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Geothermal Energy Update: Geothermal Energy Development and Utilization in Indonesia

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ABSTRACT

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'. Indonesia also known as the world largest geothermal potential resources given rise to large concentration of high temperature geothermal system. The total potential estimated by National Geological Agency of Indonesia (NGAI) is about 27,000 MW. In term of geothermal development and its utilizations, the Government of Indonesia (GOI) is planning to utilize those big energy resource as a leading alternative energy to substitute fossils that may be fulfilling Indonesia's growing demand for electric power in the next 20 years.

Indonesia Geothermal Association (INAGA) and NGAI reported that Indonesia is composed of 256 geothermal potential locations in which is surrounded by 29 locations (2,795 MW) of prospective geothermal energy in which 18 locations (1,205 MW) planned to develop and operated by existing developers mainly composed of Pertamina Geothermal Energy and its partnerships while 3 locations (1,590 MW) have been tendered and 6 others are still waiting for the new bidding.

The current geothermal fields operated from 7 locations with total capacity of as a minimum of 1196 MW consists of Darajat (260 MW), Dieng (60 MW), Kamojang (200 MW), Gunung Salak (377 MW), Sibayak (12 MW), Lahendong (60 MW), and Wayang Windu (227 MW).

The Direct-use of geothermal in Indonesia is starting to grow since Pertamina Geothermal Energy (PGE) - the subsidiary of Pertamina, state oil and gas company - and National Research Institute (BPPT) launching the Mushroom harvesting project in Kamojang in year 2000 and now PGE work with local Cooperative in Lahendong (North Sulawesi) to develop palm sugar and white copra processing . This is not including spas and developed swimming pools which is uncounted numbers. Some others institution (NGO's and the Universities) are also on the research progress of direct using geothermal for purifying Akarwangi (the raw materials for perfume). Geothermal (ground-source) heat pump use is not well known in the country.

Since the economic crisis affected Indonesia in 1997 and started to recovered in 2003 has affected power sector demand and growth in Indonesia. This has resulted in black out in the whole country which are varies from time to time and from place to place. Furthermore, the changes in the regulatory environment for the geothermal industry and the firm commitment from the GOI are the major issues affecting the future growth of the Indonesian geothermal industry.

During the energy recovery situation, GOI is setting a strategy to prepare Indonesia to become independent in meeting its energy requirement. GOI has gradually increased the national electricity tariff, and assessed a differential electricity tariff structure by region to support electricity infrastructure investment with regards to the needs of the region. In geothermal sector, GOI continues to encourage investors by offering incentives in exploration activities, and lessens the amount of risk by allowing the government assessing exploration activities as it is stipulated in the Geothermal Law.

Following the issuance of the Geothermal Law No. 27/2003, GOI issued the Government Regulation No.59 Year 2007 regarding the geothermal business activities and Ministry of Energy Decree (MED) No.14 Year 2008 concerning on geothermal energy prices - that focuses on the importance of geothermal energy utilization on top of the utilization of other renewable energy. This decree then revised by MED No.5 Year 2009 concerning on energy price, and on the law protection towards the investor for the maximum use of Indonesian geothermal energy. These policies are issued to support to have a total Geothermal Power Plant Installed Capacity of 9,500 MWe by the year 2025. Cost of geothermal energy produced is slightly lower than those generated from fossil fuel such oil and gas, but still un-compete to that generated from coal fire plant. It is slightly higher specially than those from main mouth fire power plant. Thus, the opportunity to develop geothermal power plant in Indonesia is widely open to private.

To support those GOI policies, a local and international companies are now increasing their activities in order to meet the energy demand in power sector. Pertamina Geothermal Energy with its own activities and its partner explore some area which are not produced yet. Some other new company are also involved in exploration stage or even in the development stage of utilize the geothermal power. All activities are supporting the GOI policy to meet the second stage of 10,000MW accelerating power plant project, which are mainly composed of 60% of geothermal. Thus, the opportunity to develop geothermal power plant in Indonesia is still widely open. Finally, in regard to investment substance GOI also expected to be able to maintain Indonesian country risk, to set up competitive basic electricity price, to determine market-demand currency rate, to arrange clear fiscal regulations, and to implement contract sanctity.

1. INTRODUCTION

The growth rate of geothermal development for electricity in Indonesia is relatively slow until the world oil crisis in 1971. Since then the government stresses on a guideline for energy policy, namely intensification on survey and exploration of energy resources including geothermal and coal; diversification of energy by means of reducing on oil depending utilization and promoting through development utilization and customary use of substitute fuel. For geothermal, the government is started to issue the President Decree No.16/1974, President Decree No.22/1981, President Decree No.23/1981, President Decree No. 45 in 1991 and President Decree No.49/1991. These decrees appointed the Pertamina, National Oil Company to conduct exploration, exploitation and utilized the steam into energy. The decree also introduced a total project that passes through a system. During this period, private sectors have signed 12 contract areas that are mostly big scale geothermal development and committed to develop and utilize geothermal energy by 3800 MW electric relatively.

Monetary crisis that has occurred since mid of 1997 gave significant impact on Indonesia economy. Independent Power Producer (IPP) model that offers a relatively high electricity price that giving the private sector high returns, must be reformed. It caused slow down geothermal business. To speed up geothermal development, President Decree No. 76 is introduced in 2000. This regulation, however, unable to invite investors in geothermal development mainly because of Indonesia is still in economic recovery stage.

Indonesian Geothermal Association (INAGA) in an effort to anticipate this turbulent global competition has integrated work quality and management processes into its organization strategy. As a professional organization and government's partner, INAGA continues focusing its long-term commitment and efforts to help making Indonesia's energy policy with a strong foundation in the next millennium. The mission becomes our focal point in the development of INAGA organizational strategies and programs. They are designed to support our national goals and realize important opportunities in three areas: enhancing energy security; strengthening economic competitiveness; and addressing concerns on environment. Although Indonesia is one of a handful of countries to have developed geothermal energy, its development has proceeded very slowly and is currently facing difficult challenges. Over a span of 30 years, Indonesia has only developed at least 1100 MW or about 4 percent of 27,000 MW of geothermal potential.

The early 1995s, the GOI did the awarding of eleven contracts for development of geothermal power plants, with a total committed REPELITA VI capacity (GOI's five year plans) of 1,498 MW in original completion dates between 1998 and 2002 and a commitment contract capacity of 3,692MW. However, as a result of the 1997-1998 financial crisis, the Government suspended (postponed) twenty seven Independent Power Projects, including eleventh geothermal projects. As of May 2002, the government successfully resuscitated all geothermal contracts with one under legal dispute (Karaha Bodas, West Java).

