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Country Update: Geothermal Energy Use and Development in Indonesia

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ABSTRACT

It is well known that geothermal of Indonesia is associated with volcanoes that lie along Sumatra, Java, Bali and the islands in eastern part of Indonesia. At WGC2010 in Bali, the potential of geothermal of Indonesia was reported at about 27,000 MWe. Now, National Geological Agency of Indonesia (NGAI) and Directorate General of New, Renewable Energy & Energy Conservation of Indonesia is up to date to increase to more than 28 GWe composed of 312 geothermal potential locations (Geological Agency of Indonesia, 2013).

The current geothermal fields are operated from 10 locations with an increase of three new geothermal fields in three locations compare to seven locations in the year 2010. The installed electrical capacities consist of 1,342 MWe with additional capacities of 145 MWe in year 2012 compare to 1,186.3 MWe in WGC2010. The installed capacities consists of Darajat (259 MWe), Dieng (60 MWe), Kamojang (200 MWe), Gunung Salak (377 MWe), Sibayak (13.3 MWe), Lahendong (80 MWe), Wayang Windu (227 MWe), Lumut Balai – South Sumatra (110 MWe), Ulumbu – Flores (5 MWe) and Mataloko - (2.5 MWe).

The direct-use of geothermal in Indonesia has been stagnant in growth which has been reported by Pertamina Geothermal Energy (PGE) and National Research Institute (BPPT) for the mushroom harvesting project in Kamojang since year 2000 and palm sugar processing project of Masarang Cooperative Institute and PGE, and white copra processing & Chilies drying project of PGE in Lahendong (North Sulawesi). This does not include spas and developed swimming pools which are unknown. Some other institutions (NGO’s and the Universities) are also progressing on research of direct use of using geothermal for purifying Akarwangi (the raw materials for perfume). Geothermal (ground-source) heat pump use is not well known in the country.

In term of geothermal development and its utilization, the Government of Indonesia (GOI) is committed to utilize the biggest geothermal energy resources to become the world’s largest geothermal producers in the world as a leading alternative energy. To attract the investors to develop geothermal, GOI has gradually increased the national electricity tariff to achieve the economic viability, and assessed a differential feed in electricity geothermal tariff structure by region to support electricity infrastructure investment with regards to the needs of the region. However, the progress of geothermal development is behind the expectation to become 5,000 MWe by 2014/2015. It is likely due to the unattractiveness of the geothermal price, high risk in PPA, purchase guarantee and uncertainty in the protection and conservation of forest area.

Finally, it is expected that the installed capacity of geothermal in the year 2025 will be more than 6,000 MWe.

1. INTRODUCTION

Indonesia is one of a handful of countries to have developed geothermal energy for electricity. The development has proceeded very slowly and is currently facing difficult challenges. Over a span of 40 years, Indonesia has only developed 1,346 MWe or about 4.6 percent of the 29,000 MWe of geothermal potential by the year 2013 and will increase to 1,399 MWe in 2014. This means, only an additional 203 MWe from 2010 at the end of 2014.

Indonesia started to develop geothermal in 1974 by establishment of the President Decree No.16/1974, and then strengthened by President Decree No.22/1981, President Decree No.23/1981, President Decree No. 45 in 1991 and President Decree No.49/1991 to develop geothermal in order to diversify the energy use.

Since the Geothermal Law No 27/2003 followed by the Government Regulation No.59 in 2007 as the new regime of geothermal activities, to help guide the business entities, cooperative bodies and the government to activate the geothermal business in Indonesia, it looked like the growth of geothermal development is very slow. However, the government has been issued a so called President Instruction No.4 Year 2010 to accelerate develop of the electricity sector by mandating PLN to take almost 4,000 MWe from geothermal in the 10,000 MWe fast track program phase II. This regulation is in line with the focus of the energy sector to accelerate the use of geothermal energy. The supporting regulation shows that the GOI gives priority to accelerate the use of geothermal in the National Energy Policy. Geothermal is expected to contribute at least 12% of the national electricity needs in 2025. Currently Indonesia is the world's 3rd largest geothermal electricity producer after the United States and the Philippines

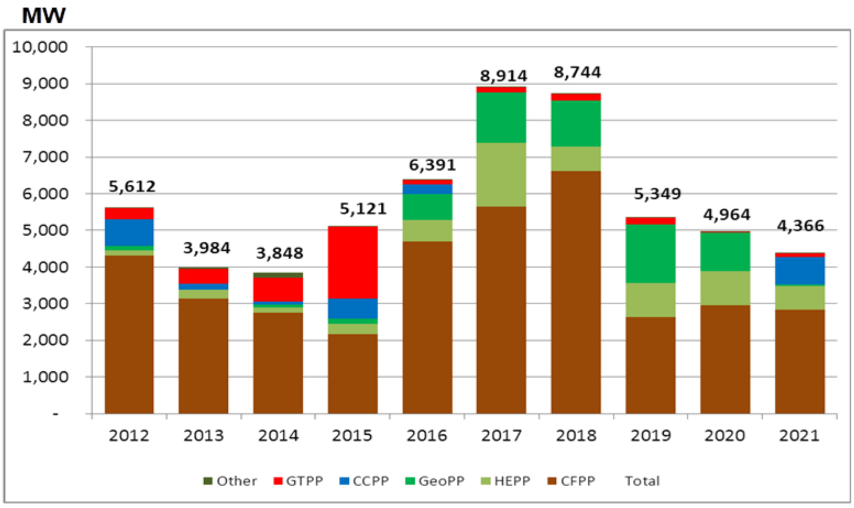
At the 2010 World Geothermal Congress in Bali, President Susilo Bambang Yudhoyono announced a plan to build 44 new geothermal plants by 2014, more than tripling the capacity to 4,000 MWe. By 2025, Indonesia aims to produce more than 9,000 MWe of geothermal power, becoming the world's leading geothermal energy producer. This would account for 5% of Indonesia's total energy needs.

It is also targeted by the government that in 2022, Indonesia will reach 100% national electrification, therefore there exists many business opportunities in achieving the electrification ratio target by 2022. PLN as a state-owned electricity company and Independent Power Producer (IPP) plays a significant role to achieve this target. We generated this information through various sources such as Ministry of Finance, PLN, etc.

The government provides an opportunity to the private sector to participate in the development of geothermal power and issued the amendment of the Government Regulation (GR) Number 59 of 2007 to GR No. 70 of 2010 on the Geothermal Business and Operations, the Ministry of Energy Regulation No. 2 year 2011 on the ceiling price policy and the regulation No. 22 year 2012 on the Feed in Tariff. In addition, GOI through PIP provided Rp.9 Trillion fund facility (GFF – Geothermal Fund Facilities) taken from National Budget period of 2011-2016 for the development of 4.840 MWe Geothermal Field and Power Plant.

