SMALL SCALE GEOTHERMAL DEVELOPMENT STRATEGY FRAMEWORK

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ABSTRACT

With request to the promotion for diversification of energy resources geothermal energy is an alternative energy, renewable, relatively clean and nonexportable resource; the maximum utilization of these resources therefore has a first priority as Indonesia is one of the world prominent volcanics countries with many active volcanic phenomena.

Most of the geothermal prospects are located in rural areas, which have limited small diesel generating plants or no electricity at all; under the energy sector policy of the Government of Indonesia which stressed rural electrification, taking into account the equity of development for all Indonesia's regions and with the goal of National benefits.

To ensure that small scale geothermal power plants for rural electrification can be implemented most effectively and efficiently, a strategy framework needs to include appropriate arrangement for project planning; from scientific study to construction periods, which are currently a constraint on both cost and time domains.

This paper discusses the strategy framework approaches, including a possible combining of a serial plural activities and streamlining of contract packages.

Indonesia as a country which is made up more than 16,000 islands of varying sizes, located between 6° N-11° S Lat and 95° - 141° E Long. The stretch of the seas between the islands, the distribution of population and the pattern of load growth results in a condition where interconnection of the system in the whole country is technically and economically not a viable solution for the time being. Moreover this country consists of more than 61,000 rural villages varying widely in size and level of income, which, again complicates the distribution planning.

The Government of Indonesia stresses a guideline for the energy policy, namely: intensification on the survey and exploration of resources; diversification of energy by means of reducing oil depency utilization and promoting through development, utilization and customary use of substitute fuels; conservation of natural resources with goals to economize and efficiently use energy utilization; and indexation of each energy need with the most appropriate energy resources available in the country.

Table 1 Geothermal Potential in Indonesia and its classification

Reserves potential			
	Proven		1,057 MW
	Probable		1,218 MW
	Possible		7,803 MW
		Subtotal	10,078 MW
Resources potential			
	Hypotetive		6,132 MW
	Speculative		36,500 MW
		Subtotal	42,632 MW
		Total	**52,710 MW**

As stipulated in the Presidential Decree No. 45, October 91, National Oil Mining Company (PERTAMINA) has full authority to explore and exploit large scale geothermal energy through out the country, while other enterprises and cooperatives only have it for a small scale geothermal which is defined as geothermal development of less than 10 MW.

This decree provides a good opportunity for PLN as the holder of the Electricity Enterprise Authority, to develop geothermal energy at isolated areas which have small diesel generating plants or even have no electricity at all, under one management system, from upstream activity (steam development) to downstream activity (power plant construction).

RURAL ELECTRIFICATION PROGRAM

The total number of villages in Indonesia are comprised as 61,975 rural villages which very widely in site and level of income. According to Department of Home Affairs, there are 3 (three) categories of villages, namely: Modern, Transitional and Traditional villages.

Table 2 Categories of Villages

No.	Categories of Villages	Break Down Java	% Outside Java
1.	Modern	50	24
2.	Transitional	48	56
3.	Traditional	2	20

The villages which have been electrified under the rural electrification program up to the end of the first year of the five of the Five Year National Planning, known as PELITA V (March 1994) is 30,394, which basically are operated by PLN and cooperatives. The PLN's target for the next five year planning (March 1999) is 18,619 villages.

Before the fiscal year 1990/91 the rural electrification program was financed by the government's and PLN's budget; afterwards from this fiscal year the World Bank (WB) has been providing a loan for this program under Rural Electrification Project Stage I (REI) with the following objectives:

(1) Implementation of an investment program to construct facilities to electricity about 4,5000 new villages during the fiscal year 1990/91 and 1991/92; including 33,000 kms of MV and LV power lines, 571,000 KVA transformer capacity, 11,000 kW diesel generation capacity and connection of about 1.3 million new consumers.

(2) Development and implementation of pilot demonstration program for increasing productive use of electricity.

