GLOBAL
ENVIRONMENT
FACILITY

Republic of the Philippines

Leyte-Luzon Geothermal Project

Project Document
May 1994

THE WORLD BANK

GEF Documentation

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CURRENCY EQUIVALENTS
(as of December 31, 1993)

Currency Unit	=	Pesos (₱)
₱ 1	=	US$0.036
US$1	=	₱27.6

WEIGHTS AND MEASURES

GWh	=	Gigawatt hour (1,000,000 kwh)
MWe	=	Million Watts of energy.
kWh	=	Kilowatt-hour (860 kilo-calories)
TWh	=	Tera watt hour (10^9

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
BTO	Build-Transfer-and-Operate
DENR	Department of Environment and Natural Resources
DOE	Department of Energy
ECO	Expanded Cofinancing Operation
EDC	Energy Development Corporation
EOIS	Efficiency and Operational Improvement Study
ERB	Energy Regulatory Board
ESMAP	Energy Sector Management Assistance Program
GEF	Global Environment Facility
GET	GEF's Global Environment Trust Fund
JEXIM	Export and Import Bank of Japan
NPC	National Power Corporation
OPSF	Oil Price Stabilization Fund
PNOC	Philippine National Oil Company
RECs	Rural Electrification Cooperatives

FISCAL YEAR
January 1 to December 31

PHILIPPINES

LEYTE-LUZON GEOTHERMAL PROJECT

Grant and Project Summary

Source of Funds: Global Environment Trust Fund

Grantee: Republic of the Philippines.

Grant Recipients: The Philippines National Oil Company's Energy Development Corporation (PNOC-EDC) and the National Power Corporation (NPC)

Amounts: SDR 21.6 million equivalent (US$30 million), US$15 million to NPC and US$15 million to PNOC.

Terms: Grant

Cofinanciers: (a) The World Bank; (b) The Japan Import and Export Bank (JEXIM); (c) three BOT contractors for the power plant; (d) Eurobonds for the converter station with the support of an ECO operation from the Bank; (e) the Swedish Agency for International Technical and Economic Cooperation (BITS)

Objectives: The grant would provide financial support for the Leyte-Luzon Geothermal project, reducing its cost and making financially more attractive the use of environmentally preferable geothermal energy for power generation. The Project would also support the following objectives: (a) meet the rapidly increasing demand for power in Luzon using indigenous and environmentally superior geothermal energy; (b) strengthen the energy sector by implementing institutional, planning and financial improvements recommended by the ESP; (c) support the large ongoing private sector participation in power generation, and facilitate it by extending the national grid; (d) strengthen NPC's capabilities in environmental and social impact analyses; (e) introduce ECO cofinancing in the Philippines; and (f) ensure the financial viability of NPC and PNOC for undertaking a long-overdue investment program.

Financing Plan:

	Local	Foreign	Total
	---- US$ million ------		
GET Grant PNOC		15.0	15.0
GET Grant NPC		15.0	15.0
IBRD-PNOC		114.0	114.0
IBRD-NPC		113.0	113.0
Energy Sector Loan (3163-PH)-On going works		13.3	13.3
JEXIM-PNOC		114.0	114.0
JEXIM-NPC		56.0	56.0
BOT-Contract	63.9	556.5	620.4
ECO-Supported Bond Issue-NPC		100.0	100.0
BITS Grant for Converter	26.6	12.4	39.0
PNOC Internal Cash Generation	71.7	20.3	92.0
NPC Internal Cash Generation	9.2	32.7	41.9
TOTAL FINANCED 1/	**171.4**	**1162.2**	**1333.6**

1/ Totals may not add due to rounding.

Economic Rate of Return: 11%

Poverty Category: Not applicable.

Map: IBRD No. 25290

REPUBLIC OF THE PHILIPPINES
LEYTE-LUZON GEOTHERMAL PROJECT

1. Country/Sector Background. Power demand growth in the Philippines has been uneven, largely following variations in GDP growth. In the last two years, it was severely restricted due to supply constraints; still, power sales increased 6.2% p.a. between 1986-92. Once adequate power supply is restored 1994 due to substantial new capacity added, sales are expected to rise by an average of 9% p.a. until the year 2000. In absolute terms, annual per capita consumption for power is very low (371 kWh)--equal to just a couple of weeks of per capita use in developed countries. Even considering the effect of energy conservation programs and conservative estimates of GDP growth, the peak demand is expected to double by the year 2000 to 8,260 MW. This will require substantial investments, sound financial policies and increased private sector participation.

2. The private sector has become a principal player in the energy sector. Exploration for hydrocarbons is exclusively with the private sector; and, oil refining and distribution are carried out by two private companies (CALTEX and Pilipinas Shell Petroleum Corporation) in addition to Petron (the oil subsidiary of state-owned PNOC). However, the Government sold 40% of Petron shares to Aramco in March 1994 and will sell another 20% to Petron's staff and the public by mid-1994. PNOC, one of the largest corporations in the Philippines, was created in 1973 as a holding company for several energy subsidiaries (oil refining, coal, geothermal), which were established to ensure the country's oil supply and to develop indigenous resources. After Petron's privatization, the main activity of PNOC would be to develop geothermal energy through its subsidiary PNOC's Energy Development Corporation (PNOC-EDC). In the power sector, practically all distribution is in the private domain. This includes: (a) MERALCO (Manila Electricity Company), a private utility in Metro Manila that distributes about 60% of the country's total electricity; (b) 12 private utilities that retail electricity in different cities; and (c) about 120 member-owned rural electrification cooperatives (RECs), which distribute power and manage retail sales in rural areas. There are also two state-owned corporations in the sector: (a) the National Power Corporation (NPC), which sells power in bulk to power utilities and is responsible for power generation and transmission, and (b) the National Electrification Administration (NEA), responsible for financing and providing related technical support to the RECs. Under the Energy Sector Plan (ESP), the Government is studying options for NPC's gradual privatization, which is likely to require several years, given constitutional, regulatory, commercial and financial constraints and the need to analyze options broadly identified by a USAID-funded study. It is in this context that the Bank is currently conducting a sector study on the Power Sector Structure, which will be completed by mid-1994; after this, detailed transactional studies will be conducted. The Government's present strategy of steadily increasing the private sector role in power generation and operational management is adequate.

3. With regard to incremental investment in power generation, NPC's Board of Directors is sucessfully implementing a policy to bring the private sector into the development of all new power plants (except multi-purpose hydro), and has entered into 35 contracts with private companies to construct, finance and operate power plants under Build-Own-Transfer (BOT), Build-Transfer-Operate (BTO), Rehabilitate-Operate-Lease (ROL) and other schemes. About 27 of these projects will be in operation by end of 1994. Total power generation contracted with the private sector amounts to about 5,000 MW, about 80% of the incremental capacity between 1993-99. To support such vast private sector investments, ways and means are needed to improve planning systems to ensure an optimal integration of private and public efforts.

4. The Power Crisis and the Project. Over the 1991-93 period, the Philippines experienced an acute power shortage; this posed a grave threat to its economic recovery because it translated into prolonged outages that

hampered industrial and commercial activities. As a result, unemployment increased and economic losses may have reached almost US$1 billion a year. Solving this problem became a national priority but conventional power supply projects (coal, geothermal and hydro) take about three-six years to be completed and could not provide relief in the short term. Thus, the Government launched a "fast-track" generation expansion program based on combustion turbine or diesel-engine driven systems which were contracted as BOT/BTO projects with the private sector. While these plants are operationally more expensive than base- load plants, they were the only power sources that could be commissioned within one or two years. These plants played a crucial role in meeting the Philippines power deficiencies and will meet peak system requirements in the future, but they are not a cost effective way to meet base-load power needs. However, by using geothermal energy in Leyte and substantially interconnecting the country's power systems, the proposed project provides a more cost effective option for Luzon. In addition, it is environmentally preferable to other thermal options. In any case, the substantial private participation already achieved has transformed the sector (de facto) and addressed the issues of adequately contracting and dispatching the power needed. These issues are being studied by consultants under the Leyte-Cebu Geothermal Project.

5. It is also important to continue ongoing efforts to strengthen the regulatory authority and to improve energy efficiency and demand-side management. These efforts have already succeeded in introducing efficient lighting schemes, rating of electrical appliances, conducting energy audits, applying strict conservation measures at public offices and, given the high price of electricity (more than twice the average in Washington D.C.) in promoting other energy conservation measures. Power demand charges to reduce peak loads will be introduced under the project and further actions are being studied by the Bank's Energy Sector Management Assistance Program (ESMAP).

6. <u>Institutional Issues</u>. While a severe three-year drought, which seriously curtailed hydro capacity, was in large part responsible for the power shortages, poor institutional performance also contributed to the crisis: Environmental approvals for new power projects were substantially delayed and financial and institutional weaknesses in NPC prevented it from making needed investments. Moreover, NPC's finances deteriorated severely in 1991 when costs rose sharply due to a large currency devaluation and higher oil prices (resulting from the Gulf War). The Supreme Court decision to stay a *pari passu* tariff increase added to NPC's financial difficulties; as a result, the Government needed to contribute about US$135 million to NPC. In 1991-92, the Corporation's cash situation was also jeopardized because it was required to pay oil taxes that were not included into its tariffs (pending an appeal to the Supreme Court). However, the final Court decision (May 1993) reconfirmed that NPC is exempt from such taxes and will allow it to recover about US$400 million in overdue tax refunds over the next few years. NPC's equity was also increased by the Congress in 1993, mainly by a ₱3 billion infusion from the surplus in the Oil Price Stabilization Fund (OPSF). Further, NPC agreed to a reform program whose implementation streamlined its structure, reduced the number of vice-presidencies from 26 to nine between 1991-93, and eliminated more than 2,000 staff. NPC is also establishing targets for improving project implementation, internal audits and controls, and rationalizing and decentralizing functions (including a plan to establish separate units for Luzon, Visayas and Mindanao). Under the Electric Power Crisis Act of 1993, the President was given special powers to solve the power crisis; these include facilitating tariff increases, speeding-up project approvals, and increasing technical salaries in the sector. A comprehensive management audit ("Efficiency and Operational Improvement Study") was completed in October 1993 and its recommendations would be implemented under the project (para. 16).

7. <u>The Energy Sector Plan (ESP)</u>. Sector reform is the highest priority of the new administration. As a result of its dialogue with the Bank, in January 1993, the Government prepared and approved the ESP, which charts a course of action to improve the operations of the energy sector as a whole. The ESP sets out measures and implementation schedules in all areas of concern, particularly for sector coordination, regulatory development, private sector

participation, power and oil pricing, environmental management, energy conservation, operational efficiency and project implementation. The Government would implement the ESP and annually review with the Bank the progress achieved. Some of the plan's key measures have already been introduced, such as establishing the Department of Energy (DOE) and initiating actions to improve NPC's finances, including automatic increases to the cost of purchased fuel and energy. These measures would ensure an adequate financial performance in future years.

8. Lessons Learned from Previous Bank Operations. Problems experienced in previous projects included delays in implementing required tariff increases, cost overruns due to project design changes, cumbersome contract award procedures and weak project management. We have endeavored to resolve these problems by assisting in establishing an improved regulatory framework and a system of automatic tariff increases linked to the cost of purchased fuel energy, by strengthening NPC's procurement processes and placing the responsibility for each project under a project director, and by using turnkey contracts rather than separate bids for each component.

9. Project Objectives. The grant would provide financial support for the Leyte-Luzon Geothermal project, reducing its cost and making financially more attractive the use of environmentally preferable geothermal energy for power generation. The Project would also support the following objectives: (a) meet the rapidly increasing demand for power in Luzon using indigenous and environmentally superior geothermal energy; (b) strengthen the energy sector by implementing institutional, planning and financial improvements recommended by the ESP; (c) support the large ongoing private sector participation in power generation, and facilitate it by extending the national grid; (d) strengthen NPC's capabilities in environmental and social impact analyses; (e) introduce ECO cofinancing in the Philippines; and (f) ensure the financial viability of NPC and PNOC for undertaking a long-overdue investment program.

10. Project Description. The project includes the following components: (a) PNOC-EDC would develop a 440 MW geothermal energy field to expand Leyte geothermal capacity from 200 MW to 640 MW, including: (i) drilling about 65 additional producer and injector wells in Malitbog, Mahanagdong and Alto-Peak; (ii) contracting technical services for geothermal drilling; (iii) constructing steam gathering systems; (iv) constructing the related subtransmission systems in Leyte; (v) constructing a pilot reinjection plant for CO_2; and (vi) recruiting consultants to assist with project implementation; (b) PNOC-EDC would also enter into BOT contracts with private sector companies to construct and operate 440 MW geothermal power plants; and (c) NPC would (i) contract two high voltage DC (HVDC) monopole converter stations and related electrode stations at Ormoc and Naga, to be financed by a US$100 million Eurobond issue partly supported by an Expanded Cofinancing Operation (ECO) of the Bank; (ii) construct overhead transmission lines in Leyte (about 77 km at 230 kV); (iii) install a submarine cable (about 19 km at 350 kV, 440 MW) crossing the San Bernardino Strait (19 km) and linking the Leyte-Luzon lines; (iv) construct a twin circuit HVDC overhead transmission line from Ormoc to Matnog cable terminal (about 176 km at 350 kV) and from Cabacungan to Naga (about 256 km at 350 kV); (v) rehabilitate the Naga-Tayabas transmission line (about 205 km at 500 kV); (vi) recruit two advisers for strengthening its environmental and social engineering departments; and (vii) recruit consultants to design the Casecnan hydroelectric project and to support project implementation. To support the project the GET grant would partially finance the technical services for geothermal drilling and the pilot reinjection plant for PNOC, and the HVDC overhead transmission line and environmental advisers for NPC. Details of the project are provided in Annexes 1 and 2.