Annual growth of energy is 8.65% per year. Capacity growth projection of the electricity in the period 2012 – 2021 is shown in the graph below.

Table 1: Graphic of the electricity growth projection (Sources: PLN, 2013)



In 2011, the total generating capacity of national (PLN, IPPs and PPU) in Indonesia was of 38.9 GWe. Approximately 76% of them are in the Java-Bali region, 13% in Sumatra, Kalimantan and the rest in other islands (Sulawesi, Maluku, NTB-NTT, Papua). In terms of input fuel, coal-fired plants and oil has the highest share, which amounted to 42% (16.5 GWe) and 23% (9 GWe), followed by gas-fired plants with a share of around 22% (8.4 GWe). The high share of generator fuel is offset by increasing the share of power plants fueled by renewable energy, such as geothermal, with a share approaching 3% (1.2 GWe), as well as hydro-based generation to share the range of 10% (3.9 GWe). In addition, solar power and wind energy have also started operating with a total capacity of 1.6 MWe. This paper will discuss the Indonesian geothermal status and update the regulation in the implementation of power sector during the last five years term.

2. GEOLOGICAL BACKGROUND

Geothermal power in Indonesia is an increasingly significant source of renewable energy. More than 200 volcanoes are located along Sumatra, Java, Bali and the islands of eastern part of Indonesia, which is known as 'The Ring of Fire'. It lies between the eastern end of the Mediterranean Volcanic Belt and western side of the Circum Pacific Volcanic Belt, and is blessed with abundant geothermal resources. As a result, current calculations indicate that the geothermal potential is approximately 29 GWe (Figure 1) and put this country as the biggest geothermal energy potential in the world.

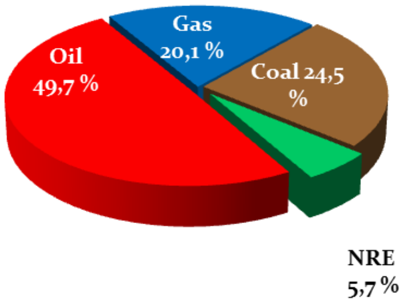


Figure 1: The figure below show the use of New Renewable Energy (NRE) and fossil fuel in the National Energy Mix of Indonesia (MEMR 2013).

Geological Agency of Indonesia reported that Indonesia is composed of 312 geothermal potential locations of which 58 locations (15,627 MWe) of prospective geothermal have been issued the IUP. These locations are planned to be develop and operated by existing developers with total potency of 10,869 MWe and 4,834 MWe are mainly composed of Pertamina Geothermal Energy and its partnerships concession while 39 locations have been tendered under Geothermal Law regime (4,758 MW) from which 19 concessions have been awarded IUP.

As seen in the Table 2, from 312 locations 12.386 GWe is the resource potential and 16.524 GWe is the reserve potential. But, the proven reserve is only 2.3 GWe (14%) and concentrated in Java Island. We need our best effort to realize energy potential to became proven reserve.

Table 2: The energy potential of Indonesian geothermal prospect (Geological Agency of Indonesia, 2013).

No	Island	Number of Location	Energy Potential (MWe)					Total	Installed
			Resources		Reserve				
			Speculative	Hypothetic	Possible	Probable	Proven		
1	Sumatera	93	3183	2469	6790	15	380	12837	**122**
2	Jawa	71	1672	1826	3786	658	1815	9757	**1134**
3	Bali-Nusa Tenggara	33	427	417	1013	0	15	1872	**5**
4	Kalimantan	12	145	0	0	0	0	145	
5	Sulawesi	70	1330	221	1374	150	78	3153	**80**
6	Maluku	30	545	76	450	0	0	1071	
7	Papua	3	75	0	0	0	0	75	
	Total	**312**	7377	5009	13413	823	2288	28910	**1,341**
			12,386		**16,524**				
			28,910						

Sumatera had the largest geothermal potential, 12.8 GWe or 44% of the potential is there, but unfortunately only 122 MWe of installed capacity, this installed capacity come from Ulubelu 110 MWe and Sibayak 12 MWe constructed and operated by PT.Pertamina Geothermal Energy. All the high temperature geothermal systems are found within the Sumatera, Java, Sulawesi, and Eastern Island Volcanic Zone, which lies over an active subduction zone between the eastern end of the Mediterranean Volcanic Belt and western side of the Circum Pacific Volcanic Belt (Figure 2 and Table 2).

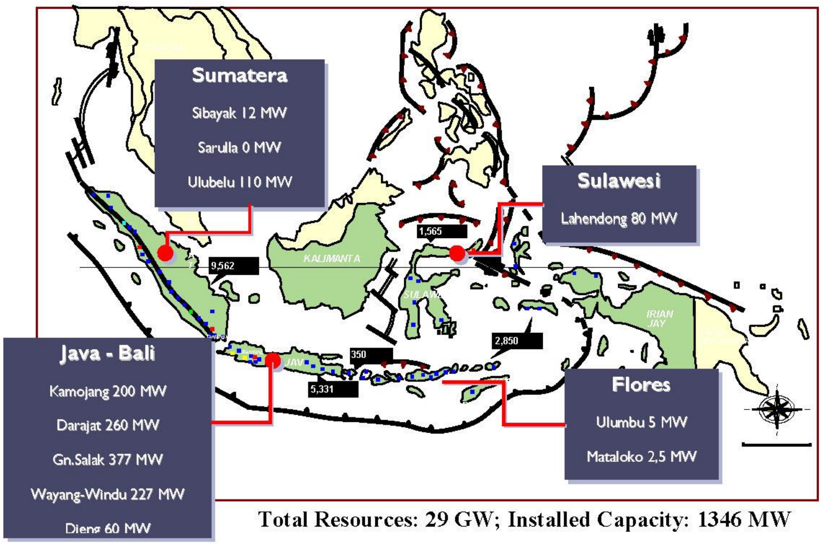


Figure 2: Location map of Indonesian geothermal resources and its installed capacity.

Infrastructure is to be the major obstacle in the development of geothermal in Sumatra. Since 2008, Pertamina Geothermal Energy (PGE) began to develop these working areas in Sumatera: Ulubelu, Lumut Balai, Hululais and Sungai Penuh. Later on in 2011

Supreme Energy started exploring there working area in Muaralaboh, Rajabasa and Rantau Dedap and are expected in this year that Sarulla will be developed. If all of these projects can be done, in 2016-2017 the geothermal installed capacity in Sumatera with additional 1100 MWe will be come true. But, it's depending on how easy it is to get the permit and also the preparation of infrastructure including the grid.

3. GEOTHERMAL RESOURCES AND POTENTIAL

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According to the Geological Agency of Indonesia (GIA), it is indicated that one third of the 29 GWe geothermal potential is located in Java and Bali, the most populous islands with the highest demand for electricity. The geological and geochemical surveys have been carried out on the 312 locations and on 200 locations respectively. A geophysical survey was conducted on the 45 locations.

