0	0	0	46
Total		**187**				**374**

1) Include thermal gradient wells, but not ones less than 100 m deep

4.2.1. Project Pipeline for Geothermal Plant of 1,257 MW

The project pipeline composes of nine areas of geothermal field to develop and install about 1,257 MW of power plants by 2030 in addition to the geothermal part of 35 thousand GW project in Indonesia. These areas are composed of: Sungai Penuh (110 MW), Lumut Balai (220 MW), Hululais (165 MW), Cibuni (10 MW), Tabanan (65 MW), Tulehu (7 MW), Muaralaboh (220 MW), Rantau Dedap (220 MW), and Sorik Marapi (240 MW). While the 35 thousand project is planned to be commissioned between 2019 to 2024 as of 496 MW composed of: Jaboi (Aceh operated by PT Sabang Geothermal Energy - 10 MW), Hululais Unit 1 (Bengkulu, by PGE - 55 MW), Muara Laboh Unit 1 (West Sumatra by Supreme Energy Muara Laboh - 80 MW), Rantau Dedap Unit 1 (South Sumatra by Supreme Energy Rantau Dedap - 86 MW), Sorik Marapi Unit 1(North Sumatra by PT Sorik Marapi Geothermal Power - 80 MW), Patuha Unit 2 dan 3 (West Java by Geo Dipa Energi – 110 MW), Dieng Unit 2 (Central Java by Geo Dipa Energi – 55 MW),and Ulumbu Unit 5 (NTT).

4.2.2 Exploration Project and its development plan.

Beside the ongoing pipeline project, there are 22 geothermal areas under exploration to confirm the proven reserves and encounter the steam to supply at least 1,645 MW worth of power plants for the year 2030. Those projects are: Arjuno Welirang (185 MW), Atadei (10 MW), Baturaden (220 MW), Blawan Ijen (110 MW), Candi Umbul Telomoyo (55 MW), Danau Ranau (40 MW), Gn. Lawu (110 MW), Gn. Rajabasa (220 MW), Gn. Sirung (5 MW), Gn. Talang- Bukit Kili (20 MW), Gn. Tangkuban Perahu (60 MW), Jaboi (10 MW), Kaldera Danau Banten (110 MW), Kepahiang (110 MW), Oka-Ile Ange (10 MW), Seulawah Agam (55 MW), Sokoria (30 MW), Songa Wayaua (10 MW), Telaga Ngebel (165 MW), Way Ratai (55 MW), and Gn. Ungaran (55 MW).

Instead of the above-mentioned areas, optimization of existing production areas is ongoing, covering about 2.646.5 MW. This includes a re-linquist area, Kotamobagu.

4.2.3. Government Drilling Project and New Geothermal Areas to Offer.

The new geothermal project areas will be offered by the government through auction based on the Geothermal Law No 21/2014 and all of its derivatives regulation. There are 22 areas in total. These include a few numbers of the government drilling project of 310 MW located in Wae Sano (NTT, 151 MW), Jailolo (North Maluku, 75 MW), Bituang (South Sulawesi, 54 MW), and Nage (NTT, 30 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. These have a total installed capacity expected by 2030 to be about 945 MW.

4.3. 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.

Figure 2: The suspended Palm sugar processing unit operated by Masarang Foundation using 4 tones/hour brine from Lahendong geothermal power plant.

4.4. Heat pumps use

So far, there is no heat pump use in Indonesia as reported in the WGC2015 in Melbourne. This is because the geothermal potential in Indonesia is mainly composed of high enthalpy geothermal system and the overall utilization is still low. In this case, Indonesia is still optimizing the use of geothermal for electricity rather than for heat pumps.

4.5. Human resources and investments

So far, total human resources involved in the geothermal development are 2,190 persons, not including 43 foreign consultants (Table 4). While the total investment in the past five years are 5606 million US$. This investment has been significantly increased from year 2010-2015 (Table 5).

