UTILIZATION OF SMALL SCALE GEOTHERMAL POWER PLANTS FOR RURAL ELECTRIFICATION IN INDONESIA

Vincent T. Radja and Edison Saragih

PLN, Indonesia

Key words: power generation industry, small geothermal plants, rural electrification, Indonesia

ABSTRACT

Indonesia is currently in the midst of a major rural electrification program. The national government is performing an evaluation of all fuel sources in the country and is encouraging the development of a diversified electrical power generation industry. This diversification includes utilizing the extensive indigeneous geothermal resources on many remote islands in mini geothermal plants to reduce dependence on small diesel power generators and conserve oil for export.

The geothermal reserves in Indonesia are estimated at about 10,000 MWe while the resource potential is about 42,600 MWe.

Rapid development of mini geothermal power plants of less than 10 MWe in capacity is expected in numerous locations such as Ambon and Lombok in the next few years.

1.0 INTRODUCTION

Indonesia is made up of more than 1,300 islands of varying size located between 6^0 N -11' S lattitude and 95^0 - 141' E longitude. The stretch of seas between the islands, the distribution of population, and the pattern of electrical load growth is such that interconnecting the electrical system throughout the whole country is not technically or economically viable at the present time.

Indonesia has more than 61,000 rural villages of widely varying size and wealth, which makes electrical transmission planning very complex. Small diesel generating plants are common. The Indonesian government is implementing a rural electrification program and is promoting the use of substitute fuels to increase the amount of Indonesian oil available for export.

Regional studies on the total geothermal resources in Indonesia indicate the potential resource base is around 42,600 MWe. The possible, probable, and proven geothermal reserves as calculated by the Indonesian Departement of Mines and Energy in 1994 are believed to be around 10,000 MWe.

There are more than 200 prospective geothermal areas which are mostly located in rural areas and are isolated from the existing electrical grid. Accordingly, the development of mini geothermal power plants in these areas can meet the government's electrification and petroleum export goals. This paper describes the ongoing progress of the rural electrification project and discusses the positive values of geothermal energy for the entire country of Indonesia.

2.0 ENERGY POLICY

The Indonesian government has developed a national energy policy which includes the following main components.

1. Evaluating all energy resources in the country.
2. Diversification of energy sources and reducing the dependency on oil by promoting conservation and use of substitute fuels.
3. Making sure each energy need is met with the most appropriate energy resource available within the country.

Geothermal energy is viewed as an alternative energy which is renewable, relatively clean, and nonexportable. The utilization of geothermal resources has a first priority as this resource is particulary abundant in the volcanic islands of Indonesia.

Presidential Decree No. **45,** dated October 1 1991, gives the State Electricity Corporation (PLN) authority to develop small scale geothermal power plants of less than 10 MWe in size. This development includes both the resource development and power plant. It is intended that this Decree will speed up development of geothermal energy in rural areas and conserve oil for export purposes.

3.0 GOETHERMAL PROSPECTS AREAS

3.1 Reserve and Resources Potential

Past regional studies on the total geothermal potential of Indonesia indicated around 16,000 MWe may be present. In 1994, a study by the Technical Commision on Geothermal Study by the Department of Mines and Energy concluded the reserve and resource potentials were 10,078 and 42,632 MWe respectively (Table 3.1).

In Indonesia the reserve potential is broken into possible, probable, and proven potential. The resource potential consists of speculative and hypothetical potential. **Speculative** potential is based on reconnaissance studies. **Hypothetical** potential is based on preliminary chemical and thermal discharge data. **Possible** reserves are based on detailed geoscientific studies. **Probable** reserves are based on models of reservoir simulation and wildcat well results. **Proven** reserves are based on production well results.

