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THE STATUS OF GEOTHERMAL ENERGY DEVELOPMENT IN INDONESIA UP TO THE YEAR 2000

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ABSTRACT

The electric power sector in Indonesia will be expanded with an additional generating capacity of about 5255 MW at the end of the fourth Five-Year Development Plan, 1984/1985 to 1988/89, from the existing 3912 MW. At present a 30 MW geothermal condensing plant and two noncondensing monobloks of 2 MW and 25 kW have been operating successfully since 1979. Geothermal energy will be developed primarily for electic power and a total of 220 MW, 660 MW and 550 MW will be added during Repelita IV (1984-1989), Repelita V (1989-1994), and 1995 up to the year 2000, for a total capacity of nearly 1500 MW. These goethermal plans and programmes will accelerate exploration of 18 areas in Sumatera; 29 areas in Java; 16 in Sulawesi; and 14 in Bali, the Lesser Sunda Islands, and Mollucas (Figure 1).

INTRODUCTION

During Repelita IV Indonesia is expected to grow at an average annual rate of 5 percent during the next 5 years. It is estimated that the country needs commercial energy of about 292 million barrel of oil equivalent (BOE) in 1988/89. Approximately 182.41 million BOE or 62.5 percent would have to be supplied by oil and the remaining 37.5 percent could be supplied from nonoil resources such as hydro, coal and geothermal. The plan called Repelita IV is based upon the state policy called "Garis-Garis Besar Haluan Negara." Repelita IV is a continuation and enhancement of the previous plans and is built on the achievements of Repelita I, II, and III (Arismunandar, 1984).

While Repelita I dealt with the urgent need for stabilization, rehabilitation and the first stages of development, Repelita II was designed to deal with the problem of expanding employment opportunities, raising the level of income, a more equitable distribution of the gains of development among the various regions, providing adequate supplies of basic human needs, improving the nutritional status of the population and enhancing the quality of life. Repelita III continues these goals as central goals of development and sets the order of priorities accordingly.

The essential goals of Repelita IV are to raise the living standards and levels of knowledge of the Indonesia people, to strive for a more equal and just distribution of welfare for the whole population and to lay a strong foundation for the next stage of development. With an expected population growth of about 2 percent per annum, the real per capita Gross Domestic Product will increase by 15.6 percent in the 5-year period. The industrial sector will expand at the most rapid rate of 9.5 percent per annum, and transport and communication is projected to grow at 5.2 percent per annum. At the same time the agricultural sector is expected to grow by about 3 percent and mining by about 2.4 percent per year. Energy sector policies and programmes during the Repelita IV period are as follows:

a. Increasing and expanding survey and exploration of energy resources (intensification).

b. Reducing dependence on petroleum in the overall energy consumption by developing and using nonoil energy resources. Nonrenewable and exportable resources (such as oil) would be used primarily as a means of increasing foreign exchange earnings (diversification).

c. Economizing energy use and using energy efficiently and wisely (conservation).

d. Matching each energy need with the most appropriate energy sources available in the country (indexation).