11. Project Implementation. NPC will implement the transmission component and PNOC-EDC will undertake the geothermal development component and contract with the private sector to develop the generation plants. PNOC-EDC has already signed three BOT contracts for power generation in Leyte that aggregate to 536 MW (for both Leyte-Cebu and Leyte-Luzon). These energy conversion agreements use the same basic contract employed by NPC for other BOT projects, and were signed in September-October 1993 with Ormat Inc. (125 MW), Magma Power Company

(231 MW), and California Energy Company and CE Philippines Ltd. (180 MW), including 180 MW for Leyte-Cebu and 356 MW for Leyte-Luzon. Since the project construction will take five years, there is adequate time to contract the additional 100-140 MW BOT capacity. The BOO (build-own-operate) contract between NPC and PNOC-EDC to supply electricity was signed prior to Board presentation. The project preparation required considerable financial engineering by the Bank to complete a large financial plan for a complex project. In fact, the project financing would have not been feasible without Bank technical support and GEF financial assistance. The Bank's monitoring efforts would continue during project implementation, and would be supported by the project's consultants and periodic reports. The results of the pilot plant and the CO_2 emissions would be reviewed by foreign consultants when the geothermal system is operating (Schedule D).

12. The project cost is estimated at US$1266.9 million, with a foreign exchange component of US$1095.5 million (86% of the total). The total financing required, including interest during construction, is US$1333.6 million and includes two proposed Bank loans, for a total of US$227 million equivalent (17.0% of total): US$114 million to PNOC and US$113 million to NPC. A GET grant of US$30 million equivalent (SDR 21.6 million, 2.2% of the total) to the Government is recommended to make the geothermal alternative more competitive with a least-cost coal plant. Subsidiary grant agreements would be signed with NPC and PNOC each for US$15 million equivalent, to be withdrawn for specific components pari passu with the project implementation (Schedule B and Annex 4).

13. The remaining financing would be provided by: (a) internal cash generation of US$133.9 million (18.8% of the total excluding the BOTs), of which US$92.0 million would be from PNOC and US$41.9 million from NPC); (b) JEXIM would jointly finance US$170 million with the Bank (US$114 million for PNOC and US$56 million for NPC, 12.7% of the total), which would review project procurement and the awarding of contracts; (c) a Eurobond issue bonds for US$100 million (7.5%) to finance the converter stations, to be supported by an Expanded Cofinancing Operation (ECO); (e) a grant from the Swedish Government of about US$39 million equivalent (2.9%); (f) three BOT contracts for the generating plants totalling US$620.4 million, or 46.5% of the total) and (g) US$13.3 million (1%) of ongoing geothermal exploration being carried out under the Energy Sector Project (Loan 3164-PH). Advance contracting has been used for the transmission components, to better define the large investment and financing needed and to ensure the timely procurement for the project. Retroactive financing of up to SDR 2 million (10% of the proposed grant) is included for project expenditures incurred after August 1993. To facilitate disbursements a special account of US$2 million equivalent would be opened on terms and conditions satisfactory to the Bank. A breakdown of costs and the financing plan are shown in Schedule A. Amounts and methods of procurement and disbursements, and the disbursement schedule are shown in Schedule B. A timetable of key processing events and the project supervision plan is shown in Schedule D. A map is also attached.

14. Project Sustainability. In developing and implementing the ESP, the Government has provided a sound environment in which the sector can grow and strengthen its organization, planning and finances. NPC has already taken important steps that will require greater responsibility and accountability from regional managers; also, it established Project Directors, improved its procurement systems and would substantially increase staff salaries, allowing it to hire and retain competent staff. In turn, these actions will improve project implementation and plant maintenance. NPC's revised tariff structure, and particularly the approved system of automatic adjustments to purchased fuel and energy costs, will ensure adequate resources to cover its operation and debt service and help finance the large investment needed in the power sector. PNOC-EDC's operation and maintenance of renewable geothermal resources (under previous projects) has been satisfactory and is expected to continue as such. The joint action envisioned between PNOC-EDC and private BOT contractors will ensure that the power generated under the project will be reliable.

15. Rationale for GEF Involvement. The use of geothermal steam for power generation, followed by re-injection of the exhaust liquids into the ground,

has considerable environmental advantages over other fossil fuels in terms of reducing CO_2 emissions (and other gasses responsible for global warming), sulphites, particulates and NOX. Therefore, the project would help reduce global warming, since CO_2 emissions from alternative coal-fired plants are about 10-15 times greater. The grant would also strengthen NPC's social engineering and environmental management departments, which are critical for the adequate implementation of its future power investments.

16. The GEF grant would help develop critically needed energy in the Philippines and support a source that is indigenous and environmentally superior. Although the grant is small in the context of a project that totals US$1.2 billion, it was critical for the investment decision and influenced the Government in its choice of geothermal over the least-cost coal alternative (Annex 3). Due to high transmission costs, the project's cost of US¢6.4 per kWh is greater than those of coal-fired plants, which range between US¢5.4-5.7/kWh. Moreover, although the project is economically viable in relation to existing power rates, the present value of its capital costs and operating expenses exceeds those of a coal plant by US$90 million at a 10% discount. Even with the GEF grant, this project is more expensive than the coal alternative by US$60 million in net present value terms. However, for the Government this additional expense is justified considering the benefits that will be gained from the grid interconnection and a more robust and diversified power generating system, the use of indigenous energy, and a significant reduction in local pollution. The project is a cost-effective method of reducing CO_2 emissions (3,200,000 tons per year). Thus, carrying out the project with the support of the GEF grant would reduce CO_2 emissions at a cost of US$1.60 per ton, which is much lower than other GEF projects (which are generally in the order of US$13-US$23 per ton of CO_2). The project is pioneering the optimization of the geothermal pressure utilization (reducing the number of wells) and further includes a pilot project for further reinjection of additional global warming gases from geothermal plants into deep wells, that has not been tried elsewhere, and, if successful could use be used for the project and other countries.

17. Agreed Actions. Considerable progress has been achieved in the sector through the implementation of the ESP and key reform actions, and by the approval of tariff increases for NPC. In addition, the following actions have already been completed: (a) the implementation of a fuel and purchase cost adjustment system (which will index about 82% of NPC costs); (b) the signing of energy conversion contracts between PNOC-EDC and three BOT contractors for about 540 MW (of which 340 MW is allocated to Leyte-Luzon); (c) the appointment (by NPC and PNOC-EDC) of high-level Project Directors for their project components; and (d) the signing of a BOO contract between PNOC-EDC and NPC for the supply of power under the project. The signing of a 10-year power supply contract between NPC and MERALCO would allow the Government to properly define future capacity additions and is a condition of effectiveness for the NPC loan. In order to ensure that the large financing required by the project is in place, the following are conditions of cross-effectiveness: (a) the signing of a subsidiary loan agreement between PNOC and PNOC-EDC; (b) the effectiveness of BOT contracts with PNOC-EDC for 300 MW; (c) the effectiveness of the GET grant agreement, which requires the execution of subsidiary grant agreements with PNOC and NPC; and (d) the effectiveness of the JEXIM cofinancing loans. Failure to obtain financial closure by December 31, 1994 on foreign bonds for US$100 million for the converter stations, which are supported by the ECO, or to obtain these funds from other sources, would give the Bank the right to suspend the NPC loan.

18. Agreement was also reached at negotiations on the following: (a) the Government will carry out the ESP and exchange views with the Bank on its implementation; (b) the Government and NPC would annually review with the Bank the power development plan; (c) between 1994 and 1996 the Government would repay NPC all outstanding tax refunds; (d) NPC would: (i) annually review with the Bank the implementation of the recommendations of the Efficiency and Operational Improvement Study; (ii) achieve an after-tax rate of return on its net revalued fixed assets in operation not lower than 8% and a debt service ratio higher than 1.3; (iii) carry out the project in accord with environmental

standards acceptable to the Bank; (iv) carry out a Relocation and Compensation Plan satisfactory to the Bank; (v) strengthen both its environmental and social engineering departments by adding two advisers and at least five qualified staff; (vi) introduce demand charges (as a condition for goods disbursements under the NPC loan); and (vii) conduct a satisfactory valuation of its fixed assets and update it annually; and (e) PNOC-EDC would: (i) carry out the project in accord with environmental standards acceptable to the Bank; (ii) carry out a Resettlement Plan satisfactory to the Bank; (iii) maintain a debt-equity ratio not to exceed 70:30; (iv) maintain a current ratio not lower than 1.0; and (v) maintain a debt service ratio not lower than 1.25.

19. Environmental Aspects. After the mitigation measures provided for in the Environmental Assessment are implemented, the project will only have a minor environmental impact; it will, however, yield considerable benefits in reducing local pollution and global warming. This is because the CO_2, SO_x and particulate emissions from the project will be small, only a minor fraction of what would otherwise be emitted by alternative coal or oil plants. Environmental impacts will include minor deforestation at the site of the geothermal plants and near the transmission lines (an Environmental Summary for the total Leyte geothermal development was circulated to the Board on June 30, 1992 and an update covering the capacity expansion from 350 MW to 700 MW was circulated on June 22, 1993). The geothermal component is expected to displace some 127 families (mainly as a result of H_2S odors), whom PNOC-EDC would resettle within a short distance from their existing residences. The resettlement plan prepared by PNOC-EDC is satisfactory and plans to increase the income and living standards of the families affected. Transmission lines will be routed along existing roadways and have been designed to avoid any environmentally sensitive areas and minimize the impact of the right-of-way on houses or crops. Nevertheless, some relocation (normally within a few meters) and compensation for the right- of-way will be needed for 361 households. NPC's Relocation and Compensation Plan for the transmission lines has also been agreed upon, and includes satisfactory policies on resettlement and compensation for those affected.

20. Project Benefits. The project would establish a reliable, environmentally superior power supply for the Luzon region, which includes Metro Manila, the largest industrial and population center in the Philippines. It would also interconnect the total country through the Leyte system, which would dispatch power in an optimal manner and reduce the reserve capacity required in the individual systems. Also, the project would establish a sound basis for sector development by restructuring and strengthening it, improving NPC's corporate efficiency, policies and finances, and increasing the participation of the private sector in power generation. The project's economic rate-of-return, based on existing tariffs, is 11%, which is satisfactory.

21. Risks. In the past, NPC's slow procurement procedures have often delayed implementation; however, NPC has reorganized its procurement system and key bids will be awarded before Board presentation. Further, a substantial part of the project would be implemented by private BOT contractors and PNOC-EDC; and, to minimize such delays, NPC and PNOC-EDC have appointed high-level Project Directors (supported by staff and consultants) to coordinate all project activities. Another risk is that the large financing required for the project will not materialize, but co-financing commitments have been received and would be confirmed prior to the grant's effectiveness. Also, the separation of the generation plants into three BOT contracts would facilitate their financing and the replacement, if needed, of any non-performing contractor; moreover, the BOT contracts were awarded in August 1993, and they will be signed and guaranteed by substantial performance bonds before loan effectiveness. A third risk is that geothermal capacity will be lower than estimated, but it has been confirmed by PNOC-EDC consultants and certified by independent foreign reviewers; moreover, the Leyte field is expected to yield about 300 MW more geothermal resources in nearby Alto-Peak. Finally, there is a risk that tariffs will not be increased, but this risk has been reduced since present tariffs are adequate, the Energy Regulatory Board has approved the principles for setting NPC's tariffs, and automatic tariff adjustments for fuel costs and purchased energy are being implemented. The new Government has

targeted the energy problem as a top priority and has successfully restored NPC's financial viability.

Attachments
Washington, D.C.
May 9, 1994

Schedule A

PHILIPPINES

LEYTE-LUZON GEOTHERMAL PROJECT

Estimated Costs and Financing Plan

Estimated Cost	Local	Foreign	Total
	---- (US$ million) ---		
A. PNOC-GEOTHERMAL DEVEL.	58.6	205.6	264.2
A1. GOODS AND EQUIPMENT	5.4	136.0	141.4
A2. WORKS	30.1	65.9	96.0
A3. TECH. ASSISTANCE & OTHER	23.0	3.8	26.8
B. POWER PLANT (BOT)	52.7	482.3	535.0
C. NPC-TRANSMISSION LINES	30.0	256.7	286.7
C1. SUPPLY & ERECT CONTRACTS	24.9	249.2	274.1
C2. TECH. ASSISTANCE & OTHER	5.1	7.5	12.6
TOTAL COST	141.3	944.6	1085.9
PHYSICAL CONTINGENCIES	8.8	59.5	68.3
PRICE CONTINGENCIES	21.5	91.3	112.8
TOTAL COST WITH CONTINGENCIES	**171.4**	**1095.5**	**1266.9**
Interest During Construction		66.7	66.7
TOTAL FINANCING REQUIRED	**171.4**	**1162.2**	**1333.6**
FINANCING PLAN			
GET Grant PNOC		15.0	15.0
GET Grant NPC		15.0	15.0
IBRD-PNOC		114.0	114.0
IBRD-NPC		113.0	113.0
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TOTAL FINANCED 1]	**171.4**	**1162.2**	**1333.6**

1] Totals may not add due to rounding.