(3) Provision of technical assistance/consulting services.

In connection with the previous program, further RE II is now being implemented. With the following objectives:

(1) Electrification of 7,000 villages in the second and third year of PELITA VI (1995/96 - 1996/97), comprising about 2.1 million new consumers through the construction of an estimated 28,000 kms of MV lines and 35,000 kms of LV lines, 1.3 million poles and 833 MVA of distribution transfer capacity.

(2) Economic sub-transmission schemes aimed at capturing efficiency and provision of technical assistance.

(3) Renewable energy development for minihydro project and mini geothermal project.

More over in 1993 the UNDP forwarded to the World Bank Global Environmental Facility (GEF) Division, a GEF proposal entitled "Integration of Renewable Energy System within a least-cost Rural Electrification Strategy with Renewable Energy Development (RED) Project proposal has been agreed with following objectives:

(1) Catalyze rapid penetration of renewable energy based small power projects.

(2) Facilitate private sector participation in renewable energy communication.

(3) Promote environmentally sound energy resource development.

(4) Strengthen Indonesia institutional and market capacity to support renewable energy development.

The development of mini geothermal projects for rural electrification program was initiated in 1981 when Volcanological Survey of Indonesia (VSI) and PLN, under bilateral cooperation with Japan International Cooperation Agency (JICA) implemented a geoscientific survey and exploratory drilling at Kerinci, West Sumatera.

The first exploratory drilling was not entirely suitable for purpose of power generation, however the second exploratory drilling in which was part of feasibility study 1989, gave a steam production 375 kW of generating electricity and production steam for proven potential for 5 MW. So far implementation for this project is being planned.

More over in 1988 PLN, under bilateral technical cooperation which the Government of New Zealand was promoting Ulumbu Mini Geothermal Project in Flores. Contractual have been appointed in 1993 under PLN's, budget, vertical drilling (1887 m) and one directional drilling (878 m) have been finalized by 1994. Reinjection well and separator installation should be implemented prior to well testing program and a full feasibility study will be ready by 1996. Project construction costs will be covered by RED's loan.

Two projects consisting Tulehu (Ambon) and Sembalun (Lombok) have been initiated with the geoscientific study finished by PLN in 1994. Subject to reservoir assessment of scientific studies and drilling the demonstrates the presence of an adequate resource, the IBRD has confirmed to finance both projects under RE II loan. Contract evaluation and negotiation for supervising consultant services to support drilling and scientific study is now under progress.

The US Department of Energy (USDOE) is completing its scientific study of 15 sites where micro geothermal power plants may be feasible, 3 sites have been selected for further activity, further more the Government of New Zealand had done the similar study for 16 sites of Sumbawa and Flores islands.

GEOTHERMAL DEVELOPMENT

Unlike other forms of conventional power generation, geothermal development deals with subsurface geological phenomenon which are considered as heat sources, and requires that an energy resource should be proven before a project can proceed. Geothermal energy is site specific and if steam resources are not available then the site is abandoned. Therefore, the resource identification is on the critical path for geothermal development.

Basically there are three institutions involved in geothermal development, namely: Directorate of Vulcanology (known as Volcanological Survey of Indonesia, VSI) dealing with identification survey and preliminary study, PERTAMINA for steam development activities and PLN for feasibility study, engineering design, construction and operation of geothermal power plants. However, this arrangement is still viewed with reluctance in PLN, as PLN purchases steam from PERTAMINA under its Joint Operation Contract (JOC) which is not competitive enough compared to other energy resources. The new concept of the total project has been introduced through build-operate-transfer (BOT) and build-operate-own (BOO) structures in electricity privatization which practically have been used only for large scale projects.

The dichotomy between upstream and downstream territories, steam producer and steam purchaser, JOC and Energy Sales Contract (ESC), and repetition of resource feasibility which is mostly requested by lender institutions, causes complexity in geothermal development as indicated by the slow progress of geothermal power plant construction (300 MW installed).