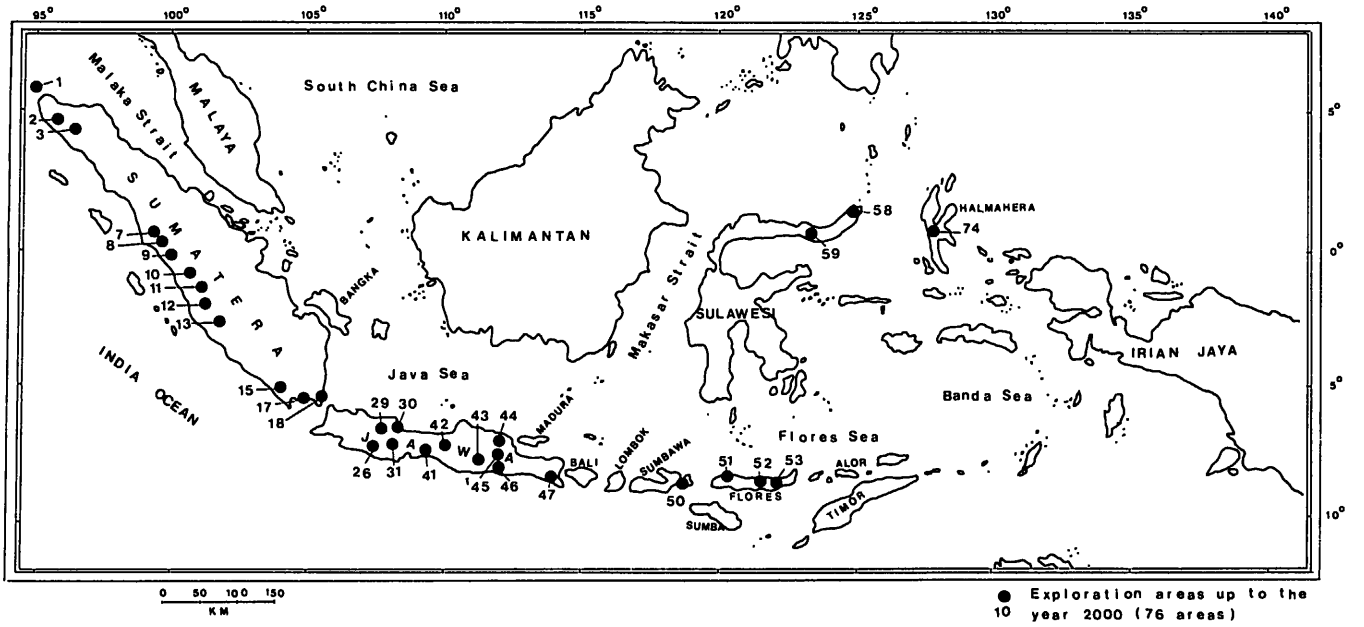

Figure 1. Map of Indonesia showing 76 areas planned for geothermal exploration up to the year 2000

ENERGY DEVELOPMENT PROGRAMMES

Oil and Gas

Oil production is projected to increase from 475 million barrels in 1984/89. Production of natural gas is projected to increase from 1,776 billion to 1,980 billion cubic feet. Liquid natural gas export, which has reached 8.4 million tonnes to date, will be increased to 17.6 million tonnes by 1988/89 (Wyarso, 1984).

Coal

Total production of coal in 1983 was 485,669 tonnes, of which nearly 50 percent was exported. Coal production will be increased to 9 million tonnes at the end of the planning period to meet the rapid growth of domestic demand for coal, especially for the cement industry and several coal-fired power plants.

Hydro Power

Currently, about 1316 MW of hydro power have been installed. Total potential for the whole country has been estimated at around 75,000 MW. Indonesia will add 1425 MW hydro power, including 50 MW for mini hydro-power plants.

Geothermal Energy Resources

Indonesia is situated on a volcanic belt and has a humid climate; the prospect for geothermal energy development is, therefore, bright. It is estimated that the total potential may reach 10,000 MW. At present, a 30 MW geothermal plant and two wellhead generators of 2.25 MW each have been operating successfully. A total of 220 MW and 660 MW will be added during Repelita IV and V.

Other Sources of Energy

Nuclear energy has been considered as an open option for the supply of energy for electric power. Planning and study have been carried out, followed by the introduction of a 30 MW multipurpose reactor. Wood and agricultural waste have been used traditionally as cooking fuel in most rural areas of Indonesia. The possibilities of using solar and wind energy will be explored further, especially for rural applications. Peat seems to be a potential energy source for the country. It is estimated that the total deposit may reach about 200 billion tonnes (Arismunandar, 1984).

Electric Power

The electric power sector in Indonesia will be further expanded with an additional generating capacity of about 5256 MW as shown in Table 1. The role of oil-fired power plants will be reduced from 86 percent today to about 56 percent at the end of the planning period (1988/89). It is expected that an additional 7000 villages with around 1.6 million consumers will be reached through the programme (Sardjono, 1984).

