COUNTRY UPDATE ON PHILIPPINE GEOTHERMAL DEVELOPMENT AND OPERATIONS, 1991-1995

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ABSTRACT

After a hiatus in geothermal development which commenced in 1984, geothermal generating capacity in the Philippines has increased over the past three years from 890 to 1071 MWe Construction activities have now commenced for the commissioning of a further 851 MWe by mid 1997. Current delineation drilling and engineering studies are expected to lead to the commissioning of a further 230 MWe by the end of the decade It is thus expected that the Philippines will have 2152 MWe of geothermal power generation by the year 2000. The means for achieving such rapid development have been: a pressing need for electric power to support industrial growth and modemisation, deregulation of power generation thus allowing for the entry of the private sector, and the formulation of Build-Operate-Transfer Legislation which has promoted strong participation by power generation utilities and plant manufacturers in the current development program.

1. INTRODUCTION

In the last country update on geothermal development in the Philippines, Datuin and Roxas (1990) reported installed geothermal capacity in the Philippines at 890 MWe and that it was intended to increase this to 2160 MWe by the year 1995. They noted, however, that potential impediments to achieving this target included a high government royalty structure imposed on steam field developers and the fact that the State owned National Power Corporation (NPC) held monopolistic control on power generation,

These concerns proved to be correct and for the early part of the decade no new geothermal developments were pursued (as had been the case throughout the mid to late nineteen eighties)~ There then occurred a number of events which provided a strong stimulus to geothermal development and have in fact allowed for the 1990 development objectives to be largely met in spite of a compressed time scale These events included

- an energy crisis on Luzon in the early nineties which led to severe electricity rationing in the capital city of Manila and eventually led to the state owned National Power Corporation (NPC) relinquishing sole control on power generation;
- the resurrection in late 1992 of a Government Energy Department which had been disbanded six years previous following a change in Government. This allowed the incoming Government to develop strong initiatives in the energy sector and implement a country wide Master Energy Plan (R.P. Department of Energy, 1993);
- introduction in 1990 of Build-Operate-Transfer legislation (Republic Act 6957) allowing far private sector development of geothermal and other types of power plant and infrastructural facilities;
- revisions to the Geothermal Development Act which are intended to make geothermal exploration and development more attractive to private investors (in progress).

As a result there has been a strong upswing in geothermal power development over the past three years Installed geothermal capacity in the Philippines as at January 1995 has increased to 1071 MWe and a further 851 MWe is fully committed for construction and commissioning on or before June 1997 (Table I) Ongoing resource delineation and engineering studies at the Mt Labo. Northern Negros and Mt Apo geothermal fields are expected to lead to the installation of an additional 230 MWe beyond that. The Philippines thus expects to have 1922 MWe of geothermal power plant installed by mid 1997 and 2152 MWe by the year 2000

Based an current and projected increases in installed geothermal energy capacity worldwide. it is apparent that Philippine capacity throughout the latter part of the decade will closely peg geothermal capacity in the United States. (Generation in the USA as at April 1992 has been estimated at 2100 MWe, declining at a rate of 10% p.a through to the year 2000 due mainly to continuing pressure reduction in the Geysers field Against this, 682 to 1106 MWe of new capacity is programmed in the United States over the rest of the decade. By the year 2000 it is thus likely that the USA will have from 2065 to 2490 MWe of geothermal generation - McLarty and Geyer, 1992)

