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The Role of Pertamina Geothermal Energy (PGE) in Completing Geothermal Power Plants Achieving 10,000 MW in Indonesia

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ABSTRACT

More than 70 high enthalpy geothermal fields and prospects have been identified in Indonesia. Pertamina (National Oil company) has estimated that the combined potential of these resources represents about 20,000 MW in 2000. Since then, the National Geological Agency of Indonesia has identified more than 27 GW electric potential that may rise from 256 locations of geothermal fields over the country. Indonesia may have the highest geothermal potential in the world.

15 of the 18 existing geothermal areas that were drilled to explore, confirm, and develop geothermal resources in Java, Sumatra, Bali and Sulawesi, are operated by Pertamina Geothermal Energy (PGE). PGE is a subsidiary company of Pertamina as of December 2006 due to the Indonesian rule separating the geothermal and oil and gas activities regulated in the Oil & Gas Law. One of the other areas is operated by PLN (National Electricity Company), one is operated by a Cooperative Body and one more is operated by a private company. As of March 2009, seven geothermal fields are operating in Indonesia with a combined installed capacity of 1168.3 MW.

Starting in 1982, geothermal development in Indonesia has been expedited by government regulations and Pertamina operated three geothermal field producing 162 MW in total, namely 140 MW in Kamojang, 2 MW in Sibayak and 20 MW in Lahendong. Following that, eight private international geothermal companies signed contracts of joint operation with Pertamina for eight contract areas between 1982 and 1994. As a result of these contracts, between 1994 and 2009, Pertamina, PGE and its partners PLN, Dizamatra Powerindo and Geo Dipa Energy had completed geothermal projects at Salak (377 MW), Darajat (260 MW), Wayang Windu (227MW), Dieng (60 MW) in Java, Sibayak (13.3 MW) in North Sumatera and Lahendong (60 MW) in North Sulawesi. The new project in Sarulla geothermal field (110 MW) and 10 MW from Bedugul field (Bali) are expected to be completed by 2011.

The severe economic crisis that started in late 1997 resulted in significant delays to several geothermal projects in the advanced exploration and development stages. Patuha, Dieng and Karaha Bodas projects were delayed in time schedule and were changed in management from California Energy to Geo Dipa Energy for Dieng Patuha and to PGE for Karaha Bodas project.

The business climate has grown more conducive for investment in the last three years. The issuance of new Regulations on Geothermal No.27/2003, Oil and Gas No.22/2001 and Government Regulation No. 31/2003 push Pertamina to do their business through PGE in developing geothermal power, whether PGE owned, GDE, or PGE joint operation. PGE own operation is planning to have a total Geothermal Power Plant Installed Capacity of 1035 MW by the year 2014. This will be a part of 10,000 MW accelerated power plant project proposed by the GOI. The implementing of 1342 MW planned installed capacity needs business strategy and financial support as well as human resources support, to develop and operate steam field and power plant facilities in a timeframe of less than three years in construction.

1. INTRODUCTION

Indonesia has numerous active volcanoes associated with a large concentration of high-temperature geothermal systems on or close to the plate margins in Sumatra, Java, Nusa Tenggara, Sulawesi and Halmahera (Figure 1).

The Indonesian government conducted a more complete inventory in 1972 with technical assistance from Italy, Japan, New Zealand, and the USA. This survey was following the successful exploration activities done by the Dutch in the 1920s in Kamojang, West Java. To accelerate geothermal development and encourage energy diversity in the country, the government issue new policies through a presidential decree No.16 in 1974 appointing the state-owned oil company Pertamina to explore and develop geothermal energy in conjunction with domestic and international partners.

Pertamina then estimated that the combined potential of these resources represents about 20,000 MW (Fauzi, 1998; Pertamina, 1994). This might place Indonesia as having the highest geothermal potential in the world. Unfortunately, the utilization of the resources is extremely low, only 807 MW until 1997 when the economic crisis happened. The role of Pertamina as manager of geothermal was eliminated by the Law No.22 Year 2001 on Oil & Gas and was transferred to PGE as a subsidiary of Pertamina.

