Proceedings World Geothermal Congress 2005
Antalya, Turkey, 24-29 April 2005

The Role of Pertamina in Geothermal Development in Indonesia

Amir Fauzi, Suryadarma, Sukusen Soemarinda, Eben E. Siahaan

Pertamina

ABSTRACT

At least 70 high enthalpy geothermal fields and prospects have been identified in Indonesia. Pertamina has estimated that the combined potential of these resources represents about 20,000 MW. Indonesia may have the highest geothermal potential in the world. From 1973 to 2004, 19 geothermal areas were drilled to explore, confirm, and develop geothermal resources in Java, Sumatra, Bali and Sulawesi. As of May 2004, seven geothermal fields are operating in Indonesia with a combined installed capacity of 807 MW.

Since 1982, geothermal development in Indonesia has been expedited by government regulations that allow the participation of the private sector, both local and international, in partnership with Pertamina. Seven private geothermal companies signed contracts of joint operation with Pertamina for 10 contract areas between 1982 and 1997. As a result of these contracts, by 2003, Pertamina and four private developers, together with the government utility PLN, had completed geothermal projects at Kamojang (140 MW), Salak (330 MW), Darajat (145 MW), Wayang Windu (110MW), Dieng (60 MW) in Java, Sibayak (2 MW) in North Sumatera and Lahendong (20 MW) in North Sulawesi. And another 170 MW, Darajat (110 MW) and Kamojang (60 MW), is expected to be completed by 2006. The severe economic crisis that started in late 1997 has adversely affected power sector demand and growth in Indonesia. This has resulted in significant delays to several geothermal projects in the advanced exploration and development stages. Changes in the regulatory environment for the geothermal industry and the resolution of the economic crisis are the major issues affecting the growth of the Indonesian geothermal industry.

In spite of the issues, increases in the power demand and electricity tariffs in the last three years, the business climate has changed, being more conducive toward investment. In addition, the issuance of new Regulations on Geothermal No.27/2003, Oil and Gas No.22/2001 and, Government Regulation No. 31/2003 keep Pertamina still interested in doing business in developing geothermal power, whether Pertamina's own or joint ventures. Pertamina, through its subsidiary company PT. PGE, is planning to have a total Geothermal Power Plant Installed Capacity of 1500 MW by the year 2010. The 1500 MW planned installed capacity comes from both the existing fields and new prospects. To achieve the 1500 MW target, alliance is a necessity.

1. INTRODUCTION

The Indonesia archipelago has numerous active volcanoes associated with a 7000 km-long plate boundary (Figure 1) along which there is both convergent and strike-slip movement. This has given rise to a large concentration of high-temperature geothermal systems on or close to the plate margins in Sumatra, Java, Nusa Tenggara, Silawesi and Halmahera (Figure 1).

Geothermal energy exploration started in Indonesia in the early 1900"s. The Dutch drilled successful shallow test wells at Kamojang, Wet Java, in the 1920"s, and started a country-wide inventory of thermal features. The Indonesian government conducted a more complete inventory in 1972 with technical assistance from Italy, Japan, New Zealand, and USA. The results of these studies were used as a basis to issue new policies to accelerate geothermal development and encourage energy diversity in the country. To implement the new policies, the government issued a decree in 1974 appointing the state-owned oil company Pertamina to explore and develop geothermal energy in conjunction with domestic and international partners.

At least 70, high enthalpy geothermal fields and prospects have been identified in Indonesia (Figure 2). Pertamina has estimated that the combined potential of these resources represents about 20,000 MW (Fauzi, 1998; Pertamina, 1994). Indonesia may have the highest geothermal potential in the world.

This paper discusses the role of Pertamina in geothermal development in Indonesia : the past and the future.

2. GOVERNMENT POLICIES

In 1974, through Presidential Decree (PD)No. 16/1974, the Indonesian government appointed Pertamina to conduct exploration and operation of the geothermal fields. This decree allowed Pertamina to operate the Kamojang field and to explore other geothermal resources in Indonesia.

The Government of Indonesia issued PD No. 20/1981 allowing Pertamina to enter joint ventures with local and international partners. The presidential decree led to endorsement of a Joint Operations Contract (JOC) between Pertamina with 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. Amoses Indonesia signed a JOC with Pertamina and an ESC with PLN for the Darajat contract area in 1984.