Recently, the government declared a new Geothermal Law No 27/2003. This Law is followed by the Government Regulation No.59 year 2007 as a guide for the business entities, cooperative bodies and the Government to activate the geothermal business in Indonesia. This regulation is line with the focus of the energy sector to push accelerate the use of geothermal energy and mainly deregulates the right of regional autonomy, fiscal reform, sanctity of existing contract, introduce the transparency process and level of playing field, and regulate the geothermal steam field license. The supporting regulation shows that the government will push to accelerate the use of geothermal in the near future. Government blue print for geothermal development is issued in the Government Regulation No..3/2006. Geothermal is expected to contribute at least 5% of the national energy needs. To support the policy, government has issued to Minister of Energy Decree regarding to a pricing policy to attract the economic of return of the project. In the year 2008, there is a Decree No.14/2008 and then revised by the Minister Decree No.5 year 2009 in order to make the project is economic fair of return. This might increase the use and activate the business entities to develop geothermal even for direct or indirect use of geothermal.

This paper discusses the Indonesia geothermal status in the implementation of Power Sector Restructuring. In doing with the aim of processes, INAGA works together with government to disseminate its vision so that geothermal resources should become energy of choice in the expanding Indonesia energy market by virtue of its natural environmental benefits and its potential opportunities to add value in supports of Indonesia's sustainable national development.

2. GEOLOGICAL BACKGROUND

Indonesia is Located between the eastern end of Mediterranean Volcanic Belt and western side of Circum Pacific Volcanic Belt, and is blessed with abundant geothermal resources. Trial calculations indicate approximately 27 GWe (Figure 1) equivalence of that forty percent of geothermal energy in the earth's crust is released in the Indonesian archipelago and neighboring areas and put this country as the biggest geothermal energy potentials in the world.

Indonesia Geothermal Association (INAGA) and NGAI reported that Indonesia is composed of 256 geothermal potential locations in which is surrounded by 29 locations (2,795 MW) of prospective geothermal energy in which 18 locations (1,205 MW) planned to develop and operated by existing developers mainly composed of Pertamina Geothermal Energy and its partnerships while 3 locations (1,590 MW) have been tendered and 6 others are still waiting for the new bidding.

Today, 1196 MW Power Plant from geothermal energy have been developed as of 2009. The developed geothermal locations distribute in 7 areas: Kamojang, Darajat, Wayang Windu and Salak in West Java; Dieng in Central Java; Sibayak in North Sumatera and Lahendong in North Sulawesi. It is quite apparent that the geothermal resources in Indonesia have been underdeveloped and neglected in spite of their huge potential.

Indonesia possesses a variety of energy resources. While a substantial portion of the country's energy mix continues to rely on oil (Table 1).

PLN and businessmen are pushing for greater utilization of other primary sources of energy, particularly coal and "non-transportable" fuels, such as geothermal and natural gas. Geothermal and hydropower have also been considered the right answer to energy diversification needs and rising concern over environmental issues and declining non-renewable energy resources. The National Committee on

Climate Change has recommended conversion from coal and petroleum-based fuels to the use of renewable energy sources to reduce emissions. The government has tried to promote development of renewable resources but with little success.

The government's general policy through Government Regulation No.5 Year 2006 for Natinal Energy Policy (NEP) has clearly advocated diversification of energy sources to contribute use of geothermal of at least 5% of national energy mix by 2025. These means, 9500 MW of national electricity in 2025 will supplied by geothermal power plants. But no commitment to implement this policy has been forthcoming (due to the fact PLN as single buyer is not a law enforcement). Statistics from the Ministry of Energy and Mineral resources (MEMR) indicate that renewable energy utilization (hydropower and geothermal) accounts for only about 3% of total reserves. The growth of electricity demand has not been enough to drive renewable energy development. Recently, since the petroleum fuel prices is increase, may stimulate further utilization of alternative energy, mainly geothermal.

The Indonesian fossil energy reserve is very small when compared with world energy potential (in terms of natural oil, for example, Indonesia has only got 1 % of the world energy potential, and in natural gas 3 % from the world energy potential, and in coal, 3.6 % of the world energy potential). Energy supply comes from two sources of energy that are fossil energy (oil, natural gas and coal) and renewable energy such as biomass, hydro power and geothermal. However the energy supply is mostly come from fossil energy. In the year 2008, the contribution of fossil energy to the total energy mix is around 27%, while the contribution of geothermal is 3% (Table 1).

3. GEOTHERMAL RESOURCES AND POTENTIAL

All the high temperature geothermal systems found within the Sumatra, Java, Sulawesi, and Eastern Island Volcanic Zone, which lies over an active subduction zone between the eastern end of Mediterranean Volcanic Belt and western side of Circum Pacific Volcanic Belt **(figure 1**). According to the Geological Agency of Indonesia (GIA), the indicated resource base for geothermal energy total 27,000 MW (13 billion barrels of oil equivalence), of which about one third (8000 MW) are located in Java and Bali, the most populous islands with the highest demand for electricity. GIA estimates that there are more than 256 geothermal locations in the country, including 84 in Sumatra, 76 in Java, 51 in Sulawesi, 21 in Nusa Tenggara, 3 in Irian Jaya, 15 in Maluku, and 5 in Kalimantan. The Geological and geochemical survey have been carried out on 256 locations and on 200 locations. While the geophysical survey is conducted on 45 locations.

It is planned to develop for electricity generation for 2000 MW by the year 2010, for 4600 MW by 2016, and 6000 MW by the year 2020 , and 9500 MW by 2025 (targeted) respectively. Most of the 256 prospects of Indonesia have high temperature geothermal resources. The total geothermal prospects and its potential reserve and resources are tabulated in the **Table 2**.

Table 1: Present and Planned Production of Electricity

	Geothermal		Fossil Fuels		Hydro		Other Renewables (specify)		Total	
	Capacity MWe	Gross prod. GWh/yr	Capacity MWe	Gross Prd. GWh/yr	Capacity MWe	Gross prod. GWh/yr	Capacity MWe	Gross prod. GWh/yr	Capacity MWe	Gross Prd. GWh/yr
In Operation in Desember 2009	1196	8175	36.134	84.100	4.200	8.942	543	-	42.073	
Under Construction in Desember 2009	-	-			-					
Funds committed but not yet under construction in desember 2009					-					
Total Projected use by 2015	5929		66.542		5061		736		78.268	

Table 2: Indonesian geothermal prospect & resources

No.	Propinsi	Jumlah Lokasi	Potensi Energi (MW)					Total	Produksi
			Sumber Daya		cadangan				
			Spekulatif	Hipotesis	Terduga	Mungkin	Terbukti		
1	Aceh	17	630	298	282			1310	
2	Sumatera Utara	16	1500	170	1627		329	3626	2
3	Sumatera Barat	16	925	73	700			1698	
4	Bengkulu	5	450	223	600			1273	
5	Sumatera Selatan	5	725	392	794			1911	
6	Lampung	13	925	838	1072		20	2855	
7	Bangka-Belitung	3	75					76	
8	Riau	1	25					26	
9	Jambi	8	375	259	358	15	40	1047	
10	Banten	7	450	100	285			835	
11	Jawa barat	38	1500	784	1297	488	1557	5626	955
12	Jawa Tengah	14	275	342	614	115	280	1626	60
13	Yogyakarta	1			10			10	
14	Jawa Timur	11	137,5	365	654			1165.5	
15	Bali	5	75		226			301	
16	NTT	18	100	353	575		14	1042	
17	NTB	3		74	70			144	
18	Sulawesi Utaara	5	25	125	540	110	65	865	40
19	Gorontalo	2	25		15			40	
20	Sulawesi Tengah	14	300		66			366	
21	Sulawesi Selatan	16	325		49			374	
22	Sulawesi Tenggara	13	250		51			301	
23	Maluku Utara	9	150	117	42			309	
24	Maluku	6	125		100			225	
25	Irian jaya	2	50					50	
26	Kalimantan Barat	3	50					50	
TOTAL		251	9467.5	4613	10027	728	2305	27140.5	1052
			14080.5		13060				