The geothermal development road map released in 2006 is planned to develop for electricity generation for 2,000 MWe by the year 2010, for 4,600 MWe by 2016, and 6,000 MWe by the year 2020, and 9,500 MWe by 2025 (targeted) respectively. Most of the 312 prospects of Indonesia have high temperature geothermal resources. However, the realization of geothermal development is still lower than that program. The total geothermal prospects and its potential reserve and resources are tabulated in the Table 2.

4. GEOTHERMAL UTILIZATION

Indonesia currently utilizes geothermal fields mainly for indirect use to generate electricity. However, the direct use of geothermal is also well known in the rural since the history of human life. The modern use of geothermal are now be counted to support the national use of geothermal.

Today, 1,346 MWe from geothermal energy power plants have been developed as of 2013. It is increase of about 159 MWe from it installed capacity of 1,187 MWe in 2009. The developed geothermal locations distribute in 9 commercial areas: Kamojang, Darajat, Wayang Windu and Salak in West Java; Dieng in Central Java; Sibayak in North Sumatera, Ulu Belu in South Sumatra, Lahendong in North Sulawesi, and Ulumbu in Flores. With one additional field at Mataloko in Flores, in which geothermal power is commissioned by PLN from a GOI pilot project of 2.5 MWe to become 10 areas of geothermal operations in Indonesia. In addition, this year 2014, there are 58 MWe projects under construction to be commissioned from Patuha geothermal (55 MWe) and Mataloko (2.5 MWe) and next year 2015, there are also another 135 MWe from Lahendong (20 MWe), Lumut Balai (55 MWe), and Kamojang Unit 5 and Karaha unit 1of 30 MWe each.

4.1. Installed Power and the project of on going

The geothermal power is generated from ten areas of high temperature geothermal systems. The total capacity of geothermal power plants installation is about 1,346 MWe. These are operated from Darajat (260 MWe), Dieng (60 MWe), Kamojang (200 MWe), Gunung Salak (377 MWe), Sibayak (12 MWe), Lahendong (80 MWe), Wayang Windu (227 MWe), Ulumbu (5 MWe), Mataloko (2.5 MWe) and Patuha (60 MWe). This number accounts for 3.5 percent of the approximately 36,000 MWe of total installed electric capacity, of which PLN generates about 21,000 MWe, IPPs 1,600 MWe, and captive power of 13,519 MWe. These are operated for electricity generation of 1,397 MWe by PGE and its joint operation contractors (i.e Chevron, MNL, Geodipa Energy), and PLN (see Figure 2, and Table 3).

Table 3. Installed and Planned Geothermal Power Plants in Indonesia (Ministry of Energy, 2014); Note: * 22 more areas that have been awarded to develop for the year 2025 energy mix plan.

No.	Geothermal Field	Developer	Installed Capacity (2013)	Development Planning Up to 2025	Cummulative installed Capacity Up to 2014
1	Sibayak	PGE	12	12	12
2	Sarulla	PGE/PLN	0	330	0
3	Lumut Balai	PGE	0	220	0
4	Ulu Belu	PGE	110	220	110
5	Salak	PGE/CGS	377	377	377
6	Patuha	Geodipa	0	165	55
7	Wayang Windu	PGE/MNL	227	227	227
8	Kamojang	PGE	200	230	200
9	Darajat	PGE/CGI	260	260	260
10	Karaha	PGE/KBC	0	30	0
11	Dieng	Geodipa	60	170	60
12	Lahendong	PGE	80	120	80

13	Bedugul	PGE/BEL	0	10	0
14	Hulu Lais	PGE	0	110	0
15	Sungai Penuh	PGE	0	110	0
16	Kota mobagu	PGE	0	80	80
17	Iyang Argopuro	PGE	0	55	55
18	Ciater	WSS	0	30	0
19	Ulumbu	PLN	5	10	10
20	Mataloko	PLN	2.5	5	2.5
21	Tulehu	PLN	0	20	0
22	Cibuni	Yala Teknosa	0	30	2
23	Jaboi	Sabang Geo En.	0	10	0
24	Muaralaboh	Supreme EM	0	220	0
25	Rantau Dedap	Supreme ERD	0	220	0
26	Rajabasa	Supreme ER	0	220	0
27	Others*		0	3322	0
Total			**1,346**	**6,638**	**1,404**

There are also 48 areas which exist and are being developed. These 38 areas are: (a) Sarula, Sungai Penuh, Hululais-Tambang Sawah, Lumut Balai, Karaha, Iyang - Argopuro, Bedugul, Tompaso and Kotamobagu under development by PGE itself or with its contractors for electricity generation; (b) Kawah Cibuni, Ciater, and Tulehu are three areas outside of PGE activities, which are operated by Yala Teknosa (Cooperative Body), PT Wahana Sambada Sakti and PLN, National Electricity Company; and (c) out of those field mentioned, the developers are committed and projected to commence the geothermal power plants in the new working area (see Table 3) with a total capacity of 6,638 MWe in 2025. Those geothermal fields operate using the existing geothermal rule, i.e. PD No.45 Year 1991 and the Geothermal Law No27/2003.

The government and developers has targeted three geothermal power plants (PLTP) with a combined capacity of 62 MWe will start operating in 2014. The three geothermal power plants are PLTP Patuha with a capacity of 55 MWe, PLTP Ulumbu with a capacity of 2x2.5 MWe, and PLTP Cibuni with a capacity of 2 MWe. In 2015, the total capacity of geothermal power plants will increase by 35 MWe which will come from the unit 5 of PLTP Kamojang in West Java.

4.2. Field Development and Its Status

At the 2010 World Geothermal Congress in Bali, President Susilo Bambang Yudhoyono announced a plan to build 44 new geothermal plants by 2014, more than tripling the capacity to 4,000 MWe. By 2025, Indonesia aims to produce more than 9,000 MWe of geothermal power, becoming the world's leading geothermal energy producer. This would account for 5% of Indonesia's total energy needs.

Since, then, it was 58 WKP and permits have been issued as part of the geothermal acceleration project in the 10,000 MWe Fast Track II. The geothermal power contract was expected to reach the capacities of 3,977 MWe, but due to the un-economic viable of the project, most of them are no realization. Only a few projects are running for exploration and development base on the permit. Its only three new projects are moving from the new regulation regime and the rest are projects ran by PGE and PLN. Most of the projects still have difficulty 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.

However, GOI now works more realistic in supplying the electricity to increase the electrification ratio and avoid the electricity crisis. Through a 10,000 MWe acceleration crash program project, GOI issued a new incentive related to price, tax and fiscal policy.