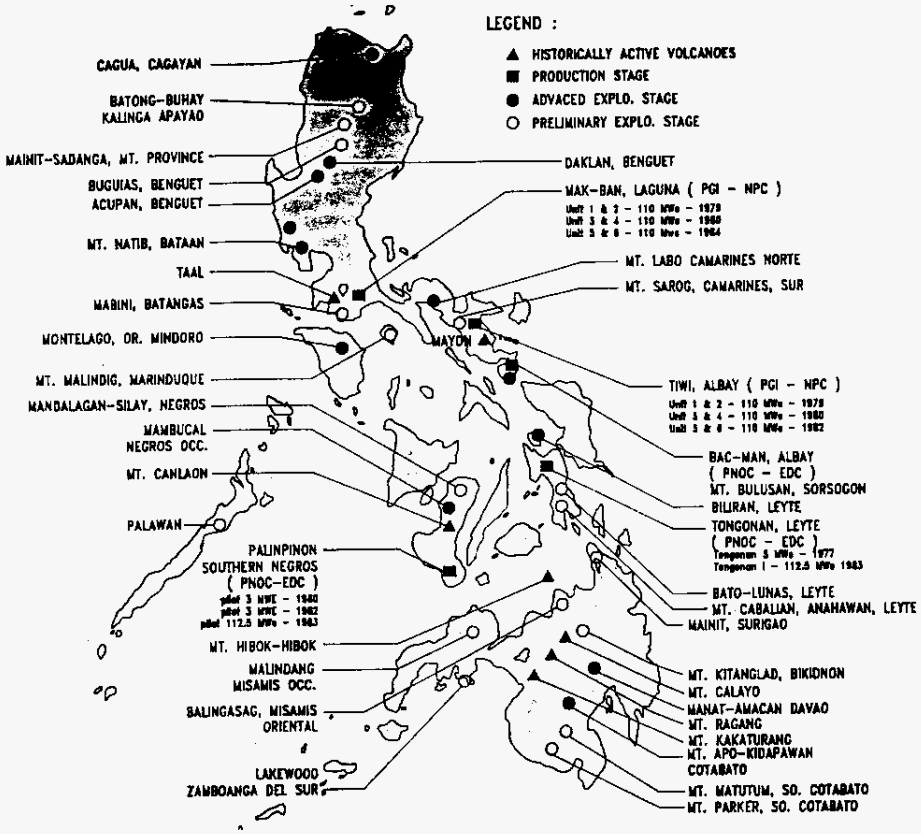
2. COMMERCIAL CONSIDERATIONS

The major problem in developing and exploiting large geothermal resources is the amount of capital required for power plant -typically 3 to 4 times the cost of developing steam fields (Javellana, 1993) The Philippines as with many countries has had problems with mobilising this sort of capital from a single source, both from within the multilateral aid agencies who are facing very strong competing demands for their limited funding resources, and from the private sector

The recent advent of Build-Operate-Transfer(BOT) legislation in the Philippines has been crucial in realising the current geothermal development expansion program as it has allowed for the entry of international power utilities to fund. construct and operate geothermal power plants. This has allowed the Philippines to rapidly increase much needed electrical generation without increasing national debt.

The commercial strategy that has been adopted to-date (for the Leyte and Mt Apo projects - Table 1) has been for PNOC-EDC. as a government owned corporation, to move from its traditional role as steam field developer and operator to instead sell wholesale electricity to NPC, the state owned power utility Conversion of steam to electricity has been subcontracted by PNOC-EDC to third parties through BOT contracts. This approach results in the Philippine Government (through PNOC) assuming control of resource development and exploitation and (through NPC) guaranteeing the purchase of power thus relieving the third party BOT power plant partners of resource and market risks This and other commercial considerations are discussed in more detail by Javellana et al , 1995 (this conference).

Figure 1



3. CURRENT DEVELOPMENT ACTIVITIES

3.1 Leyte Geothermal Power Project

The Leyte geothermal power project is the largest geothermal development undertaken in the Philippines It will result in the commissioning in mid 1996 of 200 MWe of electricity for export by AC submarine cable from the islands of Leyte to Cebu, followed by the commissioning in mid 1997 of a further 450 MWe for export by DC cable from Leyte to Luzon

Steam field development in Leyte is being undertaken wholly by PNOC-EDC and the HVAC and DC transmission systems by NPC. Both of these components are being funded by the World Bank whereas the power plants are being independently funded through BOT contracts. The project has attracted a high level of international interest and numerous foreign companies have taken contractual positions in the project. These include California Energy. Magma Power, Ormat Power Systems and the Oxbow Geothermal Corporation with BOT contracts and Fuji Electric and Ormat Power Systems for plant supply (Table 1)

Being both steam field developer and future owner of the Leyte power plants after expiry of the BOT grace periods PNOC-ELX has been in an excellent position to have the Leyte power plants optimised to the thermodynamic characteristics of each production sector. This has resulted in an increased generation capacity of some 15% relative to non-optimised steam field developments undertaken in the Philippines in the nineteen eighties.