This paper discusses the role of PGE in completing geothermal power plant in support of the government crash program for 10,000 MW of geothermal project development in Indonesia.

2. GEOTHERMAL BUSINESS POLICIES

The first Presidential Decree (PD) No. 16/1974 appointed and allowed Pertamina to conduct exploration and operation of the geothermal fields on Indonesia. This decree was used by Pertamina to operate the Kamojang field and to explore other geothermal resources in Indonesia.

To complete the geothermal activities, the Government of Indonesia issued PD No. 22/1981 allowing Pertamina to explore and operate the geothermal fields and sell the steam to PLN for generating electricity. Pertamina was also allowed to enter joint ventures with local and international partners.

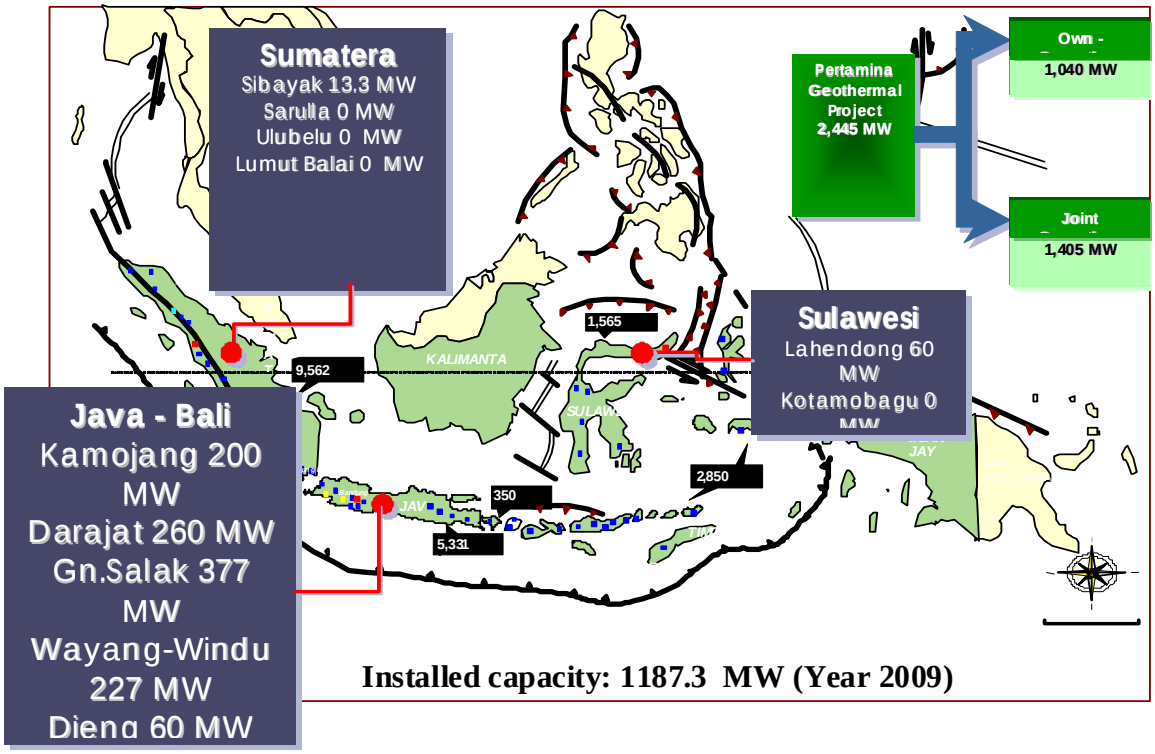

Figure 1: Location map of Indonesian geothermal resources and their installed capacities.

The presidential decree led to endorsement of a Joint Operations Contract (JOC) between Pertamina and Unocal Geothermal of Indonesia Ltd, and an Energy Sales Contract (ESC) with the State Electric Company (PLN) for the Gunung Salak contract area, West Java, in 1982.

Amoseas Indonesia signed a JOC with Pertamina and an ESC with PLN for the Darajat contract area in 1984. In order to attract the investment from international organizations, PD No. 45/1991 was issued to allowed Pertamina and its partnerships to build and operate geothermal power plants, called total project. This PD No.49/1991 was promulgated simultaneously to provide economic incentives to support implementation of the PD No. 45/1991. Both regulations sought to accept the attractiveness of the geothermal development as summarized in Tables 1 and 2.