From developers' activity, PGE, Chevron, Star Energy, Supreme Energy and PLN have drilled more than 80 wells in the last 5 years in addition to 430 wells drilled by PGE, Chevron, MNL, BEL, PLN, GAI and Yala Teknosa before the year 2009. During 2009 to 2013, Indonesia has confirmed a total proven and probable reserve of 3,101 MWe and a total possible reserve of 13,413 MWe.

The total wells drilled for electricity-generating capabilities of each area existing and being developed are: SIBAYAK (still 10 wells), SALAK (97 wells, 8 wells addition from 2009), WAYANG WINDU (51 wells, 12 wells addition from 2009), KAMOJANG (87 wells, 5 wells more from 2009), DARAJAT (68 wells, 12 wells more than those in 2009), LAHENDONG (13 additional wells compare to 23 wells in 2009) and DIENG (still 52 wells). The rest of the number of wells drilled were from SARULA (13 wells), SUNGAIPENUH (1 well), HULULAIS-TAMBANG SAWAH (3 wells), LUMUT BALAI (18 additional from only 3 wells in 2009), ULU BELU (additional 26 wells from only 9 wells in 2009) PATUHA (19 wells), KARAHA (7 additional wells in the last 3 years compare to 14 wells in 2009), BEDUGUL (3 wells), and TOMPASO (5 wells), BANTEN (1 well), MUARALABUH (5 wells), RANTAU DEDAP (2 wells), and TULEHU (1 well), which has no electricity used and currently are under developing. The other wells drilled are KAWAH CIBUNI (1 well), ULUMBU (3 wells), CISOLOK – CISUKARAMAI (1 well), MATALOKO (6 wells), SOKORIA (1 well) and ATADEII (2 wells) which were drilled by Yala Teknosa, PLN and GAI (see Table 4).

Table 4. Numbers of well drilled in Indonesian Geothermal Area during 1974 to 2009 and 2009-2014

No	Project/(Contract Signed)	Contract Size (MW)	Contractor/ Operator	Total No. of Wells Drilled (2014)
1	Kamojang (1982, 2012)	230	PGE	87 (82 wells– in 2009)
2	Salak (1982, 1994)	495	PGE/CGS	97 (89 wells – in 2009)
3	Darajat 1,2,3 (1984)	330	PGE/CGI	68 (56 wells – in 2009)
4	Sarulla 1,2,3 (1993)	330	PGE/SOL	13
5	Dieng 1-4 (1994)	400	Geo Dipa	52
6	Iyang Argopuro 1	55	PGE	0
7	Karaha 1,2 (1994)	400	PGE	14
8	Patuha (1994)	400	GeoDipa	19
9	W. Windu (1994)	400	PGE/MNL	51 (39 wells – in 2009)
10	Bedugul1,2,3 (1995)	400	BEL	3
11	Cibuni	10	Yala-Tek	1
12	Sibayak1,2 (1996)	40	PGE/DP	10
13	Lahendong (1999)	125	PGE	36 (27 wells – in 2009)
14	Kotamobagu (2009)	40	PGE	3
15	HuluLais1,2, (2009)	110	PGE	3 (0 - in 2009)
16	S. Penuh 1 (2009)	55	PGE	1 (0 – in 2009)
17	Ciateur Prahu (1999)	55	WSS	0
18	T.Perahu (2008)	55	Indo Power	0
19	Cisolok (2008)	55	Rek- Industri	1
20	Tampomas (2008)	55	J. Sarana Jabar	0
21	Jaboi (2009)	20	Bukaka	0
22	Sukoria (2009)	20	Bakrie Power	1
23	Jailolo (2009)	20	Star Energy	0
24	Ulu Belu: 1, 2, 3, 4	220	PGE	35 (9 wells – in 2009)
25	Lumut Balai: 1,2,3,4	220	PGE	21 (3 wells – in 2009)
26	Ulumbu 1	50	PLN	3
27	Ata Deii	20	-	2
28	Mataloko	40	GIA	6
29	Banten	0	PGE	1
30	Muaralabuh	220	SEM	5
31	Rantau Dedap	220	SERD	2
32	Rajabasa	220	SER	0
33	Tulehu	20	PLN	1
	Total	**5360**		**513**

4.2.1. Kamojang (200 MWe)

This is the oldest geothermal field developed in Indonesia shown by a 250 KWh mini block geothermal power plant in 1978. The field is operated by Pertamina Geothermal Energy (PGE) generating 200 MWe from 4 units of power plants. The first unit of the 30 MWe plant is still in operation for more than 32 years old.

At present, the gathering facilities are supplied by the total of 87 wells which were drilled for exploration, production, re-injection and monitoring of the unit 1 to unit 5 of the Kamojang power plant. The size of the productive area is about 21 square km with an estimated electrical potential equal to 270 to 300 MWe. New exploration activities identified resources sufficient to increase the existing plant by an additional of 60 MWe. Now, PGE is completing the EPC for a fifth unit of the geothermal plant with an output capacity of 30 MWe. The COD of this unit is planned to launch in mid of 2015.

4.2.2. Sibayak (13.3 MWe)

Sibayak geothermal field in North Sumatra operates a 13.3 MWe plant compose of a 2 MWe plant of Monoblock manufactured by GDA and generated electricity since June 1996, and 2 unit of 5.65 MWe of the Chinese geothermal plant operated by Dizamatra Powerindo. The field is managed by PGE. There is no additional capacity of power plant invested to increase its power generating capacity, even though PGE signed an agreement to allow expansion of the next unit of power plant. In order to increase the capacity of the area, there is a study to use a binary plant to improve the field performance. The 2 MWe plant now is retired.

4.2.3. Lahendong (60 MWe)

Four units of power plant of 20 MWe have been commenced in this area since 2002, 2008, 2009 and 2012. PGE as the developer, plan to develop two more unit of 20 MWe in the area mainly in the expansion of Lahendong to Tompaso geothermal prospect. The additional 40 MWe is planned to commence in the year 2015 and 2016 using nine production wells drilled in the last five years. The drilling and steam field gathering system is under gone. Total wells drilled now are 36 of exploration, production, reinjection, monitoring and abandoned. Recently, PGE offered to use brine technology to optimize the use of Lahendong geothermal fluid to increase the power plant capacity of 7.5 MWe respectively.

4.2.4. Ulu Belu

The Ulu Belu area is located in southern part of Sumatra. It is associated with the volcanic depression of Mt.Sula, Rindingan and Tanggamus. Since 1993, PGE drilled three exploration slim holes and 32 development wells in the north block of Ulu Belu area to support four unit of 55 MWe unit power plant. 12 wells were drilled before 2009. The possible and proven reserve is about 540 MWe.

The steam field and steam supply is managed by PGE for such unit. The geothermal system is dominated by hot liquid dominated system with temperatures from 240° to 260°C. The first and second unit of 55 MWe is commenced at the end of 2012 using Fuji Power Plant. The field now is undergone to construct the 3rd and the 4th unit of 55 MWe power plants.