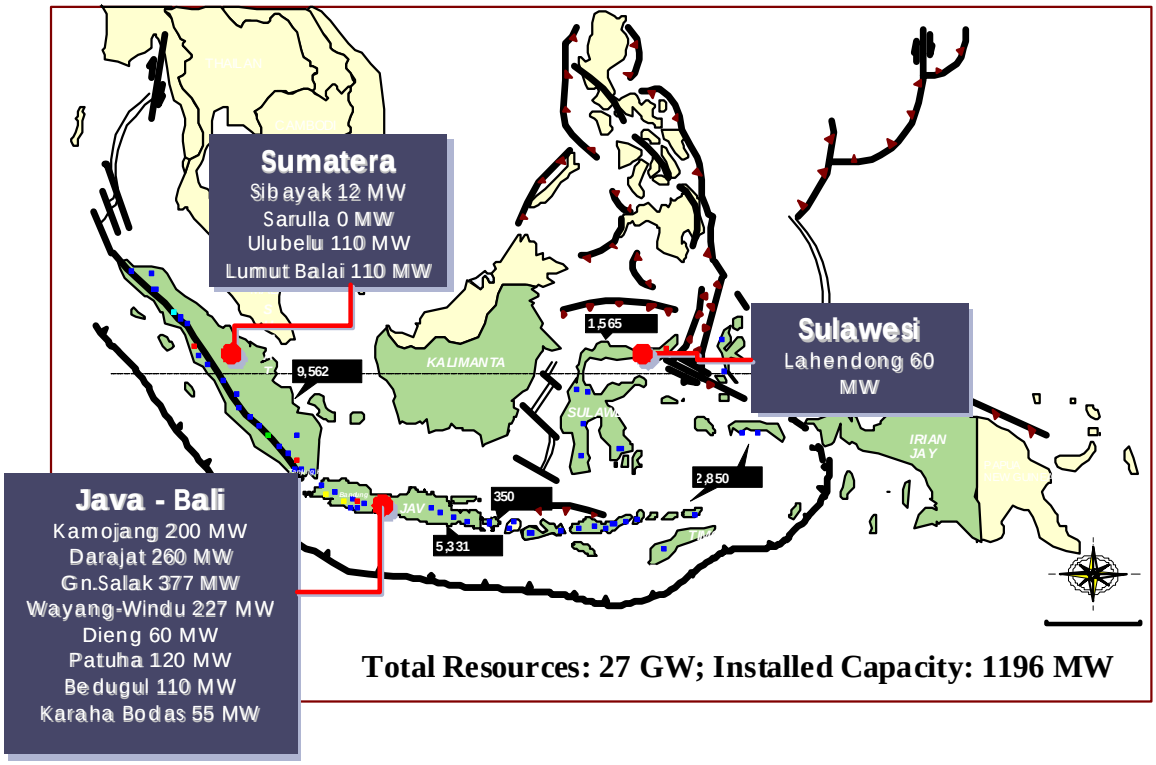

Figure 1: Location map of Indonesian Geothermal Resources and its installed capacity.

4. GEOTHERMAL UTILIZATION

Indonesia currently utilizes geothermal fields mainly for indirect use to generate electricity. However, the direct use of geothermal are 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.

4.1. Electric Power Installation and generation

The electric power is generated from a high temperature geothermal systems detected from geological survey and exploration drilling. There are 22 areas of high temperature geothermal systems with electricity-generating capabilities are exist and being developed. These 22 areas are:

a. SIBAYAK, SALAK, WAYANG WINDU, KAMOJANG, DARAJAT, LAHENDONG, and DIENG, which has seven high temperature systems. These are operated for electricity generation of 1196 MWe by PGE and its joint operation contractors (i.e Chevron, MNL, Geodipa Energy), see figure 1 and 2, and Table 3.

b. SARULA, SUNGAI PENUH, HULULAIS-TAMBANG SAWAH, LUMUT BALAI, ULU BELU, PATUHA, KARAHA, IYANG - ARGOPURO, BEDUGUL, TOMPASO and KOTAMOBAGU, which has eleven high temperature systems, non of which is used for electricity, and currently are under developing of by PGE own or with its contractors for electricity generation.

c. KAWAH CIBUNI, CIATER, TULEHU and ULUMBU, which has four high temperature systems outside of PGE activities, are operated by Yala Teknosa (Cooperative Body), PT Wahana Sambada Sakti and PLN, National Electricity Company.

Those geothermal fields are operating using the existing geothermal rule, i.e PD No.45 Year 1991. The use of the Geothermal Law No27/2003 is started by operating six geothermal areas i.e: JABOI, TANGKUBAN PERAHU, CISOLOK – CISUKARAMAI, TAMPOMAS, SOKORIA and JAILOLO which also have a high temperature systems. These are pointed to operate by BUKAKA TEKNIK, INDONESIA POWER, REKAYASA INDUSTRI, PT JABAR JASA SARANA, BAKRI POWER and STAR ENERGY.