Table 4. Allocation of professional personnel to geothermal activities (restricted to personnel with university degrees)

Year	Professional Person-Years of Effort					
	(1)	(2)	(3)	(4)	(5)	(6)
2015						105
2016						615
2017						495
2018						420
2019						555
Total				43		2,190

(1) Government, (2) Public Utilities, (3) Universities, (4) Paid Foreign Consultants, (5) Contributed Through Foreign Aid Programs, (6) Private Industry

Table 5. Total investments in geothermal in (2019) US$

Period	Research & Development Incl. Surface Explor. & Exploration Drilling	Field Development Including Production Drilling & Surface Equipment	Utilization		Funding Type	
			Direct	Electrical	Private	Public
	Million US$	Million US$	Million US$	Million US$	%	%
1995-1999						
2000-2004						
2005-2009	60	501		659		
2010-2014	69	700-800		400-450	98	2
2015-2019	70	3083		2523	98	2

5. DISCUSSION

In the last five years, only 510 MW additional geothermal power plants have been installed and commenced through 2019. The previous target of 4000 MW, in addition to the 1438 MW installed capacity in 2014, was failed to be reached. It is likely due to the

fact that geothermal energy has unique attributes which pose challenges to its development. The major issue is caused by the pricing of the energy sold 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 64 areas to the private and state own companies to develop geothermal power plant as part of ten thousand MW respectively by 2030. The total potency is about 13,371 MW, out of these areas, there are also 13 area of preliminary survey and exploration assignment of private companies of 1988 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), amount USD49 million to be used for exploration drilling, Global Environment Facility (GEF) amount of USD6,25 million 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.

6. FUTURE DEVELOPMENT AND INSTALLATION

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. The Government has initial plans to develop geothermal power plants with 2,000 MW of capacity in 2008, 3442 MW in 2012, 4600 MW in 2016, and 6000 MW in 2020. By 2025, Indonesia is expected to install 7,200 MW of power plants. In fact, there is very few investors who won the tender, continuing the project as GOI investment plan. Consequently, GOI has revised and released the plan for 2025 geothermal development and re-evaluated to establish the new road map of geothermal development for 2030. The future development and power plant installation expected is shown in Figure 3.