4.2.5. Lumut Balai

The Lumut Balai geothermal system is water dominated. The reservoir temperature varies from 260° to 290°. It is located in the South Sumatra associated with Sumatra volcanic belt. The prospect area is predicted at 70 km^2. The proven and probable reserve is more than 100 MWe. Since 2007 until now, PGE has drilled 21 wells, three of which were drilled before 2009 to support 220 MWe electric capacities. The first unit of 55 MWe power plant is proposed to commence in 2015.

4.2.6. Hulu Lais

This field is also located in the southern part of Sumatra. The exploration drilling has been conducted since 2010. Three exploration wells have been completed and encountered a hot dominated geothermal system. These three wells were originally planned to drill at the end of 2009 and followed by a development drilling to support a two unit of 55 MWe power plants proposed to commence on 2013 and 2014. But, a non-technical problem was encountered during the period of drilling preparation. The first and third wells encountered a downhole temperature of 200-210°C, while the second well indicated a good productive at downhole temperature of 300°C. The new program for Hulu Lais field has been re-scheduled to commence on 2017 and 2019 of 2 unit of 55 MWe. The potential prospect could be developed to 200 MWe from about 500 MWe of its potential.

4.2.7. Sungai Penuh

PGE prepared the exploration drilling in 2010. The first exploration well has been completed in June 2013 in order to support a first unit of 55 MWe power plant from total of 200 MWe potential. The drilling activities took 6 months due to a technical problem. This might cost double of the average well cost drilled by PGE of a six to seven millions USD per well.

The main barrier in preparing such activities is a very limited infrastructure and location of the prospect is situated in the National Park of Kerinci Seblat. The prospect of Sungai Penuh geothermal area is located in the main graben of Sumatran Fault lying in the middle part of Sumatra. From the first well, it has been encountered a hot water geothermal reservoir at temperature of 211°C.

4.2.8. Kotamobagu

Kotamobagu is located 250 km from Manado, North Sulawesi. There are two exploration wells that have been drilled in 2010 and 2011 so far. Both wells are dry and no indicative to produce. It seems that the drilling pad is out of the prospect boundary which is located in the conservation forest. The prospect is predicted with about 230 MWe potential as a liquid-dominated resource with temperatures varies from 250°C to 290°C. PGE proposed to re-scheduled the project from 2013 to commence in 2019 and 2020 of two unit of 20 MWe power plant.

4.2.9. Tompaso

As part of the Lahendong geothermal area, Tompaso has been expected to construct two unit of 20 MWe plant managed by PGE to produce electricity by 2012. But, from the nine wells drilled, indicated that there should be some more wells drilled and the project also to be re-scheduled into 2015 and 2016 respectively. The probable reserve is about 120 MWe from its total potential of about 220 MWe. One reinjection well has a good indicative of permeability. The project is financed using the World Bank support. PGE has invested about USD50 million for this project only in the drilling program. It looks like the economy of scale should be re-calculated and re-negotiated with PLN as the buyer.

4.2.10. Iyang - Argopuro

The prospect is located in the East Java lying mainly in the protective forest and national park. Even this prospect has 200 MWe electric respectively and the G&G survey has been completed by PGE for resources confirmation, there is no additional progress in this area. PGE is still waiting for permit clarification from the government to explore. In this case, and expecting the new regulation of geothermal will come, PGE proposed to continue conducting the surface geological and geophysical survey and drilling activities to confirm reserve and commence the one unit of 55 MWe plant by 2019.

4.2.11. Gunung Salak and Darajat

Chevron and its partners, PT PGE, and PT Austindo Nusantara Jaya, still operate the Salak and Darajat geothermal fields, both located on the island of Java. Salak is managed by Chevron Geothermal Salak (CGS) and Darajat is operated by Chevron Geothermal Indonesia (CGI). There are nine power plants in the two fields with a combined capacity of 647 MWe. Chevron operates five of these plants, with a capacity of 398 MWe. Awibengkok of Gunung Salak geothermal field produces steam capable for 377 MWe compose of 6 unit power plant and Darajat produces about 270 MWe at Darajat compose of three unit of 55 MWe, 95 MWe and 110 MWe unit plants. The total of both fields is about 50 percent of Indonesia’s total capacities.

During the last five years, six new wells including one well for re-injection were drilled at Salak to delimit the potential to expand field production. This means, there were 100 wells in existence, from which two wells for re-injection, two wells for condensate, five wells are used to monitor the reservoir of the field, 23 wells are non-active wells including five wells are abandoned. Looking to the future, the feasibility of installing additional generating potential has been assessed in both fields. It seems, hard to plan some additional power plant to commence.

The Salak geothermal system is a liquid-dominated, fracture-controlled reservoir with benign chemistry and low-to-moderate non-condensable gas content (Stimac et al., 2010). The reservoir is the largest producer of geothermal power in Indonesia (Ibrahim et al., 2005), while Darajat geothermal system is a steam dominated system. If the required steam supply is achieved, then the third unit of Darajat is proposed to up its capacity to 120 MWe to produce 280 MWe in total respectively. The use of the existing wells is supplemented by the 12 new wells that were drilled in 2009, 2010 and 2011 to supply steam for Darajat geothermal plants. Recently, 49 wells exist in Darajat, four of which are used for condensate. As a result of these activities record investments in both field is about 80’s million USD.

4.2.12. Sarulla

The Sarulla area is located 300 km south of Medan in North Sumatra. This project includes Silangkitang, Namora-I-Langit, and Sibualbuali (Gunderson et al, 2010).

Since the project is taken over by a Consortium of Medco Power, Itochu, ORMAT, and Kyushu Electric under Sarulla Operation Ltd (SOL) regarding of JOC with PGE, there is no significant progress made in supporting a tight schedule of commissioning were planned at 2011, 2012 and 2013 as committed for the 10,000MWe crash program project. SOL as the operator of the project to develop 330 MWe, worked to finalize the re-negotiation of the project schedule mainly in PPA and price re-settlement. For maintaining the 13 wells in three different areas, SOL also worked over of some productive wells in Silangkitang. The project will be financed by JABIC and ORMAT using of three binary units of 110 MWe ORMAT plant.

4.2.13. Karaha Bodas

Since Karaha Bodas Company LLC (KBC), a joint venture between Caithness (40.5%) and Florida Power & Light (40.5%), both of the US, and Tomen of Japan (9%) and a local company Sumarah Daya Sakti (10%) executed the international arbitral award against PT Pertamina and PLN for the postponement of its contract by Indonesian government, the project now is managed by PGE. In 2008, PGE maintained some wells were drilled by KBC. In the last three years PGE has worked over of one well and drilled another five new wells to support 30 MWe plant to commence in 2015. This planning of re-commissioning date is a new plan of PGE since commencing in 2012 was delayed. PGE has invested at least USD 22-25 million for drilling of a new well. It still needs some more fund to support EPC of the steam gathering and power plant facilities. Previously, KBC has drilled about 22 wells of slime hole, standard hole and big hole size of well with total investment of USD75-100 million.