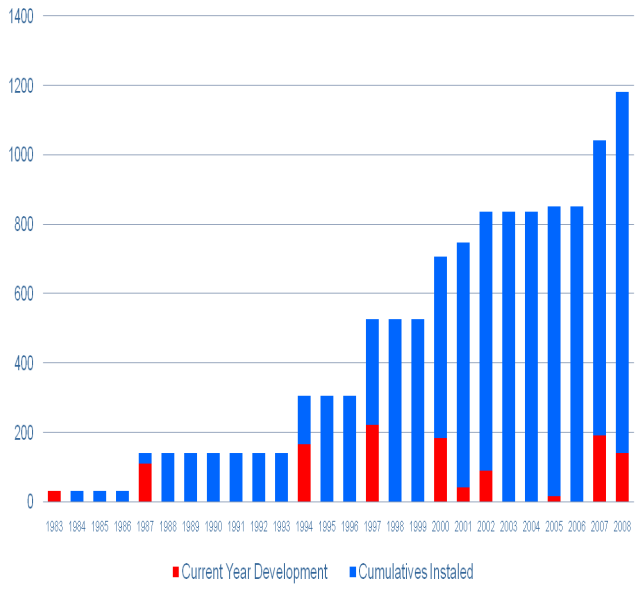

Figure 2: Installed capacity Indonesian geothermal power plant

Table 3. Installed Geothermal Power Plants in Indonesia

No.	Geothermal Field	Developer	Production (2009)	Development Planning Up to 2012	Cummulative installed Capacity Up to 2014
1	Sibayak	PGE	12	7.5	19.5
2	Sarulla	PGE/PLN	0	220	330
3	Lumut Balai	PGE	0	55	220
4	Ulu Belu	PGE	0	110	220
5	Salak	PGE/CGS	377	0	417
6	Patuha	Geodipa	0	60	180
7	Wayang Windu	PGE/MNL	227	125	482
8	Kamojang	PGE	200	0	260
9	Darajat	PGE/CGI	260	110	370
10	Karaha	PGE/KBC	0	30	140
11	Dieng	Geodipa	60	55	170
12	Lahendong	PGE	60	67.5	127.5
13	Bali	PGE/BEL	0	10	175
14	Hulu Lais	PGE	0	55	110
15	Sungai Penuh	PGE	0	55	110
16	Kota mobagu	PGE	0	40	80
17	Iyang Argopuro	PGE	0	0	55
Total			**1,196**	**1,030**	**3,465**

Beside those fields, there are a new Geothermal Areas that have been ready to be over through bidding process i.e: ATADEII, SEULAWAH, UNGARAN, IJEN, and MATALOKO.

The total capacity of geothermal power plants installation is about 1196 MW. These are operated from 7 locations consists of Darajat (260 MW), Dieng (60 MW), Kamojang (200 MW), Gunung Salak (377 MW), Sibayak (12 MW), Lahendong (60 MW), and Wayang Windu (227 MW) with total 1196 MW of installed geothermal capacity. This number accounts for 3.5 percent of approximately 36,000 MW of total installed electric capacity, of which PLN generates about 21,000 MW, IPPs 1,600 MW, and captive power 13,519 MW. The average peaks of production can be about 1196 MW required by Java-Bali, Sumatera and Sulawesi system as shown in Table 3.

The 1196 MW figure of installed geothermal power generation comprised 420 MW built by state utility company PLN and the rest is built by IPPs scheme. With the operation of these plants, the country saves the equivalent of some 45,000 barrels/day of oil for 30 years. In 2009, Indonesia produced about 47.00 million tons of geothermal steam, which translates into about 8175 GWh of electricity**.**

4.2. Field Development and Its Status

Since the new regulation on geothermal business activities is issued in 1991, it was signed 11 geothermal power sales contract with total capacity of 3,692 MW. But due to the economic crisis in 1997, only three have moved forward. The planned projects were previously expected to come on stream between 1998 and 2002. However, GOI is committed to promote increase the use of geothermal in the national energy mix policy. The projects are still difficult to move forward due to investment uncertainty as the price of electricity is set by GOI without consider the economic viability of geothermal development cost. How ever, GOI now move realistically in supplying the electricity to increase the electrification ratio. Since then, GOI declare to increase its capacity and development or even through the 10,000 MW acceleration crash program project, from which geothermal contribute half of that.

Of the 256 prospects, PGE has drilled 100 wells in 6 geothermal prospects - PT PERTAMINA has identified 70 high-temperature geothermal prospects. Sixteen (16) exploration wells and fifty six (56) development wells drilled during 1989 to 2000 have confirmed a total proven reserve of 1,946 MW and a total probable and possible reserve of 7,165 MW. These are done during the geothermal development up to the year 2005. Now, there are some additional well drilled by PGE for exploration and development wells in 7 geothermal areas to become 159 wells exclude well drilled by Chevron, MNL, BEL, PLN, GIA and Yala Teknosa with total of 430 wells.

The well drilled for electricity-generating capabilities are exist and being developed from. These areas are: SIBAYAK (10 wells), SALAK (89 wells), WAYANG WINDU (39 wells), KAMOJANG (82 wells), DARAJAT (56 wells), LAHENDONG (23 wells) and DIENG (52 wells), which has electricity generation of 1196 MWe operated by PGE and its joint operation contractors (i.e Chevron, MNL) or Pertamina Subsidiary and joint venture company (Geodipa Energy).

The rest of numbers of well drilled were from SARULA(13 wells), SUNGAIPENUH, HULULAIS-TAMBANG SAWAH, LUMUT BALAI (3 wells), ULU BELU (9 wells), PATUHA (19 wells), KARAHA (14 wells),

BEDUGUL (3 wells), and TOMPASO (5 wells), BANTEN (1 well), which has no electicity used and currently are under developing of by PERTAMINA own or with its contractors for electricity generation. The others well 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 NGAI (see Table 4).

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

No	Project/(Contract Signed)	Contract Size (MW)	Contractor/ Operator	No. of Wells Drilled (2009)
1	Kamojang (1983)	200	PGE	82
2	Salak (1982, 1994)	495	PGE/CGS	89
3	Darajat 1,2,3 (1984)	330	PGE/CGI	56
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	39
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	27
14	Kotamobagu (2009)	40	PGE	0
15	HuluLais1,2, (2009)	110	PGE	0
16	S. Penuh 1 (2009)	55	PGE	0
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	9
25	Lumut Balai: 1,2,3,4	220	PGE	3
26	Ulumbu 1	50	PLN	3
27	Ata Deii	20	-	2
28	Mataloko	40	GIA	6
29	Banten	0	PGE	1
	Total	**3475**		**430**

All of the NEW Geothermal Areas that have been drilled and or have been surveyed, are now ready to be over through bidding process with total of 22 areas. Six of these were tendered and pointed six companies i.e; BUKAKA TEKNIK, INDONESIA POWER, REKAYASA INDUSTRI, JABAR JASA SARANA, BAKRI POWER and STAR ENERGY to develop six areas of JABOI, T.PERAHU, CISOLOK-CISUKA RAMAI, TAMPOMAS, SUKORIA and JAILOLO.

4.2.1. Kamojang (200 MW)

Pertamina started exploration activities in Kamojang in 1974 and installed a 250 KWh mini block geothermal power plant in 1978. PLN then built on this initial success with the construction of Indonesia's first commercial geothermal electric power plant in late 1982 with a capacity of 30 MW. Units II and III (2x55 MW), the US$61 million World Bank financed project, commenced operation in 1987.

The facility is at present supplied by 31 production wells. The size of the productive area is about 21 square km with an estimated electrical potential equal to 270 MW. An IPP agreement signed by Asia Power and PT. Latoka Trimas Bina Energy in December 1994, with PLN to develop 2x30 MW in Kamojang field, West Java, with an investment of US$72 million, were re-negotiated due to the postponement of the project by PD No. 39/1997 and PD No.5/1998, and pointed PGE to built the 60 MW plants. This power plant has been commissioned and inaugurated by President of Republic of Indonesia during the UNFCCC December 2007 in Bali. Instead, exploration activities identified resources sufficient to increase the existing plant by an additional 110 MW. PGE plans to build a fifth geothermal plant with an output capacity of 60 MW which is enough to supply electricity to approximately 0.6 millions Indonesian.