Table 3.1 Geothermal Potential in Indonesia and its classification

Classification	Potential
Reserves Potential	
Proven	1,05 MW
Probable	1,218 MW
Possible	7,803 MW
Total	10,073 MW
Resource Potentials	
Hypotetive	6, 132 MW
Speculative	36, *500* MW
Total	42. 632 MW

By the end of 1994 the installed geothermal power base in Indoensia consisted of 309.5 MWe from power plants at six different areas (Table 3.2).

Table 3.2 Committed Geothermal Power Plants in Indonesia

Capacity Scales	**in** MW			
	1995	1996	1997	1998
Major Scales				
Krnj 1,2,3	140	140	140	140
Krnj 4	**55**	110	110	110
Sal 1,2	**55**	***55***	***55***	***55***
Sal 3,4		55	***55***	55
D j 1	*55*	*55*	*55*	*55*
D j **2**		**55**	**55**	55
Die I	20	20	20	20
Die 2,3		110	110	110
Lhd		20	20	20
Small Scales :				
Die, mono	2	2	2	2
Lhd, Bin	***2.5***	***2.5***	2.5	***2.5***
Ulb	3	3	6	6
Krc	0.4	**5.4**	**5.4**	10.4
Lorn			5	10
Arnb		5	10	10

3.2 POTENTIAL DISTRIBUTION

There are 207 known prospective geothermal areas spread along the Mediterranean and

Circum Pacific volcanis belts throughout .Indonesia (Table 3.3). Most of these are in rural areas and are considered remote with respect to the existing electical grid.

Table 3.3 Geothermal Potential in Indonesia based on its Distribution

No.	Island	Total (Pros)	Reserve (MW)	Resource (MW)
1.	Sumtr	68	3,531	14,248
2.	Java	65	5,019	10,836
3.	NTn	13	278	3,315
4.	Sulws	48	1,250	11,315
5.	Maluku	68	65	13
	Total	207	10,078	42,632

4.0 RURAL ELECTRIFICATION PROGRAM

There are 61,975 recognized rural villages in Indoensia which can be classified into three categories: modern, transitional, and traditional villages (Table 4.1). These vary widely in size and income level. On Java, the most populated island in Indonesia, 98% of the villages are modern or transitional while outside of Java this figure decreases to 80%.

Table 4.1 Categories of villages

No.	Categories of Villages	Breakdown in Java	Outside Java
1.	Modem	50	24
2.	Transition	48	56
3.	Traditional	2	20

As of March 1994, there were 30,394 villages electrified under the Rural Electrification Program. this marked the end od the Five Year National Plan known as PELITA. PLN's target for the next five years is electification an additional 18,619 villages. Most rural electrification is conducted by PLN but in some areas cooperatives are also involved.

4.2 Rural Electrification by PLN

Prior to fiscal year 1990/1991 the rural electrification program was financed by the Indonesian government through PLN's budget. Since then International Bank for Reconstruction and Development (IBRD) has been loaning funds for this program under the Rural Electrification Project Stage I (RE I) with the following objectives.

1. An investment program has been implemented to electrify about 4,500 new villages during fiscal years 1990/1991, and 1991/1992. This includes 33,000 km of MV and LV power lines, 571,000 KVA of transformer capacity, 11,000 kW of diesel generation capacity, and the connection of about 1.3 million new customers.

2. Developing and implementing a pilot demonstration program for increased the productive use of electricity.

3. Suppling technical assistance and consulting services.

To expand on the previous program, a second RE II program is underway with the following objectives.

1. Electrification of 7,000 rural villages in the second and third years of PELITA VI (1995/1996 - 1996/1997). This includes adding about 2.1 million new customers through the construction of an estimated 28,000 km of MV line and 35,000 km of LV lines, 1.3 million poles, and 833 MVA of distribution transfer capacity.