GEOTHERMAL RESOURCES IN INDONESIA

Indonesia is a world-famous volcanic country and is frequently subjected to crustal movements. In addition Indonesia has an average annual precipitation of 2000 mm. The resulting ground water is heated by magma and surfaces in the form of hot springs, fumaroles, and mud pools. Indonesia may be considered a country with rich geothermal resources. Almost half of the volcanic centers in Indonesia (88 out of 177 centers) bear evidence of fumarola and solfatara activities.

The Pattern of Geothermal Surveys in Indonesia

Surveys for geothermal energy resources in Indonesia can be divided as follows (Radja 1984):

Table 1. Power Expansion Plan During Repelita IV, 1984/85 — 1988/89

Types of Power	Existing Capacity 1979/80-1983/84 (MW)	Total Additional Capacity (MW)	Total Capacity* 1984/85-1988/89 (MW)	% 1988/89
Hydropower	537	1425	1962	21.3
Diesel	793	1100	1893	20.6
Geothermal	30	220	250	2.7
Coal Fired	—	1830	1830	20.0
Oil Fired	1556	630	2186	23.8
Mini Hydro	—	50	50	0.7
Gas Turbine	996	—	996	10.9
Grand Total	3912	5255	9167	100

(*) Total Capacity = Existing Capacity + Total Additional Capacity

Table 2. Plan of Additional Installed Capacity from Geothermal Resources, 1985 to 1995

Name of Project	Capacity	Year of Completion
REPELITA IV: (1984-1989)		
Kamojang 2,3	110 MW	87/88
Dieng 1	55 MW	88/89
Salak 1	55 MW	88/89
	220 MW	
REPELITA V: (1989-1994)		
Dieng 2	110 MW	89/90
Salak 2	55 MW	89/90
Darajat 1,2	110 MW	91/92
Salak 3,4	110 MW	92/93
Lahendong	30 MW	92/93
Bedugul	55 MW	93/94
Banten 1,2	110 MW	93/94
Cisolok 1,2	110 MW	93/94
	660 MW	

a. Prewar Surveys (before the year 1928).
b. Between 1964 and 1974
c. Present development, 1974 to 1984
d. Program up to the year 2000.

Prewar Surveys. Research on geothermal energy in Indonesia was started in 1926 at the Kamojang area of West Java, and then at the Dieng area in Central Java. A report on the Kawah Kamojang investigation by Ch. A. Stehn was presented to the Fourth Pacific Science Congress in 1928. After Stehn's investigation no activity on geothermal resources took place until 1964.

Surveys Between 1964 and 1974. A UNESCO Vulcanological Mission visited Indonesia in 1964. In 1968 a French team (EAURAFTEEP) conducted a study in Java and Bali. In the years of 1969/1970/1971 the Power Research Institute and the Geological Survey of Indonesia acquired funds to survey Sumatera, Java, Sulawesi, the Mollucos and Nusatenggara (Radja, 1977).

In 1971 a French volcanological team lead by Mourice Krafft visited Java, Bali, Flores, Sumatera and Sulawesi for 8 months. Also a New Zealand mission lead by Kent Seal visited Sulawesi, Bali, Java and Sumatera (Radja, 1977).

Present Development, 1974 to 1984. In 1975 a total of NZ $24 million was extended by the New Zealand government for the Kamojang Geothermal Project. The government has given priority to six areas to be explored by Pertamina: Kamojang, Cisolok, Banten, Salak and Dieng in Central Java, and Bali. Based on these studies Indonesia has a potential of between 8000 and 10,000 MW, i.e. 5500 MW in Java, 1100 MW in Sumatera, 1400 MW in Sulawesi and 200 MW on other islands.

Program From 1985 to 1995. Table 2 shows the installed capacity from geothermal resources planned for the period 1985-1995.

1995 Up To The Year 2000. Preliminary inventories have been carried out by the Vulcanological Survey of Indonesia (VSI) and Pertamina for: Nusatenggara, 9 areas; Mollucos, 4 areas; Bali, 1 area; Sumatera, 18 areas; Java, 29 areas; and Sulawesi, 16 areas (Table 3). Geothermal resources that could be developed for electrical power generation between 1995 and the year 2000 are estimated to be 550 MW, especially from Dieng, Ijen (Java), Kotamobagu (Sulawesi), Bali, Flores (Nusatenggara), Kerinci and Souh (Sumatera). In line with the government energy diversification policy, the electric energy generated from geothermal resources would reach nearly 1500 MW in the year 2000 (Radja, 1984).