4.2.2. Sibayak (12 MW)

Pertamina are developing Sibayak geothermal field in North Sumatra since 1991 and operated a 2 MW plant of electricity since June 1996. This fields then operated by PGE PGE has invested to drill 10 standards hole for more than US $20.0 million investments in drilling activity and SAGS.. In order to increase its power plant capacity, PGE signed an agreement with Diazamatra Powerindo to develop at least 2 unit of 5 MW plants. The area is expected to supply steam for a 40 MW power plant. Due to lack of a productive area, the expansion of the next unit of power plant might not be continued. In order to increase the capacity of the area, there are some additional survey is planned to conduct in the Sinabung prospect. Sinabung is a next prospective regions in the area. This might increase the numbers of installed capacity in the development fields.

4.2.3. Lahendong (60)

In May 1999, Pertamina signed a contract with PLN to supply steam to unit I (20 MW) geothermal power plant constructed by PLN. The two parties also agreed on a steam price of US$0.02/KWh. The project commenced operational in August 2002, after waiting over one year for commercial operation and 20 years of pre constructing and commissioning period due to tightly negosiation on steam price between PLN and Pertamina. This is the second lowest price of the geothermal steam in the country due to uncertainty of the project developed by Pertamina since 1982. Pertamina expects to derive an annual income of Rp 22 billion from this project and may reduce the loss. The additional 40 MW is commissioned in the year 2008 and 2009 using five production wells and two re-injection wells

drilled by PGE since 2005 dedicated for this unit. The more three 20 MW additional unit is expected to commission by 2012. The drilling and steam field gathering system is under gone. Recently, PLN offered to cooperate with PGE in the development of unit 4 (1x20 MW) in anticipation of continuing electricity demand growth in North Sulawesi.

Previously, BPPT (research of technology agency) conducted Indonesia's first disappointment binary cycle power plant in the area, with the assistance of a $5 million soft loan from France. The 2.5-MW plant is a pilot scheme to gather experience in the development of other small-scale geothermal power stations and is not succeed to continue operations due to poor plan. The plant is now redundancy of use. Instead, PGE are now conducted the feasibility study to use the brine water from such existing unit to generate 7.5 MW electricity. The unit is expected to commission in 2012.

4.2.4. Ulu Belu

The Ulu Belu Area is located 100 km west of Bandar Lampung in South Sumatra, and is associated with the volcanic depression surrounded by the quaternary volcanic of Mt.Sula, Rindingan and Tanggamus. Between 1993 and 1996, three exploration slim holes were drilled by Pertamina at the Ulubelu field in South Sumatra. The wells encountered a steam cap overlying a liquid-dominated resource with temperatures from 210° C to 230° C. Since 2006, PGE drilled 9 exploration and development wells in the north block of Ulu Belu area to support two 55 MW unit power plant that will be built by PLN. The possible reserve is about 300 MW, but the proven reserve encounter in the field is about 240 MW. The geothermal system is dominated by hot liquid dominated system with temperatures from 240° to 260° C. The steam field and steam supply is managed by PGE for such unit. Since the reservoir capacity are cover more than those unit demand, PGE will construct some two additional power plant as a total project to produce another 110 MW.

4.2.5. Lumut Balai

The Lumut Balai Area is located 150 km west of Palembang in South Sumatra. The prospect is identified by PGE since 1996. Two exploration wells were drilled by PGE since 2007 a probable reserve of about 75 MW and proven reserve of 20 MW. The geothermal system of Lumut Balai is water dominated with reservoir temperatures vary from 260° to 290° C. The prospect area is predicted of 70 km2. PGE proposed to develop at least 4 unit of 55 MW Power Plant starting to commission at 2012 from the first one.

4.2.6. Hulu Lais

Exploration drilling has been prepared to conducted at two geothermal areas Hulu Lais (Bengkulu – South Sumatra) and Sungai Penuh (Jambi – Central Sumatra). Drilling activities have been prepared since 2008 and 2009. Pre - feasibility studies for those three fields are finalized in 2008 to support develop 55 MW each. Development drilling are conducted after the resources of each filed is confirmed and will followed by a notice of intention to develop. The fields are proposed to commercially operate on 2012. Hulu Lais is located 200 km from Bengkulu, Southern part of Sumatra. Geological and geophysical exploration survey has been conducted to support drilling activities for geothermal development in the area. Three exploration wells were proposed to drill at the end of 2009 and followed by a development drilling to support a two unit of 55 MW power plants proposed to commence on 2013 and 2014. Hulu lais is a hot water dominated geothermal system cover 36 km2, with temperature vary from 250° to 280° C. The potential prospect is could be developed to 200 MW from about 500 MW of its potential.

4.2.7. Sungai Penuh

The prospect of Sungai Penuh geothermal area is located in main graben of Sumatran Fault lying in the middle part of Sumatra. The main prospect is located in the National Park of Kerinci Seblat, with total of 200MW potential. These might be the main barrier to utilize the prospect and develop the power plant. However, there are a 60 MW reserve cover a low terrain topography in the out side of the National Park could be used for future development. PGE now prepare for drilling of the first exploration wells in order to support a unit of 55 MW power plant. The geothermal reservoir and temperature is expected to be hot water system overlying a liquid-dominated resource with temperatures from 230° C to 240° C.

4.2.8. Kotamobagu

Kotamobagu is located 250 km from Manado, North Sulawesi. There are no exploration drilling has been done so far. The prospect is predicted about 230 MW potential as a liquid-dominated resource with temperatures from 250° C to 290° C. PGE proposed to drill three exploration wells in 2009 and 2010. From its pre-feasibility studies, PGE proposed to develop a unit of 40 MW power plant in 2013.

4.2.9. Tompaso

Tompaso is located 60 km south of Manado in north Sulawesi and is part of Lahendong geothermal Area. The probable reserve is about 120 MW from its total potential of about 220 MW. Surface exploration has been done by Pertamina since 1984. Recently, PGE has drilled two exploration well and two development well with a proven generating capacity of 75 MW. In 2009 and 2010, PGE plan to drill some additional well to support commitment of supply of 40 MW plant. The power plant is expected to construct 2 unit of 20 MW plant managed by PGE to produce electricity by 2011 and 2012.

4.2.10. Iyang - Argopuro

Surface exploration surveys have been conducted at 1 other prospects in Java island, namely Iyang Argopuro geothermal field. The prospects is located in the East Java in which the highest electricity demand in the region. The G&G survey has been done since 1987 and has been completed by PGE for resources confirmation. The main problem of geothermal development in the area is due to the prospective resources are located mainly in the protective forest and national park. How ever, PGE plan to continue conducting the surface geological and geophysical survey in 2009 to confirm and located the exploration drilling site. This prospect has 200MW electric respectively.

4.2.11. Gunung Salak

In 1982, Unocal Geothermal Indonesia signed the first Joint Operation Contract (JOC) and Energy Sales Contract (ESC) for geothermal exploration and development covering an area of 117,650 hectares in Gunung Salak, West Java.