In the past, it required 7-9 years to prepare a geothermal power project up through the feasibility study and additional 4-5 years up to commissioning time.

Experiences in mini geothermal development had faced similar delays as a result of contractual and administrative problems. Well drilling at Kerinci by VSI and JICA, which was completed in 1989, was producing a renewable power output. However this well has no longer productive since 1992 as it had not utilized as appropriate. Ulumbu Project, Flores which is totally managed by PLN project, was now more than four years behind schedule. This project was initiated in 1988 and till now well testing is still under preparation with a last revised schedule that anticipates that the project will be commissioning in 1998.

STRATEGY FRAMEWORK

Table 3 Technical Comparison Slim Hole and Conventional Drilling

Remarks	Slim Hole Drilling	Conventional Drilling
Drilling Depth, feet	3500 - 7000	3500 - 7000
Hole Diameter at final depth, inch/mm	2-3/50-75	6-81/2/150-216
Rig, Weight, m.tons	14-22	40-65
Installed power, kW	74-90	280-350
Drill string weight, m. ton	3.5-5.5	30-42
mudpump power, kW	44-73	180-300
Hole Volume, 1/m	3.5-6.0	18-37
Mud tank capacity, M3	5	50-75
Circulated mud volume, M3	8-10	80-110
Additive cost of drilling mud, %	20	100 (50*-64m²)
Casing weight, Kg/m	4.4	25
Casing cost, %	30	1000
Drill site area, %	24(25x32m²)	100

A particular opportunity exists in mini geothermal development, where institutional and project management are handled by a single system management. Furthermore as its distribution is concerned the geothermal prospect areas are widely located across the archipelago where rural villages are located.

The overall structure of the framework program for mini geothermal development is to promote the diversification policy through development, utilization and customary use of geothermal energy under the rural electrification program with respect to the equity of development all over the country. An important focus of the program is to match the strategy framework with pragmatic concerns and the most recent reliable technological development.

Pragmatic concern is connected with project development schedule and contractual arrangements, geoscientific study, drilling, analysis of resources, engineering, economic, financial and environmental feasibility as well as simple design activities which should all be combined in one package based on parallel configurations.

It means that physical risk is higher than usually encountered in for large scale geothermal development, however in terms of cost, which commonly is called sunk cost, the difference can be neglected as the design engineering fee is concerned with use of simple modular design concept. The schedule of power plant installation follows a simple order, the longest item is the administrative contract management which occupies 2/3 of the time schedule allocation.

The critical path of the schedule is drilling activity, which is usually connected with a high risk operation. Contractual arrangements are to be undertaken efficiently by utilizing an integrated drilling services tender, the purpose of which is to ensure an integrated approach for preparatory works, drilling, supply materials, cementing services, well logging, equipment, and related production testing, with development controlled by a single contractor.

Slim Hole Drilling (SHD) and Ultra Slim Drilling (USHD) techniques as well, obviously should be used in mini geothermal development. Current practical experiences (6 micro drill - AB, Camenon) indicate that using such techniques environmental impact, access constraint and operation cost can be reduced by a significant amount with the assumption as following figures: horizontal radial flows, homogene formation, incompressible fluids and steady state flows; resulting the ratio between production discharges of SHD and conventional drilling will be 0.892: 1.0 (D'Arcy law).

In order to focus so that the tight time schedule is properly executed, construction planning has to depend on modular design concept approaches. Which are currently in innovation development trends in mini geothermal power plants manufacturing. The goal of this concept is to optimize efficiency and cost-effectiveness in terms of using modular components of proven design, short delivery times, flexible and faster design, easy operation and maintenance.

CONCLUSIONS

The strategy framework to consist of combining of serial order activities into tight parallel schedule, contractual arrangements of integrated drilling services utilizing slimhole techniques and application of modular design concept. This strategy should be referred with recent technology geothermal development. The higher risk grade particullary paid for the rural electrification program where its physical infrastructures and human resources are currently a constraint on both economic development and the alleviation of poverty.