2. Provision of technical assistance and increased efficiency of economic sub-transmission schemes.

3. Develop renewable energy, specifically mini hydro and mini geothermal projects.

4.3 Promotion of Small Geothermal Projects

The development of mini geothermal projects was initiated in 1981 when the Volcanological Survey of Indonesia (VSI) and PLN in bilateral cooperation with the Japan International Cooperation Agency (JICA) implemented a geoscientific survey and exploratory drilling at Kerinci, West Sumatera. The first exploratory well was not suitable for electrical power generation, however the second exploratory well in **1989** produced enough steam to generate **375** kW of electricity and indicated a potential of 5 MWe. Implementation of this project is now being planned.

In **1989** PLN, in bilateral technical cooperation with the Government of New Zealand, began promoting the Ulumbu Mini Geothermal Project in Flores. Contracting for drilling activities commenced in **1993** and hopefully production drilling activity will commence in **1994.**

Under the RE II Program, PLN has requested a loan from the World Bank for exploration and production drilling for mini geothermal plants at Tulehu, Ambon, and at Sembalun, Lombok. In addition, funds for construction of 3 MWe plant at Ulumbu, Flores, and a **350** kW plant at Kerinci, Surnatera have been ask for Geoscientific studies are now being implemented using PLN's budget for the Tulehu and Sembalun sites. Drilling has been completed at Ulumbu and a workover is planned on a well at Kerinci.

By year **1995** plans are in place for geoscientific studies of seven locations where mini geothermal development is possible.

5.0 SMALL SCALE GEOTHERMAL DEVELOPMENT

5.1 Legal Aspects

Three Indonesian institutions are involved in geothermal activities. The Directorate of Volcanology, known as the Volconological Survey of Indonesia/VSI, performs reconnaissance surveys and preliminary studies. PETAMINA, the state oil and gas corporation develops steamfields. For the Bank requirement PLN performs feasibility studies for both the resources and engineering, engineering design, construction and operation of geothermal power plants. Under authority of Presidential Decree No. **45,** PLN has the authority to fully develop small scale geothermal power plants. This assures an integrated approach with a one company management system.

5.2 Technological Aspects

Installation of mini geothermal power plants can be implemented as soon as exploratory drilling has proven the availability of steam. However, to minimize costs and contractor risk, drilling of slim holes prior to full diameter wells is a recommended strategy. These programs may be combined using lump sum contracting.

It is anticipated most mini geothermal power plants will have back pressure turbines such as the monoblock which can be easily installed in difficult and isolated rural terrains. These turbines commonly operate more than 8,000 hours per year and can serve base-load power. In Indonesia many diesel power plants are only operated six to seven hours per day but mini geothermal power plants can operate in excess of **22** hours per day.

5.3 Contractual Aspects

Generally a steam developement project requires four individual contract documents for drilling, cementing, materials supply, and geological logging. For small scale geothermal developments, a streamlined contractual arrangement may be negotiated with an integrated drilling services company. The master contract will define all responsibility for all activities under the direction of the Consultant or PLN.

6.0 CONCLUSIONS

Most of the rural electrification in Indonesia is powered by diesel plants. The promotion of mini geothermal utilization will have a national benefit to Indonesia as new geothermal developments will allow additional oil to be exported.

Currently is a great potential for future mini geothermal power plants as there are currently about 31,581 villages remaining to be electrified in Indonesia.

The national energy diversification policy of the Indonesian government assures that geothermal energy will be substituted for diesel generation wherever it is economically feasible.

REFERENCE :

1. Flores Mini-Geothermal Power Project Ulumbu Geothermal Field Flores, Indonesia, by KRTA Ltd, New Zealand.

2. Rural Electrification Utilizing Geothermal Energy in Indonesia, by Vincent T. Radja of State Electricity Corporation, Indonesia.

3. The Role of Geothermal Energy in the Context of the Future Electric Power Supply in Indonesia, by Vincent T. Radja & Saibun Sitompul of State Electricity Corporation.

4. Geothermal Steam Pricing in Indonesia, by Vincent T. Radja & Edison Saragih of PLN, Indonesia.