Unocal is responsible for supplying steam to Pertamina, which in turn sell it to PLN for power generation. PLN completed construction of the 2x55-MW geothermal power plant in 1994 and another 55 MW in 1997. Unocal has

invested more than $100 million to develop this field. The company reported that the field is able to supply a power plant with a capacity of 600 MW.

Gunung Salak (165 MW-IPP): In November 1994, Unocal and its local partner, Nusamba, signed a ESC with PLN for the construction of an additional 165-MW power plant. The three 55 MW units started operation in 1997. Unocal will operate all six units for 15 years, and then transfer operator ship to PLN under a BOT mechanism. Since 2006, Chevron took over Unocal and continue to sell geothermal steam for the power plants for the full 30-year life of the plants. Unocal spent approximately $380 million in development of geothermal resources for the last three power plants. The plants currently operate 20% more electricity due to Java-Bali power shortages and up rate the capacity to 377 MW in total.

4.2.12. Sarulla

The Sarulla Area is located 300 km south of Medan in North Sumatra. In February 1993, Unocal under UNSG Ltd company signed another geothermal contract to exploit geothermal resources in a 980 square kilometer area around Sarulla and Sibualbuali, North Sumatra. UNSG is a partner of Pertamina for Sarulla project under JOC. The agreement is a total project contract consisting of a JOC agreement with Pertamina and ESC with PLN. Pursuant to the terms of the JOC, Unocal invested over US $60 million in resource exploration and development and drilled 13 wells in three different prospects and discovered high temperature geothermal systems in each area. These project include Silangkitang, Namora-I-Langit, and Sibualbuali (Gunderson et al.). Resource feasibility studies have been submitted to Pertamina in support of the early program of 330 MW development at Silangkitang and Namora-I-Langit. Notice of intention to develop has been submitted in 1997. The steam available is about 80MW at Silangkitang and 46 MW at Namora I Langit. The proven reserve of Sibual Buali is 20MW (total potential 90 MW), in Silangkitang is 1000 MW (total potential of 395 MW) and Namora I Langit is about 210 MW (total potential is about 965 MW). Before economic crisis in 1997, PLN and Unocal agreed to the development of a power facility with a total capacity of 220 MW, with 55 MW to be completed by 1999. The power price for the contract was to be $0.07597/kWh for the first 14 years, $0.05750/kWh for the following 8 years and $0.05208/kWh for the remaining 8 years. As a first stage Unocal planned to construct a 2x55-MW power plant, operate, and maintain the field facilities and electricity generation facilities, under a BOT for the first 15 years. Following the contract agreement, the company planned to invest US $100 million for the development of infrastructures and plant site.

However, the government postponed the project in 1998 due to economic crisis. The devaluation of the Indonesian Rupiah affected PLN's ability to pay its dollar-denominated power purchase contract.

The 210 MW Notification of Reserve Confirmation at Namora I Langit Project was submitted to Pertamina in 1999. UNSG struggled to find an alternative structure that results in a price for electricity that PLN deems affordable. The project was finally agreed by UNSG to release to PLN.The project now is taken over by a Consortium of Medco Power, Itochu, ORMAT, and Kyushu Electric under Sarulla Operation Ltd regarding of JOC with PGE. SOL will be the operator of the project to develop 330 MW. The project will be financed by JABIC to support a tight schedule of commissioning at 2011, 2012 and 2013 as committed for 10,000 MW cash program.

4.2.13. Darajat.

Daradjat (Phase I): In December 1984 Amoseas signed a Joint Operation Contract (JOC) with Pertamina and an Energy Sales Contract (ESC) with PLN to develop geothermal energy within a 56,650 hectare area in Daradjat, West Java. Amoseas, which acts as the operator for the project, confirmed a resource sufficient to generate a 55-MW power plant and with potential for at least 400 MW. After investing US $55.2 million for the construction of 55-MW power plant, PLN started commercial operation in November 1994, with steam supplied by Amoseas. In 1995 Amoseas re-negotiated and amended the ESC that enabled the company to drill 17 more development wells.

Daradjat (Phase II): In 1996, Amoseas signed a PPA with PLN for the construction of a 275 MW geothermal power plant with total investment of US $330 million. Amoseas completed unit I (80 MW Plant) in 1999, but the plant was suspended by the government in 1998. As a result of contract renegotiation, PLN and Amoseas reached a final long-term solution in April 2000, with price of electricity dropped to US $0.042/KWh from US$0.0695 in the original PPA. The two parties signed an amended agreement in July 2000 for commercial operation.

May 2004 — Amoseas Indonesia Inc., a subsidiary of ChevronTexaco, signed a contract with state-owned oil company Pertamina and Indonesia's national power company PT Perusahaan Listrik Negara (PLN), and local partner PT DGI to expand the geothermal power plant in Darajat, West Java.

Darajat III supplement the two existing units, Darajat I and Darajat II, which at present have successfully generated up to 145 MW of clean electricity. Power generated from Darajat III is about 110 MW commencing in 2008 and contribute Darajat geothermal field 260 MW generating capacity including 95 MW up rating from unit 2 in the year 2007. The Unit 3 is now proposed to up rate its capacity to 120 MW respectively.

Now, Darajat is taken over by Chevron and operated under the Chevron Gothermal Indonesia Ltd. since 2006 to operate and maintain the steam field and the power plant in the continuation of JOC with PGE respectively.

4.2.14. Karaha Bodas

In December 1994, Karaha Bodas Company LLC signed a PPA with PLN for the construction of a 220-MW geothermal power plant in West Java, with 55 MW to be completed by 1998. Karaha Bodas Company LLC was 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%).

KBC drilled about 22 wells and had an international arbitration claim against PT Pertamina and PLN for the postponement of its contract by Indonesian government. Based on Presidential Decree No. 39/1997 and No. 5/1998, the project is one of the 27 projects that were postponed by the government because of the impact of the economic crisis. The Government unilaterally defaulted on its obligations under those contracts. Finally, by virtue of Presidential Decree No. 15/2002 (March 2002), after five years, the government agreed to resume the electric power plant projects. The impact is that the developer in the year 1998 sued PT Pertamina through the process of the

International Arbitrary Body in Switzerland. As per 2008, the dispute with regard to their detriment has not been settled. However, the final award has been executed by Caithness the USA Court.

Due to some reason, the area has been released to PGE since 2008. Now, PGE would utilize the reserve encountered for supporting a unit of 30 MW power plant at 2012.

4.2.15. Dieng geothermal field

Dieng (60MW-IPP): In December 1994, Himpurna California Energy Limited (HCE), a joint venture between PT Himpura Enersindo Abadi (10 percent) and California Energy International of the US (90 percent), signed a contract to undertake Dieng geothermal project in Central Java. The contract was for a total power capacity of 150 MW, with total investment of US $192 million to be completed by 2001. The plant was planned as 4 units. Unit I, with a capacity of 55 MW, was certified for commercial operations in July 1998. All construction, exploration activities and operations for Unit II were suspended in 1998. From the 48 exploration and development wells, HCE identified the field's potential as 350 MW. Currently, the field is operated by PT. Geo Dipa Energy, the subsidiary company of Pertamina and PLN and produces about 60 MW. The field is planed to increase its capacities to 180 MW as its resources is more than those covered from drilling wells.