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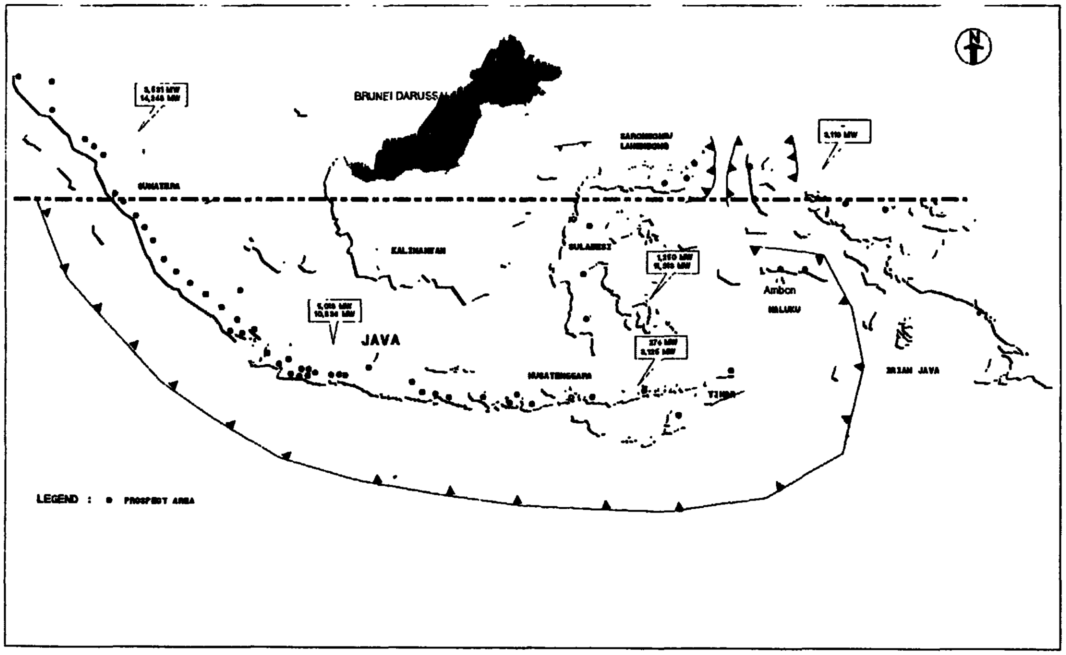
FIG.I **RESERVE AND RESOURCE POTENTIALS OF GEOTHERMAL IN INDONESIA**