3.2 Mindanao 1 Geothermal Project

The Mindanao I Geothermal Project is an initial 50 MWe development being undertaken by PNOC-EDC on the northwest slopes of Mt Apo (Figure 1) A total of fifteen wells have been drilled to date and *50* MWe of steam production has been confirmed available at wellhead

Protecting the high quality of the natural environment, in which the project is located has been a major concern during exploration and development activities Numerous sensitive environmental and social issues have been successfully resolved and incorporated into a development plan to the satisfaction of the majority of concerned parties (de Jesus, 1993)

A steam field fluid collection and disposal system is currently under construction by PNOC-EDC at the Mindanao project A BOT contract has been recently awarded to the Oxbow Geothermal Corporation for the construction and operation of a 50MWe power scheduled for commercial operation in January of 1997 Further delineation drilling is ongoing with the objective of committing before the end of 1995 to a further 70 MWe power development for commissioning in 1998 With rapidly increasing industrialisation and urban growth being achieved in Mindanao and a high reliance on hydro power which has historically been quite variable due to prolonged droughts. there is then considerable interest in expanding geothermal developments at Mt Apo and elsewhere in Mindanao

3.3 Malt-Ban Field

The Makiling-Banahaw (Mak-Ban) field located is immediately south of the major power market of Manila city and owned by NPC and operated by Philippine Geothermal Inc. (PGI). It is a large field which was initially commissioned at 110 MWe in 1979 and has sustained 330 MWe of generation at a high capacity factor since 1984. Reservoir performance has been panicularly *good* and this has led PGI and NPC to proceed with a 4 x 20 MWe generation expansion program which will be base loaded on top of the existing 330 MWe plant. Work is now in progress to install these units and they will be progressively commissioned during 1995.

To increase the efficiency of utilisation of geothermal heat and to maximise power to a power deficient grid, PGI and NPC have recently commissioned three Ormat binary power plants utilising heat from waste brine with an aggregate electrical output of 15.7 MWe. These plants include an acid injection system into the brine for pH control on silica scale fouling.

Table 1 **Present and Future Geothermal Generation Capacity in the Philippines (1995 to 2000)**

Field	Location/ Sector	Unit #	Unit Capacity (MWe)	T/G Manu -facture	Installed Capacity (MWe)	For Installn (MWe)	Totals (MWe)	Com- mission Date	Power Plant Operator	Steam Field Operator
Mak-Ban	Bulalo	1 to 6	55	Mitsubishi	330			1979-1984	NPC	PGI
	Bulalo	7 to 9	5.2	Ormat	15.7			1994	NPC	PGI
	Bulalo	10 to 13	20	Mitsubishi		80		1995	NPC	PGI
	Maibarara	14	11	?		11		1996	NPC	PGI
							437			
Tiwi	Tiwi	1 to 6	55	Toshiba	330	-		1979-1982	NPC	PGI
							330			
Bacon Manito	Palayan	1 & 2	55	Ansaldo	110			1993/94	NPC	PNOC-EDC
	Cawayan	3	20	Fuji/Toshiba	20			1994	NPC	PNOC-EDC
	Botong	4	20	Fuji/Toshiba		20		1995	NPC	PNOC-EDC
							150			
Mt Labo	Labo	1	20	?		20		1998	To be bid	PNOC-EDC
	Labo	2 & 3	50	?		100		2000	To be bid	PNOC-EDC
							120			
Leyte	Tongonan I	1 to 3	37.5	Mitsubishi	112.5			1983	NPC	PNOC-EDC
	Upper Mahiao	4	118	Ormat		118		1996	Cal Engy/BOT	PNOC-EDC
	Malitbog	5	77	Fuji		77		1996	Magma/BOT	PNOC-EDC
	S. Sambaloran	6 & 7	77	Fuji		154		1997	Magma/BOT	PNOC-EDC
	Mahanagdong	8 to10	60	Fuji		180		1997	Cal Engy/ BOT	PNOC-EDC
	Alto Peak	11	77	Fuji		77		1997	Magma/BOT	PNOC-EDC
	Tongonan 1	12	14	?		14		1997	Under bid	PNOC-EDC
	S. Sambaloran	13	12	?		12		1997	Under bid	PNOC-EDC
	Mahanagdong	14 to 16	6	?		18		1997	Under bid	PNOC-EDC
							763			
Sthn. Negros	Palinpinon I	1 to 3	37.5	Fuji	112.5			1983	NPC	PNOC-EDC
	Palinpinon II	4 & 5	20	Fuji	40			1994	NPC	PNOC-EDC
	Palinpinon II	6 & 7	20	Fuiji		40		1995	NPC	PNOC-EDC
							193			
Northen Negros	N.Negros I	1	40	?		40		2000	To be bid	PNOC-EDC
							40			
Mindanao	Matingao	1	50	Toshiba		50		1997	Oxbow/BOT	PNOC-EDC
	Sandawa	2	70	?		70		1998	To be bid	PNOC-EDC
							120			
					1071	**1081**	**2152**			

