THE PHILIPPINES' GEOTHERMAL POTENTIAL AND ITS DEVELOPMENT: AN UPDATE

B.S. Tolentino and B.C. Buñing

Geothermal Division
PNOC Energy Development Corporation
7901 Makati Avenue
Makati, Metro Manila, Philippines

ABSTRACT

Within a span of 12 years, since the 1973 oil crisis, the Philippines has become the world's second largest producer of geothermal energy.

Today, the country has four developed geothermal fields with a combined generating capacity of 894 MWe, and about 25 more prospects in various stages of exploration and development.

The Philippines hopes to attain a 50 percent energy self-sufficiency by the end of 1985, and possibly greater towards the turn of the decade, with development of its geothermal and other indigenous-energy programs.

INTRODUCTION

The Philippines, like most developing countries, was stunned by the 1973 oil crisis. As it was almost 95 percent dependent on imported oil, supply uncertainties threatened to abort on-going programs on economic, social and political development of the country. What was worst was the skyrocketting oil bill — from only US $230 million in 1974 to as high as US $2.6 billion in 1982 (Ministry of Energy, 1984a).

The government's initial steps towards greater participation in the oil industry — from refining to marketing, and even international and inter-island oil movement — provided some cushion to the impact of the energy crisis. But it became increasingly clear that the country could not forever depend on imported oil, and thus, alternative energy resources should be tapped to ultimately achieve energy self-reliance. The government, therefore, was forced to embark on an energy strategy which would reduce the country's dependence on foreign petroleum.

This energy strategy mandates, among other things, the implementation and maintenance of a comprehensive, aggressive and accelerated energy resources development program. Thus, diversification from depletable to alternative sources of energy was accelerated, with emphasis on indigenously abundant and regenerative forms (Malixi and Tolentino, 1982). And slowly but steadily, geothermal is rising to the top of all these alternative sources in chopping down the country's dependence on oil.

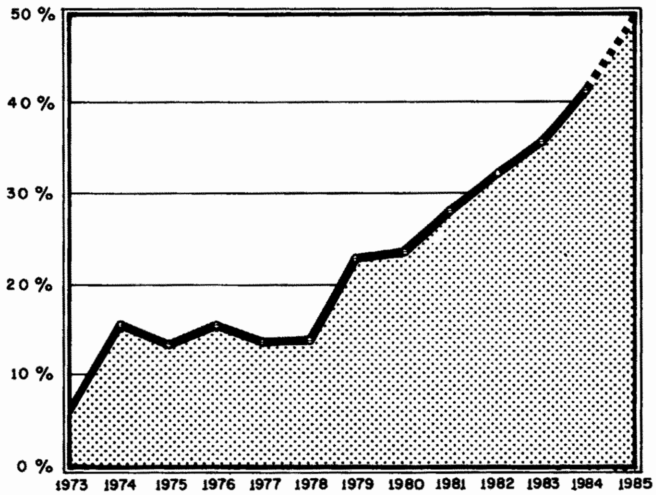

Figure 1. Energy self-reliance 1973-1985 (in percentage independence from foreign oil).

GEOTHERMAL ENERGY'S CONTRIBUTION

In 1983, geothermal energy accounted for 7.03 million barrels of oil equivalent (MMBOE) of the total energy used

Table 1. National Geothermal Power Expansion Program*, Installed and Planned Capacities (in MWe)

Field	1983	1984	1985	1988	1989	1990	Total 1990
Tiwi	330.0						330.0
Mak-Ban	220.0	110.0					330.0
Tongonan	115.5				37.5		153.0
Palinpinon	118.5						118.5
Bacon-Manito				55.0	55.0		110.0
Total	784.0	110.0		55.0	92.5		1041.5
Cumulative Total	784.0	894.0	894.0	949.0	1041.5	1041.5	

Table 2. National Power Expansion Program* Installed and Planned Capacities (in MWe)

			1983	1984	1985	1988	1989	1990	Total 1990
Geothermal	Luzon		550.0	110.0		110.0	0.0		
	Visayas		234.0	0.0		37.5	37.5		
	Mindanao		0.0	0.0		0.0	0.0		
		Sub-Total	784.0	110.0		110.0	37.5		1,041.5
Fossil Fuels	Luzon		2,230.0				0.0	0.0	
	Visayas		238.3				0.0	0.0	
	Mindanao		172.9				100.0	100.0	
		Sub-Total	2,641.2				100.0	100.0	2,841.2
Hydroelectric	Luzon		1,126.2					23.0	
	Visayas		2.0					0.0	
	Mindanao		435.6					0.0	
		Sub-Total	1,563.8					23.0	1,586.8
Nuclear	Luzon				620.0				620.0
		Sub-total							620.0
		TOTAL	4,989.0	110.0	620.0	110.0	137.5	123.0	
		Cummulative Total	4,989.0	5,099.0	5,719.0	5,829.0	5,966.5	6,089.5	6,089.5

*SOURCE: National Power Corporation Power Expansion Program, June 1984.

in the country, or an equivalent of 7.14 percent contribution (Ministry of Energy, 1983). The following year, 1984, saw its contribution rise to 8.33 percent, or 7.80 MMBOE worth about US $27 million — second only to the 10 percent contribution of hydro resources to the country's energy requirement (Velasco, 1985). It was a major leap in the geothermal sector's share of the pie from a low 2.73 MMBOE in 1979 with 223 MWe of generating capacity, to the 1984 level with 894 MWe of installed capacity. About this time also, the country's dependence on foreign oil has been reduced to 58 percent — down from 64.5 percent in 1983 (Figure 1) and closer to the target of 50 percent energy self-reliance by 1985 (Velasco, 1985).

THE PAST: A RESUMÉ

The Philippines has a "geothermal advantage" by being located within the so-called "Circum-Pacific Belt of Fire" where vast geothermal resources associated with decadent tectono-volcanism have been proven to exist. Early workers from the Commission on Volcanology (now Philippine Institute of Volcanology and Seismology) obviously realized this advantage when they initiated local studies on geothermal energy in 1962. In cooperation with the National Science Development Board (now National Science and Technology Authority), they conducted geoscientific exploration initially in the Tiwi area (Figure 2), and later in some other localities with known thermal manifestations such as Tongonan and Mak-Ban.

The Tiwi project gained more momemtum when an electric bulb was lighted by geothermal power for the first time in the Philippines on April 12, 1967. And before the end of this year, the Philippine legislature passed a law facilitating access to geothermal prospect areas and setting aside such areas as national reservations. Thus, long before the crisis that started in 1973, the Philippines had laid down the groundwork for the exploitation of geothermal energy.