The issuance of Geothermal Law No.27/2003 and Oil & Gas Law No.22/2001 which demonstrate that it can and will meet its future contractual obligations keep Pertamina, through its subsidiary company PGE, interested in doing business in developing geothermal power, either PGE owned or as joint venture.

3. GEOTHERMAL FIELD OPERATED BY PERTAMINA AND PGE

Pertamina started exploration activities in Kamojang in 1974 and installed a 250 KW monoblock geothermal power plant in 1978. This was followed by the first large scale (30 MW) geothermal development in 1982 (Radja, 1995). Pertamina and PLN, the State Electric Company, installed 140 MW of steam gathering facilities and power plants, respectively. At the same time, to support accelerated geothermal development, private foreign companies developed subsequent projects in partnership with Pertamina. The first private development contracts were signed in 1982 – 1984, between Pertamina and Unocal for Salak project and Amoseas for Darajat geothermal field, but initial development was slow.

Table 1. Installed Geothermal Power Plants in Indonesia

Area	**Capacity In Operation (MW)**	**Operator/ Contractor**
Kamojang	200	PGE
Sibayak	13.3	PGE
Lahendong	60	PGE
G. Salak	377	PGE/Chevron Geothermal Salak (CGS) Ltd.
Darajat	260	PGE/Chevron Geothermal Indonesia (CGI) Ltd.
Dieng	60	PGE/GeoDipa Energy
Wayang Windu	217	PGE/Magma Nusantara Ltd. (MNL)
Sarulla	0	PGE/Consortium of Sarulla Operation Ltd. (SOL)
Patuha		PGE/GeoDipa Energy
Total	**1187.3**	

Table 2. PGE's Geothermal Power Plant Contract or Business Permitted

No	Project/ Year/ (Contract Signed)	Contract Capacity (MW)	Contrac-tor/ Operator	Status Commis-sion on 2014 (MW)
1	Kamojang Unit 1,2,3,4 & 5 (1983)	200	PGE	260
2	Salak 1,2,3,4,5,6 (1982, 1994)	495	PGE/CGS	377
3	Darajat 1,2,3 (1984)	330	PGE/CGI	260
4	Sarulla 1,2,3 (1993)	330	PGE/SOL	330
5	Dieng 1-4 (1994)	400	Geo Dipa	180
6	Iyang Argopuro 1	55	PGE	55
7	Karaha 1,2 ,3(1994)	400	PGE	140
8	Patuha 1,2,3 (1994)	400	GeoDipa	180
9	Wayang Windu 1,2,3,4 (1994)	400	PGE/MNL	447
10	Bedugul 1,2,3 (1995)	400	BEL	175
11	Sibayak 1,2 (1996)	40	PGE/Diza-matra	19.5
12	Ulu Belu: 1, 2, 3, 4	220	PGE	220
13	Lumut Balai: 1,2,3,4	220	PGE	220
14	Lahendong 1,2,3,4,5,6 (1999)	125	PGE	127.5
15	Kotamobagu 1,2 (2009)	150	PGE	80
16	HuluLais 1,2, (2009)	110	PGE	110
17	Sungai Penuh 1 (2009)	150	PGE	110
	Total	**3680**		**3465.3**

The contracts were renewed using PD 45/1991, that allow for a total project instead of just managing the steam field and selling the steam to PLN. This resulted in the first power generation commencing at Gunung Salak (110 MW) and Darajat (55 MW), West Java, in 1994 and 1995 respectively (Sussman et al., 1997). Seven private geothermal companies signed contracts of joint operation with Pertamina for 10 contract areas between 1994 and 1997. As result of these contracts, an additional 480 MW started commercial operations, Salak (330 MW), Wayang Windu (110 MW), Darajat (90 MW), and Dieng (60 MW) in Java. Pertamina also independently developed Sibayak (2 MW) in North Sumatra and Lahendong (20 MW) in North Sulawesi. This resulted in 807 MW generating capacity by the time the economic crisis happened in 1997 and stopped the geothermal development growth. As a result of the crisis, the government wished to renegotiate the contracts in terms of price and time line of project development in years 2001-2003. Since then, geothermal activities have been subject to Geothermal Law and Pertamina activities became focused on the oil and gas business, while the geothermal development is started to transfer to its subsidiary company as a mandate of Government Regulation No.31/2003. This caused Pertamina to transfer its geothermal activities and its liabilities to PGE.