Notes on Operators:

NPC	National Power Corporation	Cal Engy	California Energy
PGI	Philippine Geothermal Inc.	Magma	Magma Power Company
PNOC-EDC	PNOC - Energy Development Corporation	Oxbow	Oxbow Geotheremal Corporation

PGI and NPC are also proceeding with an 11 MWe power development at Maibarara, a small satellite geothermal field located west of the Mak-ban field. This is scheduled for commissioning in late 1995.

3.4 Tiwi Field

The Tiwi geothermal field located in the Bicol region of Southern Luzon is also owned by NPC and operated by PGI. Similar to the Mak-Ban field it was commissioned at an initial level of 330 MWe, between 1979 and 1982. Field output has since dropped and it now averages 270 MWe. PGI and NPC are presently finalising plans to increase generation by a variety of means such as optimisation of existing power plants to improve generation efficiency, installation of binary power plants to utilise waste brine and low pressure steam turbines to utilise steam from drawn-down production wells.

4. RECENTLY COMMISSIONED PLANT

Over the past five years there has been only 165 MWe of new geothermal plant installed in the Philippines (Table 1) and all of this has been commissioned since December of 1993. For the 10 years prior to that there was a complete hiatus in geothermal power plant development since the commissioning of Tiwi units 5 & 6, Mak-Ban units 5 & 6, Leyte units 1 to 3, and Palinpinon units 1 to 3 (over the period 1982 to 1984). The reasons for this were a combination of political and economic factors as discussed in detail by Datuin and Roxas (1990).

4.1 BacMan Geothermal Field

After more than five years of delay, the BacMan field in 1990 became the first of the new development projects to be approved in response to the worsening power crisis that existed on Luzon that time.

Two 55 MWe turbines were commissioned between December 1993 and May of 1994 and these are now in full commercial operation supplying the Luzon grid. A 20 MWe unit in the Cawayan sector was commissioned in June 1994. A second 20 MWe unit in the Botong sector was programmed for commissioning in mid 1994, however, there is still no firm date from NPC for completion of the power plant despite PNOC-EDC having had all required wells and fluid collection and disposal systems in place since December of 1993.

Present production operations at Bacman at a level of 130 MWe are proceeding smoothly and both reservoir and reinjection performance has significantly exceeded expectations. There may be a future basis to install additional flashed steam generation capacity and/or binary power plants to recover heat from waste brine flows.

4.2 Palinpinon II

A staged installation of 4 x 20 MWe plants is currently in progress at the Palinpinon II field in Southern Negros. The first two of these units were commissioned in 1994 in the Nasuji and Balasbalas field sectors and have been in commercial operation ever since. Installation of the units 3 and 4 in the Songongon sector is now essentially complete and steam admission and turbine performance trials are in progress. Commercial operation is expected to commence in the second quarter of 1995.

With the completion of the four Palinpinon II plants there will be a total 192 MWe of geothermal power available for distribution throughout the islands of Panay, Negros and Cebu which are interconnected with submarine cables. In mid 1996, with the further interconnection of Leyte to Cebu, there will then be a five-island electricity grid spanning the Visayan islands. This grid will in turn be interconnected by mid 1997 to Luzon via the DC cable link being developed for the Leyte geothermal plants.