Summary of Proposed Procurement Arrangements (US$ Million equivalent)

Procurement Method	ICB	LIB	LCB	Other	NBF	Total
1A.WORKS (PNOC)	0.0	14.8	0.0	0.0	101.9	116.7
	0.0	(13.2)	0.0	0.0	(0.0)	(13.2)
Civil, Structural					42.8	42.8
					(0.0)	0.0
Drilling Tech. Services		14.8				14.8
		(13.2)				(13.2)
Insulation, Elect.Mechan.					37.2	37.2
					(0.0)	(0.0)
Transm. & Substations					21.9	21.9
					(0.0)	(0.0)
1B.GOODS (PNOC)	1.8	0.0	0.0	0.0	165.1	166.9
	(1.8)	0.0	0.0	0.0	(0.0)	(1.8)
Rig Lease					50.1	50.1
					(0.0)	(0.0)
Drilling Materials					52.6	52.6
					(0.0)	(0.0)
Pipes & Valves					35.6	35.6
					0.0	0.0
Other Equipment					7.9	7.9
					0.0	0.0
Pilot CO2 Reinjection	1.8					1.8
	(1.8)					(1.8)
Transmission & Substations					19.0	19.0
					(0.0)	(0.0)
1C.CONSULTANCIES & OTHER	0.0	0.0	0.0	0.0	31.6	31.6
	0.0	(0.0)	(0.0)	0.0	(0.0)	(0.0)
Technical Assist. (PNOC)					4.3	4.3
					(0.0)	(0.0)
Compensation & Administration					27.3	27.3
					(0.0)	(0.0)
TOTAL PNOC	1.8	14.8	0.0	0.0	298.6	315.1
	(1.8)	(13.2)	(0.0)	0.0	(0.0)	(15.0)
2. BOT POWER STATION					620.4	620.4
					(0.0)	(0.0)
3A.GOODS & INSTALLATION (NPC)	65.5	0.0	0.0	0.0	251.3	316.9
	(14.5)	0.0	0.0	0.0	(0.0)	(14.5)
Converter, Electr.& Stations					126.6	126.6
					(0.0)	(0.0)
Luzon HVDC T/L & Elect.	65.5					65.5
	(14.5)					(14.5)
Submarine Cables					68.4	68.4
					(0.0)	(0.0)
Naga-Tayabas T/L					56.4	56.4
					(0.0)	(0.0)
3B.CONSULTANCIES & OTHER				0.5	11.1	14.5
				(0.5)	(0.0)	(0.5)
Technical Assist. (NPC)						2.9
						(0.0)
Enviromental Advisor				0.5		0.5
				(0.5)		(0.5)
Hydro design					5.2	5.2
					(0.0)	(0.0)
Compensation & Admin.					5.9	5.9
					(0.0)	(0.0)
TOTAL NPC	65.5	0.0	0.0	0.5	262.5	331.4
	(14.5)	0.0	0.0	(0.5)	(0.0)	(15.0)
TOTAL PROJECT	67.3	14.8	0.0	0.5	1,181.5	1,266.9
	(16.3)	(13.2)	(0.0)	(0.5)	(0.0)	(30.0)

Note: Figures in parenthesis are the respective amounts financed by the GET grant.
ICB: International competitive bidding. **LIB:** Limited international bidding.
NBF: Not GET financed includes all other cofinancing component, administration and compensation expenditures.
Other: Other includes consultancies.

Disbursements of GET Grant

Category	Amount SDR Million	% of Expenditures to be Financed
Philippine National Oil Company: Technical services for drilling	9.5	90%
Goods and installation Pilot CO_2 reinjection	1.3	100% of foreign expenditures and 100% of local expenditures (*ex factory*) for goods and 100% for related installation
Subtotal PNOC	10.8	
National Power Corporation Goods and installation Leyte HV transmission Line	10.4	26% of foreign expenditures and 26% of local expenditures (*ex factory*) for goods and 26% for related installation services
Environmental advisors	0.4	100%
Subtotal NPC	10.8	
Total	21.6	

Estimated Disbursements:

Bank Fiscal Year	FY94	FY95	FY96	FY97
	(Million US$)			
Annual	5.5	11.2	11.8	1.5
Cumulative	5.5	16.7	28.5	30.0

PHILIPPINES

LEYTE-LUZON GEOTHERMAL PROJECT

Timetable of Key Project Processing Events

(a)	Time taken to prepare the project:	4 years
(b)	Prepared by:	PNOC and NPC
(c)	First Bank mission:	June 1989
(d)	Completion of the appraisal:	July 8, 1993
(e)	Negotiations:	March 10-18, 1994
(f)	Planned date of effectiveness:	August 1994
(g)	List of relevant PCRs and PPARs:	Fourth Power Project (PPAR P-0980); Fifth Power Project (PCR P-4388); Six Power Project (PCR P-4847) Rural Electrification Project (PPAR P-5732); Coal Exploration Project (PCR P-6960) Seven Power Project (PPAR No. P-8574)

This report is based on the findings of an appraisal mission consisting of Claudio Fernandez (Principal Financial Analyst), John Irving (Senior Power Engineer), Moiffak Hassan (Petroleum Specialist Engineer), Enrique Crousillat (Energy Economist) and P. T. Venugopal (Financial Consultant) who visited the Philippines in June 1993. The report was edited by Mrs. Barbara Koeppel. Peer reviewers were Messrs. Rafael Moscote, Albert B. Gulstone and Jamil Sopher. The project was cleared by Mr. Callisto E. Madavo, Director EA1, and Mr. Vineet Nayyar, Chief, EA1IE.

Philippines

Leyte-Luzon Geothermal Project

TECHNICAL ANNEXES

Annex 1 - Leyte Geothermal Resources and Development

Introduction

1. Geothermal energy in the Philippines is related to the volcanic origin of the archipelago. Geothermal regions and springs are widespread and production potential is high. Potential geothermal resources in the Philippines are estimated at about 8,000 mega Watts energy (MWe), of which about 2,000 MWe are considered proven reserves. About 75% of the geothermal resource potential has already been identified in various sectors located in the Luzon and Visayas Islands. Some 400 wells have been drilled country wide for exploration, delineation and development of geothermal resources, and the experience gained so far indicates that most of the fields discovered are larger than originally estimated. This is the case in sectors located in the Greater Tongonan Area, Palinpinon and Bacon Manito.

2. The first geothermal use for power generation started when Philippines Geothermal Inc. (PGI), a subsidiary of Union Oil, commissioned the first turbine (55 MW), at Tiwi, 320 km southeast of Manila. Since then, the Philippines has continuously increased its geothermal production capacity to become the second largest producer after the United States. Currently, geothermal power plant capacity accounts for about 14% of the total power generation capacity installed.

3. The Philippines has four geothermal fields on stream supplying steam for geothermal power plants having a combined capacity of 894 MW. Two of these fields, Tiwi and Makiling Banahaw (Mak-Ban), are situated in Luzon and have a rated installed capacity of 330 MW each. The other two fields are Palinpinon and Tongonan in the Visayas and have a rated installed capacity of 234 MW. In addition, 150 MW were commissioned in 1993, from Bacon Manito (Bac-Man) in Luzon. Palinpinon, Tongonan and Bacon Manito are developed and operated by the Energy Development Corporation (PNOC-EDC), a wholly-owned subsidiary of the Philippines National Oil Corporation (PNOC).

4. PNOC-EDC plans to develop four geothermal sources located in the Greater Tongonan area and Alto-Peak, referred to as Leyte A development, on Leyte Island (map). They will provide an additional 640 MW of power generation capacity, which will be commissioned in two phases during 1996 and 1997 under the project and the Leyte-Ceu Geothermal project. The Leyte developments depend on the installation of submarine HVDC cables linking the island of Leyte to Cebu, to transmit 200 MW, and Luzon via Samar, to export 440 MW.

Geological and Hydrothermal Setting

5. The geology of Leyte Island is dominated by a tertiary NW-SE trending volcanic arc known as the Volcanic Belt. Most of the geothermal manifestations in Leyte are associated with this structural Belt, e.g, Biliran, Greater Tongonan Fields, Alto-Peak, Lobi, Mahagnao, Bato-Lunas, Cabalian and Anahawan. The stratigraphy of the Greater Tongonan and Alto-Peak areas is characterized by an intrusive basement complex of undetermined age overlain by an Oligocene to Pleistocene volcano-sedimentary sequence. Most of the geothermal sources in the area originate in the Bao and Mahiao Formations which are situated at the lower part of the above mentioned sequence. The heat source is provided by hot spots

associated with intrusive dikes, domes and volcanic activities, believed to have taken place during the recent geologic history of the area.

6. Nearly all the productive geothermal zones are situated within the Mahiao formation. The most prolific are at depths greater than 1,200 m (below -500 m RSL). Faults are the major source of permeability and almost all the permeable zones can be attributed to the intersection of highly dipping faults of tensional origin, which act as conduits for hot fluids, and but also serve as channels for cold ground water or volcanic acid fluids.

7. Most of the wells drilled in the Greater Tongonan and Alto-Peak sectors are characterized by at least two significant permeable zones situated at depths ranging generally from -200 to -1600 m RSL. Permeable zones occur at greater depths in the Mahanagdong sector, down to -2400 m RSL. Well output characteristics show wide variations, even within the same sector, reflecting the heterogenous nature and complexity of faulting and the associated fracture system. In terms of mass flow, well output varies from 10-130 kg/second of reservoir fluid and the average enthalpy of the fluids produced is about 1,300 kJ/kg. Certain wells situated in the Upper Mahiao and Mahanagdong sectors discharge fluids having enthalpy in excess of 1800 kJ/kg, indicating higher contributions of steam in the total mass flow from either shallow two-phase zones or down-hole flashing brines. The average power potential output is about 2.2 kg/s of steam per MWe.

8. The wells drilled in the Greater Tongonan and Alto-Peak sectors discharge neutral brine having salinities ranging from 2,000-10,000 mg/kg of sodium and potassium chlorides with significant concentration of trace elements such as lithium, silicium, calcium, boron, etc. Some wells discharge acid sulphate fluids resulting perhaps from mixing condensing steam with down-flowing cool meteoric water. There is also a significant concentration of non-condensable gas produced with the brine. The major part of the non-condensable gas being carbon dioxide (CO_2)-(average: 2 gr/kg of steam), with minor amounts of hydrogen sulfide (H_2S), ammonia (NH_3) and residual gases like hydrogen, nitrogen, argon and methane.

9. Temperature profiles recorded at different levels in wells drilled in Upper Mahiao, Malitbog, Mahanagdong and Alto-Peak, show that the highest temperatures in the area to be within the Mahiao and Alto-Peak sectors. Reservoir fluid temperatures attain 320-330°C in Mahiao and probably (based on mineralization) up to 340 °C in Alto-Peak. The high temperature zones are believed to be associated with strong convective upflows in the central part of these sectors. Reservoir pressures are generally hydrostatic, suggesting the fracture systems to be extensive or in communication with extensive feeding zones.

Resource Assessment

10. Recoverable geothermal "reserves" depend mainly on reservoir rock type and properties, specific heat of rock and contained fluids, initial and abandonment reservoir temperatures, and configuration of the power generation installed. Geothermal reserves are expressed in MWe and are determined by estimating the stored heat using volumetric techniques. A probabilistic Monte Carlo type of analysis, Figure 1, is often used to reflect inherent uncertainties in the parameters mentioned above. Reserve estimates are revised periodically, during the exploitation life, to refine and validate previously assumed parameters, based on the additional data collected on the dynamic behavior of the source.

11. To date, more than 65 deep wells have been drilled in the Greater Tongonan and Alto-Peak sectors to explore, delineate and exploit the geothermal resources encountered. The great majority of these wells were successfully tested within the geothermal resource boundaries of the above mentioned

sectors, and depending on their location, wells are completed as either producers or injectors (see Table 1). The 20 wells drilled in the Lower Mahiao and Sambaloran sectors have been exploited since 1983 to supply steam to Tongonan I power generation units. The data gathered from the wells drilled are generally of good quality and constitute a reliable base for the assessment of geothermal resources of the sectors under consideration.

Table 1 - Summary of Resources and Development Status

Sector	No of Wells Prod.	Inj.	Drill Aband.	Resource MWe Available	Potential*	Power Generation MWe Installed	Utilized	Targeted	Additional Wells**
Tongonan I	13	8	2	17	30	112.5	70	25	
U Mahiao	7	4	2	63	130	0		130	8
Mahanagdong	6	0	0	55	205	0		165	23
Malitbog	11	5	2	104	240	0		240	24
Alto Peak	4	0	1	20	95	0		80	18
Total	41	17	7	259	700	112.5		640	73

Source: Appraisal Mission, based on PNOC revised assessment and review by International Consultant)

Notes:
Available: At wellhead and confirmed from long term testing.
Potential: Expected resources identified (Proven undeveloped).
* : Optimized
** : Wells programmed by PNOC until 1997.

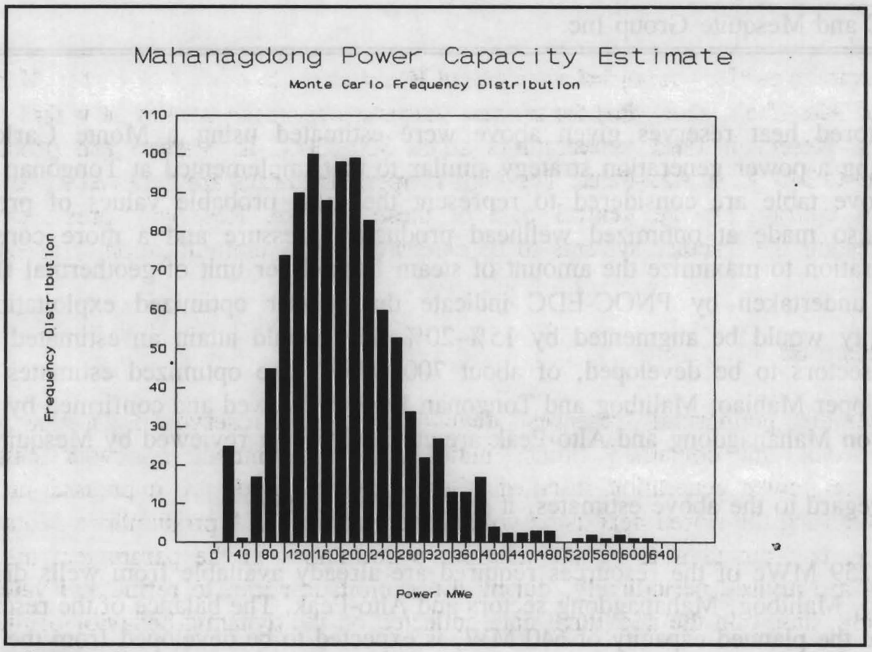


Figure 1

12. PNOC-EDC has recently updated the resource assessments for all the sectors planned to be developed under Leyte-Cebu and Leyte-Luzon to include the data obtained from the latest wells drilled in the Greater Tongonan and Alto-Peak sectors. These assessments were further reviewed and confirmed by an independent consortium of international consultants led by Mesquite Group Inc, of USA. The main results obtained from the assessments are summarized in Table 2.

Table 2 - Summary of Geothermal Reserves (MW)

Sector	Available Now	Targeted for Develop-ment	STORED HEAT ESTIMATES		OPTIMIZED CAPACITY	
			PNOC-EDC	Mesquite 1]	PNOC-EDC	Mesquite
U. Mahiao	63	130	118	140	130	Confirmed
Malitbog	104	240	165	170	240	Confirmed
Mahanagdong	55	165	195	170	195	2]
Alto Peak	28	80	80	80	95	2]
Tongonan I	17	25	20	25	30	Confirmed
TOTAL	259	640	578	585	700	

1] Mesquite used a Monte Carlo analysis to estimate stored heat.
2] Estimates are being reviewed by Mesquite

Source: PNOC-EDC and Mesquite Group Inc.