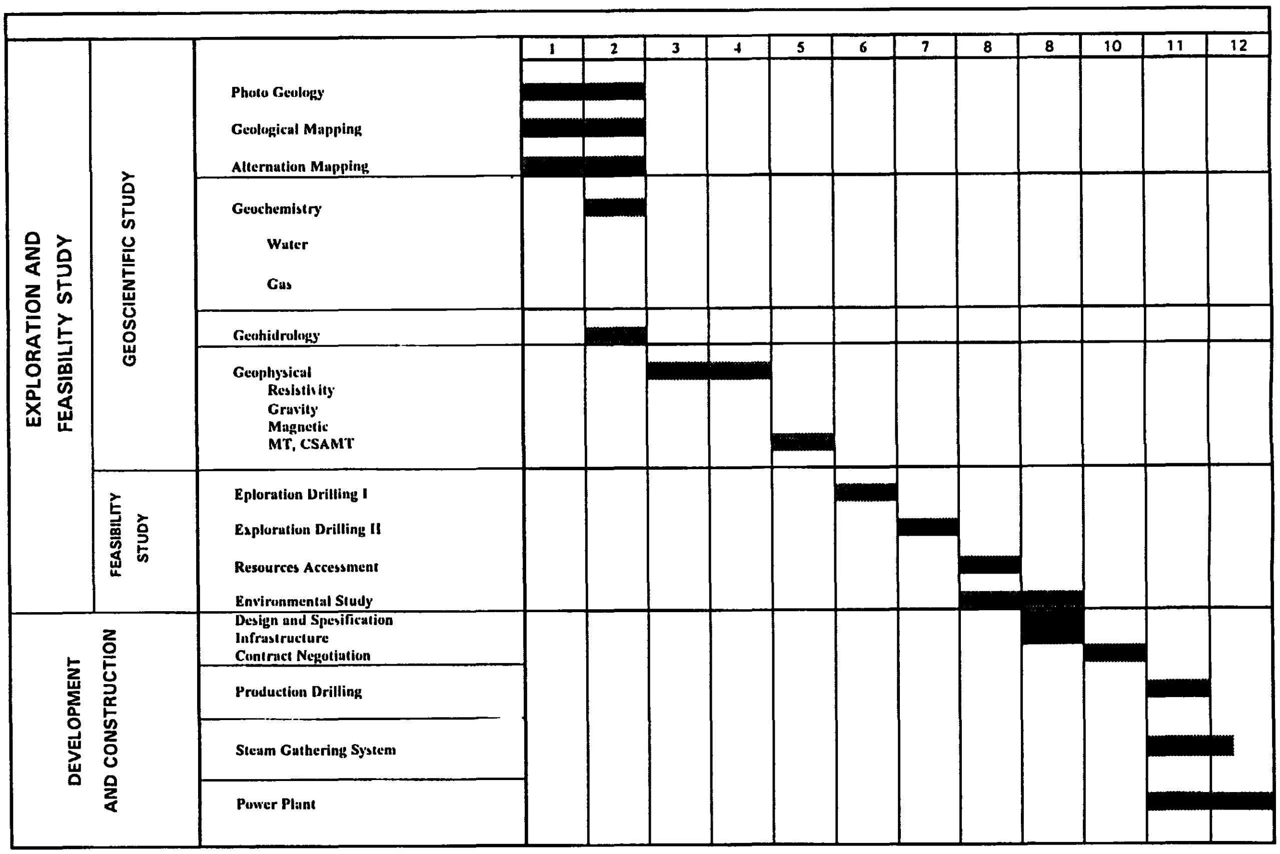


Figure 3 - Conservative schedule of Conventional Geothermal Developments

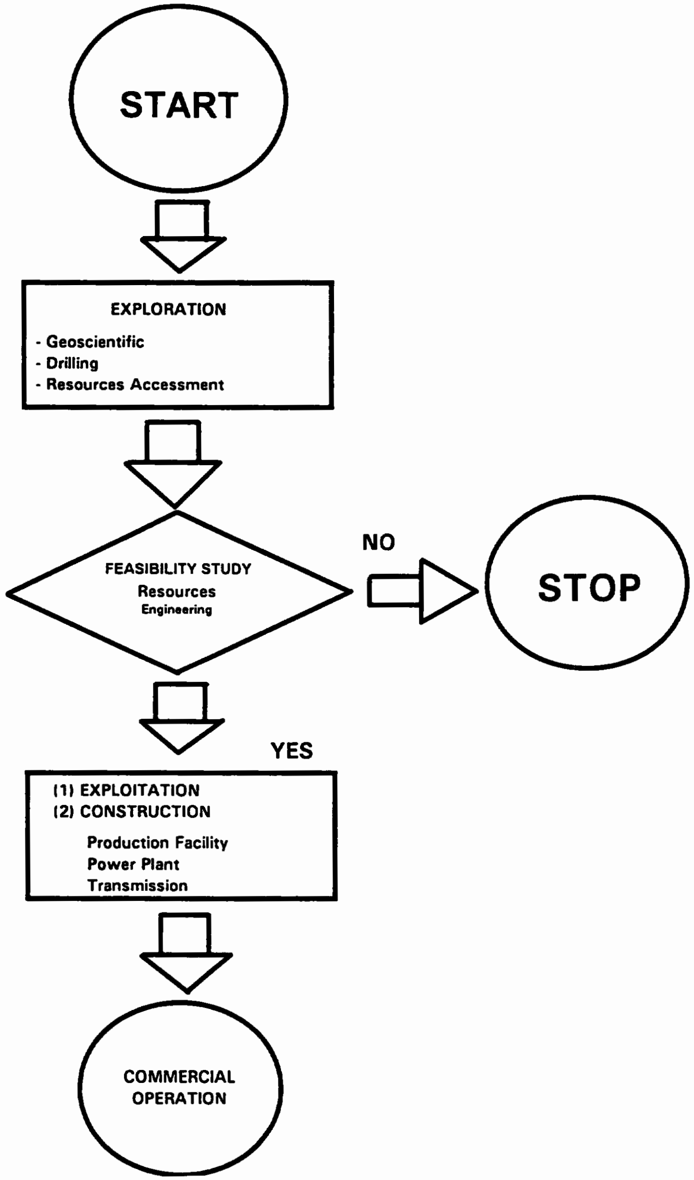