Due to a shortage of funds the development of geothermal energy shall be carried out mainly through a Joint Operation and Energy Sales Contract with foreign contractors.

Due to the fact that the production of geothermal energy is not an exportable commodity, and utilization is limited to the generation of electric energy for domestic consumption, the Indonesian government deemed necessary to issue several incentives to attract foreign companies to develop geothermal resources, by establishing Joint Operation and Energy Sales Contracts as with Union Geothermal of Indonesia for Salak in 1982 and Amoseas for Darajat in 1984, both in West Java (Radja, 1984).

Table 3. Geothermal Investigations Since 1980-1984 and Plans For 1985 Up To The Year 2000

Explanation: Just to give information to foreigners on our activities in collecting data, every year we have ten activities as follows: 1. = Inventarization, 2 = Geological survey, 3. = Geochemical survey, 4. = Gravity survey, 5. = Geoelectric survey, 6. = Gas in soil-air, 7. = Thermal mapping, 8. = Temperature gradients, 9. = Test drilling, 10. = Steam monitoring

Steps: 1 - Indication; 2-4 - Prospective; 5-8 - Potential; 9-10 - Measured.

No.	Geothermal Field	Pre-1979	1979/1980										1980/1981										1981/1982										1982/1983										1983/1984									
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
	SUMATERA																																																		
1.	Sarue, Jibue-Kaneke-Subang, Pulau Weh	•													•																												•									
2.	Seulawah Agara, Seulimeun, Aceh Besar													•	•	•	•		•																										•								
3.	Takengon, Aceh	•													•																																					
4.	Pahai, Sumatra Utara	•																																																		
5.	Hellatoba, Tarutung, Sumatra Utara	•																																																	
6.	Sibual-buali, Tapanuli Selatan, Sumatra Utara	•																				•																														
7.	Palu-Pasaman, Sumatra Barat	•		•																		•													•											•					
8.	Palu-Pasaman, Sumatra Barat	•		•																		•													•											•					
9.	Oubadak-Pasaman, Sumatra Barat	•		•																		•													•											•					
10.	Peconia-Penangawa, Muaralabuh, Sumatra Barat	•																																													•	•				
11.	Semurup, Sungai Penuh, Kerinci, Jambi	•												•																																					
12.	Lempur, Sungai Penuh, Kerinci, Jambi	•	•	•	•	•									•	•	•	•	•	•		•																					•	•				•			•		
13.	Serampos, Sungai Penuh, Kerinci, Jambi	•		•																																														
14.	Margabayur, Bengkulu	•																																																	
15.	Souh Antatai, Lampung	•																																													•	•				
16.	Hulubeki, Lampung	•																																																	
17.	Wai Ratai, Lampung	•												•												•																					•	•		•		
18.	Rajabasa-Kahanda, Lampung	•												•			•									•																					•					
	JAVA																																																		
19.	Rawa Danau, Banten, Java Barat																																																		
20.	Cisolok, Sukabumi, Java Barat																																																		
21.	Cisukarame, Sukabumi, Java Barat																																																		
22.	Perbakti-Kiaraberes, G. Salak, Sukabumi, Java Barat.																																																		
23.	Clanten, G. Salak, Sukabumi, Java Barat																									•																									
24.	Kawah Kamojang, Bandung Java Barat																																																		
25.	Kawah Karaha, Bandung, Java Barat																																															•			
26.	Ciwidey, Bandung, Java Barat																																																		

