Proceedings World Geothermal Congress 2000
Kyushu - Tohoku, Japan, May 28 - June 10, 2000

GEOTHERMAL DEVELOPMENT PROGRESS IN INDONESIA: COUNTRY UPDATE 1995-2000

Sayogi Sudarman [1)], Suroto [1)], Kris Pudyastuti [1)], Suhariyanto Aspiyo [2)]

[1)]. PERTAMINA--Geothermal Division, Jakarta
[2)]. PLN--Engineering Service Division, Jakarta

Key Words: Electricity usage, geothermal development progress, resource assessment, professional manpower, Indonesia.

ABSTRACT

This paper evaluates the progress of geothermal development in Indonesia over the period December 1995 to December 1998 and reports projections to the end of year 2000 and year 2005. This paper also discusses the electrical energy mix in Indonesia and geothermal professional involvement.

In 1995 the installed electrical capacity in three fields was 305 MWe plus 4.5 MWe from pilot plants at two fields. The total geothermal electrical capacity was only about 1.6% of the total electrical energy usage in Indonesia in which oil and gas plants were still dominant (>80%). Over the period ending in December 1999 there has been no direct-use of geothermal beyond pre-existing traditional use. All development to date has been associated with the conversion of geothermal energy to electricity. Also no new high temperature resources have been drilled in this period.

By January 2000, it is expected that installed geothermal power plant capacity will be about 769.5 MWe from six fields and about 529.5 MWe in operation. This operation figure is about 45% of the initial target set in 1995 and will equal about 2.7% of the total electrical energy usage in Indonesia. Starting in year 2000, PLN planning envisions progressive reduction in the burning of oil and gas for electricity production to about <70% of the total mix by replacing it with coal, hydro, and geothermal energy.

By 2005, in spite of the recent market dislocation it is projected that geothermal electricity generation will increase rapidly to about 1,907.5 MWe from 15 fields that have an estimated proven reserves of about 3,910 MWe. Two new fields and three extensions are expected to be under development by January 2000, and the remaining seven new fields plus six extensions will come under development during the next five years. By the end of 2005 it is expected that geothermal will constitute about <7% of the total electricity energy usage in Indonesia.

In parallel with the development mentioned above, INAGA (the Indonesian Geothermal Association) projects that professional development specific to geothermal activity (University degrees) will increase from 221 persons in 1995 to about 526 persons in 1999.

INTRODUCTION

In the period of January 1995 to January 2000, almost no regional surveys were done in Indonesia. Detailed surveys were performed within proven fields with two main objectives: to delineate possible field extensions and to increase the accuracy of drilling targets. Therefore, the total number of prospects identified is still the same as, for example, reported by Prijanto and Sudarman (1997a, 1997b). There are as many as 217 prospects, of which 70 prospects are categorized as high T systems (T reservoir >220°C). The distribution of the 70 prospects are: Sumatra (31), Java-Bali (22), Sulawesi (6), Nusatenggara (8) and Maluku (3) with a total potential of about 20,000 MWe including the total reserves of about 9,900 MWe

Geothermal development in Indonesia concentrates mostly in Sumatra, Jawa-Bali and North Sulawesi as these areas have appropriate infrastructure and until recently have had rapid growth of electricity demand.

METHODOLOGY

The method used in this paper is a qualitative evaluation approach. The data were compiled from internal and industry sources and published papers.

These evaluations include resource assessment, development progress, and human resources developments.

GEOTHERMAL RESOURCE ASSESSMENTS

The latest geothermal potential assessment in Indonesia was updated in 1994 (Figure 1) and is compared to calculations from 1987 and 1980. The results indicate that resource assessments increase through time because of the availability of more detailed data and more extensive survey coverage in the prospect areas, i.e.: ~20,000 MWe in 1994, ~16,000 MWe in 1987 and ~10,000 MWe in 1980's (Prijanto and Sudarman, 1997a).

A total reserve of about 9,100 MWe is defined by the summation of proven (2,000 MWe), probable (600 MWe) and possible (6,500 MWe) potential for fields distributed in Sumatra, Java-Bali, Sulawesi and other islands (Figure 1). This reserve potential is calculated based upon detailed study. The progress of estimating proven reserves versus total installed capacity for the period 1995 to 2005 is graphed in Figure 1.

ELECTRICITY USAGE

The energy mix used to produce electricity in Indonesia includes fossil fuel (oil, gas and coal) and renewables (hydro and geothermal). The structure of this energy mix, excluding captive power, in 1998 is shown in Table 1. The table indicates that the geothermal energy share is only about 3.4% by January 2000 compared to 1.6% in December 1995. This increase of geothermal share is expected to continue to <7% by year 2005 produced from 15 geothermal fields as shown in Table 2.

