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MAXIMIZING COMMUNITY BENEFITS AND MINIMIZING ENVIRONMENTAL IMPACTS IN THE GUNUNG SALAK GEOTHERMAL PROJECT, INDONESIA

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ABSTRACT

The 330 MW Salak geothermal field in West Java, Indonesia has been developed in a manner that has enabled Unocal Geothermal of Indonesia (UGI) and its partners to successfully mitigate impacts on the surrounding environment. The project has shown that commercial geothermal development in a protected forest area can preserve the environment and provide economic benefit to the surrounding community.

Salak field is situated in an area of dense primary rain forest, which is very sparsely populated. The surrounding population lives in small villages, some of which lie close to the forest boundary. Principal economic activity is wet rice cultivation and fish farming supplemented by collection of forest products. The construction of the first phase of the Salak project (110 MW) started in 1990 and began providing power in 1994. An expansion development program (220 MW) was initiated in 1994 and commercial operations started in late 1997. A 1989 environmental impact assessment (EIA) for the initial development was followed in early 1994 by a second EIA, which incorporated Unocal's Phase 1 experience and addressed stricter measures to protect the environment.

Community projects were developed using three criteria: to directly improve the public health, education and local environment; encourage self-help and community participation; and to create a positive awareness of UGI's role in the project area and its contribution to the local economy.

UGI's well-planned community development program and responsible environmental management has been very successful, and the project won a prestigious environmental award from the Indonesian government in 1997.

1. INTRODUCTION

The Gunung Salak geothermal project is located in the middle of a protected forest about 60 km south of Jakarta (Figure 1). The contract area was formed in 1982 when Unocal Geothermal Indonesia (UGI) entered into a Joint Operating Contract (JOC) with the Indonesian National Oil Company (PERTAMINA) and the national electrical utility of the Indonesian government, PT. PLN. The first geothermal exploration at Salak was conducted from 1982 through 1986. UGI drilled several deep (<2000m) wells at Awibengkok and Kawah Ratu prospects. The discovery well Awi-1 was drilled in 1982 in Awibengkok. The Kawah Ratu field showed little commercial potential and further exploration was focussed on Awibengkok. The first 110 MW (2 x 55 MW) power plants started commercial operation in March 1994. PT. PLN constructed the power plants (Unit 1 and 2) and UGI drilled the production and injection wells and built the surface production facilities.

Between 1995 and 1997, four additional power plants (4 x 55 MW) were built at Salak. PT. PLN built and operates Unit 3, and UGI constructed and operates Units 4-6. To meet the steam supply requirements for the four new power plants, UGI drilled additional production and injection wells and installed associated surface facilities. In November 1997 the installed capacity of Salak was increased to 330 MW, making this field one of the six largest operating geothermal plants in the world (Soeparjadi, et al., 1998).

During the exploration and development phases at Salak, many community and environmental issues challenged UGI. These included working in a sensitive and remote protected forest area, and transporting heavy equipment on a narrow access road through several local communities. Despite these impediments, the project was completed on time and on budget without significant negative environmental impacts, while creating economic benefit for the community living around the project site.

The well-defined and implemented Salak environmental management and community development program earned UGI PERTAMINA's Patra Adikriya Bhumi Pratama environmental award in 1997.

UGI and PERTAMINA continue to work with the communities, local government and local universities to improve the environment of the Salak protected forest and social well being of the surrounding communities.

2. PROJECT AND ENVIRONMENTAL BACKGROUND

The Awibengkok geothermal field hosts a high temperature liquid dominated reservoir containing relatively benign fluid (Table 1). During the first development phase from 1991 through 1994, eight production wells and six injection wells were drilled to fulfill the initial steam requirements for the first two

power plants, with an installed capacity of 2 x 55 MW (Figure 2). The production wells (Awi 7, 8 and 11) are located in the central part of reservoir, while the injection wells (Awi 9 and 10) were drilled nearby. Multi-well locations with "big hole" well completions were used to minimize land removed from forest use. Starting in early 1995, another 30 wells were drilled as part the second development phase of Salak field. The 19 production wells and 11 injectors provide steam and injection capacity for the next 220 MW. These wells are located mostly in the eastern part of the field. All produced fluids (with the exception of some condensed steam from the power plant cooling towers) are injected back into the reservoir to minimize environmental impact. The units 3 to 6 development strategy was to continue producing from the central part of the reservoir and inject at the periphery of the field (Figure 3). As part of this strategy, two injection wells at Awi 10 were successfully converted to production wells. Salak field began commercial generation of 330 MW in November 1997 (Slamet et al., 1999). This strategy maximized field production while minimizing environmental impact.