As a result of implementing the new Oil and Gas Law No. 22/2001 and Government Regulation No.31/2003, PT. Pertamina (Persero) was established on September 17, 2003. As a consequence of implementing the Government Regulation, and according to Article 7, Pertamina has to transfer activities on the commercialization of geothermal to its subsidiary. On 12 December 2006, PT. Pertamina Geothermal Energy (PT. PGE), was established as its subsidiary company.

Currently, PGE manages 15 geothermal areas in Indonesia in which there are seven operating geothermal power projects comprising 1187.3 MW. Another 690 MW, Darajat up rating project (10 MW), Kamojang (60 MW), Ulu Belu (110 MW), Lahendong (60 MW), Lumut Balai (110 MW), Karaha (30 MW), Patuha (180 MW), Dieng (120 MW) and Bedugul (10 MW) are under development and construction and are expected to be completed between 2010 and 2014.

3.1. PGE Operating Fields

Seven geothermal fields are in various stages of operation to produce electricity and are now in the development stages, including Kamojang, Salak, Darajat, Wayang Windu, and Dieng, which are all on Java, Sibayak on Sumatra, and Lahendong on Sulawesi.

3.1.1. Kamojang

Kamojang is located is West Java, 40 km southeast of Bandung city. PGE operates the steam field as well as the power plant. The steam field is operated to supply steam to three PLN power plants comprising 140 MW and to PGE's one 60 MW power plant.

Kamojang is a vapor-dominated system with an average reservoir temperature and pressure of about 245°C and 35 bars, respectively. 31 wells drilled in an area of 14 km^2 supply 1050 tons/h of steam to the plants that were installed in 1982-1987. There are another 29 wells, in the eastern block, that are used to supply a 60 MW power plant commissioned in early 2008. PGE are now preparing the drilling activities in the north-eastern block, capable of supplying steam to an additional 60 MW plant. A planned 60 MW plant is now under preparation and it is expected to be completed by 2012.

3.1.2. Salak

Gunung Salak field is located 70 km south of Jakarta in West Java. In the past, Unocal Geothermal of Indonesia operated the steam field, which supplies six 55 MW power plants. Units 1, 2 and 3 were built by PLN and came on-line in March 1994. Units 4-6 started commercial operation in 1997. Units 1, 2 and 3 were constructed by PLN, and Units 4, 5 and 6 were built by Unocal under JOC with Pertamina.

PLN operates Units 1-3 and Unocal operates Unit 4-6. Since 2006, Unocal was acquired by Chevron which has taken over operation and maintenance of the steam field as well as the power plant. With 32 production and 19 injection wells, the power plants are capable of generating at least 390 MW. The six units have maintained a 95 % capacity factor or higher since start up. Thus, the capacities of the power plants were up-rated to 60 – 65 MW each with total capacity of 377 MW. The Salak field hosts a neutral-Cl liquid-dominated reservoir with temperatures ranging from 240°C to 310°C (Soeparjadi et al, 1998 and Slamet, 2000)

3.1.3. Darajat

Darajat is located 60 km southeast of Bandung,West Java. The steam field and the first 55 MW power plant were operated by Amoseas of Indonesia Inc. and PLN, respectively. In 2006 Darajat was taken over by Chevron to operate and maintain the steam field and the power plant in the continuation of the JOC with PGE. The Darajat reservoir is vapor-dominated with a temperature of about 245°C. Eight wells produce sufficient steam to operate Unit 1. Amoseas drilled 17 more development wells and constructed a second unit of 90 MW in early 1999. This unit has been completed and commercial production started on June 1, 2000. The third unit of 110 MW was started up in the year 2008 to bring Darajat geothermal field to a total of 260 MW generating capacity, including 95 MW up-rating of Unit 2 in 2007. A fourth unit of 110 MW is planned for commissioning in 2012.