The data in Table 1 also show that electricity including captive power is mostly generated from fossil fuel ~86%, in which oil and gas share about 70% by year 2000 compared to 83% in 1995.

GEOTHERMAL DEVELOPMENT PROGRESS AND ITS IMPACT

Geothermal Utilization for Electricity

Details of utilization of geothermal energy for electricity as of 31 December 1999 are given in Tables 2 and 3, and the locations of the fields are shown in Figure 1. Table 2 shows that currently installed capacity is about 769.5 MWe and plants under construction is about 23 MWe, planned is about 1,115 MWe giving a total committed target of 1,907.5 MWe by year 2005 compared to cumulative commitment of about 4,211.5 MWe. This committed target gives geothermal about a <7% share in the energy mix. Table 3 shows that most of the development areas are still in Java and that the turbines are mostly 55 MWe dry steam single flash type.

Wells Drilled for Electricity

To develop existing and future production, a total of 261 deep holes (1200m to 2500m) have been drilled plus 107 gradient holes (>250m depth), as shown in Table 4. It is estimated that by 2005 a cumulative of about 450-500 deep wells and a total of 120 gradient holes are needed. All wells are drilled for electricity generation purposes.

Geothermal Utilization for Direct Heat

As of December 1999, about five areas commercially use geothermal energy for bathing and swimming. These five areas produce an estimated total installed capacity of about 2.3 MWt and annual energy of about 42.6 TJ per year at 60% capacity factor (Table 5). All areas are located in West Java and, except Wayang Windu, the other areas are located outside of geothermal fields.

Geothermal Professional Manpower

Up to December 1999, about 526 professionals with university background are recorded for the whole of Indonesia of which about 90 personnel work for Pertamina. They mostly have oil and gas technology background with geothermal expertise developed through informal training (e.g. on the job and in-house training) and formal training in overseas geothermal institutes. The correlation between planned professional manpower needs and field development is shown in Table 6. This table indicates the high manpower needed in the period 2003-2005 in order to respond to a drastic increase in field development of about 3-4 times higher than the year 2000.

Prijanto and Sudarman (1997b) showed that to develop a 150-200 MWe geothermal production field, about 25-30 professionals are needed and the technician needs are about 2.5-3 times higher than professionals.

CONCLUSIONS

The summary of geothermal development progress in Indonesia is shown in the form of a matrix model in Table 7 from 1995 to 2005. The matrix shows

that while resource assessment does not significantly change, development progress and human resources needs jump more than twice in the first five-year period.

The planned capacity will dramatically increase by the year 2005, about three times higher than the year 2000 target.

This development progress scenario will in turn increase the geothermal share in the energy mix by about twice every five years, i.e. from 1.6% in 1995 to 2.7 and 7% in year 2000 and 2005, respectively.

Until January 2000, no commercial direct use of geothermal energy is expected, except those for public bathing in open pools.

ACKNOWLEDGEMENTS

The authors thank the Management of Pertamina for permission to publish this paper.

REFERENCES

Prijanto and Sudarman S., 1997a, Indonesia Country Report on Progress of Geothermal Resources Assessments and its Development Status, ASEAN Geothermal Power Development Meeting, Chiang Mai, Thailand

Prijanto and Sudarman S., 1997b, Geothermal Human Resources Development in Indonesia; Pertamina's Training Experience, Geothermal Association Meeting, Oradea, Romania.

Table 1. Present and Planned Production of Electricity (Not Included Captive Power, 13,250 MWe Recorded in 1998)

	Geothermal		Fossil Fuels (Oil + Gas + Coal)		Hydro		Nuclear		Other Renewable		Total	
	Capa-city MWe	Gross Prod. GWh/yr	Capa-city MWe	Gross Prod. GWh/yr	Capa-city MWe	Gross Prod. GWh/yr	Capa-city MWe	Gross Prod. GWh/yr	Capa-city MWe	Gross Prod. GWh/yr	Capa-city MWe	Gross Prod. GWh/yr
Install Capacity by Jan. 2000	769.5 (3.9)	6,000	16,600 (84.8%)	77,000	2,217 (11.1 %)	7,770	-	-	-	-	19,586.5 (100 %)	90,770
In Operation in January 2000	527 (2.7%)	4,110	16,600 (85.5%)	77,000	2,217 (11.8 %)	7,770	-	-	-	-	19,346.5 (100 %)	88,880
Under construction in January 2000	23	180	330	1,550	-	-	-	-	-	-	353	1,730
Funds commited, but not yet under construction in January 2000	1,135	8,860	7,315	33,900	970	-	3,400	-	-	-	9,420	46,160
Total projected use by 2005 (commitment)	1,927.5 (6.6%)	15,040	24,245 (82.6%)	112,450	3,187 (10.8%)	?	11,170	-	-	-	29,359.5 (100 %)	138,660