PD No. 45/1991 allowed the Pertamina partnerships to build and operate geothermal power plants. Another PD No.49/1991 was promulgated to provide economic incentives to support implementation of the PD No. 45/1991. Both regulations sought to accelerate development of geothermal projects under Pertamina management. Tables 1 and 2 summarize the status of the geothermal projects instituted under these decrees.

The issuance of new Regulations on Geothermal No.27/2003 which demonstrates that it can and will meet its future contractual obligations keep Pertamina, through its subsidiary company, still interested in doing business in developing geothermal power, whether it is Pertamina's own or a joint venture.

Indonesia is now recovering from an economic downturn, the Government of Indonesia issued the new PD No.

15/2002 to revoke PD No. 5/1998. PD No. 5/1998 decree suspended and reassessed some geothermal projects which has resulted in significant delays to the development of Sarulla, Darajat, Kamojang, Dieng, Patuha, Karaha, Bedugul (Bali) and Sibayak which are now can be continued (Table 2).

3. SUMMARY OF GEOTHERMAL DEVELOPMENT

Pertamina started exploration activities in Kamojang in 1974 and installed a 250 KW mini block geothermal power plant in 1978. 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, and the power was sold through the Java- Bali grid. Private foreign companies and in partnership with Pertamina developed subsequent projects. The first private development contracts were signed in 1982 – 84, but initial development was slow, with power generation commencing at Gunung Salak (110 MW) and Darajat (55 MW), Wet Java, in 1994 and 1995, respectively (Sussman et al., 1997). Seven private geothermal companies signed contracts for joint operations with Pertamina for 10 contract areas between 1994 and 1997. As a result of these contracts, an additional 480 MW started commercial operations, Salak (220 MW), Wayang Windu (110 MW), Darajat (90 MW), Dieng (60 MW) in Java. Pertamina also independently develop at Sibayak (2 MW) in North Sumatra and Lahendong (20 MW) in North Sulawesi. Currently there are seven geothermal operating power projects comprising 807 MW. And another 170 MW, Darajat (110 MW) and Kamojang (60 MW), are under preparation and it is expected to be completed by 2006.

3.1 Operating/ Developed Fields

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

3.1.1Kamojang

Kamojang is located is West Java, 40 km southeast of Bandung city. Pertamina operates the field and supplies steam to three PLN power plants comprising 140 MW. Kamojang is a vapor-dominated system with an average reservoir temperature and pressure of about 245°C and 35 bars, respectively. Thirty-one wells drilled in an area of 14 km^2 supply 1050 tons/h of steam to the plants, which were installed in 1982-1987. There are in existence another twenty-nine wells, in the eastern block capable of supplying steam to an additional 60 MW unit, plant. A planned 60 MW plant is now under preparation and it is expected to be completed by 2006.

3.1.2 Salak

Gunung Salak field is located 70 km south of Jakarta in West Java. Unocal Geothermal of Indonesia operates the steam field, which supplies six 55 MW power plants. Units 1 and 2 were built by PLN and came on-line in March 1994. Units 3-6 started commercial operations in 1997. Unit 3 was constructed by PLN, and Units 4-6 were built by Unocal. PLN operates Units 1-3 and Unocal operates Unit 4-6. With 32 production and 19 injection wells, the power plants are capable of generating at least 345 MW. The six units have maintained an 80 % capacity factor or higher since start up. 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 are operated by Amoseas of Indonesia Inc. and PLN, respectively. 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.

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 in dominated by two-phase conditions with temperatures of 280°C to 330°C. Currently, the field is operated by PT. GeoDipa and produces about 60 MW.

3.1.5 Wayang Windu

The Wayang Windu field is located 40 km south of Bandung in Wet 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/ Mandala Nusantara under “total project” contracts. The power plant and the steam facilities were completed and tested in July 1999. A total of 18 wells have been completed and are capable of suppliying about 185 MW of steam (Wheble, pers. comm., 1999). The field at present produces 110 MW.