13. The stored heat reserves given above were estimated using a Monte Carlo probabilistic evaluation assuming a power generation strategy similar to that implemented at Tongonan I. The results shown in the above table are considered to represent the most probable values of proven reserves. Estimates were also made at optimized wellhead producing pressure and a more consistent turbine operating configuration to maximize the amount of steam flashed per unit of geothermal fluid produced. The simulations undertaken by PNOC-EDC indicate that, under optimized exploitation conditions, resource availability would be augmented by 15%-20%, and would attain an estimated total potential output from the sectors to be developed, of about 700 MWe. The optimized estimates conducted by PNOC-EDC on Upper Mahiao, Malitbog and Tongonan I were reviewed and confirmed by Mesquite, and those undertaken on Mahanagdong and Alto-Peak are currently being reviewed by Mesquite.

14. With regard to the above estimates, it should be noted that:

a) Some 259 MWe of the resources required are already available from wells drilled in Upper Mahiao, Malitbog, Mahanagdong sectors and Alto-Peak. The balance of the reserves needed to achieve the planned capacity of 640 MW, is expected to be developed from the same sectors.

b) PNOC-EDC and Mesquite estimates are consistent and confirm an optimized output potential from the sectors projected to be developed under the Leyte-Cebu and Leyte-Luzon projects, in excess of 640 MWe.

c) Considering the incremental potential projected from Mahanagdong and the spare capacity of 35 MW available from Tongonan I[1/], PNOC could secure the 440 MWe for Leyte-Luzon without having, at least initially, to develop Alto-Peak.

d) Based on the simulations conducted by PNOC-EDC, the resource potential output is expected to be sustainable over the projects' lives. This conclusion is also supported by the actual performance of wells producing from Lower Mahiao and Sambaloran during the past 10 years.

Resource and System Optimization

15. Resource output optimization may be brought about by maintaining higher wellhead pressures and optimizing turbine(s) inlet pressures to maximize the amount of steam flashed from geothermal fluids. This is achieved by the utilization of either one or more flash separation stages, in combination with one or two conventional condensing or non-condensing turbines, to maximize the recovery of energy per unit of reservoir fluid produced. This translates into a substantial reduction of specific steam consumption.

16. Currently, there are no high pressure steam operations on the developed geothermal fields in the Philippines. The reason for this was the lack of experience and the limited simulation capabilities to predict long- term performance available at the time wet fields like Tiwi, Mak-Ban, Tongonan and Palinpinon were developed. The recent development of powerful numerical analytical methods to simulate past reservoir behavior and accurately forecast future performance have greatly reduced the capacity uncertainties. In addition, the vast amount of data obtained from 10 years of operation of Tongonan I, and from reservoir response at Lower Mahiao and Sambaloran sectors, provides a sound data base for optimizing the resources under consideration.

17. Optimization studies were undertaken by PNOC-EDC using a turbine inlet pressure of 1.5 MPa, on the basis that this inlet pressure is 30% below the mean discharge pressure observed at Lower Mahiao producers; it would allow sufficient margin for the anticipated drop in reservoir pressure. Several power station configurations, using a combination of different suites of turbines, were considered in the above mentioned study. The main results obtained are:

a) Back-pressure turbines will be installed on Upper Mahiao owing to the high wellhead pressure generally encountered in wells drilled in this sector. The exhaust steam from the turbine will be circulated into an iso-butane evaporator and the iso-butane vapor generated will drive an organic turbine to generate additional power. Similarly, the hot residual brine collected from the separator will also be circulated into an evaporator to drive a second organic turbine.

b) The sectors of Malitbog, Mahanagdong and Alto-Peak are water- dominated fields. The optimum heat cycle for Malitbog sector would be a double flash system, while Mahanagdong and Alto-Peak would be a single flash system. For these sectors, a conventional steam process cycle of power generation is used. After separation, the steam is conveyed into a condensing steam turbine to generate power. The exhaust steam is then condensed into a direct contact condenser from which the condensate is recycled back as cooling water, some of which is pumped into a cooling tower before re-injection.

1/ It is assumed that demand for power on Leyte Island from Tongonan I would remain unchanged over the next decade.

c) The hot brine from the primary separators from Malitbog is flashed at lower pressure in a second stage separator to produce additional steam for power generation, whereas brine from primary separation at Mahanagdong and Alto-Peak is piped directly to hot re-injection wells.

d) Based on the optimization studies conducted by PNOC-EDC, the output from the Upper Mahiao and Malitbog sectors is estimated to be 240 MWe and 130 MWe, respectively. In addition, on-going simulation studies on Mahanagdong and Alto-Peak indicate that optimization would enable achieving outputs of 205 MWe and 95 MWe respectively from these sectors, and optimization of the present generation configuration at Tongonan I would also result in an incremental output of 30 MWe from this sector, beyond the installed capacity of 112.5 MW.

Field Development

Strategy & Projects Components

18. PNOC-EDC plans to achieve the 200 MWe from Upper Mahiao (130 MWe) and Malitbog (70) under Phase I and the remaining resources from Malitbog (130 MWe) and the other sectors will be dedicated to Leyte-Luzon development. Under such development, Upper Mahiao is expected to deliver steam close to its estimated maximum limit. Such strategy has the advantage of completing the development of Upper Mahiao under the Leyte-Cebu phase. It would also provide more flexibility in handling large quantities of residual brine from Malitbog during the initial stages of project life. The remaining capacity from Malitbog (170 MWe), Mahanagdong and Alto-Peak will be dedicated to the Leyte-Luzon project. The steam produced from the above sectors will be delivered for power generation against a fee defined by an Energy Conversion Agreement signed with the BOT companies. The power generated will then be sold to the National Power Corporation (NPC).

19. Taking into consideration the incremental resources expected through optimization, two alternative options are being investigated to achieve the 440 MW from the above mentioned sectors as follows:

	Option I	Option II
	MWe	MWe
Malitbog Phase II	170	170
Mahanagdong	165	205
Alto-Peak	80	
Tongonan Optimization		30
Tongonan Spare Capacity	35	35
Total	450	440

20. The development of Alto-Peak will be deferred under Option II, at least during the first 5-7 years of exploitation, and the needed capacity would be provided from Tongonan I optimization and the spare capacity available from this sector. The two options were critically evaluated by PNOC-EDC for cost, project execution schedule and operational flexibility in September 1993. In both options, it is assumed that power utilization on Leyte Island from Tongonan I, estimated presently at about 70 MW, would remain almost unchanged during the coming decade.

Geothermal Projects' Components

21. The Leyte-Cebu and Leyte-Luzon geothermal projects comprise the following major components:

a) Drilling of 73 additional producers .and injectors in the Upper Mahiao, Malitbog, Mahanagdong and Alto-Peak sectors. Eight wells will be dedicated to Leyte-Cebu and 65 wells to Leyte-Luzon.

b) Installation of some 35 separators to process geothermal fluids and about 175 km of pipelines ranging in diameter from 14-42 inch to process, collect and dispose of geothermal fluids, steam and carbon dioxide (FCDS). About 25 separators and 127 km of pipelines will be installed under Leyte-Luzon project.

c) A control and data analysis system (SCADA), and erection of field utilities.

d) Installation of a power transmission ring main between the sub-stations.

e) Recovery of carbon dioxide (CO_2) from the non-condensable gas, its re-injection with residual geothermal brine into the reservoir and processing for industrial utilizations.

f) Technical assistance for the design, engineering, supervision and project management.

Drilling Program

22. It is estimated that eight additional producers would be initially needed in the Upper Mahiao sector to achieve the projected power capacity of 130 MWe for Leyte-Cebu. No additional wells would be required in Malitbog for this phase, as the available capacity from the existing 12 producers in this sector is estimated to be in excess of 100 MWe. Some 65 additional wells are planned to be drilled under the Leyte-Luzon expansion on Malitbog, Mahanagdong and Alto Peak. All 73 wells mentioned above will be drilled before 1997. PNOC-EDC is presently finalizing contracts for 3-4 additional rental rigs to implement the above program from early 1994. It is estimated that some 80 make-up and replacement wells would be drilled in all the sectors during the life of the project, as output declines due to resource depletion. The distribution and exact number of make-up wells will be determined from future reservoir simulation studies once more data on reservoir behaviors under exploitation become available. PNOC-EDC's drilling program is given in Table 3.

23. Given the number of wells needed to sustain the required output under the planned development, it would be difficult to accommodate the number of drilling pads projected, particularly in the sectors characterized by difficult terrain such as Malitbog and Alto-Peak, unless the number of wells per pad is increased and wells are drilled at a higher deviation. PNOC-EDC is also investigating the feasibility of drilling larger diameter wells to increase well productivity and hence reduce the total number of wells required.

Fluid Collection and Disposal System (FCDS)

24. The layout of the FCDS in each sector is optimized as a function of the topography in such a manner so as to minimize the length of steam lines in order to avoid excessive cooling and condensation of steam ahead of the turbines. Some 175 km of pipelines, having a diameter ranging from 14-42 inches will be laid under the projects of which 127 km are planned under Leyte-Luzon. Steam from the separators will be evacuated at a velocity of 30-35 m per second to minimize heat losses and avoid the formation of water slugs ahead of turbines. The residual brine collected from separators and condensed from exhaust steam would be re-injected at the outer limits of the sectors to sustain water recharge into the source area.

Reducing CO_2 Emission

25. Following project completion in 1997, the maximum emission of CO_2 from produced geothermal fluids is estimated at about 600,000 tons/year during the initial life of the project. This is about 10% of the amount of CO_2 that would be produced by an equivalent capacity coal-based power plant. Hence, there is considerable environmental interest in Leyte geothermal development and the proposed GEF grant under the Leyte-Luzon project. The amount of CO_2 is expected to decline progressively to about 280,000 tons/year by the year 2020. Although the flux of CO_2 in the Greater Tongonan area will be small, it would be desirable from environmental point of view not to dispose of it in the atmosphere. To this effect, PNOC-EDC has undertaken theoretical studies and field trials to investigate the feasibility of re-injecting CO_2 and evaluate the associated reservoir problems, particularly silica and carbonate scaling. PNOC-EDC expects to undertake experimental field trials this year. Whether CO_2 from the Leyte geothermal plants is injected or not is relatively insignificant in comparison with the large benefits to be realized for the global atmosphere in displacing coal generation on Luzon in favor of geothermal power generation in Leyte. The Leyte projects are expected to result in a net saving of 120 million tons of CO_2 which would not be released to the global atmosphere over the 25-year project life.

26. Should the above studies and trials confirm the feasibility of the wet disposal of CO_2, about half of the CO_2 produced will be re-injected with residual brine into existing re-injection wells situated at the periphery of the different sectors. The balance of the CO_2 produced would most likely be vented to the atmosphere, because dry injection of the gas may not be possible due to the absence of suitable reservoir storage in the areas under development. The cost of field trials for the wellhead injection option is estimated at about US $0.15 million. The cost of implementing full scale wet CO_2 re-injection is expected to be of the order of $2 million-$3 million, as gas is essentially re-cycled into geothermal residual brine using existing facilities.

27. PNOC-EDC is investigating other options for CO_2 abatement as a contingency, in the event wet injection results in adverse effects on the reservoir properties due to precipitation of silica. In such options, CO_2 is extracted from the non-condensable gas (NCG) effluent and purified for use in the bottling of carbonated drinks or conversion into dry ice for industrial use. Hydrogen sulfide (H_2S) is also extracted from the gas effluent and is converted into elemental sulfur for industrial processing. The balance of NCG is vented into the atmosphere. Both options comply with environmental emission standards, but the system using upstream gas abatement results in lower steam consumption and increased turbine efficiency.

Uncertainties Associated with Field Development

28. Although the reserve estimates made by PNOC and their confirmation by Mesquite Group Inc, support the planned expansion of generating capacities from the Greater Tongonan and Alto-Peak sectors, some uncertainties do persist relative to the maximum resources achievable and development strategies of the Mahanagdong and Alto-Peak sectors. Further delineation and evaluation of these sectors ought to be expedited to enable timely determination of the final development strategies.

29. Uncertainties relative to the recharge/drying out of the reservoir are expected to be resolved favorably. However, the reservoir responses to the large-scale development planned are difficult to identify due to the lack of data relative to the dynamic behavior of a reservoir when exploited. All the sectors will need to be monitored very closely from the initial stages of field exploitation to identify the need to optimize production and injection strategies through make-up and replacement wells that would ensure the sustainability of resources during the plant's life.

Table 3 - Additional Wells to be Drilled in Leyte

(A) - Leyte-Cebu 200 MWe

	Well Status December 1992			MWe	Additional Wells to be Drilled 1993	1994	1995	1996
Number of Wells	Prod.	Inj	Aband.					
L Mahiao/Sambaloran	13	8	2	25				
Upper Mahiao	7	4	2	63		2	6	
Malitbog I	11	5	2	104				
Total	31	17	6	192		2	6	

(B) - Leyte-Luzon 440 MWe (Option I)

	Well Status December 1992			MWe	Additional Wells Drilled 1993	1994	1995	1996
Number of Wells	Prod.	Inj.	Aband.					
Mahanagdong	6	0	0	55	2	7	7	7
Malitbog II	11	5	2	104	3	6	6	9
Alto Peak	5	0	1	20	3	5	5	5
Total	22	5	3	179	8	18	18	21

Project Implementation (*Geothermal Component*)

30. Implementation of the geothermal development components of the project will be the responsibility of the PNOC-EDC head-office. PNOC-EDC has demonstrated its ability to effectively manage the implementation of large-scale geothermal development projects. Its management team has been exposed to all phases of geothermal development and as a result, it has been able to put together a well structured organization with staff sufficiently trained to implement this project. During all phases of project design and implementation, PNOC will be assisted by international consultants who have extensive experience in geothermal reservoir development, drilling and processing and evacuation of geothermal fluids. PNOC requires that all well completions, structures and facilities, including the fluid collection and disposal network systems, meet international standards and receive certificates to that effect from recognized certification companies. These services will be provided in collaboration with the above designated international consultants.