Continued exploration in Tiwi resulted in the successful installation of a 2.5-kW noncondensing pilot plant utilizing geothermal steam. This plant paved the way for the government's decision to start the commercial

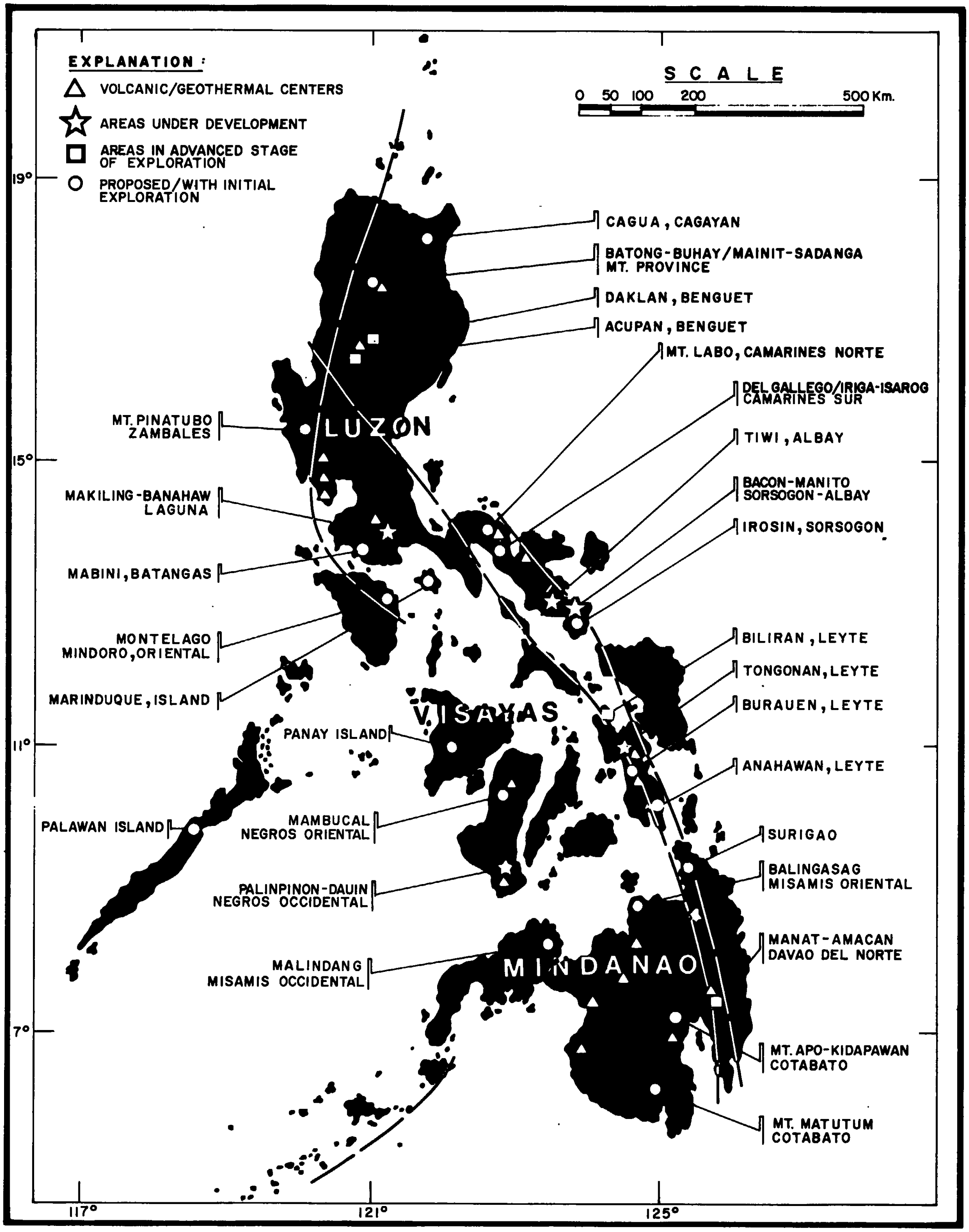

Figure 2. Philippine geothermal areas undergoing exploration and development

development of the Tiwi field. The National Power Corporation (NPC) was given the task of exploring and developing the field through a service contract with Philippine Geothermal Inc. (PGI), a subsidiary of Union Oil of California.

While Tiwi was being developed, NPC, and later PNOC-Energy Development Corporation (PNOC-EDC), continued to explore more prospects, notably Tongonan and Palinpinon in the Visayas and Mak-Ban in Luzon (Figure 2). The efforts paid off with the installation of a 3-MWe pilot power plant in Tongonan in July 1977, and the subsequent commercial utilization of geothermal energy with the harnessing of 220 MWe for the Luzon grid from two 55-MWe generating units each in the Tiwi and Mak-Ban fields. The following years saw the continuous build up of geothermal generating capacity, proceeding with the upgrading of the Tiwi and Mak-Ban fields in 1980, 1982 and 1984, and the commissioning by PNOC-EDC of a 112.5 MWe plant each in Tongonan and Palinpinon in 1983 (Table 1). By the end of 1984, a total of 894 MWe was already on stream, supplying 660 MWe to the Luzon grid and the rest to the Visayas (Table 2).

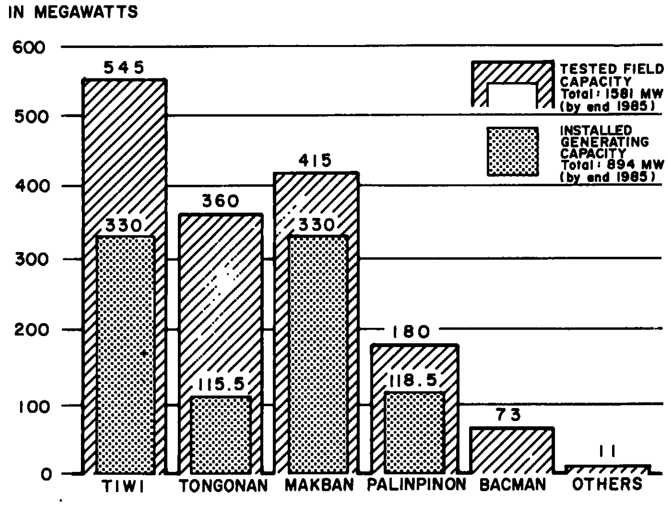

Figure 3. Geothermal development status

FIELD DEVELOPMENTS

Assessments of the geothermal potential of developed fields such as Tongonan, Palinpinon, Tiwi, Mak-Ban (Ministry of Energy, 1984b) and lately Bacon-Manito, indicate that reserves are in excess of present and planned generating capacities (Figure 3). Tiwi at present has a proven capacity of 545 MWe at the wellheads of 87 productive wells.

Mak-Ban

The second area developed by PGI, Mak-Ban in Laguna, has 415 MWe of proven capacity, and presently generates 330 MWe for the Luzon power grid. To date 69 wells have been reported completed of which 14 are injection wells. The third power plant in this field was commissioned in 1984, adding 110 MWe to geothermal's contribution to the energy requirement of Luzon Island.

Tongonan

So far, the Tongonan field in the Visayas appears to have the largest reserves in the country. The sector of the field that has been adequately tested has an assessed potential of 450 MWe for a plant life of 25 years. The total field reserves is estimated at 885 MWe. A total of 52 deep wells have been completed since the start of field development in 1977; 38 are tested production wells, nine are injection wells, and the rest are either nonproductive or to be tested yet. While 360 MWe have been confirmed at the wellheads of the 38 production wells, only 12 of these wells were proven to be sufficient to fully support the first 112.5 MWe power plant in the field. Another 37.5 MWe generating unit is planned for installation in 1989 when the projected industrial consumption of electricity in Leyte and the neighboring island of Samar will have increased.