Table 3. Continued

No.	Geothermal Field	Stages of Investigation/Year: Pre-1979	1979/1980										1980/1981										1981/1982										1982/1983										1983/1984									
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
27.	Ciater, Tangkuban Prahu, Subang, Java Barat																																																	
28.	Kawah Darajat, Garut, Java Barat																																			•															
29.	Conggeang, G. Tampomas, Sumedang, Java Barat																																	•	•		•							•							
30.	Cileungsing, G. Tampomas Sumedang, Java Barat																																•	•	•										•							
31.	Sangkuhurip, G. Cereme, Ciregon, Java Barat																																•	•	•																	
32.	Tanggeung, Cianjur, Selatan, Java Barat																																•												•							
33.	Cipanis-Jasinga, Bogor, Java Barat																																•																			
34.	Cibadak, Sukabumi, Java Barat																																•																			
35.	Batunapur-Batugede, Java Barat																																																		
36.	Maribaya, Bandung, Java Barat																																																		
37.	Cimandiri, Sukabumi, Java Barat																																																		
38.	Cisolong-Cibuncar, Java Barat																																•																			
39.	Peg. Dieng, Wonosobo, Java Tengah																																•																			
40.	Bumiayu, G. Slamet, Java Tengah																																•																			
41.	Batu Raden, G. Slamet, Puwokerto, Java Tengah																																•																			
42.	Ungaran, Java Tengah																																																		
43.	Telaga Ngebel, G. Wilis Madiun, Java Timur																																•													•	•		•				
44.	Padusan, Mojokerto, Java Timur																																•	•	•																	
45.	Cangor, Malang, Java Timur																																	•	•		•							•			•				
46.	Songgoriti-Pasuruan, Malang, Java Timur																																•	•	•																	
47.	Blawar, G. Ijen, Situbondo, Java Timur																																•		•										•							
	BALI																																																		
48.	Buya Brata, Bali																									•																									
	LOMBOK																																																		
49.	Sembalun, Sapit, G. Rinjani, Lombok	•																																																
	SUMBAWA																																																		
50.	Marongge, Sumbawa Tengah Huru Dompu, Sumbawa Timur-Selatan, Sumbawa Besar																							•																						•	•		•				

Table 3. Continued

No.	Geothermal Field	Stages of Investigation/Year: Pre-1979	1979/1980										1980/1981										1981/1982										1982/1983										1983/1984									
			1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
	FLORES																																																		
51.	Ulumbu, G. Pocoleok, Ruteng, Flores																						•																				•	•		•						
52.	Waipesi, Flores	•																																		•		•													
53.	Mutubusi, Ende, Flores	•																																											•						
54.	Bajawa, Flores	•																																																
55.	Oka-Larantuka, Flores	•																																																
	SOLOR																																																		
56.	Lomolem, Solor	•																																																
	ALOR																																																	
57.	Kalabali, Alor	•																																															
	SULAWESI																																																	
58.	Lahendong-Tompaso, Sulawesi Utara		•	•																																							•							
59.	Kotamobagu-Modoinding, Sulawesi Utara					•																															•	•												
60.	Gorontalo-Limboto, Sulawesi Utara	•	•																																															
61.	Kampung Baru, Donggala, Sulawesi Tengah	•																																																
62.	Boru-Palu, Sulawesi Tengah	•																																																
63.	Maranda-Poso, Sulawesi Tengah	•																																																
64.	Luwu, Sulawesi Selatan	•																																																
65.	Mamasa, Sulawesi Selatan	•																																																
66.	Tanah Toraja, Sulawesi Selatan	•																																																
67.	Majene, Sulawesi Selatan	•																																																
68.	Masepe-Pempe, Sulawesi Selatan	•																																																
69.	Masepe-Pinrang, Sulawesi Selatan	•																																																
70.	Senjai-Bulukumba, Sulawesi Selatan	•																																																

Table 3. Continued

No.	Geothermal Field	Stages of Investigation/Year	Pre-1979	1979/1980										1980/1981										1981/1982										1982/1983										1983/1984									
				1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0
71.	Toreo-Paraiala, Sulawesi Tenggara		•																																																
72.	Marono-Lainea-Amahalo, Sulawesi Tenggara		◦																																																
	P. BUTON																																																	
73.	Lawele-Kobongka-Sampolawe, Sulawesi Tenggara		•																																															
	HALMAHERA																																																	
74.	Jailolo-Akelano, Maluku Tengah														•												•											•												
	BACAN																																																	
75.	Bacan-Tengah-Selatan, Maluku Tengah																																																	
	AMBON																																																		
76.	Batuangut-Telaga Biru Ambon Timur Soya Atas Siriamau, Ambon																																																	