3.1.4. Dieng

Dieng is located 60 km southwest of Semarang, Central Java. Dieng is operated under JOC with Pertamina and ESC with PLN and Himpurna California Energy Ltd. (HCE), which constructed both the steam field and power plant. HCE drilled 25 wells to produce sufficient steam for the 60 MW power plant, which was commissioned in July 1998. The geothermal system is dominated by two-phase conditions with temperatures of 280°C to 330°C. The proven reserve encountered the area is about 240 MW and the possible reserve is about 400 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 planned to increase in capacity to 170 MW as its resources are more than those covered from drilled wells.

3.1.5. Wayang Windu

The Wayang Windu field is located 40 km south of Bandung in West Java. The reservoir is liquid-dominated, and temperatures range from 250° to 270°C. The resource production facilities and 110 MW power plant were built by Asia Power/Magma Nusantara Limited (MNL) under “total project” contracts. The power plant and the steam facilities were completed and tested in July 1999. A total of 39 wells have been completed since the project was 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 originally confirmed resources of only 185 MW of steam in 2000 (Wheble, pers. comm., 1999). Thus, the expansion of 117 MW unit 2 was developed and commissioned in March 2009.

The drilling activities were planned to continue and increase the capacity up to 482 MW. The feasibility studies are now in progress and the plan is to start drilling in the year 2010. The field at present produces 217 MW of electricity.

Table 3. Geothermal Working Areas and Development Planning

No.	Geothermal Field	Developer	Production (2009)	Development Planning Up to 2012	Cummulative installed Capacity Up to 2014
1	Sibayak	PGE	13.3	9.5	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			1,187.3	1030	3,465.3

3.1.6. Sibayak

Sibayak is located about 50 km southwest of Medan, North Sumatra. PGE are managing the steam field as well as the power plant and produce 13 MW of electricity in total. For supporting these activities, PGE not only operates its own 2MW Mono-block, but also works with PT. Dizamatra in supplying two units of a first Chinese power plant of 5.65 MW unit each. These power plants were commissioned in 2008. PGE manages the steam field and supplies steam to the two unit power plant. Through 1999, 10 wells have been drilled, which have a proven capacity of 38 MW. Since 1995, one well has been supplying steam to a 2 MW back-pressure power plant installed and operated by Pertamina to supply the local power grid. The reservoir is liquid-dominated with temperatures from 240°C to 275°C.

3.1.7. Lahendong

Lahendong is located 40 km south of Manado in north Sulawesi and has been under development by Pertamina

since 1984. 23 exploration and development wells have been drilled with a proven generating capacity of 80 MW. In 1992, a 2.5 MW binary power plant was installed at Lahendong, but the plant has not gone into commercial operation. In May 1999, Pertamina signed a contract with PLN to supply steam to a 20 MW power plant to be constructed by PLN. The plant started operating commercially by the year 2002 and produces 20 MW. The additional 40 MW was commissioned in the year 2008 and 2009 using five production wells and two reinjection wells drilled since 2005 by PGE dedicated for this unit. Three more additional 20 MW units are expected to be commissioned by 2012. The drilling and steam field gathering system has been undertaken. The reservoir is liquid-dominated, with relatively high temperatures ranging from 260°C to 330°C.

3.2. Confirmed resources and developing fields

Geothermal resources have been confirmed through exploration drilling at six geothermal areas and now are ready to commence when their development is completed. Those fields are: Sarulla in North Sumatra, Ulu Belu in Lampung and Lumut Balai in South Sumatera, Patuha and Karaha in West Java and Bedugul in Bali.