Table 2. Geothermal Development Progress : January 2000 and Planned vs Proven Reserves (1995 to 2005)

	MWe					MWe Proven Reserve		
	Installed (MWe) Jan 2000	In Operation Jan 2000	Under Construction Jan 2000	Planned 2005	Cum Commitment	1995	2000	2005
JAWA-BALI								
1. KAMOJANG	140	140	-	60	230	200	230	260
2. G. SALAK	330	330	-	-	495	485	485	600
3. DARAJAT	125	55	-	140	330	140	280	350
4. DIENG	60	-	-	80	400	280	280	350
5. W. WINDU	110	-	-	220	400	-	250	400
6. PATUHA	-	-	-	160	330	-	110	250
7. KARAHA	-	-	-	210	400	-	120	250
8. CIBUNI	-	-	-	10	10	-	30	60
9.BEDUGUL	-	-	-	55	400	-	-	150
Sub Total	765	525	0	935	2995	1105	1785	2630
SUMATRA								
10. SIBAYAK	2	2	-	20	44	40	40	40
11. SARULLA	-	-	-	100	1000	80	290	500
12. ULUBELU	-	-	-	55	110	-	-	200
13. KERINCI	-	-	-	5	10	40	40	40
Sub Total	2	0	-	180	1164	160	370	780
SULAWESI								
14. LAHENDONG	2.5	-	20	20	42.5	65	80	80
NUSA TENGGARA								
15. ULUMBU	-	-	3	-	10	-	10	30
TOTAL	769.5	527	23	1135	4211.5	1330	2245	3520
Field	7	4	1+1Ext	7+6Ext	15	8	13	15

Table 7. Matrix Model of Progress Summary

	January 1995 (Cumulative)	January 2000 (Cumulative)	Estimated Jan 2005 (Cumulative)
Resources Assessments			
➡ High T/Total Prospect :	70/217	70/217	70/217?
- Prospect Has Been Drilled (by Gradient or Expl. Hole)	8	24	30
- Thermal Gradient Holes (>250m)	103	210	325-330
- Total Potential (MWe)	20,000	20,000	20,000 ?
Development Progress			
➡ Steam field :			
- Development Field	6	15	17
- Production Field	5	7	15
- Deep Wells (1200-2500m)	148	261	450-500
- Proven Potential (MWe)	1,300	2,250	3,500
➡ Power Generation :			
- MWe Installed (% Energy Mix)	309.5 (2.0%)	769.5 (3.9%)	872.5-1,927.5 (<7%)
- Unit Type			
- Single flash	2	9	
- Dry steam	4	4	
- Binary	-	1	
- Unit Rating			
- Big scale (MWe)	30-55 (Mostly)	30-110	
- Pilot (MWe)	2.5	2-2.5	
➡ Direct Heat Utilization (Bathing & Swimming)	5 Areas (42.6TJ/yr, 60%)	5 Areas (42.6TJ/yr, 60%)	?
Human Resources			
➡ Professional (not included adm. & finance group)	221 (1 person/1.5MWe) Govt. Dominant	526 (1 person/1.5MWe) Govt. & Private	700-800 (1 person/2-2.5MWe) Private Dominant

Installed (7), 769.5 MWe

Planned (8)

Status : January, 2000

ISLAND	NUMBER OF PROSPECT	TOTAL POTENTIAL MWe	RESERVE MWe	RESOURCES MWe
Sumatera	31	9,561	4,085	5,377
Jawa - Bali	22	5,681	4,336	1,445
Sulawesi	6	1,565	490	1,075
Other	11	2,850	200	2,650
TOTAL	70	19,657	9,111	10,547

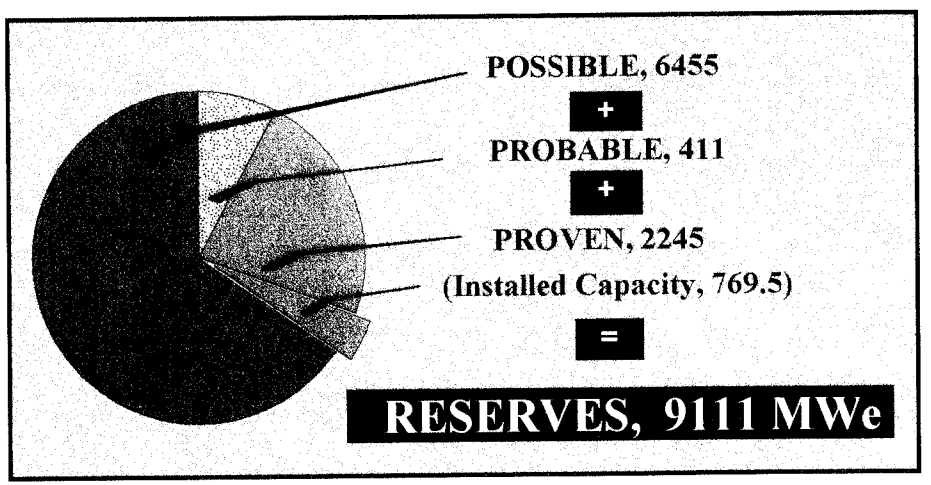

Figure 1. Geothermal Prospects Distribution in Indonesia and Its Potential and Development Progress