Palinpinon

A second field in the Visayas, Palinpinon on the island of Negros, is also in an advanced stage of development. The first plant, the 112.5 MWe Palinpinon I, was put in operation in 1983, and plans are on the way for the development and ultimate installation of a second 112.5-MWe power facility in the 1990's. A total of 53 deep wells have been drilled, including the two exploration wells in the Dauin project extension. Thirty-two of these wells have been tested productive; 12 are for injection purposes, and the rest are either nonproductive or have yet to undergo testing. A total of 180 MWe has been confirmed from the tested production wells, and 21 of these wells are alternately hooked up to the 112.5 MWe plant. Assessments done on the field have put its reserves at about 700 MWe for a 25-year plant life (GeothermEx, 1982, 1983).

Bacon-Manito

The fifth geothermal field in an advanced stage of development is Bacon-Manito in Southern Luzon. Eighteen deep wells had been completed by the end of 1984, and another well is being drilled at the time of this writing. Thirteen of these wells have a combined tested output of 73 MWe, while three are dedicated for injection purposes. Recent assessments on the resource within a drilled area of about 12 km^2 indicate that reserves of about 150 MWe for a 25-year plant life have already been delineated (Buning and others, 1985). Plans for a 110-MWe power facility are thus on the way for a projected full commissioning in 1989. Three more exploration wells were also drilled for direct heat utilization in the Manito lowlands, an extension of the Bacon-Manito Geothermal Project, north of the present site of the 110-MWe power development.

EXPLORATION ACTIVITIES BY PNOC-EDC

Today there are at least 27 identified geothermal prospects in the country, dotted by more than a hundred surface thermal manifestations that occur as hot and warm springs, cold springs, geysers, solfataras, fumaroles, altered ground, boiling mud pools and others. Most of these prospects have been identified with about 25 volcanic centers punctuating the entire length of the archipelago. (See Information About Geothermal Localities, Table 3 of accompanying Summary Country Update.)

Luzon Island, Northern Philippines

Mt. Pinatubo. PNOC-EDC completed a year-long comprehensive geoscientific investigation of the Mt. Pinatubo prospect in Zambales, Luzon Island in early 1984. Analyses of the data indicate a resource with geochemically estimated temperatures in excess of 300° C, situated within a geological environment typical of most Philippine geothermal fields, i.e., within the peripheries of coalescing Tertiary to Quaternary andesitic volcanoes. Extensive thermal manifestation, such as steaming vents, altered ground and warm springs also abound in the area. Because of its strategic location with regards to power demand and proximity to the power-hungry cities of central Luzon, this field has a high priority for power development.

Irosin-Bulusan. This prospect in Sorsogon, Luzon Island also promises to be a viable geothermal project. Although exploration activities in the area were temporarily suspended in 1984, the information gathered so far is more than enough to justify future detailed investigations. The area is situated about 35 km south of the Bacon-Manito field at the western limb of the active Bulusan Volcano. PNOC-EDC also conducted the geoscientific investigation of the prospect.

Visayas Region, Central Philippines

Biliran and Burauen. In the Visayas Region, Central Philippines, the Biliran and Burauen prospects in the province of Leyte top the list of priority areas for future development. Both prospects lie along the path of the Central Philippine Fault. The Biliran prospect has three deep exploration wells having a combined output of about 8 MWe. The third well is rated at 4.9 MWe. A maximum temperature of 332° C was measured in this well, and it was interpreted as an indication of proximity of the exploration drilling sites to the center of the resource. Additionally, vertical electrical soundings (VES) taken at 19 stations in early 1984 provided information supportive of the indications from the well data.

Detailed geochemical, geological and geophysical investigations in the Burauen prospect were completed in 1983. Aside from the impressive surface thermal manifestations, which abound all over the prospect, analyses of the data are suggestive of an extensive and high temperature resource (>300° C). A three-well exploration drilling has been planned for the area.

Mindanao-Palawan Region, Southern Philippines

Manat-Amacan. In the Mindanao-Palawan region in the Southern Philippines, seven geothermal localities have been identified. The Manat-Amacan prospect in Davao del Norte has had the most extensive exploration activities including a complete surface geoscientific investigation, three shallow exploration wells (957 to 1067 m deep), and one deep exploration well (2692 m) that was completed and tested in 1983. A maximum temperature of 267° C was recorded in the deep well, and indications of a possible resource were observed. This well, which builds up pressure and discharges without stimulation, however, displays a cyclic behaviour and dies down a few hours after each discharge. Permeability problems are, at the moment, being entertained as one of the major causes of such behavior.

Mt. Apo-Kidapawan. Another promising geothermal area in Mindanao is the Mt. Apo-Kidapawan prospect at the foot of the famous Mt. Apo. Data from a suite of geoscientific surveys conducted in 1984 are now being analyzed for siting of the first exploration wells in this prospect. A combined interpretation of traverse (Schlumberger resistivity survey) and sounding data defined a geophysical target area of about 15 to 28 km^2 at the northwestern side of Mt. Apo. Reservoir temperatures greater than 240° C have been estimated by geochemical analyses of discharges from numerous warm and hot springs, gas seepages and solfataras in the area.

Initial geoscientific studies ranging from reconnaissance surface investigations to shallow exploratory well drilling has also been conducted at other prospects throughout the archipelago, such as: Mt. Cagua, Mabini-Lemery, Montelago-Naujan, Marinduque Island, Anahawan, Mambucal, Panay Island, Balingasag, Malindang, Mt. Matutum and Surigao. More detailed work on these areas will be conducted according to national priorities on energy development.

EXPLORATION BY OTHER AGENCIES

PNOC-EDC was not alone in the exploration of the country's geothermal prospects. The Bureau of Energy Development (BED) has also been undertaking geothermal activities.

Luzon Island

Daklan and Buguias. In cooperation with the Japan International Cooperation Agency (JICA), BED started the exploration of Daklan and Buguias in 1980. The Buguias project, however, has been suspended since August 1981, and only works in Daklan were completed in 1983 with Electroconsult of Italy and PNOC-EDC, joining in drilling and testing the five deep exploration wells. Evaluation of the field and well data of Daklan provided evidence for the presence of a geothermal resource beneath the area. However, the limited zones of permeability intersected by the wells have restrained commercial steam production, with only one well producing 3 MWe.

Acupan-Itogon. JICA's interest on Buguias was shifted to a new area, the Acupan-Itogon prospect in Benguet, in 1981. Thorough surface geological, geophysical and geochemical investigations were, thus, conducted by JICA and BED, followed by the drilling of seven shallow thermal gradient holes until early 1984. Prior to the drilling of the first exploration well, PNOC-EDC also conducted shallow resistivity surveys over a 326 km^2 area to possibly correlate the resistivity anomalies found in Daklan to those of Acupan. Results revealed an isolated 6-km^2 resistivity anomaly, which appears to be associated with the thermal manifestations about a volcanic breccia pipe near the center of the prospect. At the time of this writing, the first deep exploration well is nearing completion at a total depth of 2000 m.