3.1.6 Sibayak

Sibayak is located about 50 km southwest of Medan, North Sumatra. Pertamina and PT. Dizamatra are developing the Sibayak geothermal field. Pertamina manages the steam field and plans to supply steam to a future 10 MW private power plant. Through July 1999, 10 wells have been drilled, which have a proven capacity 25 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. Fifteen exploration and development wells have been drilled with a proven generating capacity of 30 MW. In 1992, a 2.5 MW binary power plants 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 2001 and produces 20 MW. The additional 40 MW is now under preparation, five development and two re-injection wells will be drilled for this unit. This additional unit is expected to be operated by 2006. The reservoir is liquid-dominated, with relatively high temperatures ranging from 260° C t0 330°.

3.2. Confirmed Geothermal Resources

Geothermal resources have been confirmed through exploration drilling at three contract areas: Sarulla in North Sumatra, and Patuha and Karaha in West Java.

3.2.1 Sarulla

The Sarulla contract 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. These include Silangkitang, Namora-I-Langit, and Sibualbuali (Gunderson et al.). Resource feasibility studies have been submitted to Pertamina in support of the first 330 MW development at Silangkitang and Namora-I-Langit.

3.2.2 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 development of this field has been assigned to GeoDipa for continuation of the project.

PT.Yala Teknosa has drilled two exploration wells at the Cibuni prospect on the western flank of Gunung Patuha. Pertamina does not administer the contract for Cibuni because it is a small scale geothermal project and falls under different government regulations. The wells have discovered commercial reservoir temperatures, but exploration activities have been suspended.

3.2.3 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, has explored Karaha under a JOC with Pertamina and ESC with PLN. KBC has 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.

3.3 DRILLED FIELDS

Exploration drilling has been conducted at seven geothermal areas in Sumatra, Java and Bali. Additional exploration drilling is required in order to confirm commercial geothermal resources at these prospects.

3.3.1 Sumatra

Three exploration slim holes were drilled by Pertamina at the Ulubelu field in South Sumatra. Ulubelu is located 100 km west of Bandar Lampung. The wells encountered a steam cap overlying a liquid-dominated resource with temperatures from 210° C to 230° C.

3.3.2 Java

During the mid-1980's Pertamina drilled one exploration well each at the Banten and Cisolok prospect in West Java. An exploration slim hole was also drilled by Pertamina in 1992 at the Wilis-Ngebel prospect in East Java. None of the three wells discovered a high temperature geothermal resource.

3.3.3 Bedugul (Bali)

The Bedugul field, which is located on Bali about 60 km northwest of Denpasar, has been explored by Bali Energy, 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 have encountered reservoir temperatures from 245° C to 340° C.

3.4 Undrilled Prospects

Surface exploration surveys have been conducted at 34 other prospects in Indonesia. Six of these prospects have been brought to the exploration drilling stage, including Sorik Merapi, Muaralabuh, Lumut Balai, Rajabasa, Tompaso and Kotamobagu. The other 28 prospects are at different stages of exploration.

4. THE FUTURE ROLE OF PERTAMINA IN GOTHERMAL DEVELOPMENT

As a result of implementing the new Oil and Gas No. 22/2001 and Government Regulation No.31/2003, PT. Pertamina (Persero) was established on September 17, 2003. In consequence of implementing the Government Regulation, and according to Article 7, Pertamina has to transfer activities on the commercialization of geothermal to its subsidiary. Shortly after that, the establishment of PT. Pertamina Geothermal Energy (PT. PGE), as its subsidiary company, will be declared.

The new Law on Geothermal and in the framework of policy to maximize the benefits from geothermal energy agreed upon by both the Government and the Parliament, recently the Government has completed a Blue Print on the Development of Geothermal Energy of more than 6000 MW up to the year 2020. When Indonesia fully recovers from it's economic downturn, geothermal power can once again represent an important energy source to meet the expected growing demand for electricity.

Increases in power demand and electricity tariffs in the last three years may indicate that business climate has changed being more conducive for investment. In addition, the issuance of new Regulations on Geothermal No.27/2003 which demonstrates that it can and will meet its future contractual obligations keep Pertamina being still interested in doing business in developing geothermal power, whether Pertamina's own or a joint venture. Pertamina is planning to have a total Geothermal Power Plant Installed Capacity of 1500 MW by the year 2010. The 1500 MW planned installed capacity come from both the existing fields and new prospects (Table 3**).** To achieve the 1500 MW target, alliance is a necessity.