3.2.1. Sarulla

The Sarulla Area is located 300 km south of Medan in North Sumatra. Between 1993 and 1997 Unocal North Sumatra Geothermal Ltd. (UNSG) drilled 13 wells in three different prospects and discovered high temperature geothermal systems in each area. UNSG is a partner of Pertamina for Sarulla project under a JOC. These projects 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 was 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 it is 1000 MW (total potential of 395 MW) and Namora I Langit is about 210 MW (total potential is about 965 MW). The project now has been taken over by a consortium of Medco Power, Itochu, ORMAT, and Kyushu Electric under Sarulla Operation Ltd as a 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 in 2011, 2012 and 2013 as committed for the 10,000 MW crash program.

3.2.2. 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 quarternary volcanic of Mt. Sula, Rindingan and Tanggamus. Between 1993 and 1996, three exploration slim holes were drilled by Pertamina at the Ulu Belu field. The wells encountered a steam cap overlying a liquid-dominated resource with temperatures from 210°C to 230°C. Since 2006, PGE drilled nine exploration and development wells in the north block of Ulu Belu area to support two 55 MW unit power plants that will be built by PLN. The possible reserve is about 300 MW, but the proven reserve encountered in the field is about 240 MW. The geothermal system is dominated by a hot liquid-dominated system with temperatures from 240° to 260°C. The steam field and steam supply are managed by PGE. Since the reservoir capacity covers more than the demand of these units, PGE will construct two additional power plants as a total project to produce another 110 MW.

3.2.3. Lumut Balai

The Lumut Balai Area is located 150 km west of Palembang in South Sumatra. The prospect was identified by PGE in 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 varying from 260° to 290°C. The prospect area is predicted to be 70 km^2. PGE proposed to develop at least four units of 55 MW, starting with commissioning of the first one in 2012.

3.2.4. Patuha

The Patuha field, which is located 50 km south of Bandung, has been explored by Patuha Power Limited (PPL) as a Joint Venture between California Energy Company and a local partner under JOC with Pertamina, and ESC with PLN. PPL drilled 13 conventional exploration wells, 17 slim holes and 6 development wells since 1994. A moderate to high temperature reservoir has been discovered (175°C to 245°C). The possible reserve of the area is confirmed to be more than 340 MW. The development of this field has been assigned to Geo Dipa for continuation of the project. Geo Dipa proposed to build three units of 60 MW and have predicted to commission the first unit in 2012.

3.2.5. Karaha

The Karaha field is located 80 km east of Bandung in West Java. Karaha Bodas Co. (KBC), a partnership of Caithness and Florida Power and Light, explored Karaha under a JOC with Pertamina and ESC with PLN. KBC drilled nine conventional exploration wells and 19 slim holes, discovering a liquid-dominated resource overlain by a steam cap. Reservoir temperatures range from 230°C to 245°C and of about 30 MW proven reserve. 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 in 2012.

3.2.6. 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. Three conventional exploration wells and six slim holes in Bedugul prospect area have identified a commercial geothermal resource. The reservoir is liquid-dominated that is relatively dilute with neutral pH, NaCl fluids at 280-320ºC 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. The productive reservoir may occur primarily within a propylitic altered, fractured andesite/intrusive-diorite complex.

In the year 2005, BEL confirmed plans to develop a 175 MW power plant which consists of 10-12MWe unit-1 and 3 x 55MWe Unit-2 up to unit-4 starting in 2009 and ending in 2013 to support national energy supply. Well tests of both BEL-02 and -03 were 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 have been forced to reschedule 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. A 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.

3.3. Proposed Operating Fields

Exploration drilling has been prepared to conducted at three geothermal areas Hulu Lais (Bengkulu – South Sumatra), Sungai Penuh (Jambi – Central Sumatra), and Kotamobagu (Sulawesi). Drilling activities have been prepared since 2008 and 2009. Prefeasibility studies for those three fields are finalized in 2008 to support develop 55 MW each. Development drilling is conducted after the resources of each filed is confirmed and will be followed by a notice of intention to develop. The fields are proposed to operate commercially in 2012.

3.3.1. Hulu Lais

Hulu Lais is located 200 km from Bengkulu, in the Southern part of Sumatra. Geological and geophysical exploration surveys have been conducted to support drilling activities for geothermal development in the area. Three exploration wells were proposed to be drilled at the end of 2009 and followed by development drilling to support a two power plant units of 55 MW proposed to commence in 2012 and 2013. Hulu lais is a hot water dominated geothermal system covering 36 km^2, with temperature varying from 250° to 280°C. The prospect that could be developed is 200 MW from about 500 MW of potential.