31. Because of the project's relatively large size, PNOC would manage implementation in terms of three separate sub-projects: (a) a drilling component; (b) the fluid collection and disposal system; and (c) the electricity component within the PNOC field development area and coordination with the BOT companies. To ensure maximum coordination in the implementation of the "sub-project," PNOC has appointed an officer who has extensive operational and project management experience to work as overall project manager, who would be in close coordination with the already appointed Project Director.

32. To simplify procurement and reduce the risk of implementation delays, PNOC-EDC should endeavor to have maximum single responsibility turnkey contracts for the construction of the fluid collection and disposal system (FCDS). Under such contracts, the responsibility of the contractor extends

from detailed engineering to commissioning and final acceptance by PNOC-EDC. The single responsibility approach is recommended as it offers the greatest chance for the expeditious execution of contracts in spite of weather and construction risks. However, this approach is impractical for the implementation of the drilling component, since the implementation of such a component requires close interaction with disciplines beyond the capabilities of a mere drilling contractor and PNOC-EDC would be in a better position to ensure the timely implementation of such a component.

33. It is estimated that PNOC-EDC will be able to complete the project in four years. This estimate takes into account PNOC-EDC experience with the implementation of similar projects. The completion time of the geothermal component is considered realistic, particularly in view of the advanced stage of procurement preparation. The Bank has reviewed the basic engineering design prepared by PNOC-EDC for the bid packages and has found them acceptable.

34. It should be noted, however, that field development will be reviewed periodically as more data become available from new drill holes and well tests, in order to fine-tune reservoir development and FCDS. Engineering of the FCDS will be essentially undertaken by the Construction/Process Group at PNOC-EDC. The engineering design and bid documents will then be reviewed by an international consultant. Engineering design and preparation of bid documents for the major components has been completed. The procurement schedule is shown below.

Procurement Schedule

Works	Target Bid Date	Target Bid Award	Works	Target Bid Date	Target Bid Award
			D. Service Contracts		
I. FLUID COLLECTION SYSTEM			1. NDT	Jul-95	Oct-95
			2. Topo Survey	Apr-94	May-94
A. Supply			3. Geochemical Survey	Aug-94	Nov-94
1. Pipe & Fitings	Jun-94	Oct-94	4. Construction Survey	Apr-94	May-94
2. Various Valves	Jun-94	Oct-94			
3. Steam/Water Separator	Jun-94	Oct-94	II. TRANSMISSION		
4. Mechanical Equipment/	Oct-94	May-95	1. Transmission Line	Apr-94	Sep-94
Fabricated Items	Nov-94	Apr-95	2. Plant Substation	Apr-94	Sep-94
5. Balance of Plant	Nov-94	Apr-95	3. Main Substation	Apr-94	Sep-94
B. Construction			III. PILOT CO2 REINJECTION	Jul-94	Sep-94
1. Pre-Construction	by PNOC-EDC				
2. Civil Works	Jan-95	Jun-95	IV. DRILLING OPERATIONS		
3. Structural Works	Jan-95	Jun-95	A. Drilling Supplies	Quarterly	3 mos.
4. Electro-mechanical	Jan-95	Jun-95	B. Technical Services	May-94	Oct-94
5. Insulation	Jul-95	Sep-95	C. Rig Rental	May-96	Oct-96
			- Extension existing contract	May-95	Oct-95
C. Supply & Installation					
1. Instr./Power Supply	Jan-95	May-95	V. TECHNICAL CONSULTANCIES		
			A. FCDS Engineering Services		Feb-94
			B. Technical Service (KRTA)		Aug-93
			C. Project Director		Aug-93
			D. Transmision Engin. & Design	Apr-94	Sep-94
			E. Transmission Constr. Management	Apr-94	Sep-94

Figure (2)

PHILIPPINES

LEYTE A GEOTHERMAL DEVELOPMENT

Steam Process Flowsheet

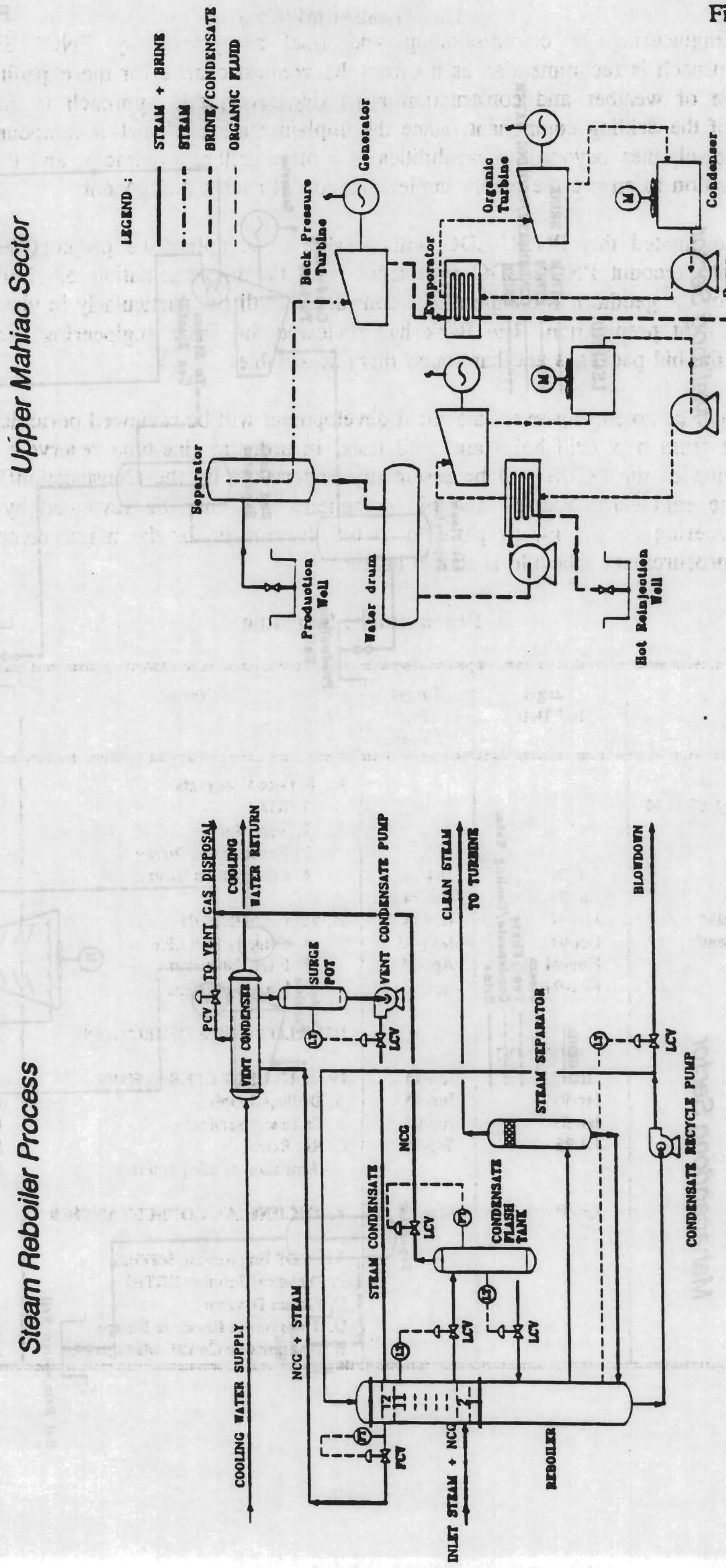


Figure (3)

PHILIPPINES
LEYTE A GEOTHERMAL DEVELOPMENT
Steam Process Flowsheet

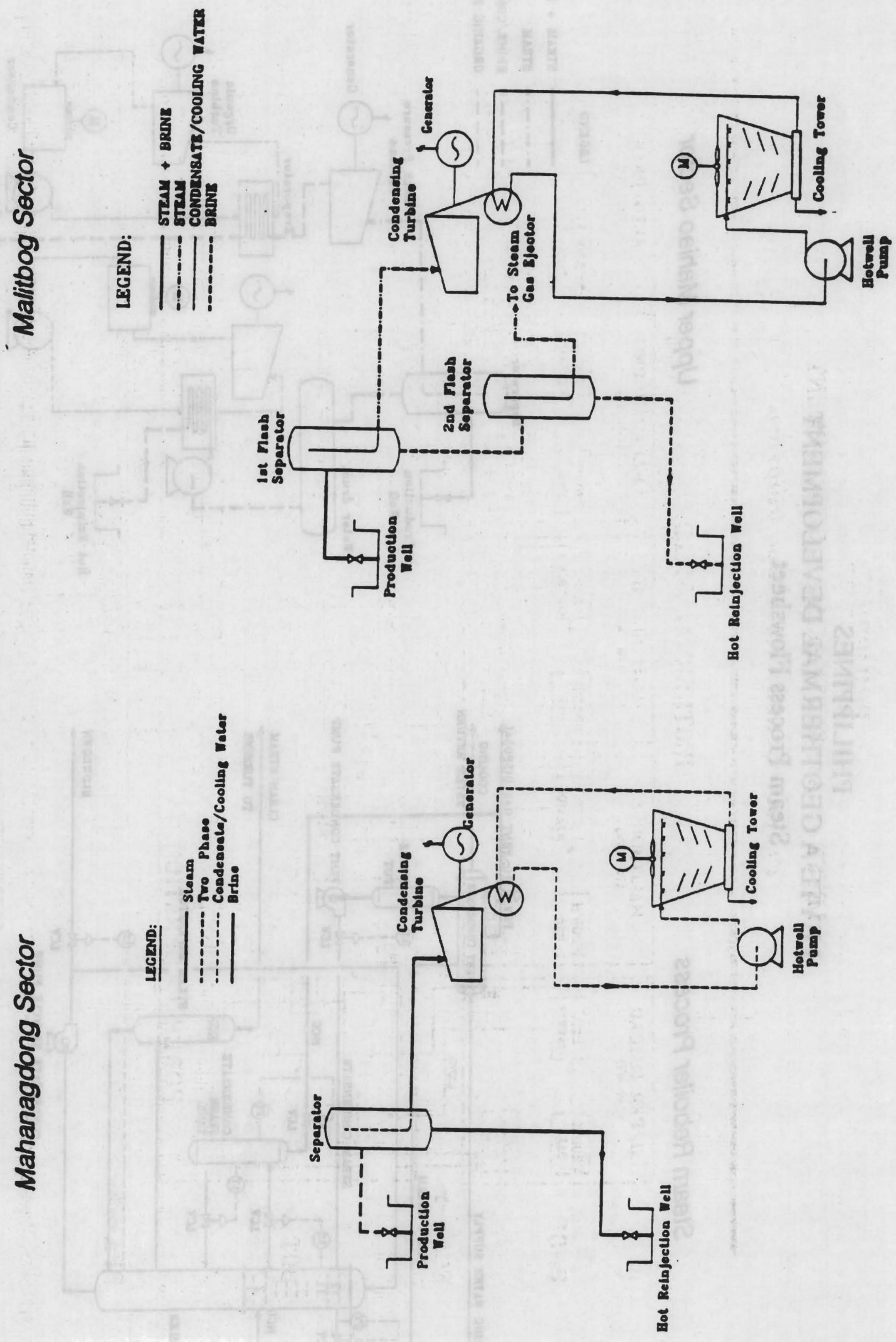
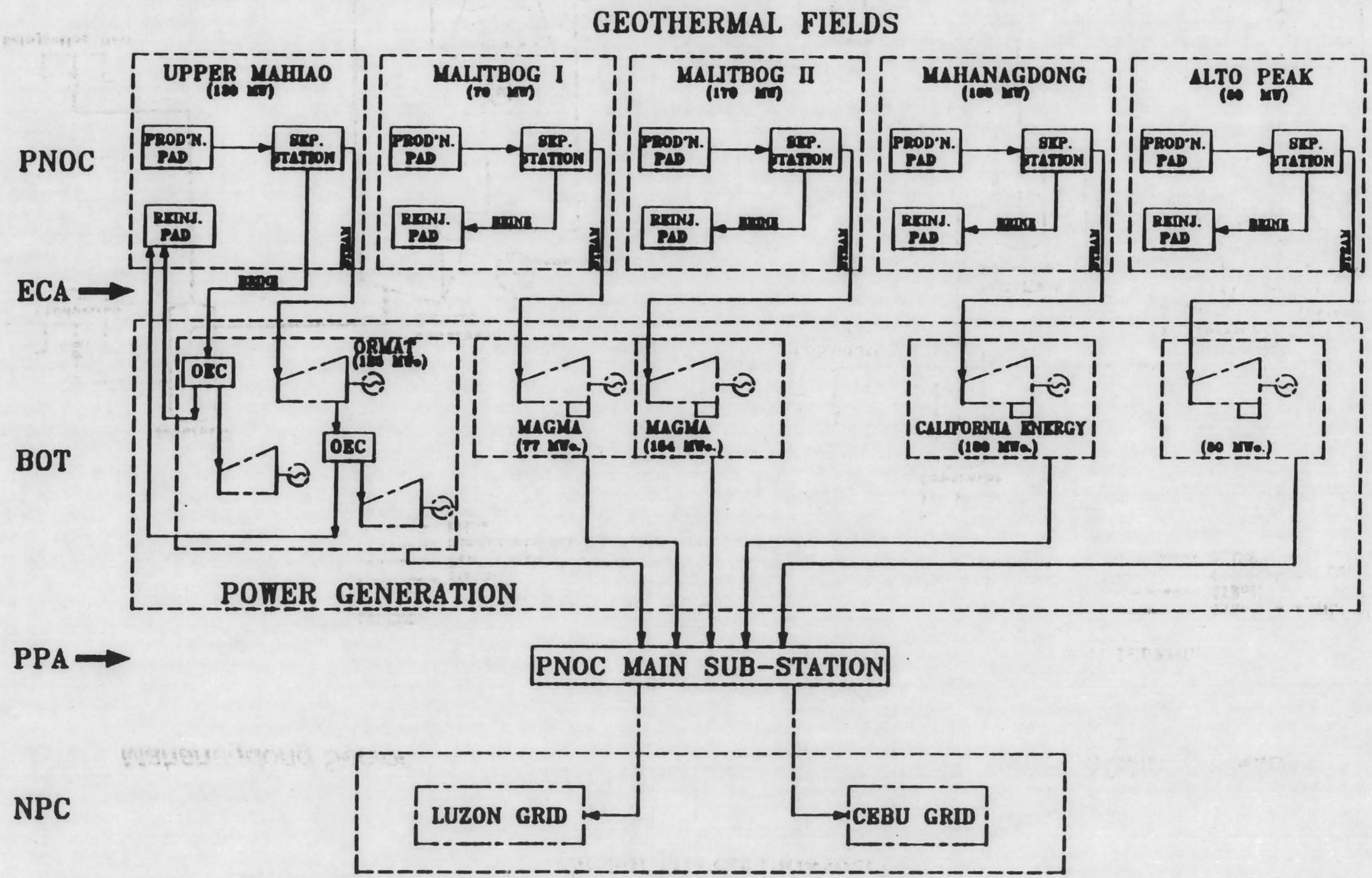