Salak occurs in the middle of a protected forest between 750 m and 1,400 m above sea level. Topographically, the field consists of highly eroded terrain with generally rounded contours and narrow, steep side ridges separated by rocky streambeds. Salak field is one of the wettest areas of Java, with a mean annual rainfall between 4,000 and 6,000 mm. A mean monthly rainfall of between 400-600 mm falls between October and April during the annual north-west monsoon, while more than 200 mm is recorded during the driest period of year, between May and September.

The total area of the Salak protected forest is about 6,700 Ha of which 175 Ha is occupied by geothermal operations and right-of-way. The Salak forest forms the principal watershed for western part of West Java and is an important conservation area. The principal vegetation type is evergreen tropical rainforest, of which there are two sub-types recognized according to elevation, sub-montane and montane forest. With its altitude range and unusually high rainfall, the forest has a great floral diversity and is of unique value as a habitat for endemic and endangered fauna such as the Javan gibbon and Javan eagle.

3. SURROUNDING COMMUNITY

Administratively, the Indonesian archipelago is divided into province, regency, district and village governments. The village is the smallest administrative unit having authority to control and deal with the local community's interest. This is based on the origins and local customs and is acknowledge in the national government administration system. On community issues, UGI deals mainly on the village level. Salak is located in Kabandungan village of West Java province, approximately 40 km off the national highway. It is neighbor to a private tea plantation and communal agricultural land. However, the socio-economic impacts of the project are not only found in Kabandungan village, but also in other villages near the project.

The population density at the project site village and nearby villages ranges between 613-1687 people per square km. The high population density at project site village is because most of the land area is predominantly forest (28%) and tea plantation (66%). Thus, the effective land area (agrarian density) or the land that can be used for farming is small (6%). Conversely, population access to land resources in the three villages near the project site is relatively more because the area controlled by plantation is only 20% of the total village area (Table 2). However, access to land resources does not guarantee that the living standard of the community will increase. This depends on the involvement of the community in plantation, employment and employment structure, level of education, and the community's effort to resolve economic pressure by developing new business opportunities. Construction of the Salak project provided many opportunities for employment and small business development. UGI also gives priority to local labor and businesses for ongoing field operations.

The education level of the community is relatively low. Only 0.3% of the total community has university education and 8% of those graduated from senior high school. About 47% have an elementary education. Education for women is relatively limited because traditional values are still upheld by the community, which does not prioritize education for women.

The principal economic activities is wet rice cultivation, supplemented by fish farming supplemented by collection of forest products. Almost 14% of the population owns wet rice fields, while 19% own dry land farmland. The rest do not own land except home gardens.

Household income levels are based on the Sajogjo standard, which is set by the poverty line. This is set at the equivalent household income required to purchase 320 kg of rice per capita per year, achieving a basic standard of living. Using this basis, 15% of the population live below the minimum poverty line.

4. ENVIRONMENTAL IMPACT AND MITIGATION MEASURES

In Indonesia, the environmental effects of development activities are controlled through the provisions of the Environmental Management Act 1997. The Act is an umbrella regulation for the sustainable management of natural and physical resources focusing on the effects of project activities on the environment. UGI recognizes its responsibility and obligation to minimize the impact of its operations

on the environment. Therefore, in 1983 at the beginning of the exploration stage UGI conducted an ecological baseline study to ensure that all the environmental characteristics in and around the field area were well understood and documented. Geothermal operations typically take place in areas of natural thermal activity (hot springs and steam vents). Following the exploration program, UGI, in collaboration with the Indonesian forestry agency, conducted several preliminary environmental impact identification studies (Table 3).

At the end of 1989, UGI performed an in-depth Environmental Impact Assessment (EIA) to identify potential environmental effects due to the initial 110 MW geothermal development. The study assessed specific environmental impacts and defined measures to minimize adverse consequences. UGI conducted another EIA in 1993 before the second development phase, to assess the environmental impact of expanding the field capacity by 220 MW. Moreover, it was an opportunity to learn from the experience gathered from the first 110 MW development and mitigate any environmental impacts and observed shortcomings of the first phase (Slamet et. al., 1999).