Batong-Buhay. In 1982, Caltex (Philippines) Inc. was awarded a survey permit by BED for the exploration of Batong-Buhay in Kalinga-Apayao and Mainit-Sadanga in the Mountain Province. The award was extended to June 1983 for additional geoscientific work in Batong-Buhay, where a 10-ohm-meter anomaly was defined over an area of approximately 6 km^2. The exploration also resulted in the identification of more hot springs and fumaroles in previously unexplored terrain, and the preliminary siting of deep exploratory wells.

Mainit-Sadanga. Work in the Mainit-Sadanga prospect involved an assessment of the operating conditions for exploration, as well as a survey on the sites for three temperature gradient holes and resistivity survey stations.

In southern Luzon, two prime prospects for geothermal energy were also investigated by two foreign exploration firms under the one-year nonexclusive geothermal exploration permit granted by BED.

Mt. Labo. Total Exploration (TOTAL) and Philippine Oil and Geothermal Exploration, Inc. (POGEI) conducted geoscientific works over 120,000 ha in the Mt. Labo prospect. Preliminary analyses of photogeological and volcanological studies, and resistivity surveys indicate the possible existence of a 15 km^2 resource area with temperatures greater than 260° C. The field data were sent to Occidental Petroleum, USA, for review and further interpretations.

Iriga-Isarog. The Iriga-Isarog prospect, not too far from the Mt. Labo area, was surveyed by Ultrana Nuclear and Minerals Corporation (with Canada Northwest Energy, Ltd.) in 1983. Reconnaissance geological and geochemical studies were conducted in the area.

DIRECT HEAT UTLIZATION

Geothermal energy development in the Philippines is not confined to electrical power generation. Considerable effort has been spent also on direct industrial application, with the Philippine Institute of Volcanology and Seismology (PHIVOLCS) in the forefront.

In March 1973, a salt-making plant utilizing geothermal water for evaporation was first put to operation in Tiwi, at the site of the present 330 MWe power generation facility (Commission on Volcanology, 1973).

Various studies on other applications of geothermal water also produced encouraging results. A fish canning process utilizing geothermal steam has been developed by PHIVOLCS (1983) at its pilot plant in Tiwi. The results proved the absence of microbial growth and the acceptability of the products.

Research on the feasibility of extracting magnesium and potassium chloride from the pilot plant's waste products is also under way.

The establishment of an industrial estate in the Manito Lowlands, the northern extension of the Bacon-Manito Geothermal Project, is also being studied. Results from tests conducted on the three exploration wells in this area proved that sufficient mass and heat are available for direct heat application of geothermal energy. In the list of uses offered to the private sector are grain and abaca pulp drying, two of the leading means of livelihood of the Manito folks, aside from fish drying.

GEOTHERMAL MANPOWER DEVELOPMENT

Coupled with the government's aggressive energy development strategies is also an extensive manpower development program. On-the-job training with experts from New Zealand has been successfully implemented. Special studies from short training missions to masterate and doctorate studies for the local geothermal scientists and engineers have been given full support by the Philippine government and sponsoring countries and international agencies such as: New Zealand, Iceland, Japan, Italy, USA, and the United Nations Development Programme. In-house personnel development programs have also been pursued by the government agencies involved in geothermal exploration and development in the country, all of which are geared towards the development of a highly capable, sufficient indigenous manpower base.

OUTLOOK

The Philippines, at present, has a total of 5,099 MWe installed capacity, of which 894 MWe (17.5%) is geothermal (Table 2). With this capacity, the eight commercial geothermal power plants in four producing fields in the country produced a combined output of about 4,540 gigawatt-hours (GWh) in 1984, which was 25.5 percent of the total electrical energy generated in that year (Table 3).

With the planned commissioning of the first nuclear power plant in the country in 1985, and other power plants in the succeeding years, geothermal's contribution to the total energy demand is expected to decline percentagewise. Nonetheless, the completion of a 110-MWe geothermal power plant in the Bacon-Manito field, Luzon Island, and an additional 37.5-MWe generating unit in the Tongonan field, Leyte Island, will bring the nationwide installed geothermal capacity to 1,041.5 MWe and a projected utilization of 6,535 GWh by 1990 (Table 3). Sustained exploration of more prospects throughout the country, not only by government-owned agencies, but also by interested foreign investors can eventually make the Philippines the world's leading producer of geothermal power, and a major user of geothermal water for direct industrial applications before the turn of the century.

ACKNOWLEDGMENT

The authors are indebted to Dr. R.S. Punongbayan of the Philippine Institute of Volcanology and Seismology, Mr. T.N. Minette of Philippine Geothermal Incorporated, Dr. R. Datuin of the National Power Corporation, and Mr. A.C. Troncales of the Bureau of Energy Development for the invaluable information they provided for this paper.

Table 3. Philippines Energy Generation Mix (GWh)*

Energy Source	1983		1984		1985		1988		1989		1990	
Geothermal	4,093	21.9%	4,540	25.5%	4,686	24.5%	5,682	24.4%	6,131	24.5%	6,535	24.4%
Fossil Fuels	11,623	62.2%	7,727	43.5%	6,000	31.4%	6,247	26.8%	7,142	28.5%	8,266	31.0%
Hydroelectric	2,965	15.9%	5,514	31.0%	6,526	34.2%	7,873	33.7%	7,957	31.8%	8,142	30.4%
Nuclear	0	0 %	0	0 %	1,900	9.9%	3,531	15.1%	3,803	15.2%	3,803	14.2%
TOTAL	18,681	100 %	17,781	100 %	19,112	100 %	23,333	100 %	35,033	100 %	26,746	100 %

*SOURCE: National Power Corporation Expansion Program, June 1984.

Heartfelt thanks are also due to Ms. E.J. Aventurado, R.C.M. Malate, P.F. Lazaro, T.A. Victoria and E.G. Garcia of the Geothermal Division of PNOC-EDC for their efforts on this project.

REFERENCES

Buning, B.C., R.A. Camales, R.C.M. Malate, M.E.G. Urbino, V.C. Clemente, M.C. Vergara, E.L. Bueza, H.P. Ferrer, and J.B. Pornuevo, 1985, A resource assessment for the proposed 110-MWe Bac-Man I geothermal power plant: PNOC-EDC unpublished report, Philippines, 147 p.

GeothermEx, Inc., 1982, An evaluation of the geothermal reservoir at Palinpinon, Negros Oriental, the Philippines (unpublished), 379 p.

GeothermEx, Inc., 1983, Geothermal resource assessment for Palinpinon II plant, Negros Oriental, the Philippines (unpublished), 88 p.

Malixi, P.V., and B.S. Tolentino, 1982, Philippine geothermal potential and national strategies for its development: Offshore Southeast Asia 1982 Confererncе Proceedings.

Ministry of Energy, 1983, Ministry of Energy Report for 1983. Philippines, 40 p.

Ministry of Energy, 1984a, Accomplishment Report: Energy Self-Reliance 1973-1983, Philippines, 16 p.

Ministry of Energy, 1984b, Energy Sector Report 1973-1984, Philippines, 28 p.