4.2.14. Dieng geothermal field

The field is operated by PT. Geo Dipa Energy (Geodipa), the subsidiary company of Pertamina and PLN and produces about 60 MWe as a continuance of Himpurna California Energy Limited (HCE). At the beginning, the field is planned to increase its capacities to 180 MWe as its resources is more than those covered from drilling wells. There is no additional investment in the Dieng geothermal field by Geodipa. HCE has invested USD192 million to completed the 48 exploration and development wells drilled and EPC worked of steam gathering and 60 MWe power plant. Previously, HCE identified the field’s potential as 350 MWe. Currently, Geodipa has been taken over as state owned geothermal company to operate and managed the Dieng and Patuha geothermal field.

4.2.15. Patuha

As the third geothermal project identified as a steam dominated geothermal system in Indonesia by Patuha Power Limited (PPL), Patuha geothermal field is more attractive than those in Dieng. The project is also operated by GeoDipa after the Indonesia's government assigned both Dieng and Patuha to the PT GeoDipa for project continuance. Currently, Geo Dipa proposed to build three units of 55 MWe power plants and the first unit of 55 MWe is commenced in June 2014 using Toshiba power plant. The field is planned to increase its capacities to 110 MWe to commission in 2017. The unit 3 will be considered later to be another 55 MWe or dependent on the next development well result.

The total investment of the unit is about USD60-70 million for power plant and about USD60 million for steam gathering. PPL has drilled 17 exploration wells (between 760-800 m depth, core hole, 6 slim hole) and 13 development wells (1,000 – 2,172 m depth). PPL identified the field's potential as steam dominated geothermal system which total proven reserve is about 200 MWe. The potential reserve calculated is about 400 MWe. The government hopes to make the business economically it is necessary to build more generating capacity of 160 MWe at the site. During operation, the operator HCE has drilled as many as 13 exploration wells, 17 wells and six development wells slim hole since 1994 and cost 136 million U.S. dollars for the construction and finance.

4.2.16. Wayang Windu

The field is operated by Star Energy Geothermal Wayang Windu Limited (SEGWWL) under a Join Operating Contract with PGE. The field is operating in full capacity of 227 MWe. The initial planning, the capacity of the field is planned to be increased to 400 MWe, with the additional exploration drilling for expansion unit. A total of 12 wells have been completed by SEGWWL since the project was taken over in the last five years to increase its capacity for the next 110 MWe units. These additional wells, are an addition to 57 wells to support the Wayang Windu operation. But, the result from the exploration drilling of expansion of the field is un-attractive. The expansion program is now in re-assessed.

4.2.17. Bedugul (Bali)

The Bedugul field, which is located on the Bali island is now suspended. There is no progress to the project plan. Initially, Bali Energy Limited (BEL) planed to drill about six wells each year starting in the early 2008 and ending in 2013. Total of the 24 productive well, and 8 injection wells will produce enough steam to supply 175 MWe power generation units and BEL will provide eight well pads that consist of three existing pads and five new pads.

The government and BEL has agreed to re-schedule the project in order to operate the first unit of 10 MWe plant by 2019.

4.2.18. Ulumbu

In 1989 PLN, in bilateral technical cooperation with the Government of New Zealand, began promoting the Ulumbu Mini Geothermal Project in Flores East Nusa Tenggara. Contracting for drilling activities commenced in 1993 and drilling activity commenced in 1994.

Under the RE Program, PLN has requested a loan from the World Bank for exploration and production drilling for the mini geothermal plants at Tulehu, Ambon, and at Sembalun, Lombok. In addition, funds for construction of 3 plant at Ulumbu, Flores, and a 350 MWe plant at Kerinci, Surnatera have been ask for geo-scientific studies have been implemented using PLN's budget for the Tulehu and Sembalun sites. Drilling has been completed at Ulumbu.

By year 1995, plans were in place for geo-scientific studies of seven locations where mini geothermal development is possible. The field is located at 650 meters above sea level, nearly 13 km from the newly formed volcano of Anak Ranaka

Trial operation of the electricity that utilizes geothermal resources in Ulumbu begins with drilling the first well in 2003. Drilling resumed later in 2006 of the second and third wells. In December 2008, GDA signed a contract with PT PAL Indonesia for the design, manufacture, and supply of equipment for the Ulumbu geothermal project on Flores Island. The first electricity was generated in November 2011. The unit 1 of 5 MWe plant has been operating since 2012 in Ulumbu. The next unit of Ulumbu plants are unit 2 & 3 which is entering a commissioning phase and will start operating in August 2014 and mid 2015 respectively for 2.5 MWe plant of each unit will be spliced into the city of Ruteng.

4.2.18. Mataloko

Mataloko geothermal field is located in Toda Belu, Flores Island, East Nusa Tenggara, eastern part of Indonesia. The five-year (1998–2003) cooperative research between Indonesia-Japan proposed an exploration well (TD = 1,000 m) to investigate a subsurface geothermal system in the Mataloko geothermal field. The first exploration well (MT-1) has shifted to MT-2 because MT-1 was plugged back with cement due to blowout of steam with gasses (H_2S & CO) around the cellar while drilling 9 5/8" hole at a total depth of 207.26 m on 18 October 2000. The data above strongly suggest that estimated down hole temperature of MT-2 ranged from about 197 – 208.6°C. At WHP of 5.9 – 6.0 Kscg, steam flow rate ranged from 14.48 – 14.71 ton/hour, whereas steam temperature in the flow line varied between 135– 140°C. Since 2008, Mataloko is one of the government projects to use a shallow hole project to use steam and generate a 2.5 MWe power plant unit. The power plant is operated by PLN and started to commission in 2013. Mataloko power plant with a capacity of 2.5 MWe started operating last year.

4.2.18. Tulehu, Maluku

PLN will begin construction of Tulehu geothermal power plant, Salahutu, Maluku with capacity of 2 unit of 10 MWe plant. The construction will be done after the funding agreement with the Japan International Cooperation Agency (JICA) is completed. The construction of Tulehu geothermal power plant is planned to be complete in 2016. The first exploration drilling has been done by PLN Geothermal, and initially expected to have the power plant in operation by 2014. This plant will scrap earlier plans to build a diesel power plant in the region and will save the state company more than Rp250 billion ($28 million). But, the drilling activities have been stop due to technically problem before total depth and the well is monitored for heating up. The whole project is now re-assessed.