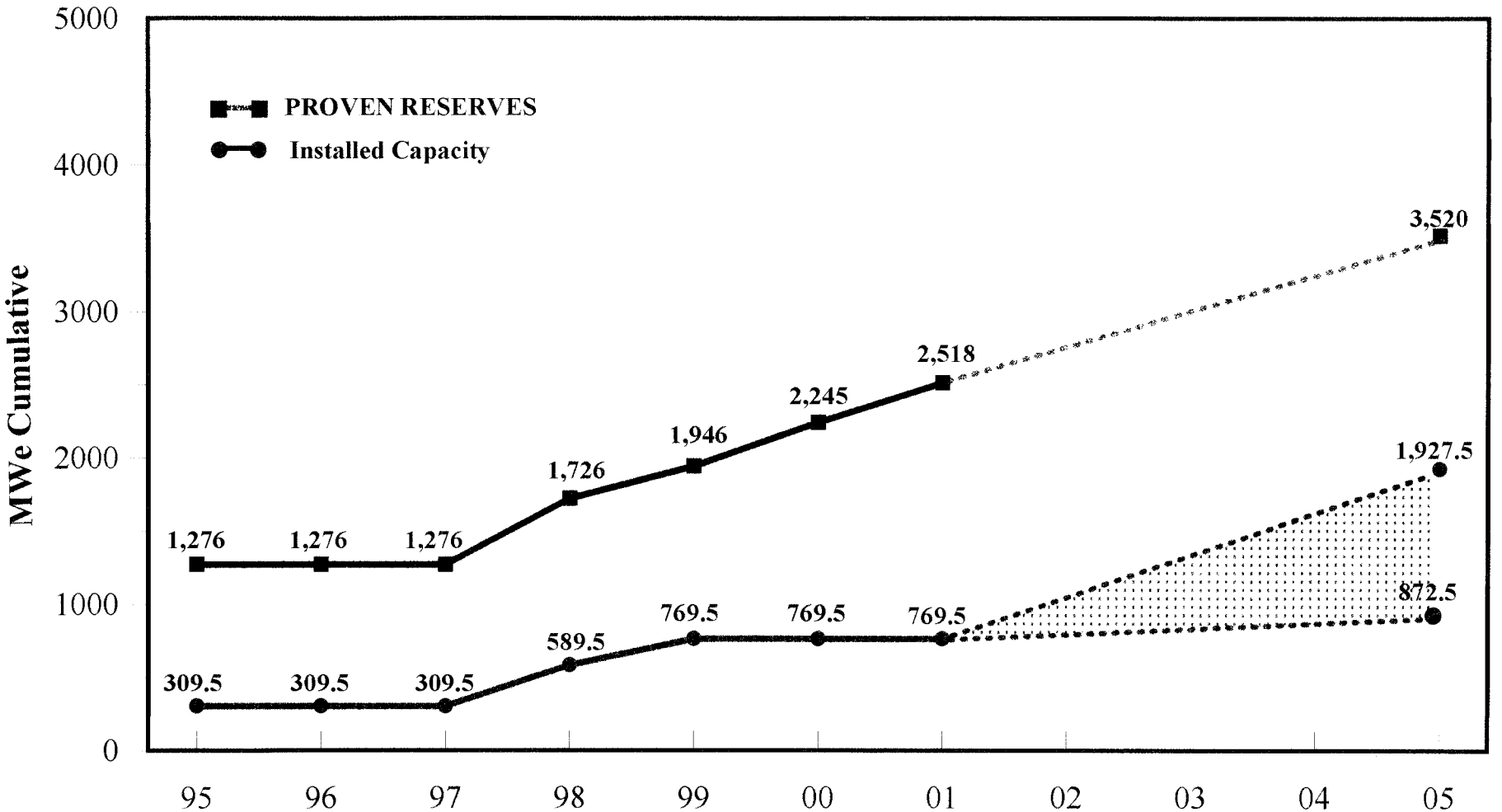

Figure 2. Correlation Between Proven Reserves and Installed Capacity