National Power Corporation, 1984, Power Expansion Program, June 1984, Philippines, 86 p.

Velasco, G.Z., 1985, Local energy contributes 42% of total (local press release), Bulletin Today, January 7, 1985, p. 24.

Commission on Volcanology, 1973. The Geothermal Salt-Making Research Plant (A joint research project of the Naval Shore Establishment, Philippine Navy, Comission on Volcanology, and National Science Development Board, Philippines.)

Table 1. Present and Planned Production of Electricity

	Geothermal		Fossil Fuels		Hydroelectric		Nuclear	
	Capacity MW_e	Utilization GWh/yr	Capacity MW_e	Utilization GWh/yr	Capacity MW_e	Utilization GWh/yr	Capacity MW_e	Utilization GWh/yr
In operation January 1985	894.0	4,686.0	2,641.2	6,000.0	1,563.8	6,526.0	620.0	1,900.0
Under construction January 1985	—	—	—	—	—	—	—	—
Funds committed, but not yet under construction January 1985	—	—	—	—	—	—	—	—
Total projected use by 1990	1,041.5	6,535.0	2,841.2	8,266.0	1,586.8	8,142.0	620.0	3,803.0

Table 2. Present Utilization of Geothermal Energy for Direct Heat

*Type of Use
- I = Industrial process heat
- C = Airconditioning
- A = Agricultural drying
- F = Fish and other animal farming
- D = District Heating
- B = Bathing and swimming
- G = Greenhouses
- O = Other (specified by footnote)

**Enthalpy information is given only if there is steam or two-phase flow.

Locality (Footnote for Comments)	Type*	Maximum Utilization					Average Annual Utilization				
		Flow Rate kg/s	Temperature °C		Enthalpy** kJ/kg		Flow Rate kg/s	Temperature °C		Enthalpy** kJ/kg	
			Inlet	Outlet	Inlet	Outlet		Inlet	Outlet	Inlet	Outlet
Tiwi[1]	I,A,F	2.1	126	100	—	—					

[1] Well CV-T-7 in Tiwi (see Table 3 also) is now used to feed hot water to a multi-purpose geothermal experimental plant.

Table 3. Information About Geothermal Localities

Rock[1] = Main type of reservoir rock.
Water[2] = Total dissolved solids, in mg/kg, before flashing. Put v for vapor dominated.
Status[3]
N = Identified geothermal locality, but no assessment information available.
R = Regional assessment
P = Pre-feasibility studies
F = Feasibility studies (reservoir evaluation and engineering studies)
U = Commercial utilization

Locality	Location To Nearest 0.5 Degree		Reservoir		Status[3]	Reservoir Temp. °C	
	Latitude	Longitude	Rock[1]	Water[2]		Estimated	Measured
Luzon and Neighboring Islands							
Acupan, Benguet	16.0 N	120.5 E			P	>240	
Bacon-Manito, Sorsogon	13.0	124.0	Andesite/tuff breccia		F	>300	326
Batong-Buhay, Mt. Province	17.5	121.0					
Cagua, Cagayan	18.0	122.0			N		
Daklan, Benguet	16.0	120.5	Volcaniclastics		P		283
Del Gallego-Iriga-Isarog, Camarines Sur	13.5	123.0			R		
Irosin-Bulusan, Sorsogon	12.5	124.0			R	>300	
Mabini-Lemery, Batangas	14.0	121.0			N		
Mainit-Sadanga Mt. Province	17.5	121.0			N		
Makiling-Banahaw Laguna, Batangas	13.5	121.0	Andesite/pyroclastics/ volcaniclastics		U		287-315
Marinduque Island	13.0	122.0			N		
Montelago-Naujan, Oriental Mindoro	13.0	121.0			N		
Mt. Labo Camarines Norte	14.0	122.5			R	>260	
Mt. Pinatubo Zambales	15.5	120.0			R	>300	
Tiwi, Albay	13.5	123.5	Andesite/pyroclastics		U		260-315
Vasayas							
Anahawan, Leyte	10.0	125.0			N		
Palinpinon-Dauin, Negros Oriental	9.0	123.0	Andesite/Diorite/ sedimentary units		U	>300	320
Biliran, Leyte	11.5	124.5	Volcaniclastics/andesite		P	>300	332
Burauen, Leyte	10.5	125.0			R	>300	
Tongonan, Leyte	11.0	125.0	Andesite		U		320
Mambucal, Negros Occidental	10.0	123.0	Andesite/sedimentary units		P	>250	
Panay Island	11.0	122.0			N		
Mindanao/Palawan							
Balingasag, Misamis Oriental	8.5	125.0			N		
Malindang, Misamis Occidental	8.0	123.5			N		
Manat-Amacan, Davao del Norte	7.0	126.0			P	>267	
Mt. Apo-Kidapawan, Cotabato	6.0	125.0			R	>240	
Mt. Matutum, Cotabato					N		
Surigao, Surigao del Norte	9.0	125.5			N		
Palawan Island	9.5	119.0			N		

Table 4. Wells Drilled For Electrical Utilization of Geothermal Resources to January 1, 1985
(Does not include thermal gradient wells less than 100 m deep)

Type of well*
T = Thermal gradient or other scientific purpose E = Exploration P = Production I = Injection

Locality (Footnote for comments)	Year Drilled[1]	Well Number	Type of* Well	Total Depth (meters)[2]	Maximum Temp. °C	Flowing Enthalpy kJ/kg	Flow Rate kg/s[3]
Tongonan Geothermal Field, Leyte Geothermal Project, Tongonan, Ormoc City, Leyte Island, Philippines							
Lower Mahiao Sector	1977	103	P	1407.2	312	1600	48
	1978	1R10	I	1546.2	255	—	Untested
	1982	105d[4]	P	1786.7	314	1324	118
	1979	101	P	1421.0	305	1977	57
	1979	102	P	1641.3	310	2000	39
	1979	108	P	1820.7	317	1970	25
	1979	106	P	1823.6	321	1953	22
	1980	IR3	I	1903.0	270	1240	85
	1982	IR5D	I	2398.1	280	1090	75
Lower Sambaloran Sector	1977	202	P	1896.9	304	1450	65
	1979	208A[5]	P	1997.6	316	2100	18
	1980	209A[6]	P	2504.9	318	1800	84
	1978	213	P	1602.7	308	1560	70
	1979	212	P	1519.0	313	1775	68
	1979	214	P	1992.4	290	1400	70
	1979	2R2	I	1531.6	304	1775	30
	1979	215	P	1562.0	303	1563	49
	1981	2R4D	I	2186.2	284	1366	75
	1981	2R3D	I	2272.5	270	1208	85
South Sambaloran Sector	1979	303	E	1942.0	280	1275	90
	1982	301D	E	2446.6	280	1319	102
Upper Mahiao Sector	1977	401[7]	E	1942.1	323	2230	27
	1977	404	P	1668.2	313	1940	28
	1977	407	P	1605.4	316	1790	35
	1978	406	P	1794.5	323	1870	40
	1980	402	E	2373.0	263	1579	6
	1980	405	E	2288.0	260	1300	96
	1980	403	E	2464.9	296	1434	30
	1980	408	E	2696.0	314	1378	11
	1981	409	P	2399.8	311	1730	49
	1981	410	P	2365.9	322	1900	29
	1983	411D	E/P	2795.0	292	1300	39
Mamban-Mahanagdong Sector	1979	MN-1	E	2486.9	199	—	Untested
	1980	MG-1	E	2335.0	282	1272	90
	1981	MG-2D	E	2210.7	252	1160	100
	1983	MG-5D	E	2703.7	300	1375	34
Malitbog Sector	1978	501	P	1665.0	284	1273	114
	1979	503	P	1985.7	306	1257	77
	1979	502	P	1995.0	281	1160	53
	1980	5R4	E/I	2342.0	245	1133	42
	1980	505D	E	2647.8	273	0	0
	1981	506D	E	2647.8	275	0	0
	1981	5R7D	E/I	2887.1	262	1116	19
	1981	508D	P	2623.8	279	1168	80
	1981	509	P	2361.3	265	1187	62
	1981	510D	P	2579.7	280	1218	65
	1981	511D	P	2538.8	287	1328	63
	1982	515D	P	2084.0	292	1330	102
	1982	514	P	2750.3	319	1250	58
	1982	513D	P	2718.1	298	1269	38