Figure (4)

PHILIPPINES
LEYTE A GEOTHERMAL DEVELOPMENT
Project Schematic Flow Diagram



ECA: ENERGY CONVERSION AGREEMENT PPA: POWER PURCHASE AGREEMENT

Philippines

Leyte-Luzon Geothermal Project

Annex 2 - NPC Project Description and Implementation

(A) Electric Interconnection System

35. The transmission system incorporated in the Leyte Geothermal Projects (i.e., both the Leyte-Cebu project and the Leyte-Luzon project) includes the first and second stage of NPC's plan to interconnect the Luzon, Visayas and Mindanao regional power systems into a single extra high voltage (EHV) power grid. The first stage, incorporated into the Leyte-Cebu project, comprises a 230 kV high voltage alternating current (HVAC) interconnection, initially providing up to 200 MW of geothermal generating capacity from Leyte to the existing 138 kV Cebu power system. The second stage, incorporated under this project, comprises the Leyte-Luzon high voltage direct current (HVDC) interconnection, which would supply the existing 500 kV Luzon power system, initially with 440 MW by 1998. The development of subsequent stages of expansion of the EHV grid, involving the extension of the HVDC transmission grid to Mindanao, expansion of the 500 kV system within Luzon, and subsequent reinforcement of the respective inter-regional transfer capacities, is currently under study. During its various stages of expansion, the grid is expected to provide a means of optimizing the development of hydro and geothermal resources in the Philippines, thereby minimizing the need for power system reserve capacity required during normal systems operations.

36. Under NPC's twenty year expansion planning study, it was recommended that the major power systems in the Philippines be interconnected to take advantage of the economic and technical benefits of power pooling. The detailed study by SwedPower in 1988 proposed links as follows, between: (a) Leyte and Luzon — 1000 MW HVDC; (b) Leyte and Cebu — 200 MW 230 kV AC; and (c) Leyte and Mindanao — 400 MW HVDC. While the power flow will be from Leyte to Luzon initially, it can be seen that the transfer characteristics equate well to the demand/resource balance based on the known feasible coal, geothermal and hydro potential as follows:

Regional Resource Potential and Power Demand (MW)

	Luzon	Visayas	Mindanao
Existing Demand 1993	3,463	511	837
Forecast Demand 2005	11,724	2,143	4,326
Local Coal	1,200	125	485
Geothermal Resource	1,100	965	140
Hydro Resources	10,100	640	3,627
Net Export(+)/Import(-) 2005	+673	-413	-434

37. During the feasibility stage, various alternatives for transmission line development in the Leyte-Luzon corridor have been investigated by NPC and their consultants in consultation with the Bank. The decision to utilize HVDC as the backbone system for future development was undertaken after looking at a number of alternatives, including the extension of the 500 kV system which had already been constructed to evacuate the geothermal power at the Bacon Manito and Tiwi fields at the southern tip of Luzon. Based on the cost estimates available, it was concluded that a bipolar +350 kV -350 kV HVDC line was the least-cost option as designed in stages to be ultimately upgraded to 880 MW by adding

additional converter units in parallel with the first-stage facilities. On this basis, during early 1993, bids were invited for the supply of a 440 MW bipolar system with an option to upgrade to 600 MW at a later date. However, bid prices at about US$400/kW were about 50% higher than expected. It was considered that a first stage 440 MW monopolar alternative would be the better option, with provision for upgrading to 880 MW when the prospect for increased capacity could be realized. After examining various options for providing additional generation and transmission to meet the demand forecast for Luzon and Cebu, NPC decided to pursue implementation of the Leyte transmission components as follows:

(a) The first stage of the Leyte-Cebu interconnection to meet the base load requirement of Cebu after commissioning by 1997.

(b) Uprate the Leyte-Cebu interconnection to 400 MW to meet the expected combined load demand in Cebu, Negros and Panay (700 MW) by the year 2000.

(c) The first stage of Leyte-Luzon HVDC power transmission to meet the load requirement of Luzon after commissioning by end-1997.

(d) Uprate the Leyte-Luzon HVDC transmission to its final rating of 880 MW to meet the load requirements of Luzon in about the year 2000 and optimize the utilization of indigenous sources of energy that are locally available.

(B) Development of Leyte Projects

38. Under the project, PNOC has contracted with NPC to provide 640 MW of base load capacity on a "take or pay" basis at an average rate of 1.60 Peso/kWh for Leyte-Luzon, including taxes and royalties over a 20 year period. The contract provides for 200 MW for the Visayas region (most of which is assigned to Cebu), with the balance of 440 MW assigned to Luzon. PNOC will be responsible for the development of the steamfield resource, the details of which are described in Annex 1. It will undertake drilling production wells to generate an initial capacity of 640 MW by 1997, and construction of pipelines to provide steam to the five stations under three separate BOT contracts in two stages: (a) under the Leyte-Cebu project at Upper Mahiao (130 MW) and Malitobog (180 MW); and (b) under the Leyte-Luzon project at Mahanagdong A (110 MW), Mahanagdong B (55 MW), and Alto-Peak (80 MW). There is a possibility that by optimizing the geothermal potential at Mahanagdong A, the full capacity can be provided without having to exploit the more expensive development at Alto-Peak. PNOC-EDC will also be responsible for the construction of 230 kV transmission lines to carry power from the geothermal power stations to PNOC's 230 kV Malitbog central substation.

39. NPC will be responsible for the provision and operation of the Ormoc substation, and onward transmission of power both to the Cebu 138 kV system and through the HVDC line to Luzon. Power will be generated from NPC's existing Tongonan plant (107 MW, which expected to supply about 30 MW power surplus for the Leyte-Cebu system), and from the BOT plants contracted with PNOC-EDC. NPC's transmission system includes submarine cables and overhead transmission lines and the reinforcement of other affected transmission systems. The first stage of the Leyte-Luzon HVDC link is planned as a 440 MW 350 kV monopole facility designed for upgrading to a ±350 kV, 880 MW bipolar operation in the future. The two 440 MW converter stations would be installed at the new Ormoc substation in Leyte, and at NPC's existing substation at Naga in Luzon. Their design would allow for expansion to 2x440 MW to match the overhead lines and submarine cables, which are already rated for 880 MW. Ultimately, further expansion of the HVDC link could be achieved by paralleling the existing 440 MW lines, or by building a new HVDC facility, possibly operating at a higher voltage.

40. The 350 kV monopolar link, to be commissioned by end-1997, comprises two converter stations linked by a twin circuit DC transmission system rated for 880 MW transfer capacity. The environmental conditions, insofar as they affect the design of the system, are summarized in Table 1. The interconnection between Leyte and Luzon thus consists of two sections of overhead transmission line, one of 256 km on Leyte and Samar and the other of 176 km on Luzon. The DC overhead transmission line will be bundled 3-772 mm^2 ACSR $\pm$350-kV twin sets of bundled conductors on steel towers connecting the main substations and the two cable terminals at Cabacungan, Samar in Luzon and Matnog, Sorsogon in Leyte. Two 19 km submarine cables would cross the San Bernardino Strait connecting the respective cable terminals. The overhead line from Matnog to Naga Converter Station, which is connected to the Luzon 500 kV network via the existing Naga Substation will initially operate at 230 kV. The ground return system will be directed through driven anode/cathode earthing rods located approximately 20 km from the converters. The metallic portion of the ground return cable systems will be directly buried to prevent pilferage.

(C) Project Implementation

41. The project will be divided into turnkey packages to ensure that the responsibility for implementing each component of the project is clearly defined. Taking into account the specialized nature of the work, the financing arrangements and the need for competitive bidding, the turnkey packages have been designed as follows:

(a) Furnishing and installing complete HVDC submarine cables.

(b) Furnishing and installing the overhead transmission lines and electrode lines.

(c) Furnishing and installing the converter, electrode and cable terminal stations.

The scope of the contracts is described below, together with details of the relevant design details:

42. **Submarine Cable Turnkey Project.** The HVDC Submarine Cables will be laid across the San Bernardino Strait from Matnog in Sorsogon to Cabacungan in Samar (2 oil filed, 19 km, 440 MW $\pm$350-kV). The main design parameters for the submarine cable are:

Transmission power at receiving end (MW)	1 x 400 MW
Transmission DC voltage (Uo)	350 kV
Transmission current (Nominal)	1150 A
Overload current for 30 sec. at nominal service voltage (Uo)	2300 A
Lightning impulse withstand voltage (Up1)	900 kV
Switching surge withstand voltage (Up2)	720 kV
Creepage distance (min)	48 mm/kV

43. A marine geophysical survey of the Leyte-Luzon Interconnection Project jointly conducted by the Mines and Geoscience Bureau and the Geoscience Services Department of NAPOCOR in San Bernardino Strait identified corridors suitable for laying the submarine cables. The strait is underlain by a succession of semi-consolidated-to-consolidated sediments, probably laid down during late tertiary. The area is devoid of deposits of consolidated sediments, except in places where there is recent accumulation of sand and other materials (mostly shells and coral fragments), which are deposited in large sand bodies/banks with ripple-like structures. However, these sand bank deposits are concentrated only along the inner sides of Sorsogon and Samar, wherein they are laid down by the combined action of longshore, wave, and tidal currents in a relatively high energy environment. A channel-like structure about 800

meters wide is also evident, snaking northeasterly near the Sorsogon side, but is strangely lost going farther seaward towards the Pacific Ocean. Basically, there are three main stratigraphic units recognized: (a) Unit I — composed mostly of sand bank deposits; (b) Unit II — the most dominant and recognizable, consisting mostly of medium- to-coarse grained consolidated sediments, probably originating from the Bulusan pyroclastics. It is disrupted by parallel fault scraps and some minor fractures. Slump features were also observed suggesting that some mass movement or creep is going on; and (c) Unit III — bedrock consisting possibly of the Gatho Formation. The above conditions confirm the results of an earlier survey carried out along the cable route recommended in the JICA Feasibility Study Report of 1982.

44. **Overhead HVDC and Electrode Transmission Line Turnkey Project.** The overhead HVDC and electrode system project includes:

(a) The HVDC bipolar overhead transmission lines from the Ormoc converter station to the Cabacungan cable terminal station. These will be at ±350 kV, and will have a total length of 432 km of 3-772 mm Martin.

(b) The bipolar overhead transmission lines from the Naga converter station to Matnog cable terminal station. These will be at ±350 kV, and comprise 176 km of lines (3-772 mm^2).

(c) The electrode lines from the Naga converter station to the Calabanga electrode station on Luzon. These will comprise 13 km of lines (2-772 mm^2).

(d) The electrode lines from the Ormoc converter station to the Albuera electrode station on Leyte. These will comprise 23 km of lines (2-772 mm^2).

The main design parameters for the transmission lines are:

Conductor Type:	ACSR A1/S2B 772 mm^2 Martin, except for ACSR A2/S2B 772 mm^2 Martin (for San Juanico Crossing & for very long span lengths)
Overhead Ground Wire:	7/6 AWG galvanized steel with nominal cross section of 931 mm^2
Electrical Design:	
Nominal voltage ± 350 kV	
Nominal current 1143 A	
Transmission Capacity	1 X 400 MW
Min. insulator creepage distance	36 mm/kV
Avg. voltage gradient along insulator string	85.8 kV/m
Max. shielding angle to outer conductor in tower	15°
Rated switching impulse withstand voltage	1360 kV (1100 2/)
Rated lighting impulse withstand voltage	2100 kV (1270 1/)
Rated short circuit current	4 KA - 1 sec.
Frequency DC	
Flashover distance	4,080 (2,500 1/)
Mechanical Design	
Wind load on tower	270 km/hr.

2/ On the first 1.5 km. from the converter stations and cable terminals, values w/ in brackets will be used. For a DC voltage of 20 kV rms, string insulator limit shall not cause a noise level exceeding 60 dB over 1 mV at a measuring frequency of 500 kHz in tests in accordance with IEC Publication 437.

Insulator Swing/clearance conductor-earth	185 km/hr.	
Earthquake design	0.2.g	
Load Factor- (vertical)	1.5	
Worst normal (transverse)	1.0	
Condition for tower (longitudinal)	1.5	
Design Limitations for conductors and overhead ground wire:		
	Conductors	OGW
@5°C, still air, final tension	27%of UTS	15% of UTS
@25°C, still air, final tension	20% of UTS	26% of UTS
@5°C, full wind, final tension	40% of UTS	20% of UTS

Final sags under max. temp. calculated at + 60°C

Conductor Clearance to ground:	
Track rail 12:1 to 14.5 m	
Public streets, alleys & roads in urban and rural districts	12.1 m
Driveways to residence garage	12.1 m
Spaces or way accessible to pedestrian only	10.5 m
San Juanico Crossing	35.6 m

All other type of obstructions, in accordance with the Phil. Elec. Code Part II, issue of 1974

Conductor Spacing $D + 0.8 \sqrt{(f+1)} + 0.007\,U$

where D = horizontal spacing in m.
f = final conductor sag @ ± 60° C in m.
1 = vertical length of insulator in m
U = highest voltage in kV

Minimum Conductor-earth clearance of towers:	
@ + 30° C, still air	4,500 mm
@ + 5° C, reduced wind (111 km/hr)	2,000 mm
@ + 5° C, full wind (185 km/hr)	1,000 mm

45. **Naga-Tayabas Transmission Line**. The Naga-Tayabas 500 kV EHV line is not part of the project (since it is needed for the present transmission system), but is a very critical link for the power from Leyte reaching the Luzon grid. The repair and rehabilitation of this 205 km line (500 kV-EHV) is being bid for a turnkey contract with supplier credits. This is because a substantial quantity of the line's conductors, insulators and some of the steel towers were lost to pilferage when the line was not energized for a couple of years. The cost of this repair/rehabilitation is estimated at US$47 million. The rehabilitation of the line is to be completed before the end of1995, one and one half years before the test/commissioning of the Leyte-Luzon HVDC power line.