5. CONCLUSIONS

The Indonesian geothermal industry has made impressive strides under the Indonesian government's energy policies and Pertamina's contract administration to develop the geothermal potential of Indonesia. The past role of Pertamina in geothermal development in Indonesia had been able to identify of at least 70 high enthalpy geothermal fields and prospects which represent the combined potential of about 20000 MW and 807 MW installed capacity.

Increases in power demand and electricity tariff in the last three years may indicate that business climate has changed being more conducive for investment. In addition, the issuance of new Regulations on Geothermal No.27/2003 which demonstrate that it can and will meet its future contractual obligations keep Pertamina being still interested in doing business in developing geothermal power, whether

Pertamina own or joint venture. The future role, Pertamina, through its subsidiary company PT.PGE, is planning to have a total Geothermal Power Plant Installed Capacity of 1500 MW by the year 2010. The 1500 MW planned installed capacity come from both the existing fields and new prospects. To achieve the 1500 MW target, alliance is a necessity.

ACKNOWLEDGEMENTS

The authors thank the management of PERTAMINA for permission to publish the information provided in this paper.

REFERENCES

Fauzi, A., 1998, Geothermal development in Indonesia: An overview; Geothermia, Rev de Geoenergia, Vol 14(3), pp. 147-152.

Fauzi, A., Bahri, S., Akuanbatin, H., 2000, Geothermal development in Indonesia : An overview of industry status and future growth; inProc. World Geothermal Congress.

Gunderson,R.P.,Ganefianto,N.,Riedel, Ken, Sirad-Azwar, L., and Suleiman, S., 2000 Exploration results in the Sarulla Block, North Sumatra, Indonesia; inProc. World Geothermal Congress.

Ibrahim,R.F., Fauzi,A., Suryadarma, 2005, The Progress of Geothermal Resources Activities in Indonesia; in Proceedings World Geothermal Congress, 2005, this volume.

Pertamina, 1994, Indonesia Geothermal Reserves and Resources: Publication of Pertamina Geothermal Division.

Pertamina, 2003, Business Profile "PERTAMINA GEOTHERMAL INDONESIA : Publication of Pertamina Geothermal Division.

Radja, V.T., 1995, The rile of geothermal energy in the context of the future electric power supply in Indonesia; in Proceedings of the world Geothermal Congress 1995, Florence, Italy, 18-31 May, Vol. 1, pp. 173-189.

Slamet, U., 2000, Maximizing Community Benefits and Minimizing Environmental Impacts in the Awibengkok field; in Proceedings World Geothermal Congress.

Soeparjadi, R., Horton, G. D., and wendt, B.E., 1998, A review of the Gunung Salak geothermal expansion project; 20th New Zealand Geothermal Workshop, pp. 153-158.

Sussman, D., Mosby, M.D., and Williamson, K.H., 1997, Geothermal Energy Development in Southeast Asia: Unocal's Experience, electricity Conference on Power Fuel and Power Developments, ASEAN and Far East Region, Chiang Mai, Thailand, January.

Table 1. Installed Geothermal Power Plants in Indonesia

Area	Capacity In Operation (MW)	Additional steam availability at WH	Operator/ Contractor
Kamojang	140	74	Pertamina
Sibayak	2	15	Pertamina
Lahendong	20		Pertamina
G. Salak	330		Unocal
Darajat	145	205	Amoses
Dieng	60		GeoDipa
Wayang Windu	110		Mandala
Sarulla		141	Unocal
Patuha		60	GeoDipa
Total	**807**	**495**	

Table 2. Indonesian Geothermal Power Plant Contracts

No	Project/ Year contract Signed	Contract Capacity (MW)	Contractor	Status On PD 15/2002
1	Kamojang Units 1, 2, 3 1984	140	Pertamina	On-Line
2	Salak;1982 amanded 1994	495	Unocal	On-Line
3	Darajat;1984 1996&2004	330	Amoseas	55MW,70MW,110MW On-Line
4	Sarulla 1993	330	Unocal	On-Line
5	Dieng Unit 1- 4 1994	400	GeoDipa	On-Line
6	Kamojang U 4 1994	60	Pertamina	On-Line
7	Karaha 1994	400	?	On-Line
8	Patuha 1994	400	GeoDipa	On-Line
9	Wayang Windu 1994	400	Mandala	On-Line
10	Bedugul 1995	400	Cal Energy	On-Line
11	Cibuni 1995	10	Yala Teknosa	On-Line
12	Sibayak 1996	120	Pertamina/ Dizamatra	On-Line
13	Lahendong 1999	20	Pertamina	On-Line
	Total	**3475**		