Table 4 Continued.

Locality (Footnote for comments)	Year Drilled[1]	Well Number	Type of* Well	Total Depth (meters)[2]	Maximum Temp. °C	Flowing Enthalpy kJ/kg	Flow Rate kg/s[3]
Malitbog Sector (continued)	1982	5R1D	I	952.5	230	1040	100
	1982	516D	P	2787.5	286	1280	22
Tongonan Geothermal Field	1973	TGE-7	T	576.9	148		
	1974	TGE-1	T	464.2	181		
	1974	TGE-2	T	362.5	80		
	1974	TGE-3	T	585.5	125		
	1974	TGE-5A	T	420.6	194		
	1974	TGE-8	T	610.2	77		
	1975	TGE-4	T	310.9	197		
	1975	TGE-6	T	615.7	138		
	1975	TGE-9	T	610.5	93		
	1976	TGE-10[8]	T/I	593.5	254		
	1976	TGE-11	T	620.5	113		
Southern Negros Geothermal Project, Valencia, Negros Oriental, Philippines							
Palinpinon I Sector	1980	OK-7	P	2882.8	318	1410	86
	1980	OK-9D	P	2543.0	322	1340	49
	1981	OK-10D	P	2435.8	273	1350	51
	1981	PN-13D	P	2697.1	317	1360	46
	1982	PN-14	P	3077.1	312	1373	30
	1981	PN-15D	P	2715.6	283	1150	79
	1982	PN-16D	P	3104.7	326	1414	41
	1981	PN-17D	P	2954.4	290	1070	54
	1982	PN-18D	P	3147.1	306	1242	43
	1982	PN-19D	P	3024.4	303	1328	47
	1982	PN-20D	P	2690.9	330	1346	49
	1982	PN-21D	P	2862.2	288	1023	39
	1982	PN-22D	P	2698.6	318	1296	49
	1982	PN-23D[12]	P	2878.9	323	1313	79
	1982	PN-24D	P	3105.9	319	1387	26
	1982	PN-26	P	2773.8	309	1330	95
	1983	PN-27D	P	2860.2	291	1353	72
	1983	PN-28	P	2893.2	303	1350	59
	1983	PN-29D	P	2808.0	299	1250	65
	1983	PN-30D	P	2920.7	312	1239	54
	1983	PN-31D	P	2695.5	265	1728	53
	1981	OK-12D	E/I	2666.8	297		142
	1982	PN-1RD	I	2941.4	278		143
	1982	PN-2RD	I	3394.0	304		46
	1982	PN-3RD	I	3132.4	294		Untested
	1982	PN-4RD	I	3085.1	284		130
	1983	PN-5RD	I	2540.5	235		54
	1983	PN-6RD	I	2589.3	252		147
	1983	PN-7RD	I	2562.0	266		152
	1983	PN-8RD	I	3046.7	291		107
	1983	PN-9RD	I	3039.5	267		96
Palinpinon II Sector	1978	OK-5	E	1975.2	308	2000	32
	1980	OK-6	E	2770.8	285	1280	80
	1983	OK-8RD	E/I	2436.9	274		Untested
	1981	OK-11D	E	2461.0	274		0
	1981	SG-1	E	2762.8	277	1150	53
	1981	SG-2	E	2944.6	283	1275	85
	1983	SG-3D	E	2642.2	281	1263	73
	1982	NJ-1D	E	2848.5	285		No MTD
	1982	NJ-2D	E	2892.2	279		0

Table 4 Continued.

Locality (Footnote for comments)	Year Drilled[1]	Well Number	Type of* Well	Total Depth (meters)[2]	Maximum Temp. °C	Flowing Enthalpy kJ/kg	Flow Rate kg/s[3]
Palinpinon II Sector (continued)	1983	NJ-3D	E	2693.4	263	1269	88
	1983	NJ-4D	E	2760.9	282	1140	54
	1983	NJ-5D	E	2781.9	298	1248	52
	1983	NJ-6D	P	2600.5	288		Untested
	1983	NJ-7D	P	2836.6	273		Untested
	1983	NJ-8D	P	2922.4	280		Untested
Other Southern Negros Wells	1976	N-1	E	603.3	206	845	26
	1976	N-2	E	610.5	175	415	5
	1978	N-3	E	970.9	240	1103	40
	1978	OK-1	E	1978.9	190		0
	1978	OK-2	E	1164.4	254	1420	25
	1978	OK-3	E	1521.8	224		0
	1978	OK-4	E	2130.0	299		0
	1983	PN-25D	E	3329.3	293		0
		DN-1	E	2623.6	240	806	46
		DN-2	E	2670.2	198		0
Bacon-Manito Geothermal Project, Boundary of Albay and Sorsogon Provinces, Bicol Peninsula, Philippines							
	1979	MAN-1	E	1367.8	214		0
	1979	MAN-2	E	1636.7	248		0
	1981	CN-1	E	2553.1	269	1280	100
	1981	IM-1	E	2583.0	252	2050	77
	1981	PB-1A	E	2662.1	254		0
	1982	CN-2D	E	1708.1	237	1320	11
	1982	PAL-1	P	2480.4	274	1110	46
	1982	PAL-2D	P	2707.6	293	1910	29
	1983	PAL-3D	P	2154.7	282	1330	52
	1983	PAL-4D	P	2641.1	302	1420	36
	1983	PAL-5D	E	2761.6	268	1200	47
	1983	PAL-6D	E	2833.9	274	1590	10
	1983	PAL-8D	P	2973.0	306	1700	82
	1983	PAL-7D	P	2153.2	268	1300	24
	1983	PAL-1RD	I	1852.0	252		Untested
	1984	PAL-2RD	I	1517.9	238		Untested
	1984	PAL-9D	E/P	2409.3	258	1235	27
	1984	PAL-10D	E/P	2485.1	325	1361	42
	1984	PAL-3RD	I	2103.5			Untested
Biliran Geothermal Project, Biliran Island, Philippines							
		BN-1	E	2424.4	254		16
		BN-2	E	2439.8	210	983	25
		BN-3	E	2469.6	332	1824	23
Daklan Geothermal Project, Benguet Province, Philippines							
		DK-1A	E	2692.5	284	1285	14
		DK-2	E	1622.3	209		0
	1981	DK-3	E	2743.1	246		0
	1981	DK-4	E	2748.0	286		0
		DK-5	E	2836.9	260		0
Northern Negros (Mambucal) Geothermal Project, Negros Occidental, Philippines							
		MC-1	E	1220	189		0
		MC-2	E	1433	169		0

Table 4 Continued.