46. **Converter Substations, Electrode and Cable Terminal Stations Turnkey Project.** The project includes two 440 MW monopolar converter stations at Ormoc and Naga, AC switchgear and filters, DC switchgear and filters, auxiliary equipment and civil works. The Ormoc converter station includes dynamic resistors and one 230/13.8-kV station service transformer, the remote electrode stations at Calabanga and Albuera for the Naga and Ormoc HVDC terminals, respectively; and the cable terminal stations on both sides of the San Bernardino Strait where the overhead lines and submarine cables are interfaced. The two stations are located at Matnog, Sorsogon and at Cabacungan, Samar.

47. The installation of the AC Interconnection of Converter Stations includes:

(a) Two 230 kV AC bays in Naga substation for connection of converter stations.

(b) The tie line from Naga 230 kV substation to converter stations: 4-795 MCM, 230 kV STDC, 0.50 km.

(c) Two 230 kV AC bays at Ormoc substation for connection of converter stations.

(d) Line protection.

The design parameters for the AC connection are:

VOLTAGE		LEYTE	LUZON
Nominal system voltage		230 kV	230 kV
Normal operating voltage		230 kV	230 kV
Max. system voltage, steady state		242 kV	242 kV
Min. system voltage steady state		219 kV	219 kV
Min. temporary system voltage		207 kV	207 kV
Max. duration	1 hour	1 hour	1 hour
Max. temporary system voltage		253 kV	253 kV
Max. duration	1 hour	1 hour	1 hour
Surge arrester rated voltage		192 kV	192 kV
Max. continuous operating voltage		149 kV	149 kV

Insulation withstand level on the a.c. side of the power transformers and other apparatus in the a.c. switchgear (internal insulation, phase-to-earth, withstand level):

Lighting impulse (1.2/50 us)			
a.c. switchgear	650 kV	550 kV	900 kV
a.c. lines	1050 kV		1050 kV
Switching impulse			
a.c. switchgear	N. A.	N.A.	N.A.
a.c. lines	560 kV		560 kV
60 Hz, 1 min.			
a.c. switchgear	275 kV	395 kV	395 kV
a.c. lines	183 kV		183 kV

Insulation withstand level across open switching device (disconnectors):

lighting impulse	750 kV		1050 kV
60 Hz, 1 min.	315 kV		460 kV

Short-Circuit Characteristics	LEYTE	LUZON
	AT 138 kV	AT 230 kV[3/]
Normal max. power (sys. 3-phase)	3090 MVA	5500 MVA
Normal min. power (sys. 3-phase)	785 MVA	1650MVA[4/]
Single line to ground fault current	6.8 kA	kA [5/]

FREQUENCY		LEYTE	LUZON
Nominal frequency of system		60 Hz	60 Hz
Steady state frequency variation max.		± 0.3 Hz	± 0.6 Hz
Temporary frequency variation		± 3.0 Hz	± 3.0 Hz
-duration	1 h	1 h	
Transient frequency variation		max. 5.0 Hz	5.0 Hz
-duration	10 min.		10 min.

CREEPAGE DISTANCES

Creepage distances, based on r.m.s. phase-to-earth voltage, on the a.c. side, and voltage to earth on the d.c. side, shall be as follows:

Outdoor insulators and bushings subjected to:

-a.c. voltage min. 3.0 cm/kV

3/ 500 kv Naga-Kalayan

4/ No local generation in Southern Luzon; one 240 kV branch Naga-Kalayaan out of service.

5/ 10 percent higher than symmetrical, 3-phase fault current.

-d.c. voltage	min. 4.3 cm/kV
-d.c. + a.c. voltage	min. 4.3 cm/kV

All indoor insulators and bushing subjected to:

-d.c. voltage	min. 2 cm/kV
-d.c. + a.c. voltage	min. 2 cm/kV

For all outdoor bushing, excl. capacitors, attached in a horizontal position (±30 degrees), all creepage distances shall be increased by 20 %.

48. The parameters of the converter stations are:

Scheme	Monopole	
Mode of Operation	Ground Return	
Rectifier Station at normal operation		Ormoc
Inverter station at normal operation		Naga

Operation	**Rated**	**80% Voltage**	
Power to DC cable (end DC on Samar)		1x440 MW	1x352 MW
Cable Voltage		±338.5 kV	271 kV
Voltage range, rectifier end (Ormoc)		+2.2%/-2.6%	+2.2%/-2.6%
Voltage range, inverted end (Naga)		±2.2%	±2.2%
Current	1300 A	1300 A	
Current Range		±3.0%	±3.0%
Energy availability, monopole guarantee		>98%	
Forced outage rate, monopole guarantee		<5%	

Electrode Station (Naga and Ormoc)

Resistance to remote earth	0.5 ohm
Electric field strength close to electrode	0.1 V/dm
Step potential above electrodes	50 V/m

Converter Transformer

Rating of each unit	170.2/85.1 MVA
Number	Three-single phase
Rated voltage	398.4/239.02/239.02 kV
Connection	YNyd

Dynamic Resistor

Location	At Ormoc Station only

Thyristor Valve

Type		12-pulse valve
Thyristor per valve	48	
Number of redundant thyristor per valve		2
Number of non-faulty thyristors per valve		44

Valve Cooling System Deionized Water

DC Smoothing Reactor

Type		Air-cooled
Inductance	240 mH	
Continuous DC rated current		1340 A

Filters and Shun Capacitor

	Filter 1	Filter 2	Filter 3	Filter 4	
Reactive power at 230 kV (MVAR)		15	20	30	40
Tunning frequencies (Hz)		660/780	1440/2160	660/780	1440/2160
Q value	25	6	20	8	

Insulator and Bushing

	Minimum	
AC voltage, outdoor, vertical		30 mm/kV
DC voltage, outdoor, vertical		43 mm/kV

DC+AC voltage, outdoor, vertical		43 mm/kV
AC voltage, outdoor, horizontal		36 mm/kV
DC voltage, outdoor, horizontal		52 mm/kV
DC+AC voltage, outdoor, horizontal		52 mm/kV
AC voltage, indoor	20 mm/kV	
AC voltage, indoor	20 mm/kV	

Switchgear Data and Ratings

Converter Transformer Breaker and AC Filter Breaker

Operating mechanism	Spring	
Breaking medium	SF_6	
Operating sequence	0.3sec-CO … 3min-CO	
Rated voltage	245 kV	
Rated current		3150 A

(D) NPC Project Management

49. The transmission system must be completed before July 1, 1997, to avoid penalties and charges under the BOO contract with PNOC (and PNOC's BOT contract). Government approval of the project by NEDA has been obtained. An updated relocation and compensation plan for the people and property affected by the transmission line has also been completed. The Environmental Clearance Certificate from the Department of Environment and Natural Resources has also confirmed all environmental approvals required for the project. The project implementation schedule is summarized in Table 2. NPC has appointed a Project Director to oversee all aspects of the work and to interface with PNOC's Project Director.

50. A project organization has been defined to administer and manage the turnkey projects, with manning from NPC's engineering department. The proposed project organization includes the same Project Director for both the Leyte-Luzon and the Leyte-Cebu Geothermal Projects, to be supported by 16 persons at headquarters. For the two projects, NPC would set up a local Project Management office with a total of 102 staff, under a Project Manager in Tongonan. Under the Project Manager, there would be three general divisions: Design and Engineering (23 staff), Project Control and Administrative Services (15 staff) and two local divisions, the Site Management in Luzon (40 staff) with four subdivisions (OHTL, Stations, Naga-Tayabas, Submarine Cable), and the Site Management in Leyte-Samar (19 staff), including subdivisions for the OHTL and the power station. Consultants will be hired to provide specialized technical assistance.

51. The tender documents include provisions for the Contractors to provide technical training to NPC staff for developing expertise in engineering, operation, repair/maintenance and quality assurance of HVDC lines.

Table 1 - Environmental Conditions

CABLES				STATIONS		
	Samar	Luzon			Leyte	Luzon
				Elevation above sea level-m	41.5	380
Mean Temperature °C	26.6	27.0			26.6	27.0
Mean Max. Temperature °C	30.5	31.1			30.5	31.1
Mean Min. Temperature °C	22.7	23.9			22.7	23.9
% Mean relative Humility	85	84			85	84
Max. outdoor temp. for air conditioning					34°C	30 °C
* Annual rainfall (mm)	3346	3382			3346	3382
Lightning Storms(days/yrs)ave.	134	81			134	81
Wind velocity						
Basic (km/hr)	185	185			185	185
Design wind (km/hr)	270	270			270	270
Seismic Design conditions	0.2g.	0.2g.		For valve hall	0.4g	0.4g
				For building & equip.	0.2g	0.2g
Oceanographical conditions	Waterflow is mainly of tidal current dominated each day by 2 flood currents and 2 ebb currents. Maximum current near seabed reaches 3 knots.					
Seabed conditions	Consists mainly of sands (rough and fine), corals, stones and rocks.					
	Submarine Route	Samar	Luzon			
Burial cables depth (m)	1.5	1.2-1.6	1.2-1.6			
Thermal resist. ground °Cm/W	1.1	1.2	1.2			
Maximum sea water temp. °C	30	-	-			
Maximum ambient air temp. °C		40	40		40	40
Maximum ground temp. °C		30	30		30	30
Solar radiation (W/m²)		1035	1035		1035	1035
Anti Pollution Design	0.12 mg/cm²				0.2 mg/cm²	0.2 mg/cm²
Protective filling on land	≤1.0°C m/W					

Philippines

Leyte-Luzon Geothermal Project

Annex 3 - GET Grant Justification

1. Due to its high transmission costs, the Leyte-Luzon project is not the least cost expansion project. However, it provides considerable environmental benefits compared to the system's "least-cost solution", i.e imported coal fired power plants. The costs of Leyte-Luzon were compared to alternative coal-fired plants, based on various implementation options that ranged from an efficiently managed "turn-key" contract by NPC (Table 3) to BOTs[6/]. Two BOT alternatives were considered, based on actual data of recently signed contracts for coal plants in the Philippines (Tables 5 and 7). The comparison with these two alternatives is particularly useful since they capture the costs of real options available to the power sector for undertaking an alternative coal plant under current market conditions (i.e they are real options and not a theoretical exercise). Table 1 below compares unit costs of the four alternatives, including Leyte-Luzon. Assumptions and results of this comparative analysis are presented in tables 2 to 8.

Table 1 - Unit Costs Comparison
(US.cents/kWh, for 10% discount rate)

	Leyte-Luzon	Coal-NPC (turn-key)	Coal-BOT1	Coal-BOT2
Investment	5.91	2.53	3.32	3.11
O&M	0.53	0.56	0.50	0.53
Fuel	0.00	2.33	1.93	2.00
Total	6.44	5.42	5.71	5.64

2. The Government investments decisions are taken on the basis of the least-cost power development program. However, the present value at 10% of the Leyte-Luzon Geothermal project is about US$90 million more expensive than a coal alternative (see the table below). The difference increases substantially for discount rates above 15% (the normal discount rate used for selecting public investments in the Philippines).

Impact of GET Grant on the Project

	Leyte-Luzon	Coal Plant (BOT)	Difference
Energy cost (US¢/kWh)	6.52	5.64	0.88
Present Value of Total Cost (US$ million)			
- without GET grant	1201	1111	90
- with GET grant	1171	1111	60
Comparative Rate of Return (%)			
- without GET grant	8.3%		
- with GET grant	8.7%		

6/ Turn-key capital costs based on average international experience in the construction of coal fired power plants. BOT costs are based on contract capital recovery and operation fees.

3. The GEF grant will compensate the Government for part of this additional cost, and therefore, the grant has been a critical factor for NPC, PNOC and the Government in prioriticing the project. This priority has also been influenced by other non-quantifiable benefits such as more favorable local environmental conditions as compared with a coal plant, the benefits of the electrical interconnection of the country and the lower risk associated with a more diversified and robust power system.

4. The project is also pioneering the optimization of geothermal pressure utilization (reducing the number of wells) and further includes a pilot project for reinjection of additional global warming gases into deep wells, a technique which has not been tried elsewhere and, if successful, could have useful applications in other geothermal projects.

5. CO_2 emissions from geothermal power generation are just about 5%-6% of those of an equivalent coal plant. The Leyte-Luzon project would reduce CO_2 productions substantially. Therefore the return on GEF grant would be high as the cost of $1.60 per ton of CO_2 reduced would be lower than other alternative projects considered by GEF. In relation to the additional economic cost incurred in choosing Leyte-Luzon instead of a BOT coal plant, the cost per ton of CO_2 reduced would be $4.05, a very low level compared to the cost of energy efficiency efforts in the regions which range from $13.5 to $22.8.

6. The reduction in CO_2 emissions associated to the Leyte development would be even higher, because similar benefits would be obtained from the parallel implementation of the Leyte-Cebu Geothermal project (200 MW), which, due to its shorter transmission line, is financially viable without any GEF contribution. Moreover, it is estimated that about 200-300 MW of additional geothermal energy could be developed in Leyte, although these estimates would have to be verified by proper well developing and testing in other areas in Leyte. This additional development which could use the same transmission line constructed by the project. The success in the developing of large geothermal resources (with the Philippines becoming the largest user of geothermal energy by 1998) will foster further interest and investments in geothermal exploration and development elsewhere.