4.2.18. Cibuni

Cibuni is located in west Java and close to Patuha geothermal project. The project has been delayed since 1998. There are three wells drilled in 1996-1997 and estimated the probable reserve is about 50 MWe of steam dominated reservoir system. The first well is a productive well, which produce 36 tonnes/hour of steam. The depth of the wells are between 800 – 1,600 m. The 2nd and 3rd wells have been canceled due to drilling problem. The field is operated by Yala Teknosa (Cooperative Body) and proposed to install 2 unit of 5 MWe by 2019.

4.2.19. Ciater

CIATER geothermal field is located in the northern part of Tangkuban Perahu project. The field is proposed to install one unit of 30 MWe by 2019. Some manifestations in this area have been utilized for Ciater geothermal direct use as a tourist destination, i.e spa and swimming pool. WKP Tangkuban Parahu I (Ciater) currently held by PT. Wahana Sambadha Sakti with an area of 20 km^2. There are about seven geothermal manifestations of acidic hot springs that appear in the area of Ciater and contain a lot of silica sinter and precipitated of iron, aluminum and phosphate.

4.2.20. Muaralabuh

This is one of the three gothermal projects ongoing using the Geothermal Law No.27/2003. The two others are Rantau Dedap and Rajabasa in Southern Sumatra. Muara Laboh is located in West Sumatera Province. The concession covers an area of about 62,300 ha at elevations ranging from 450 to 2,000 meters and is bordered by Taman Nasional Kerinci Seblat (Kerinci National Park) in the west and south. The geothermal prospect is indicated by a long and wide distribution of thermal manifestations, consisting of fumaroles, mud pools and hot springs which are located along the graben associated with Great Sumatera Fault zone.

PT Supreme Energy Muara Laboh (SEML) has been awarded in 2010 as the project company to develop Muaralabuh. PPA was signed in early 2012. The Government Guarantee Letter from the Ministry of Finance of the Republic Indonesia for the Muara Laboh project was also issued at same time in 2012. The signing of the PPA and issuance of the Guarantee Letter resulted from several months of intensive and constructive negotiations between the parties, driven by the shared goal of accelerating the development of geothermal energy in Indonesia. On September 21 2012, SEML did the first exploration well drilling ML-A1. This is a series of 4-6 drilling exploration wells in the area which proved the existence of geothermal resources was sufficient to build a geothermal power plant of 220 MWe.

Currently, SEML has completed the exploration drilling program covering 6 wells (ML-A1, ML-B1, ML-C1, ML-E1, ML-H1, ML-H2). All the wells now are monitoring for data evaluation and reserve calculation. From the first test of the first well in December 2012 has confirmed the existence of a geothermal system and a well with a conservative estimate of 20 MWe power capacity. In the near future, a long-term test will be performed on the well, to further confirm the reservoir conditions and the well productivity. The target is to produce a sufficient amount of steam to supply a 220 MWe power plant, to be built in 2014. SEML has spent about USD100 million for this field.

4.2.21. Rajabasa

Rajabasa geothermal project is situated at the southern end of the Sumatera Island and covers an area at sea level to 1,280 meters high. The project is operated under a partnership between PT Supreme Energy and Sumitomo Corporation. The project has a planned power generation capacity of 2×110 MWe and could fuel the complete electricity demand of the province. Supreme Energy expects to start operation of the plant in 2017, providing electricity to the region. The PPA was signed in 2012 and The Government Guarantee Letter from the Ministry of Finance of the Republic Indonesia for Rajabasa project was also issued in 2012, following the tender award of the Rajabasa concessions to the Supreme Energy Consortium in early 2010.

The delay of exploration drilling was caused by waiting for permits from Minister of Transportation and by the end of 2013 year while civil construction activities and other significant tasks have temporarily been suspended since June 2013. Now, the work is in progress, as the Forest Area Borrow-Use Permit (IPPKH) from Ministry of Forestry has been issued in early 2014.

4.2.22. Rantau Dedap

The exploration program has started since 2011. Rantau Dedap project, South Sumatra has entered the Power Purchase Agreement (PPA) in 2012.The first exploration drilling RD-B1 was conducted in early February 2014 at Rantau Dedap Geothermal Working Area. This well is a series of 5-7 drilling exploration wells in the area, to prove the existence of geothermal resources, to support sufficient to build a geothermal power plant with the capacity of 220 MWe.

The field is operated by PT Supreme Energy Rantau Dedap (SERD). The SERD project is a joint venture by PT Supreme Energy, GDF Suez and Marubeni Corporation. The project plans to drill five 2,400 meter deep wells and are expected to start operating in 2018. They are expected to power two plants of 110 MWe unit. Its potential reaches 600 MWe.

In the Rantau Dedap power plant project, the consortium is investing around US$3 million to $4 million per megawatt, making the total investment up to $700 million. Half its investment will be spent on the power plants. The electricity that will be generated by Rantau Dedap power plant will be sold to PLN for 8.86 US cents per kilowatt hour (kWh) under a 35-year contract. Meanwhile, the electricity generated by power plants in Muara Laboh and Rajabasa will be sold for 9.4 and 9.5 US cents per kWh, respectively.

4.2.23. Exploration stage of new geothermal project

The new geothermal project base on Geothermal Law No27/2003 and all of its derivatives regulation is now quite slow. Tangkuban Parahu (PT Tangkuban Parahu Geothermal Power), Mount Tampomas (PT Wika Jabar Power), Cisolok-Cisukarame (PT Jabar

Rekind Geothermal Power), JABOI (PT. Sabang Geo Energy), SOKORIA (PT. Sokoria Geo Indonesia) and JAILOLO (PT Star Energy Halmahera) which have been awarded before 2010 were stagnant. It seems no significant progress in project planned. The major issue is caused by pricing of the energy sold, PPA 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 company, lack of human resources, etc. However, in the last 5 years, there are total of 38 new working areas that have been issued the geothermal permit for exploration and exploitation. These fields and the numbers of total capacity install are shown in Table 3, while the total numbers of wells drilled is seen in the Table 4.

4.3. Direct Utilization

There is no new recorded of geothermal direct use in Indonesia as reported in the WGC2010. As have been reported that Indonesia began developing geothermal direct utilization (non-electricity) for hundreds of years mainly for spa and swimming pool using natural hot springs. Before the twentieth century, the geothermal fluid (geothermal) is only used for bathing, washing and cooking. Today the utilization of the geothermal fluid is very diverse.

Today, the National Research and Technology Agency (BPPT) still works to investigate methods to apply geothermal energy in the agricultural sector, particularly the use of geothermal energy to sterilize the growing medium used in mushroom cultivation. Palm sugar processing using brine produced from Lahendong geothermal field is suspended. The more use of geothermal for agriculture such as copra drying in Lahendong, Mataloko and Wai Ratai Lampung, mushroom cultivation in Pengalengan, tea drying and pasteurization in Pengalengan and also geothermal direct use for large catfishes growing in Lampung is running better. Total brine use was about 50 tonnes/hour for each field. Fish farming is also using geothermal fluid in Lampung.