Locality (Footnote for comments)	Year Drilled[1]	Well Number	Type of* Well	Total Depth (meters)[2]	Maximum Temp. °C	Flowing Enthalpy kJ/kg	Flow Rate kg/s[3]
Davao (Manat-Amacan) Geothermal Project, Davao del Norte, Philippines							
	1977	TGH-1	T	137	29		0
	1977	TGH-3	T	198	34		0
	1977	TGH-5	T	121	92		0
	1977	TGH-6	T	153	71		0
	1977	TGH-9	T	183	29		0
	1977	TGH-11	T	129	29		0
	1977	TGH-12	T	128	24		0
	1977	TGH-13	T	126	70		0
	1979	TGH-14	T	244	52		0
	1979	TGH-15	T	244	24		0
	1979	TGH-16	T	146	32		0
	1979	TGH-17	T	232	32		0
	1979	TGH-18	T	244	53		0
	1979	TGH-19	T	244	58		0
	1979	TGH-20	T	245	57		0
	1978	MANAT-1	E	1067	104		0
	1978	MANAT-2	E	957.3	98		0
	1978	PANI-BASAN-1	E	919.2	48		0
	1983	AMACAN-1	E	2692.4	267	1610	5
Tiwi Contract Area							
Naglagbong	1975	7		2743.20	275		45
		9		1847.09	287		54
		10		579.12	252		36
		11		1584.96	273		87
		12		1798.93	283		58
	1976	13		2033.02	279		41
		14		2276.86	294		54
		15		2888.89	276		40
		16		712.01	289		165
		17		1699.87	231		19
		18		1524.00	281		150
		19		1379.83	285		133
	1977	20		2168.96	284		36
		21		886.97	283		55
		22		2275.03	264		68
		23		2268.63	277		67
		24		1674.88	277		104
		25		2133.60	281		16
		26		2129.03	274		51
		27		2118.36	275		107
	1978	28		2164.99	307		82
		29		2316.48	279		9
		30		1514.86	297		127
		31		1293.27	307		169
		32		2200.05	293		62
		33		2096.11	284		73
	1979	34		1558.75	229		3
		35		2112.26	300		54
		36		1608.73	274		43
		37		492.56	274		51
		38		1127.76	289		44
		39		1234.44	256		31

Table 4 Continued.

Locality (Footnote for comments)	Year Drilled[1]	Well Number	Type of* Well	Total Depth (meters)[2]	Maximum Temp. °C	Flowing Enthalpy kJ/kg	Flow Rate kg/s[3]
Naglagbong (continued)		40		1219.20	277		26
		41		479.76	230		33
		43		1263.70	284		6
		44		772.06	285		54
		45		759.26	234		15
		46		1593.80	242		24
		47		1335.33	294		65
	1980	48		1354.84	288		46
		49		1190.24	286		45
		50		635.51	266		59
	1982	51		1219.20	279		21
	1983	52		1414.27	273		18
	1980	53		907.39	218		30
		54		893.67	269		171
	1982	55		1173.48	241		31
	1980	56		2170.48	282		34
	1982	57		255.12	206		33
	1981	58		198.12	206		4
		59		647.70	246		86
		60		731.52	235		18
	1981	62		897.03	257		8
		63		570.59	231		24
	1982	64		936.35	227		15
	1983	65		1233.22	274		9
Bariis	1981	1		1751.38	195		11
		2		2252.78	302		10
		3		2489.61	319		144
Sadurong	1982	1		1200.91	239		102
Kapipihan	1979	1		1476.15	272		74
		2		1449.02	278		32
		3		1787.65	296		13
		4		2118.97	284		70
	1980	5		1260.04	292		36
		6		1928.16	278		39
		10		1200.91	291		12
		11		1130.20	273		107
		12		1363.37	288		29
		13		1307.59	287		19
	1981	16		1169.52	290		30
	1980	17		938.17	266		28
		18		1454.51	291		23
	1981	19		1216.15	256		18
		20		1428.90	269		28
	1980	21		1714.50	293		61
	1981	22		1691.34	288		37
		24		1655.67	248		27
		25		1658.42	270		46
	1980	27		1364.89	257		68
Matalibong	1980	1		1316.43	260		74
	1983	2		2782.82	267		7
	1981	3		1242.36	294		30
	1980	8		1065.89	272		24
	1981	14		2688.34	284		36
		15		1203.96	298		37
		17		2413.10	297		92

Table 4 Continued.

Locality (Footnote for comments)	Year Drilled[1]	Well Number	Type of* Well	Total Depth (meters)[2]	Maximum Temp. °C	Flowing Enthalpy kJ/kg	Flow Rate kg/s[3]
		Mak-Ban Contract Area					
Bulalo		1			313		59
	1975	2	I	2423.16	283		
		3A		987.25	284		43
		4	I	2502.41	313		
	1976	5	I	2457.91	269		
	1976	6		906.48	279		128
		7		1909.57	329		45
		8		1402.08	311		43
		9		1224.08	274		47
		10		1678.53	334		50
		11		1061.92	293		64
	1977	12		2133.60	325		38
		13		1057.66	290		65
		14		1121.66	284		65
		15		2669.44	331		38
		16		1563.01	266		56
		17		2259.79	332		17
		18	I	2600.25	328		
		19		2874.57	346		10
		20		954.33	269		24
	1978	21		1786.13	324		40
		22		2688.34	311		9
		23		992.43	252		28
		24		1723.95			9
		25		1671.83	258		0
		26		875.69	267		23
		27		1629.77	306		79
		28		1879.40	279		47
		29		1920.24	317		42
		30		2861.46	241		0
	1979	31A	I	2798.98	264		
		32	I	2485.64	324		
		33	I	2670.05	282		
		34		2449.37	319		55
		35		1965.35	317		19
		36		1559.36	276		12
		37	I	2377.44	301		
		38		1889.76	326		36
		39		1597.15	288		35
		40		2087.88	313		49
		41		2065.02	275		75
		42		1266.14	267		51
		43	I	1607.82	304		
		44		2223.21	296		53
		45		2415.24	333		79
		46		2255.52	303		25
		47		1605.08	308		14
		48	I	2353.06			
		49		1384.10	323		69
		50	I	2816.66	274		
		51		1756.26	288		36
	1980	52		1606.30	293		11
		53		2819.10	326		35
		54	I	1374.65	267		

Table 4 Continued.