3.3.2. Sungai Penuh

The geothermal prospect is located in the main graben of the 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 is a 60 MW reserve covering a low terrain topography outside of the National Park that could be used for future development. PGE is now preparing for drilling of the first exploration wells in order to support a 55 MW power plant. The geothermal reservoir is expected to be a hot water system overlying a liquid-dominated resource with temperatures from 230°C to 240°C.

3.3.3. Kotamobagu

Kotamobagu is located 250 km from Manado, North Sulawesi. No exploration drilling has been done so far. The prospect is predicted to have 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 prefeasibility studies, PGE proposed to develop a 40 MW power plant in 2012.

3.3.4. Tompaso

Tompaso is located 60 km south of Manado in north Sulawesi and is part of the Lahendong geothermal area. The probable reserve is about 120 MW from its total potential of about 220 MW with temperature of 250° to 290°C. 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 plans to drill some additional wells to support a commitment of supply of a 40 MW plant. The power plant is expected to construct two units of 20 MW plant managed by PGE to produce electricity by 2011 and 2012.

3.4 . Undrilled Prospects

Surface exploration surveys have been conducted at one other prospects in Java island, namely Iyang Argopuro geothermal field. The prospect is located in East Java which has the highest electricity demand in the region. The geological and geophysical survey has been done since 1987 and has been completed by PGE for resource confirmation. The main problem of geothermal development in the area is that the prospective resources are located mainly in the protected forest and national park. However, PGE plans to continue conducting the surface geological and geophysical survey in 2009 to confirm and locate the exploration drilling site. This prospect has 200MW electric potential.

4. THE ROLE OF PGE IN COMPLETING POWER PLANT

Since the Government has completed a Blue Print on the Development of Geothermal Energy of more than 9500 MW up to the year 2025 as is stipulated in the Ministrial Decree No.5 Year 2006 as a National Energy Policy, geothermal power can once again represent an important energy source to meet the expected growing demand for electricity.

Increasing power demand and electricity tariff in the last two years may indicate that the business climate has changed, being more conducive for investment. In addition, the issuance of new Government Regulation No.59/2007, which demonstrates that it can and will meet its future contractual obligations, keeps PGE interested in doing business in developing geothermal power, whether on its own or in partnership. PGE own operation is planning to have a total Geothermal Power Plant Installed Capacity of 1035 MW by the year 2014. The 1035 MW planned installed capacity comes from both the existing fields and new prospects (Table 3). In addition to that, PGE is also planning to have more than 1500 MW in JOCs. Thus, the total capacity of 15 geothermal areas held by PGE are planning to contribute about 2800 MW of 4700 MW total government plan in the year 2014 as a time line for the second 10,000 MW power plant crash program. The quick increase of power plant development needs a huge amount of finance to support. These may come from national and international finance institutions.

5. CONCLUSIONS

The Indonesian geothermal industry has made impressive strides under the Indonesian government's energy policies and Pertamina's and PGE's contract administration to develop the geothermal potential of Indonesia. The past role of PGE is represented by Pertamina in geothermal development in Indonesia, which has been able to identify at least 70 high enthalpy geothermal fields and prospects which represent a combined potential of about 20,000 MW and include 807 MW of installed capacity.

The issuance of new Regulations on Oil & Gas No.22/2001 and Government Regulation on Geothermal Business No.59/2007 following Law No.27/2003, demonstrating that it can and will meet its future contractual obligations, keep PGE being the one national geothermal company and doing business in developing geothermal power, whether PGE owned or in partnership. In the future, Pertamina, through its subsidiary company, PT. PGE, is planning to have a total Geothermal Power Plant Installed Capacity of 2829 MW by the year 2014. The 1035 MW planned installed capacity comes from PGE own operation in both the existing fields

and in new prospects. To achieve the 2800 MW target, it is necessary to create a big effort from within PGE, the alliance scheme with JOC and the project financing support.

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