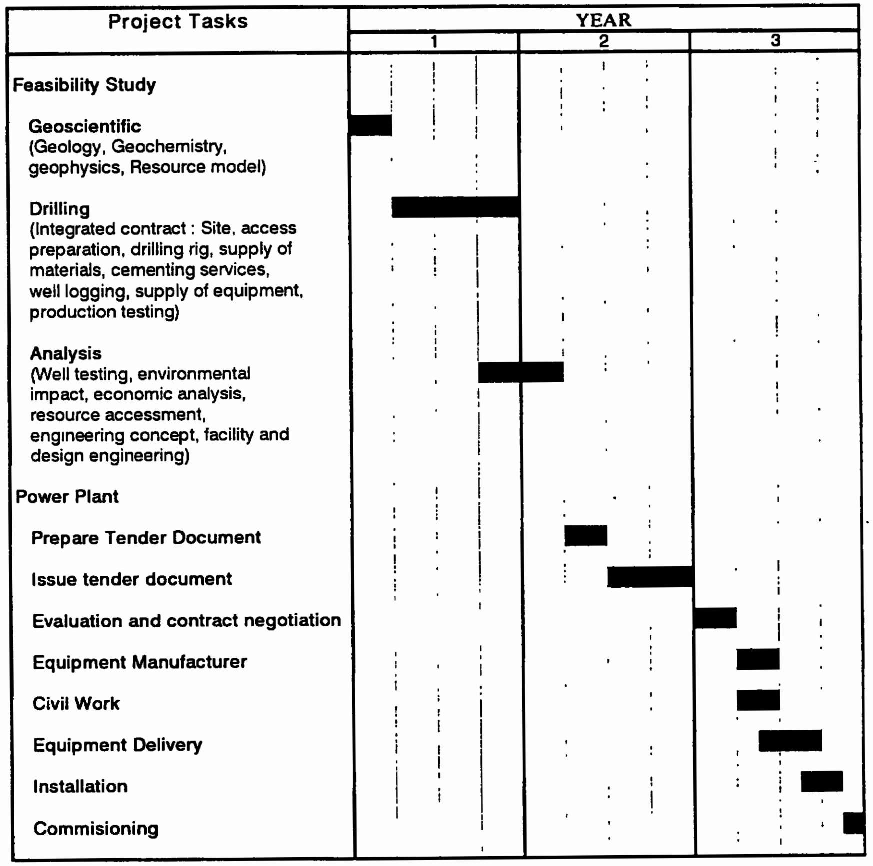


Figure 2 - Flowchart of Geothermal Development

FIGURE 4. SMALL SCALE GEOTHERMAL DEVELOPMENT SCHEDULE



ALPHABETICAL LISTING OF AUTHORS