Locality (Footnote for comments)	Year Drilled[1]	Well Number	Type of* Well	Total Depth (meters)[2]	Maximum Temp. °C	Flowing Enthalpy kJ/kg	Flow Rate kg/s[3]
Bulalo (continued)		55		2848.05	321		34
	1981	56		2599.33	305		71
	1980	57	I	2915.41	306		
	1980	58	I	2894.38	318		
		59		2946.50	319		35
		60		1022.60	278		68
		61		2510.33	317		20
	1982	62		1503.88	277		29
	1980	64		6555.32	259		27
	1982	65		3140.05	324		30
		67		2694.74	312		39
	1980	71		1761.74	302		30
	1981	75		2764.23	283		0
		76		2370.12	267		66
		79		1280.46	293		6

ADDITIONAL INFORMATION TO TABLE 4

(Applicable only to wells in Leyte, So. Negros, Bacon-Manito, Biliran, Daklan, Northern Negros, and Davao Geothermal Projects of PNOC-EDC.)

1. Year Drilled — The years quoted indicate the year each well was completed.

2. Total Depth — All depths quoted are true vertical depths measured from the casing head flange. These depths were measured during the completion of each well.

3. Flow Rate — The flow rates quoted were measured while the wells were being tested under full-bore discharge condition. Flow rates of injection wells are injection capacities, as against the discharge flow rates of production wells.

4. Well 105 was first completed on October 16, 1978 at a depth of 1796 m. It is basically an exploration/production well, but it was also used for low-temperature injection testing (flash temperature ≈ 120°C), using wells 101, 102 and 103 as injectors.

In November 1981, the well was redischarged. Its output, however, dropped from its rated capacity of 15MWe to about 5MWe, until it subsequently died down. Downhole surveys (go-devil and caliper) indicated a total blockage within the production casing (silica deposits).

The well was re-drilled (side-tracked) and completed on February 15, 1982 at a depth of 1786.7 m. Thus, it was renamed 105D to indicate that it is now a directional well. It is now one of the wells supplying steam to the Tongonan I 112.5 MWe Power Plant.

5. Well 208 was originally drilled as an exploration well in the northeastern portion of the Lower Sambaloran Sector, Tongonan Geothermal Field. It was completed on May 13, 1978 at a depth of 834.6 m. The well did not register good temperatures and injectivity although it produced about 3.6 MWe. In the hope of finding better permeability, it was deepened and completed on February 24, 1979 at a depth of 1997.6 m. It was then renamed 208A to indicate deepening of an original bore.

6. Well 209 basically underwent the same deepening process as 208A. It turned out to be one of the best producers in the Tongonan Geothermal Field after its second completion. It is now one of the wells supplying steam to the Tongonan I Power Plant with a rated capacity (full-bore opening) of 18 MWe.

7. Well 401 was the first deep exploratory well drilled in Tongonan. It turned out also to be the first commercial producer in this field. Six months after its completion, it was hooked up to a 3-MWe noncondensing power plant in the project. It supplied wet steam to this pilot plant from July 1977 until the middle of 1983 when the 112.5 MWe Tongonan I Power Plant was commissioned for commercial utilization.

8. TGE-10 was renamed 4R1 when it was utilized as an injection well for effluents from 401 and the 3 MWe pilot plant.

9. Tongonan Geothermal Field has 115.5 MWe installed capacity on 3 x 37.5 MWe Mitsubishi turbines (Tongonan I) and 1 x 3 MWe Fuji noncondensing type turbine generator (pilot plant).

On the Tongonan I, there are 12 production and five injection wells on line. Of the 12 production wells, nine operate for base load and three can be operated for peak load with allowance for contingency.

With the three turbines in operation, the nine base-load-operated wells deliver 440 tons/hour of steam to generate 25 MWe, while the three other production wells can supply additional steam to generate a total of 45 MWe, which is the current average peak load of the plant.

The 3-MWe pilot plant has been put on standby operation since the commissioning of Tongonan I.

This plant, nevertheless, used to supply electricity to Ormoc City and the nearby localities, including the Tongonan field's base camp.

10. Tongonan I Production Wells: 101, 102, 103, 105D, 106, 108, 202, 209A, 212, 213, 214, 215.

11. Tongonan I Reinjection Wells: 1R3, 1R5D, 2R2, 2R3D, 2R4D.

12. During PN-23D's MTD tests, its mass flow was 230 tons/hour. Bore output measurements during commercial operation (when the well was cut into the Palinpinon I steam gathering system), however, indicated a mass flow of 286 tons/hour. The bore output data also suggested an improvement in its permeability.

13. Palinpinon I is PNOC's second geothermal field developed for electrical power generation. The same name has been adopted for the corresponding 112.5 MWe power plant of the National Power Corporation. Twenty one production and ten injection wells are hooked up to this plant.

14. Palinpinon I Production Wells: OK-7, OK-9D, OK-10D, PN-13D, PN-14, PN-15D, PN-16D, PN-17D, PN-18D, PN-19D, PN-20D, PN-21D, PN-22D, PN0-23D, PN-24D, PN-26, PN-27D, PN-28, PN-29D, PN-30D, PN-31D.

15. Palinpinon I Injection Wells: OK-12D, PN-1RD, PN-2RD, PN-3RD, PN-4RD, PN-5RD, PN-6RD, PN-7RD, PN-8RD, PN-9RD.

Table 5. Wells Drilled For Direct Heat Utilization of Geothermal Resources to January 1, 1985
(Does not include thermal gradient wells less than 100 m deep)

*Type or purpose of well and manner of production (Uses one symbol from column (1) and one from column (2)

(1)
T = Thermal gradient or other scientific purpose
E = Exploration
P = Production
I = Injection
C = Combined electrical and direct use

(2)
A = Artesian
P = Pumped
F = Flashing

**For wellhead temperatures less than 100°C, temperatures in °C are multiplied by 4.1868 to obtain the enthalpy.

Locality (Footnote for comments)	Year Drilled	Well Number	Type of* Well (1) (2)	Total Depth (meters)	Maximum Temp. °C	Flowing Enthalpy kJ/kg	Flow Rate kg/s
Malangto, Bacon	1982	MO-1	E-F	1570.8	223		34
Albay Province	1982	MO-2	E-F	1093.9	216		57
	1984	MO-3	E-F	1200.2	218		18
Tiwi, Albay	1968	CV-T-7	E-A	212.0	154		1
Lemergy, Batangas	1979	DDH-1	E	166.2	90		nil
Mabini, Batangas	1981	DDH-1	F	330.0	118		nil

Table 6. Allocation of Professional Personnel to Geothermal Activities
(Restricted to personnel with a university degree)

(1) Government
(2) Public Utilities
(3) Universities
(4) Paid Foreign Consultants
(5) Contributed Through Foreign Aid Programs
(6) Private Industry

	(Professional Man Years of Effort)					
Year	(1)	(2)	(3)	(4)	(5)	(6)
1975	16	30		6		12
1978	83	101		13	11	38
1980	171	204		22	20	80
1981	200	34		35	34	73
1982	217	33		49	36	75
1983	311	130		32	41	68
1984	308	130		11	40	67
1985	308	22		5	26	