Table 3. Geothermal Working Areas and Development Planning

No.	Geothermal Field	Developer	Production (2004)	Development Planning Up to 2008	Cummulative installed Capacity Up to 2010
1	Sibayak	Pertamina	2	10	10
2	Sarulla	Pertamina/PLN		220	220
3	Lumut Balai	Pertamina		55	55
4	Ulu Belu	Pertamina		55	55
5	Salak	Unocal	330	0	330
6	Patuha	Geodipa			120
7	Wayang Windu	MNL	110	110	220
8	Kamojang	Pertamina	140	60	200
9	Darajat	Amoseas	145	110	255
10	Karaha	KBC		55	55
11	Dieng	Geodipa	60	120	180
12	Lahendong	Pertamina	20	40	60
13	Bali	Bali Energy		10	10
Total			**807**	**845**	**1652**

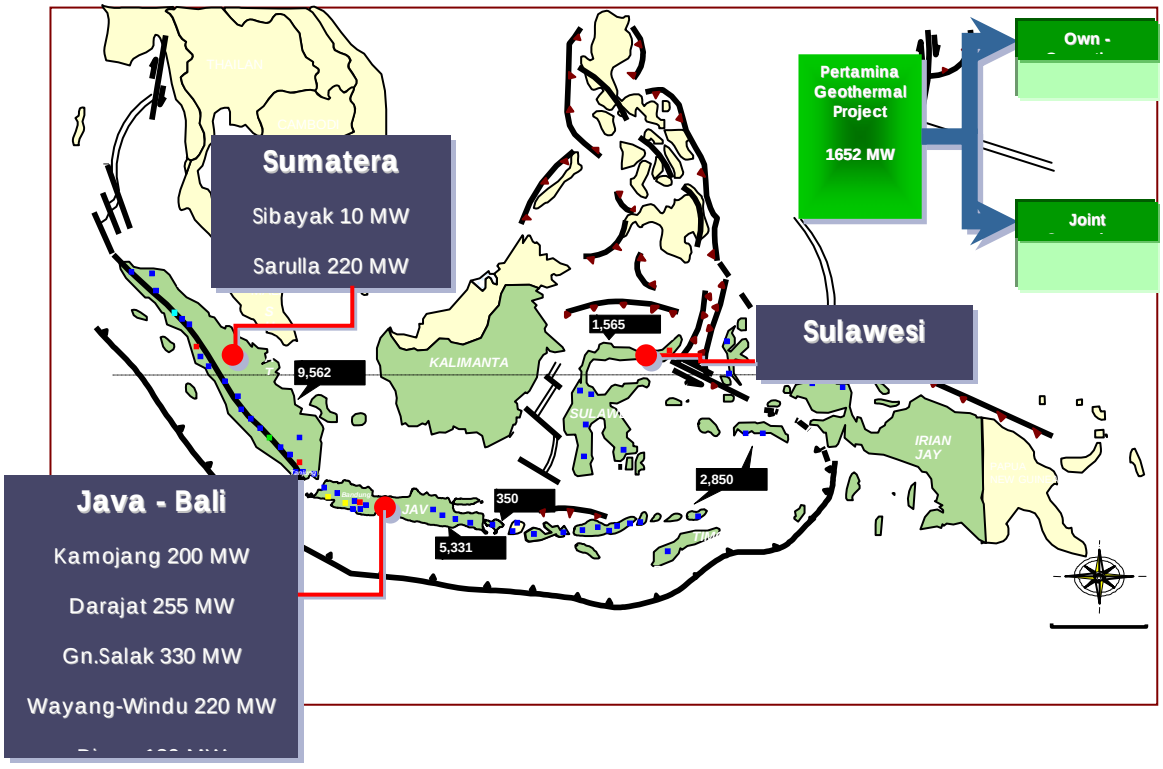

Figure.1: Location map of Indonesian Geothermal Resources and its development