Patuha: HCE also signed a total project contract for the development of Patuha geothermal field in West Java, with a total capacity of 220 MW. Total investment was planned to reach $264 million. Unit 1 (55 MW) is under review status and units 2-3 and 4 were postponed in 1998. Original scheduled for completion was in 1999. The project is also operated by GeoDipa after HCE won on an international arbitration claim against the Indonesian government for the postponement of its contract. Within this regard, the Government does not refuse the claim made by OPIC (Overseas Independent Investment Corporation). The Indonesia's government assigned both Dieng and Patuha to the PT GeoDipa for project continuance. Geo Dipa proposed to build three unit of 60 MW power plant and predicted to commission on 2012 for the first unit.

4.2.16. Wayang Windu

In December 1994, Mandala Magma Nusantara BV signed a total project contract for the development of the Wayang Windhu geothermal field in West Java, with a total capacity of 440 MW. Mandala Magma Nusantara BV (MNL) was a joint venture between the Indonesian companies Figears, Oko Satrya Mandala, and Magma Power Co. of the US. However, after the merger between California Energy and Magma Power Company, the contract principal party was changed to Asia Power Ltd of New Zealand. At the initial stage, the contractor was supposed to build a 220 MW plant at a cost of $264 million, later to be increased to 400 MW, with an estimated total investment of $800 million. The field at 2005 has generation capacity of 110 MW plant. A total of 39 wells have been completed since the project is taken over by Star Energy, a domestic oil company, in 2005, as an addition to 18 wells drilled by MNL and are capable of supplying about 400 MW. These were a great increase with respect to resources confirm only 185 MW of steam in 2000 (Wheble, pers. comm., 1999). Thus, the expansion of 117 MW unit 2 were developed and commissioned in March 2009. The drilling activities were planned to continue and increase its capacities of up to 400 MW. The feasibility studies are now on the progress and plan to start drilling in the year 2010. The field at present produces 227 MW electricity.

4.2.17. Bedugul (Bali)

The Bedugul field, which is located on Bali about 60 km northwest of Denpasar, has been explored by Bali Energy Ltd (BEL), a joint venture between a national company and California Energy under a JOC with Pertamina and an ESC with PLN in November 1994 for a 4x55 MW power plant. Three conventional exploration wells and six slim holes in Bedugul prospect area has identified a commercial geothermal resource. A reservoir consists of a liquid dominated that relatively dilute with, neutral pH, Na-Cl fluids at 280-320ºC of temperatures. The reservoir lies at depths of 1500-2500 meters, below a thick, low-permeability cap-rock composed of clay-rich, argillic altered volcanic rocks. Productive reservoir may occur primarily within a propylitic altered, fractured andesite/intrusive-diorite complex.

In the year 2005, BEL confirmed to develop 175 MW power plant which consists of a new plan of 10-12MWe unit-1 and 3 x 55MWe Unit-2 up to unit-4 starting 2009 and ending in 2013 to support national energy supply. Well test of both BEL-02 and -03 was conducted in 2004 with pressurized liquid Nitrogen stimulation to flow the wells; BEL-03 indicated gross capacity of 3-4 MWe at 15-20 barg of relatively high wellhead pressure (WHP). Notice of intention to develop has been submitted by BEL to PLN. However, the first unit of 10 MW planned to be commissioned in 2010 is sure to be delayed. PGE and BEL is force to re-schedule the construction and commercial operation to 2012.

To do this, BEL plans to drill about six wells each year starting in early 2008 and ending in 2013, and make-up wells and additional injection wells will be drilled in 2020 and 2028. Total of 24 production wells, 11 make-up wells, and 8 injection wells will produce enough steam to supply 175 MWe power generation units and BEL will provide 8 well pads that consist of 3 existing pads and 5 new pads.

The agreement under renegotiation with PLN finally reached the selling price settlement of 70% from the average electricity price in Bali.

4.2.18. New existing geothermal field

The new geothermal field were exist to develop are KAWAH CIBUNI, CIATER, TULEHU and ULUMBU, which has four high temperature systems outside of PGE activities. Those fields are operated by Yala Teknosa (Cooperative Body) for Cibuni, PT Wahana Sambada Sakti for Ciater and PLN for Tulehu and Ulumbu. The fields are proposed to install each unit of 10MW in Cibuni, 40 MW in Ciater, 10MW Tulehu, and 10 MW Ulumbu.

Those geothermal fields are operating using the existing geothermal rule, i.e PD No.45 Year 1991. The use of the Geothermal Law No27/2003 is started by operating six geothermal areas i.e: JABOI, TANGKUBAN PERAHU, CISOLOK – CISUKARAMAI, TAMPOMAS, SOKORIA and JAILOLO which also have a high temperature systems. These are pointed to operate by BUKAKA TEKNIK, INDONESIA POWER, REKAYASA INDUSTRI, PT JABAR JASA SARANA, BAKRI POWER and STAR ENERGY.

Beside those fields, there are a new Geothermal Areas that have been ready to be offered through bidding process i.e:

ATADEII, SEULAWAH, UNGARAN, IJEN, MATALOKO, etc (see Table 4 below). The numbers of total capacity install is seen on the Table 3.

4.3. Direct Utilization

Indonesia began developing geothermal direct utilization (non-electricity) more than ten years ago. The most common and traditional use is for balneology, heated swimming pool and hot springs. Five years ago, a group of researchers in the government sponsored research and technology agency (BPPT) began 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. The concept is under research (no proved commercial yet) at the Kamojang geothermal field. In addtion, some direct activities for palm sugar processing is used from brine produced in Lahendong geothermal field initiated by Cooperative body - Masarang. The total brine use is about 4tonnes/hour. The more use of geothermal for agriculture are copra drying in Lahendong, Mataloko and Wai Ratai Lampung, mushroom cultivation in Pengalengan, tea drying and pasteurization in Pengalengan. Total brine use are about 50 tonnes/hour for each field. Fish farming is also using geothermal fluid in Lampung.

4.4. Heat pumps use

Indonesia geothermal potential is mainly compose of high enthalpy geothermal system. In this case, geothermal use for indirect use is more economic viable than those for heat pump use. So, the heat pump use is not popular has an economic viable to develop.

5. DISCUSSION

Geothermal energy has unique attributes which pose challenges to its development. The following factors are part of the reason for Indonesia's lagging development of its geothermal resource:

- Exploration and resource commercialization is a costly process, and there is only a small market for the resource other than as electricity. Therefore, the developer must have assurance of a future market and know the value of the electricity at the start of exploration. Contract provisions must be flexible enough to secure a market, yet not force the utility to take or have to pay for unneeded or unused power.