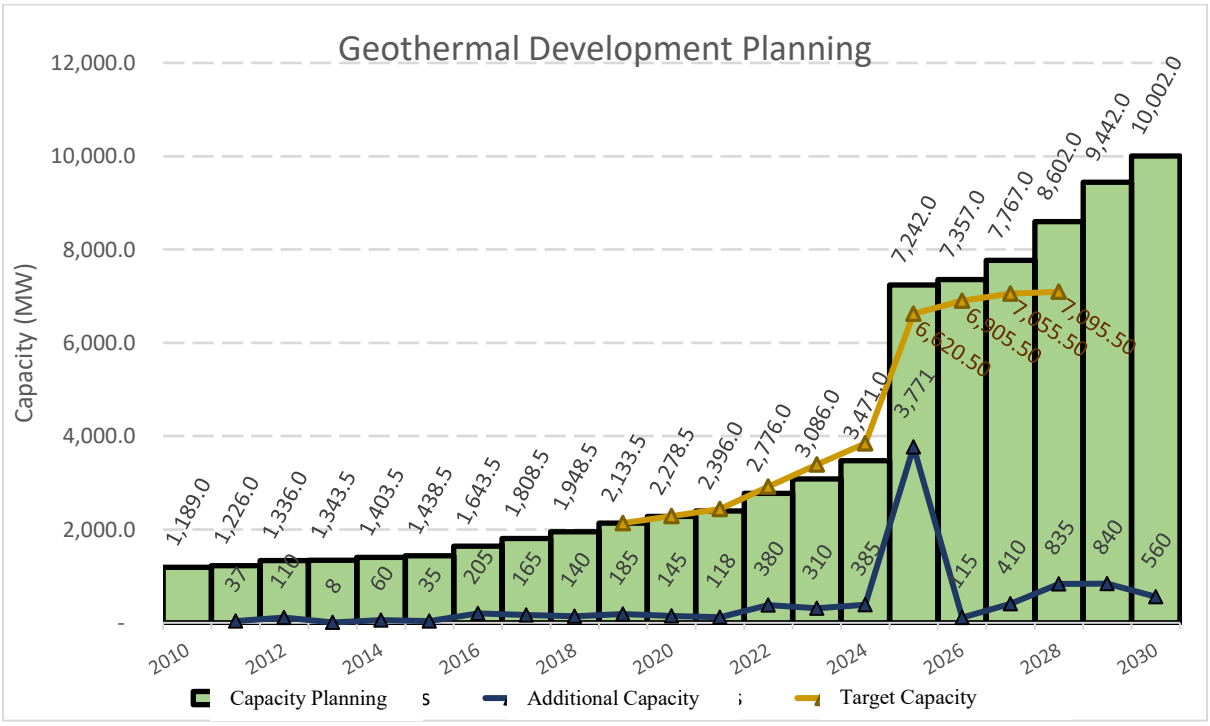

Figure 3: The new Road Map of geothermal development to install 10,000 MW power plants from year 2010 to 2030.

6.1. Development project of geothermal area of preliminary survey and exploration assignment. to install 555 MW

These areas are dedicated to assign 13 private companies in the 13 areas to install 555 MW by 2030. The private companies will hold survey for preliminary and exploration before the area is tendered. The areas then established as a new working areas which are composed of: Gn. Hamiding (100 MW), Graho Nyabu (110 MW), Sekincau Selatan (90 MW), Simbolon Samosir (50MW), Tanjung

Sakti (20 MW), Huú Daha (20 MW), Geureudong (50 MW), Cubadak (20 MW), Pentadio (5 MW), Klabat Wineru (10 MW), Bonjol (40 MW), Tandikat Singgalang (20 MW), and Lawang Malintang (20 MW).

6.2. Development of the geothermal assignment area to state own companies to install 595 MW

These are assignments of geothermal areas dedicated to PLN (10 areas) and Geo Dipa Energi (2 areas). The intention of this assignment is to accelerate the development of geothermal and facilitate the role of state-owned companies in developing geothermal in Indonesia. Those areas are: Mataloko – NTT (2 x 10 MW), Ulumbu – NTT (2x20 MW), Songa Wayaua – Maluku Utara (2 x 5 MW), Gn. Tangkuban Perahu – Jawa Barat (3 x 20 MW), Atadei – NTT (2 x 10MW), Gn. Ungaran (Central Java) – 55 MW, Kepahiang – Bengkulu (55 MW), Oka Ile Ange – NTT (10 MW), Gn. Sirung – NTT (5 MW), Danau Ranau – Lampung (40 MW), Gn. Arjuno Welirang – East Java (175 MW + 5 MW Binary), and Candi Umbul Telomoyo (85 MW + 5 MW).

6.3. Flores Geothermal Island

Flores is located in the eastern part of Indonesia. It has been established by the Minister of Energy in 2017 through Ministry Decree number 2268 K/30/MEM/2017 to develop and use all of the geothermal potential to power the island, now called the Flores Geothermal Island (Figure 4). Total geothermal potency in the island is about 735 MW compose of 18 location such as: Ulumbu: 86 MWe, Wai Pesi: 54 MWe, Wae Sano: 151 MWe Mapos: 50 MWe, Rana Masak: 20 MWe, Rana Kulan: 7 MWe, Ulugalung: 5 MWe, Nage : 30 MWe, Gou-inelika: 37 MWe, Mataloko: 52.5 Mwe, Mangeruda: 5 Mwe, Komandaru: 11 MWe, Ndetusoko: 10 MWe, Sokoria: 80 MWe, Jopu: 5 MWe, Lesugolo: 45 Mwe, Oka Ile Ange: 50 MWe, and Oyang Barang: 37 MWe.

Figure 4: Flores Island is now set as geothermal island.

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, the GOI need a clear support for private power 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 10000 MW electricity from geothermal in the next ten years through 2030.

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.

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