APPRAISAL OF SELECTED GEOTHERMAL PROSPECTS

Java

Kawah Kamojang. At present the first unit of a 30 MW geothermal plant has been officially operating successfully since February 7, 1982. Units 2 and 3 of 2x55 MW, financed by the World Bank, are expected to be on line in middle 1987 and early 1988 (Radja, 1984). Study for Units 4 and 5, 2 x 55 MW, will be started later in 1985.

Darajat. The Darajat field is about 10 km from Kamojang. Joint Operation and Energy Sales agreements were signed on November 16, 1984 by PLN (State Electrical Corporation), Pertamina and Amoseas for production of steam and generation of 110 MW of electric power at the end of 1990 (Radja, 1984). Feasibility study and design of the plant will be financed by the Asian Development Bank (Power XIX).

Gunung Salak. Joint Operation and Energy Sales agreements were signed by PLN, Pertamina and Union Geothermal of Indonesia on February 10, 1982 for production and generation of 110 MW of electric power around 1990. The feasibility study and engineering design of two 55 MW plants was financed by the World Bank. Six deep wells already had been completed by Union Geothermal of Indonesia at the end of 1984 (Radja, 1984). Construction of the plant will be financed by the 1985 Italian Government Loan.

Dieng. At present ten deep wells have been completed by Pertamina. Some discharge steam alone, others a mixture of steam and water (Sutantri, 1982). A highly conservative estimate supports a measured potential of 5000 MW in the Sikidang area. A feasibility study and engineering design of two 55 MW plants financed by the Asian Development Bank has been carried out by West Japan Engineering Consultant since January 1985. The field is scheduled to be in commercial operation at the end of the fourth Five Year Development Plan, March 1989 (Radja, 1983a).

Banten. As with any prospect in Java, the Banten field if built would connect to the main 150 Kv grid, the one constructed for the Suralaya coal-fired station. For this reason, a deep well to confirm this potential was started in February 1985. The possible power output is estimated to be 300 MW.

Cisolok - Cisukarame. Natural heat flow measured in the drainage out flow predicts a potential of 150 MW. Pertamina has plans to drill up to three deep wells in 1985 to confirm the potential, after drilling in Banten.

East Java Area. Numerous prospects have been identified in Ijen Caldera, Complex of Arjono, Welirang, Anjasmoro Volcano, Wilis and Lamongan. An extensive exploration programme by Pertamina has been conducted in this area. Plans are being made for drilling some gradient holes and deep wells in 1985 and 1986 in Ijen Caldera (Table 4).

Central Java. Additional surveys have been made in Lawu, Telomojo Slamet, Ungaran and Muria volcanic areas in central Java (Table 4).

Bali Island, Bedugul

The field referred to as Bedugul is of particular interest in that the associated hot springs are all more than 15 km from the reservoir. Estimates made for the energy contained in this field indicate a resource of 200 MW. Special arrangements for environmental protection should be made before detail surveys and exploration are done in this area.

North Sulawesi

Lahendong. The Lahendong field was predicted as water dominated in the upper parts of the reservoir, overlying a zone of hot chloride water. Two exploration wells were completed successfully by the Vulcanological Survey of Indonesia to 327 m and 364 m depth. The wells have a temperature of 165° C and a pressure of 115 psig. The first deep well of 2203 m was drilled by Pertamina in July 1984 and four wells are scheduled for 1985-1986. A feasibility study and engineering design of 2 x 15 MW plants will be financed by the government of Italy in 1985 (Radja, 1976).

Kotamobagu. In 1982 a total of 150 million Italian Lire was extended by the Italian government and entrusted by the survey to the ELC (Electro Consult Engineering) to conduct a survey on geology, geochemistry, and geophysics to assess the geothermal potential in the Gunung Ambang area, North Sulawesi. Based on the results of the investigations, the Gunung Ambang area is estimated to occupy a total area of 35 km^2. The possible power output is estimated to be 100 MW. The Makaroyan area is the second promising area for geothermal development. The Gunung Ambang area will be developed for the purpose of a cement plant that will be built during Repelita V (1989-1994) (Radja, 1982). Exploration wells will be drilled by the Vulcanological Survey in 1985.