Environmental issues identified in the 1989 and 1993 environmental impact assessment studies included:

- Decreasing the protected forest area.
- Temporary disturbance to the wildlife habitat, particularly during the exploration and construction activities.
- Increasing surface soil erosion during construction activities.
- Temporary changes in physical characteristic of stream water quality.
- Increasing effect of hydrogen sulfide concentration on the ambient air quality.
- Increasing traffic on the narrow access road causing congestion and traffic accidents.
- Socio-economic impacts which primarily create employment and new business opportunities.

Unocal mitigated the environmental issues significantly through well design management and monitoring programs and a dedicated project commitment to protect and conserve the conservation area functions. Mitigation measures were designed to:

- Provide replacement land two times larger than the actual forest area used by geothermal operations and right of way
- Implement extensive reforestation at the unused project sites.
- Minimize forest usage and control land clearing, including maximizing the use of existing cleared areas to extend surface facilities. During site clearance and construction, close supervision was maintained on the drivers of earthmoving equipment, in order to prevent unnecessary tree cutting.
- Avoid forest fragmentation leading to loss of animal pollinators and predators and a decrease of species balance.
- Operate brine and condensate reinjection. After the start of commercial operations of 330 MW installed capacity, the total amount of separated brine reinjected is up to about 11 million kg/hr or about 1,700,000 barrels/day, making this one of the world's largest volume water injection systems.
- Monitor gas emission at the cooling towers. There are strict procedures for monitoring the emitted hydrogen sulfide from the cooling towers.
- Improve and maintained the access road. Project mobilization, construction and demobilization traffic was scheduled to minimized impact to the community.
- Develop community outreach programs based on the community needs assessment and partnership initiatives.

5. UNOCAL SOCIAL RESPONSIBILITY

It is the vision of Unocal to maintain good neighbor practices and to improve the quality of life in all of the communities where the company does business. As is common in developing countries, the main community concerns for having a project in the countryside like the Salak area are to enhance local economic and social development. The development and improvement of local infrastructures and facilities is therefore the main issue in making the program.

The preliminary steps to formulate the community program involved a thorough and methodical assessment of relevant issues and the pressing needs and concerns of the local communities and government authorities. The community projects developed based on this assessment can be grouped into five areas, namely public and welfare, environmental and information, education, infrastructure, and income generating projects.

However, to avoid a dependency relation between UGI and the community, the following principles were used in developing the community program:

- UGI will develop and conduct an appropriate program in line with Unocal's mission, vision and values of improving the lives of people wherever we work. This forms the basis for growing together with local resources, particularly with those of local communities and government authorities.
- The programs should support, not replace the local government development plans, and accelerate the development process, especially in the area that is directly impacted by the project.
- The programs should be based on the assessment of issues and needs of the local communities with the input and participation of those communities.

- The programs should help develop good relations between UGI and the communities and an understanding of how the project benefits the community.

Unocal focuses on community projects that directly improve the public health, education and environmental well being, especially for the young. It encourages self-help and community participation. Public welfare projects were supported focusing on basic social services that could not be served by the government due to the limited facilities and resources. The programs included primary health care, child and maternal health assistance, and emergency medical assistance. Environmental and information sharing projects were designed to promote understanding and appreciation of geothermal operations. The activities included periodic formal and informal meetings, distributing fact sheets, making audio-visual presentations, and education in the schools and other public facilities.

Infrastructure assistance projects were implemented to respond to community needs for physical structures and facilities of general use and benefit. Each project varied in magnitude and scope in terms of the financial, technical and material requirements.

6. CONCLUSION

Development of natural resources provides benefits to the nation and community when conducted in a responsible manner. It enhances the standard of living for many people, including those not directly associated with the project. It must be respectful of the physical environment and local culture.

Table 1. Awibengkok Reservoir Characteristic

Temperature	221 – 312 ^{0}C (430 – 593 ^{0}F)
Steam Flash	17% - 100%
Permeability	up to 1,000,000 md-ft
Chemistry	NaCl brine, TDS = 13,000 ppm
NCG	average 1.0% by wt. in steam

At the Gunung Salak Geothermal project, UGI and Pertamina have proved that as responsible operators. They successfully developed a geothermal resource in a protected forest while preserving the environment and improving the lives of communities around the project.