- Unlike other power projects, geothermal power projects must include the upstream cost of locating and verifyinga resource. This upstream phase is similar to the discovery of an oil field or coal mine.

- Geothermal is site specific and must be converted into electricity in the vicinity where it is found. There is little use for geothermal energy in its original form.

- Development can be expedited with reduced business risk if growth takes place in relatively small increments, yet exploration and infrastructure costs can make the first increment of development prohibitively expensive.

Therefore, contracts should be written for the production of the largest quantity of power possible for the given resource to spread exploration and infrastructure costs over a larger sales volume.

To day, there is no genuine mechanism for considering geothermal long-term benefits such as low emissions or renewable nature for PLN. The low emissions are taken for benefits of the people and to the country. Thus, GOI should support the use geothermal for electricity by PLN. The high risk cost of development, fossil subsidy, and the associated electricity tariff required remain core problems in Indonesia's geothermal development. PLN as other private company, have to survive and compete with other private sectors.

Figure 2: Palm sugar processing unit using 4 tonnes/hour brine from Lahendong geothermal power plant.

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. To date, international companies that are operating in geothermal development projects in Indonesia are Chevron, California Energy, Magma Power Co., Caithness and Florida Power & Light. involved for short-time. The others are interested in developing a new power plant such as ORMAT International, Kyushu Electric, Itochu, Reikjavik Energy Invest, PNOC, Germany company's.

INAGA identifies the barriers to the growth of Indonesia geothermal industry:

- 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.

Indonesia possesses a variety of energy resources. While a substantial portion of the country's energy mix continues to rely on oil. PLN is pushing for greater utilization of other primary sources of energy, particularly coal and "non-transportable" fuels, such as geothermal and natural gas.

Geothermal and hydropower have also been considered the right answer to energy diversification needs and rising concern over environmental issues and declining non-renewable energy resources.

By issuing the GR No.59 Year 2007 GOI expected to attract the geothermal development in Indonesia. The problem is, there are so many differences between this government regulation and PD 45/1991 especially in term of fiscal and tax policy. However, the GOI would accommodate these issues by declaring some Ministrial Decree to reduce the tax and give some tax incentive.

On the other hand, the business activities should also consider to be run by a reputable companies from domestic or even international. There is also a need to correlate the upstream activities which is regulate in GR 59/1007 and the down stream activities that is regulate in GR 3/2005 including the autonomous regulation.

In addition, the pricing policy should also give a return of investment of economically viable. The rule of geothermal price is depend on the Ministry of Energy decree as it is stipulated in GR 59/2007. So, the MEMR should consider to issue the standardized of geothermal price. Furthermore, the capacity building of the HR should also be improved.

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

System	2009 (MW)	2010 (MW)	2011 (MW)	2012 (MW)	2013 (MW)	2013 (MW)
Java - Bali	117	5	0	330	445	1240
Sumatera	0	60	105	550	330	1240
Sulawesi	0	0	45	70	0	80
Nusa Tenggara	0	5	8	3	20	40
Maluku	0	0	0	20	0	20
Total	117	70	158	973	795	2620
Kumulatif	117	187	345	1318	2113	4733

6. FUTURE DEVELOPMENT AND INSTALLATION

Indonesia will be facing shortage of power in the near future due to the fact the sector has not been able to make adequate developments/investments in the power supply capacity to meet its growing electricity demand of beyond 9 percent per year. The Indonesian Government also permits other agencies and private developers to undertake geothermal preliminary studies and development for power generation or other utilization (See Table 3).

In addition, 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 9,500 MW of power plant. PLN and GOI are expected to invite investors for tender (see Table 4), with electricity prices is estimated by PLN with reference to international standards as stipulated in MEMR regulation No.5 Year 2009. This regulation is issued to attract the increase of investment in facing 4700 MW geothermal plant in 2014. The future development and power plant installation expected are shows in the Table 5.

7. CONCLUSIONS

As a result of the financial crisis (1997), the Government postponed and reassessed sixteen Independent Power Projects, including eleven ESC of geothermal projects. Since 2002, PLN and the Government unilaterally continued the project through electricity price re-negotiation that was to find an alternative structure. However, today is a difficult time to be a private power developer has been passed; investors have seen large opportunities after its losses in this industry; lenders are in workout mode, and Indonesia needs to committed to continue promote develop geothermal as a tempting opportunity (decent returns and low risk). In the last five years, there are a big increase in geothermal installed capacities as well as a significance 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. In addition, GOI should educate (and sell) developers and lenders on the guaranteeing the viability of the project and provide a convincing story about investments in Indonesia.

Indonesia with high geothermal potential has a significant challenge to attract private power. INAGA as government's partner for implementing the 9,500MW Road Map, proactively positions geothermal energy at competitive edge because of its renewable, environmentally sound, and of Indonesia's energy market through the technology, business, and regulatory strategies.

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Table 6. List of geothermal working areas that have ready to be offered through bidding process.

NO	Working Area	Regions	Province	Probable Reserve (MW)	BiddingStatus
1	Seulawah agam	Aceh Besar	Nangroe Aceh Darusallam	160	Prepared
2	Jailolo	Halmahera Barat	Maluku Utara	75	Finish
3	Telaga Ngebel	Ponorogo dan Madiun	Jawa Timur	120	Prepared
4	Gn. Ungaran	Semarang dan Kendal	Jawa Tengah	100	Prepared
5	Gn. Tampomas	Sumedang dan Subang	Jawa Barat	50	Finish
6	Cisolok Cisukarame	Sukabumi	Jawa Barat	45	Finish
7	Gn. Tangkuban Perahu	Subang, Bandung dan purwakarta	Jawa Barat	100	Finish
8	Jaboi	Sabang	Nangroe Aceh Darusallam	50	Finish
9	Sokoria	Ende	Nusa Tenggara Timur	30	Finish
10	Gn. Talang	Solok	Sumatera Barat	36	Prepared
11	Blawan Ijen	Bondowoso, Banyuwangi dan Situbondo	Java Timur	270	Prepared
12	Hu'u Daha	Dompu	Nusa Tenggara Barat	65	Prepared
13	Sipaholan Ria-ria	Tapanuli Utara	Sumatera Utara	75	Prepared
14	Bukit Kili	Solok	Sumatera Barat	83	Prepared
15	Sorik Marapi Roburan	Mandailing Natal	Sumatera Utara	200	Prepared
16	Marana	Donggala	Sulawesi Tengah	36	Prepared
17	Songa Wayaua	Halmahera Selatan	Maluku Utara	140	Prepared
18	Atadei	Lembata	Nusa Tenggara Timur	40	Prepared
19	Suwawa	Bone Bolanga dan Gorontalo	Gorontalo	110	Prepared
20	Kaldera Danau Banten	Serang dan Pandeglang	Banten	115	Prepared
21	Gn. Rajabasa	Lampung Selatan	Lampung	91	Prepared
22	Liki Pinangawan	Muara Laboh, Solok Selatan	Sumatera Barat	400	Prepared
TOTAL				2391	