Sumatera

Considerable geothermal activity extends throughout Sumatera mainly associated with the Barisan Mountains, which lie close and parallel to its west coast.

Banda Aceh. The most promising area is the Seulawah volcanic complex. Geological, geochemical, gravity and geoelectric studies have been done since 1980-1984.

Tapanuli of North Sumatera. More than 50 areas have been identified in Tanah Karo. Tapanuli Selatan and Tapanuli Utara by the Vulcanological Survey of Indonesia.

West Sumatera and Jambi Kerinci. In 1981 a grant was extended by the government of Japan and entrusted by the survey to the Japan International Cooperation Agency (JICA) to conduct a survey consisting of geology, geochemistry, geophysics and drilling an exploratory well with a view to assessing the geothermal potential in the Lempur area. The first phase of the survey and exploration consisted of a regional and detailed geological survey of geothermal manifestations, a hydrogeological survey and a geochemical survey. The second and third phases consisted of a gravity survey, a 1-m gas and temperature survey, and a geoelectrical survey. An exploratory well to 1005.2 m was completed in 1983.

Table 4. Working Geothermal Exploration Programme, Geothermal Division, Pertamina, 1985-1986

Areas	Geology	Geochemistry	Geophysics
I. JAVA			
1. All Java (areas)	Reconnaissance	Gas/Steam	
2. G. Ciremai (West Java)	Geologic Mapping & Volcanic Hazard		Resistivity & Gravity
3. G. Lawu (Central Java)	Geologic Mapping & Volcanic Hazard		Magnetotelluric
4. C. Telomoyo (Central Java)	Geologic Mapping & Volcanic Hazard		
5. G. Pandontelu	Geologic Mapping & Volcanic Hazard		
6. G. Pandontelu (Central Java)	Geologic Mapping & Volcanic Hazard		
7. G. Patuha (West Java)			Temperature Gradient
8. Cikawah-G. Endut (West Java)			Resistivity
9. G. Wayang-Windu (West Java)			Resistivity & Magnetotelluric
10. G. Tangkuban Prahu (West Java)			Resistivity
11. Kawah Karaha (West Java)			Temperature Gradient
12. Banten (West Java)			Microseismic
13. G. Slamet (West Java)			Temperature Gradient
14. Kalebening-Mangunan (Central Java)			Resistivity
15. G. Ungaran (Central Java)		Surface Survey	Temperature Gradient
16. G. Muria (Central Java)			Microseismic
17. G. Wilis (East Java)			Gravity & Temperature Gradient
18. Ijen (East Java)			Magnetotelluric
II. SUMATERA			
1. South Sumatera		Reconnaissance Sampling Gas/Steam and Surface Survey	
2. G. Ratai (South Lampung)			Gravity
3. Sungai Penuh (Jambi)			Resistivity
III. BALI			
1. Lake Batur			Gravity
IV. SULAWESI			
1. Lahendong		Survey Hg and CO_2	
2. D. Tondono (North Sulawesi)			Gravity
3. North Sulawesi (out site Lahendong)		Reconnaissance, Sampling Gas/Steam	

Based on the result of the investigations, the promising area in the Dua belas is estimated to occupy a total area of 15 km^2 and the possible power output is estimated to be 30 MW. The Sikai area is a second promising area for geothermal development. Approval was made by the Indonesian and the Japanese governments in August 1984 to drill a second deep well (1200 m depth). The feasibility study and engineering design of a 5 MW power plant will be done in 1985-1986 (Radja, 1984).

Lampung. The areas of Kaliandra, Souh Antatai and Wai Ratai appear to be hot water fields. Gravity, geoelectric and thermal mapping were carried out by the Vulcanological Survey between 1980 and 1984 (Table 3). The possible potential is estimated at 270 MW.