4.3 Palinpinon Drying Plant

The UNDP has funded a demonstration crop drying plant at Palinpinon which utilises waste brine from the Palinpinon I power development to hot-air dry coconuts, fruit and fish. The plant was commissioned in 1994 and routine operation is expected to commence as soon as reinjection capacity for the spent brine is obtained The project has a high social component and it is intended to establish a self sustaining local cooperative which can run and maintain the drying plant It is anticipated that when the project is demonstrated to be successful then similar plants will he established at geothermal projects elsewhere in the Philippines

5.0 FUTURE GEOTEERMAL DEVELOPMENT

Throughout the Philippines there are approximately forty geothermal prospects that have been investigated. Fifteen have been drilled and evaluated (Barnett at. al., 1984). Of the prospects not yet developed, current data indicates that commercial development will likely proceed within the next five years at the Mt Labo and Northern Negros prospects (Figure 1 and Table I). With the recent influx of BOT investments into the Philippine geothermal industry and the pending revisions to the Geothermal Development Act there is a high level of private sector interest in future participation in developing and operating ofthese (and other) fields.

6.0 TECHNOLOGY TRENDS

With nearly 20 years experience in developing producing and managing high temperature liquid dominated volcanic geothermal fields there is a high level of technical maturity and capability within the Philippine geothermal community as reflected in the Special Issue of Geothermics entitled Philippine Geothermal Systems (Vol 22, October/ December 1993). Nonetheless, there are a number of persistent problems upon which considerable technical interest remains focussed. These include the not infrequent occurrence of acid fluids leading to corrosion of casing and surface piping and wellbore deposition of anhydrite and other mineral phases; high gas levels leading to increased gas extraction requirements and development costs; difficulties in obtaining adequate reinjection well capacity at an adequate distance from production wells and then in maintaining such capacity against continuous declines due to silica scaling and premature returns of injection fluids to production wells.

Technology developments which have proven to be of considerable benefit over recent years include optimisation studies to thermodynamically and economically match steam field to power plant; increased use of secondary recovery of geothermal heat for power or indusmal heat, routine use of nitrogen gas for well discharge stimulation; acidizing mud damaged production wells and silica damaged reinjection wells to improve capacities; use of chemical tracers for on-line measurements of well output characteristics. improved two phase flow correlations for steam field piping design. testing of proprietary chemicals for inhibiting silica deposition from highly saturated waste brines; wmmercial recovery of silica from waste brines; drilling large diameter well completions to increase well outputs; improved drilling hydraulics programs for better hole cleaning and reduced occurrences of stuck drill pipe,

7.0 FUTURE OUTLOOK

With most of the clearly identifiable geothermal fields in the Philippines now developed and/or coming into commercial operation by mid 1997 with a total generating capacity of some 2000 MWe, there is now a reasonable basis to place the overall geothermal reserve in the Philippines which is useable for electric power generation in the range of 3000 (probable) to 4000 (potential) MWe (see also Sussman et al, 1993). This is substantially less than the total potential reserve of 8000 MWe suggested by Datuin and Roxas (1990) and reflects the results of exploration drilling undertaken by PNOC-EDC over the last 5 years which clearly demonstrates that not all younger volcanic features with active geothermal systems are suitable for commercial exploitation within current technology and materials. due either to poor permeability or the presence of acidic magmatic vapours.

It is thus anticipated that over the next five years most effort in the geothermal industry in the Philippines will be directed towards construction and commissioning of new plant, reservoir management, and to achieving greater utilisation efficiencies with topping and bottoming cycle plant, waste heat recovery and controls on silica deposition.

From a commercial perspective it is expected that private sector participation will become increasingly more important in the future for both steam field development and power generation. The latter may become a major arena for the private sector if the Philippine Government should elect to sell off geothermal power plants currently owned ami operated by NPC. Any such move would be consistent with the Governments interests in shedding national assets and with NPC's hemal objectives to restructure into either three regional generation/ transmission companies or to transfer generation to the private sector and to operate solely as a national transmission agency.

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