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Figure 1. Salak Contract Area

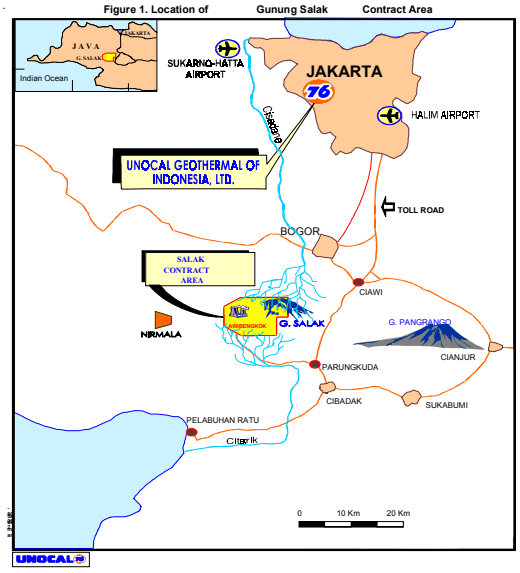

Table 2. Land Use at the Project Site and Near Site

Land Use Type	Project Site Village		Near Project Village 1		Near Project Village 2		Near Project Village 3	
	Ha	%	Ha	%	Ha	%	Ha	%
Settlement/Garden	3.34	0.10	8.50	1.10	26.20	5.30	20.00	6.60
Rice Fields	192.00	6.30	205.00	28.30	80.20	16.20	69.20	23.00
Plantation								
• State	452.00	14.10	-	-	105.00	21.20	-	-
• Private	1527.00	50.70	-	-	100.00	20.2	56.00	18.60
Dry farmland	103.10	3.50	506.60	70.00	176.10	35.60	149.70	49.60
Protected forest	840.00	27.10	-	-	-	-	-	-
Bushes	2.00	0.06	-	-	-	-	-	-
Fish ponds	5.55	0.10	2.00	0.20	0.50	0.10	2.50	0.80
Other	2.00	0.01	1.20	0.10	3.50	0.70	2.50	0.80
Total	3100.35	100.00	723.40	100.00	493.50	100.00	300.64	100.00

Table 3. Salak Environmental Study Chronology

Project	Environmental Study
1982 Contract Signed	1982/1985 Environmental Baseline Study
1983 Awi-1 Discovery Well	1983 Environmental Report at Gunung Halimun Nature Reserve and Gunung Salak Protected Forest
	1984/1985 Preliminary Environmental Study for Gunung Salak Exploration Program
1990 Began Salak Field Development, Unit 1 & 2	1990 Environmental Impact Assessment, Management and Monitoring Plan for Salak Field Development
1994 Commercial Operation Unit 1 & 2 (110 MW)	
1995 Salak Expansion Project Units 3-6 (220 MW)	1995 Environmental Impact Assessment for Salak Expansion Project
1997 Commercial Operation 330 MW	Environmental Annual Report

Figure 2. Gunung Salak Field 110 MW Development

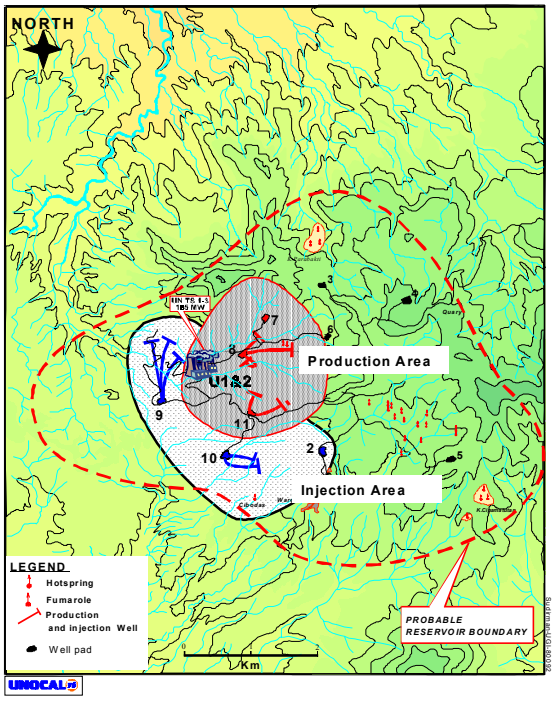

Figure 3. Gunung Salak Field 330 MW Development