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 catfishes. The farmer reported that the fishes grow better in the geothermal fluid and freshwater mixture. Close to the location of the above copra drying direct use, BPPT implemented a pilot plant of the utilization of a man-made shallow geothermal well for cocoa drying in the same field in 2008. The well is made artificially from an existing hot water seepage on the ground. It has a temperature in a range of 85 - 95ºC. The schematic diagram of this cocoa dryer facility is the same as dryer for copra, but different in the size of the downhole heat exchanger.

Figure 3: Mushroom cultivation sterilized using geothermal heat in Kamojang, Indonesia.

Figure 4: Palm sugar processing unit 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 WGC2010 in Bali. This is because of geothermal potential in Indonesia is mainly compose of high enthalpy geothermal system and the utilization is also still low. In this case, Indonesia still optimize of using geothermal for electricity rather than those for heat pump.

5. DISCUSSION

In the last five years, it is only 212 MWe additional geothermal power plant have been installed and commenced until 2014. The target of 4,000 MWe addition to the 1,189 MWe installed capacity in 2014 failed to be reached. It is unlikely due to geothermal energy has unique attributes which pose challenges to its development. The following factors are part of the reason for this failure:

5.1. The pricing policy

The pricing of energy is the main obstacle to the development of geothermal energy in Indonesia. The high risk cost of development, fossil subsidy, and the associated electricity tariff required remains the core problems in geothermal development. The price needs to be competitive with other energy alternatives, and at the same time offer the producer an attractive rate of return. The price of energy will give a return on investment whether the project is economically viable or not. Most of the geothermal projects awarded from tender is less viable in IRR.

For the new power plant development, the attractive price for economic viable is vary from 9-12 cents/kWh. To make it happen, GOI issued the Ministry of Energy Regulation No.22/2012 as it is revised from regulation No. 2 year 2011 to mandate PLN to take any power produce from geothermal. This regulation is pushing down a mandate to PLN as a single off taker. Even the price is feed in tariff, but there is no room for PLN to take since it went through tendering process of the ceiling price and there were some needs for PLN to secure the least cost. The new study from the World Bank (2014) indicate that the price of geothermal energy will vary from 11 to 29 cents/kwh based on avoiding cost of coal and the region of electricity use. The price is also dependent on the year of commission from 2014 to 2025. The lowest price is dedicated to the project commission in the region of Java, Bali and Sumatra in the year 2014, and the highest price is dedicated to the project commence in isolated areas to substitute a diesel power plants. This policy will standardize the geothermal price. So, it is expected to raise the geothermal use up to more than 7,000 MWe in 2025.

5.2. Long term benefit.

Today, there is no genuine mechanism for considering geothermal long-term benefits for PLN. The low emissions are taken for benefits of the people and to the country. Thus, GOI should support the use of geothermal for electricity by PLN. PLN as other private company, has to survive and compete with other private sectors.

In the long run, Indonesia still presents as one of the world‘s most attractive geothermal prospects but there is a need to look for new development approaches to maximize its potential. A study taken by WJEC in 2009 shown that the economic value of geothermal energy earned by the Government of Indonesia is about 17.7 cents/kWH. The value should be taken for issuing some fiscal incentive to attract geothermal development.

In the last five years, there are intensive discussions amongst geothermal stakeholders identifying the barriers to the growth of Indonesia geothermal industry such as: competitiveness of geothermal energy price; continuing subsidy of fossil fuel price; lack of political will to intensify geothermal energy utilization; shortage of competence human resources; absence of technology and research & development supports; lack of renewable incentives; lack of risk appreciation and mitigation efforts; absence of integrated energy planning; lack of information and publicity on Indonesia' geothermal potency and benefits; and low environmental awareness; Geothermal Law; absence of government guarantee, mandatory of PLN to buy the energy produced by the project company; standard PPA; tendering of geothermal process; and forestry concern. The first action to be taken by GOI is to amend the Geothermal Law No.27/2003. The draft of the Bill has been passed by GOI to the Parliament for intensive discussion and public hearing.

In addition, infrastructure can also be major obstacles in the development of geothermal in certain areas such as Sumatra. For example, since 2008 PGE began to develop this working area in Sumatera: Ulubelu, Lumutbalai, Hululais and Sungai Penuh. Later on in 2011 Supreme Energy started exploring this working area in Muaralaboh, Rajabasa and Rantau Dedap and expected in this year Sarulla will be developed. If all of this project can be done, in 2016-2017 the geothermal installed capacity in Sumatera with additional of 1,100 MWe will come true. But, it's depending on how easy to get the permit and also the preparation of infrastructure including the grid. Furthermore, the capacity building of the HR should also be improved.

6. FUTURE DEVELOPMENT AND INSTALLATION

As happened in the last few years, the growth rate of electricity demand is about 8.6% annually. This might effect of shortage of power in the near future due to the fact that the sector has not been able to make adequate developments/investments in the power supply capacity to meet its growing electricity demand of beyond nine percent per year. In addition, the Government has initial plans to develop geothermal power plants with 2,000 MWe of capacity in 2008, 3,442 MWe in 2012, 4,600 MWe in 2016, and 6,000 MWe in 2020. By 2025, Indonesia is expected to install 9,500 MWe of power plant. In fact, there are a 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. The new tariff regulation is also issued and making international standards as a complementary of MEMR regulation No.22 Year 2012. This regulation is issued to attract the increase of investment in facing more than 7,000 MWe geothermal plants in 2025. The future development and power plant installation expected are shown in the Table 5 below.

7. CONCLUSIONS

In the last five years, there is a significant increase in geothermal installed capacities as well as a significance use of brine for direct use of geothermal. However, the GOI need clear support for private power to minimize uncertainty in the project development. In addition, GOI should educate developers and lenders on guaranteeing the viability of the project and provide a development of 7,000 MWe electricity from geothermal in the next ten years until 2025.

Other business opportunities in the geothermal sector are geothermal direct use, low temperature geothermal potential, small scale power plant, services company 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.

Table 5. Future Development Planning and Installation of geothermal plant road map for 10,000 MW crash program.

System	2013 (MW) *	2014 (MW) **	2015 (MW) ***	2015 (MW) ****	2020 (MW) ****	2025 (MW) ****
Java - Bali	1240	1189	30	60	1867	413
Sumatera	1240	132	0	55	2270	199
Sulawesi	80	80	20	20	145	80
Nusa Tenggara	40	10	2.5	0	45	40
Maluku	20	0	0	0	20	20
Total	2620	1411	52.5	135	4347	752
Cumulative	4733	1411	1464	1599	5946	6638

NOTE: *2013 planned in crash program project; **2014 existing installed capacity status; ***2015 on going project; ****2015 re-scheduled of the program for power plant to install

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