Nusatenggara Timur

Because of their proximity, considerable geothermal activity extends through Bali, Nusatenggara Barat (Lombok and Sumbawa) and Flores (Nusatenggara Timur). The prospect areas are located at Ulumbu, Sukaria and Lasugolo.

Ulumbu-Flores. A joint reconnaissance survey was made by Indonesian agencies (State Electricity, Pertamina

and the Vulcanological Survey) and ELC (Italy) in 1983, especially in connection with the interisland submarine cable project that connects Bali, Lombok, Sumbawa and Flores (Radja, 1983b).

Sumbawa. A detailed geological, geophysical and geochemical survey was completed by the Vulcanological Survey in 1980-1982 in Marongge, Huru Dampu and Sumbawa Besar Moluucos. The prospects are located at Jailolo, Akelamo of Halmahera Island (Table 3).

INVESTMENT OPPORTUNITIES IN GEOTHERMAL ENERGY RESOURCES DEVELOPMENT IN INDONESIA

General Background

The government of the Republic of Indonesia has embarked on a policy to diversify the utilization of the various sources of energy in the country. Geothermal potential is widely distributed in Indonesia and it is the government's desire that this resource be developed for power generation. Initial development efforts will be concentrated on six areas in Java in which geological exploration has indicated a high probability that geothermal steam could be produced in commercial quantities. The government intends to develop these resources in cooperation with foreign companies possessing the technological capabilities and having proven their experience in geothermal development.

Depending upon the prevailing conditions of the individual geothermal field, the scope of the undertaking may include:

1. The development of geothermal steam only,
2. The development of geothermal steam and construction of a power plant, or
3. The development of geothermal steam and construction of a power plant with associated transmission lines.

The Department of Mines and Energy established a Committee to discuss and negotiate agreements with interested parties for such participation. This information memorandum will assist companies in their discussions with the Committee and will serve as a term of reference. Parties interested in participating in the development of one or more of the six indicated locations should express their interest as soon as possible. Discussion and eventual negotiation with interested parties will be conducted on a first-come, first-served basis. The Committee will schedule discussions with interested parties as soon as possible after receiving such inquiries.

Terms and Conditions

Potential Areas Offered For Development

a. Dieng (Central Java)	2000 MW
b. Kamojang (West Java)	250 MW
c. Darajat (West Java)	110 MW
d. Cunung Salak (West Java)	165 MW
e. Cisolok (West Java)	300 MW
f. Banten (West Java)	300 MW
	3125 MW

Periods and Stages of Development

a. General Survey, Exploration and Feasibility Study Period: A maximum total period of 60 (sixty) months, comprising a maximum of 48 (forty-eight) months for general survey and exploration and a maximum of 12 (twelve) months for feasibility study, are allowed. Relinquishment of an area during exploration periods shall be carried out after the exploration activities have commenced.

b. Steam Field Development and Power Station Construction Period: For projects comprising steam field development only, a maximum period of 36 (thirty-six) months is allowed. For projects comprising steam field development, and construction of power generation facilities and transmission lines, a maximum period of 36 (thirty-six) months is allowed.

c. Production Period: A maximum period of 360 (three hundred, sixty) months from the commencement of steam production is allowed.

Progress Up To Early March 1985

Joint Operation Contract And Energy Sales Contract. The first and second Joing Operation Contracts and Energy Sales Contracts on development of geothermal energy resources were signed on February 11, 1982 and November 16, 1984 between Pertamina, PLN and Union Geothermal of Indonesia, Ltd. for Salak, and Amoseas for Darajat.

Contractor is assigned to explore and develop the potential geothermal energy resources in the Gunung Salak and Darajat areas (West Java). All geothermal energy produced by Contractor shall be sold to PLN and is stipulated in the Energy Sales Contract between Pertamina and PLN. A tender to develop geothermal energy resources in Banten and Cisolok (both located in West Java) and Dieng (Central Java) is scheduled to be opened soon. Up to the year 2000 the government of Indonesia intends to develop the geothermal areas in Kamojang, Salak, Darajat, Banten, Cisolok in West Java, Dieng in Central Java, and Bali and Lahendong in North Sulawesi up to 1500 MW.

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