Table 2 - Geothermal Plant - 440 MW

(January 1993 Prices)

OPTIONS: Coal Plant (BTO) $1328/kW. Coal Cost $45.5/MT and Conversion Factor 0.93

PLANT CAPACITY (MW)	440	EXCHANGE RATE (Pesos/US$)	27.00
Plant Factor	85.0%	Transmission Losses	4.00%
Station Use	1.0%	* Conversion Factor	0.93

O & M EXPENSES (per year)			Maximum Energy Gener. GWh	3276
Geothermal Field	0.0037	$/kWh	or	326.4 P Million/Year
Generation Plant	$18.0	/kW/Year	or	213.8 P Million/Year
HVDC & Trans.	0.75%	of HVDC Investm	or	47.8 P Million/Year

	INVESTMENT COST PMn						TOTAL INVESTMENT		Energy Sales
	Geothermal Field		Power Plant		HVDC & Upgrade				(% on
	Local	Foreign	Local	Foreign	Local	Foreign	IN M P	IN M US$	Maximum)
1993	87	304	0	0	1	8	399	14.8	0.0%
1994	193	678	0	0	89	755	1714	63.5	0.0%
1995	558	1957	0	0	79	673	3267	121.0	0.0%
1996	640	2242	0	0	292	2481	5655	209.4	0.0%
1997	255	893	0	0	209	1784	3141	116.4	0.0%
1998	0	0	0	0	0	0	0	0.0	100.0%
1999	0	0	0	0	0	0	0	0.0	100.0%
2000	0	0	0	0	0	0	0	0.0	100.0%
2001	0	0	0	0	0	0	0	0.0	100.0%
		7807	0			6369	14176	525.1	

MILLION 1993 PESOS

	ENERGY GENERATION GWH			--- CAPITAL EXPENDITURES --- (With a 0.93 Conversion Factor)				----- OPERATION & MAINT. ---					
Year	Generation	Net Generation	Energy Sales	Field Devel.	Gener. Plant	HVDC & Subst.	TOTAL	Geoth. Field	Gener. Plant	HVDC & Subs.	TOTAL O & M	TOTAL GEO. COST	
1993	0.0			384.4	0.0	8.9	393.2				0.0	393.2	
1994	0.0			857.5	0.0	837.0	1694.5				0.0	1694.5	
1995	0.0			2476.2	0.0	745.9	3222.1				0.0	3222.1	
1996	0.0			2837.5	0.0	2752.0	5589.4			0.0	0.0	5589.4	
1997	0.0	0.0	0.0	1130.5	0.0	1978.5	3109.0	0.0	0.0	0.0	0.0	3109.0	
1998	3276.2	3243.5	3113.7	0.0	5794.2	0.0	5794.2	326.4	0.0	47.8	374.2	6168.4	
1999	3276.2	3243.5	3113.7	0.0	5475.6	0.0	5475.6	326.4	0.0	47.8	374.2	5849.8	
2000	3276.2	3243.5	3113.7	0.0	5189.4	0.0	5189.4	326.4	0.0	47.8	374.2	5563.6	
2001	3276.2	3243.5	3113.7	0.0	4924.8	0.0	4924.8	326.4	0.0	47.8	374.2	5299.0	
2002	3276.2	3243.5	3113.7		4687.2		4687.2	326.4	0.0	47.8	374.2	5061.4	
2003	3276.2	3243.5	3113.7		4471.2		4471.2	326.4	0.0	47.8	374.2	4845.4	
2004	3276.2	3243.5	3113.7		4271.4		4271.4	326.4	0.0	47.8	374.2	4645.6	
2005	3276.2	3243.5	3113.7		4093.2		4093.2	326.4	0.0	47.8	374.2	4467.4	
2006	3276.2	3243.5	3113.7		3923.1		3923.1	326.4	0.0	47.8	374.2	4297.3	
2007	3276.2	3243.5	3113.7		3771.9		3771.9	326.4	0.0	47.8	374.2	4146.1	
2008	3276.2	3243.5	3113.7				0.0	326.4	213.8	47.8	588.0	588.0	
2009-22	3276.2	3243.5	3113.7				0.0	326.4	213.8	47.8	588.0	588.0	
2023													
2024													
2025													
2026													
2027													
													MARGINAL COST
TOTAL (MIllion Pesos)				7686.0	46602.0	6322.2	60610.2	8160.3	3207.6	1194.2	12562.1	73172.3	US$/Kwh
TOTAL US$ Million				284.7	1726.0	234.2	2244.8	302.2	118.8	44.2	465.3	2710.1	
PRESENT VALUES AT THE GIVEN DISCOUNT RATES:													
8%	24754	24507	23526	6148	22805	4875	33828	2466	600	361	3427	37256	0.0587
10%	19389	19195	18427	5836	19369	4587	29792	1932	409	283	2623	32416	0.0652
12%	15455	15301	14689	5548	16541	4322	26412	1540	282	225	2047	28459	0.0718
14%	12513	12388	11893	5281	14200	4079	23560	1247	197	182	1626	25186	0.0784
16%	10271	10169	9762	5033	12249	3855	21137	1023	139	150	1312	22450	0.0852

Table 3 - 500 MW Coal Plant - NPC Turn-key Contract
(In January 1993 Prices)

OPTIONS: Coal Plant (BTO) $1328/kW. Coal Cost $45.5/MT and Conversion Factor 0.93

PLANT CAPACITY (MW)	500	EXCHANGE RATE (Pesos/US$)	27.00
Plant Factor	75.0%	Transmission Losses	1.00%
Station Use	4.00%	* Conversion Factor	0.93

O & M EXPENSES (per year)		Maximum Energy Gener. GWh	3285.0
O & M at $35.0 /kWh/Yea	0.1438 PMn	Crude Oil Cost-Bunker C	17.7 $/Bbl
Plant thermal efficiency	33.0%	Oil generation	600 Kwh/Barrel
Coal Heating Capacity	11,400 BTU/lb	Real Incr.Coal Price p.a	1.00%
Coal Price CIF	$45.5 per MT	Real Incr.Oil Price p.a.	1.00%

CAPITAL EXPENDITURES	Plant Cost	Transmission & Infrastr.	Other Cost & Envir.	TOTAL US$/kW
Total Cost/kW	$1,155	$110	$0	1,265
% Foreign Cost	80.0%	80.0%	80.0%	
% Physical Cont.	5.0%	5.0%	5.0%	1,328
TOTAL COST-Million US$	606	58	0	664
TOTAL COST-Million Pesos	16,372	1,559	0	17,931

YEAR	ANNUAL INVESTMENTS (% of Total)			Energy Sales (% of Max.)
1993	0.0%	0.0%	0.0%	0.0%
1994	0.0%	0.0%	0.0%	0.0%
1995	30.0%	30.0%	30.0%	0.0%
1996	40.0%	40.0%	40.0%	0.0%
1997	20.0%	20.0%	20.0%	0.0%
1998	10.0%	10.0%	10.0%	100.0%
1999	0.0%	0.0%	0.0%	100.0%
2000	0.0%	0.0%	0.0%	100.0%
2001	0.0%	0.0%	0.0%	100.0%
	100.0%	100.0%	100.0%	

Table 3 - 500 MW Coal Plant - NPC Turn-key Contract (Continue)

MILLION 1993 PESOS

	ENERGY GENERATION GWH			Coal	--- CAPITAL EXPENDITURES --- * (With a 0.93 Conversion Factor)				----OPERATION & MAINTENANCE --					NET
Year	Genera-tion	Net Genera-tion	Energy Sales	Econ. Cost P/kWh	Plant	Infra-struct.	Other	TOTAL	General O & M	* Coal Exclud. Taxes	* Oil Gener.	TOTAL O & M	TOTAL COAL COST	DIFF. COAL LESS GEO
1993	0	0	0	0.506	0	0	0	0	0	0	0	0	0	-393
1994	0	0	0	0.511	0	0	0	0	0	0	0	0	0	-1694
1995	0	0	0	0.516	4843	461	0	5304	0	0	0	0	5304	2082
1996	0	0	0	0.521	6457	615	0	7072	0	0	0	0	7072	1483
1997	0	0	0	0.526	3229	307	0	3536	0	0	0	0	3536	427
1998	3285	3154	3122	0.531	1614	154	0	1768	473	1745	76	2294	4062	-2107
1999	3285	3154	3122	0.537	0	0	0	0	473	1763	77	2312	2312	-3538
2000	3285	3154	3122	0.542	0	0	0	0	473	1780	78	2330	2330	-3233
2001	3285	3154	3122	0.547	0	0	0	0	473	1798	78	2349	2349	-2950
2002	3285	3154	3122	0.553				0	473	1816	79	2368	2368	-2694
2003	3285	3154	3122	0.558				0	473	1834	80	2387	2387	-2459
2004	3285	3154	3122	0.564				0	473	1853	81	2406	2406	-2240
2005	3285	3154	3122	0.570				0	473	1871	81	2425	2425	-2042
2006	3285	3154	3122	0.575				0	473	1890	82	2445	2445	-1853
2007	3285	3154	3122	0.581				0	473	1909	83	2464	2464	-1682
2008	3285	3154	3122	0.587				0	473	1928	84	2484	2484	1896
2009	3285	3154	3122	0.593				0	473	1947	85	2504	2504	1916
2010	3285	3154	3122	0.599				0	473	1967	86	2525	2525	1937
2011	3285	3154	3122	0.605				0	473	1986	86	2545	2545	1957
2012	3285	3154	3122	0.611				0	473	2006	87	2566	2566	1978
2013	3285	3154	3122	0.617				0	473	2026	88	2587	2587	1999
2014	3285	3154	3122	0.623				0	473	2046	89	2608	2608	2020
2015	3285	3154	3122	0.629				0	473	2067	90	2629	2629	2041
2016	3285	3154	3122	0.636				0	473	2088	91	2651	2651	2063
2017	3285	3154	3122	0.642				0	473	2109	92	2673	2673	2085
2018	3285	3154	3122	0.648				0	473	2130	93	2695	2695	2107
2019	3285	3154	3122	0.655				0	473	2151	94	2717	2717	2129
2020	3285	3154	3122	0.661				0	473	2172	95	2739	2739	2151
2021	3285	3154	3122	0.668				0	473	2194	96	2762	2762	2174
2022	3285	3154	3122	0.675				0	473	2216	96	2785	2785	2197
2023														
2024														
2025														
2026														
2027														
														MARGINAL
TOTAL (MIllion Pesos)					16143	1537	0	17680	11813	49293	2146	63252	80932	COST
TOTAL US$ Million					598	57	0	655	438	1826	79	2343	2997	US$/Kwh
PRESENT VALUES AT THE GIVEN DISCOUNT RATES:														
8%	24820	23828	23589		12277	1169	0	13447	3570	14343	625	18538	31984	0.0502
10%	19440	18663	18476		11513	1096	0	12609	2796	11147	485	14428	27038	0.0542
12%	15497	14877	14728		10813	1030	0	11842	2229	8823	384	11436	23279	0.0585
14%	12547	12045	11925		10170	969	0	11138	1805	7099	309	9213	20351	0.0632
16%	10299	9887	9788		9578	912	0	10490	1481	5795	252	7529	18019	0.0682

Table 4 - Impact GEF GRant on Comparative Reta of Return of Geothermal Plant (440 MW) vs. Coal Plant (500 MW, NPC turn-key)

GEF Grant (US$ Million): $30
Soft Loan (US$ Million) $0 At an Interest Rate of 0.0% p.a.

Year	GEOTHERMAL PLANT 440 MW EQUIV. Invest-ment Cost	O & M	TOTAL GEO. COST	COAL PLANT 500 MW Invest-ment Cost	O & M	TOTAL COAL COST	NET DIFF. LEYTE LESS COAL	GEF GRANT $30.0 Million	LEYTE LESS COAL PLUS GRANT	SOFT LOAN (MILL.$) $0.0 Million	Inte-rest Cost	Equiv. Const. Prices Million Pesos 1]	LEYTE LESS COAL +GRANT +LOAN
1993	393	0	393	0	0	0	-393	270	-123	0.00	-0.00	0.0	-123
1994	1694	0	1694	0	0	0	-1694	540	-1154	0.00	-0.00	0.0	-1154
1995	3222	0	3222	5304	0	5304	2082		2082	0.00	-0.00	0.0	2082
1996	5589	0	5589	7072	0	7072	1483		1483		-0.00	-0.0	1483
1997	3109	0	3109	3536	0	3536	427		427		-0.00	-0.0	427
1998	5794	374	6168	1768	2294	4062	-2107		-2107		-0.00	-0.0	-2107
1999	5476	374	5850	0	2312	2312	-3538		-3538		-0.00	-0.0	-3538
2000	5189	374	5564	0	2330	2330	-3233		-3233		-0.00	-0.0	-3233
2001	4925	374	5299	0	2349	2349	-2950		-2950		-0.00	-0.0	-2950
2002	4687	374	5061	0	2368	2368	-2694		-2694		-0.00	-0.0	-2694
2003	4471	374	4845	0	2387	2387	-2459		-2459	-0.00	-0.00	-0.0	-2459
2004	4271	374	4646	0	2406	2406	-2240		-2240	-0.00	-0.00	-0.0	-2240
2005	4093	374	4467	0	2425	2425	-2042		-2042	-0.00	-0.00	-0.0	-2042
2006	3923	374	4297	0	2445	2445	-1853		-1853	-0.00	-0.00	-0.0	-1853
2007	3772	374	4146	0	2464	2464	-1682		-1682	-0.00	-0.00	-0.0	-1682
2008	0	588	588	0	2484	2484	1896		1896	-0.00	-0.00	-0.0	1896
2009	0	588	588	0	2504	2504	1916		1916	-0.00	-0.00	-0.0	1916
2010	0	588	588	0	2525	2525	1937		1937	-0.00	-0.00	-0.0	1937
2011	0	588	588	0	2545	2545	1957		1957	-0.00	-0.00	-0.0	1957
2012	0	588	588	0	2566	2566	1978		1978	-0.00	-0.00	-0.0	197[illegible]
2013	0	588	588	0	2587	2587	1999		1999	-0.00	-0.00	-0.0	1999
2014	0	588	588	0	2608	2608	2020		2020	-0.00	-0.00	-0.0	2020
2015	0	588	588	0	2629	2629	2041		2041	-0.00	-0.00	-0.0	2041
2016	0	588	588	0	2651	2651	2063		2063	-0.00	-0.00	-0.0	2063
2017	0	588	588	0	2673	2673	2085		2085	-0.00	-0.00	-0.0	2085
2018	0	588	588	0	2695	2695	2107		2107	-0.00	-0.00	-0.0	2107
2019	0	588	588	0	2717	2717	2129		2129	-0.00	-0.00	-0.0	2129
2020	0	588	588	0	2739	2739	2151		2151	-0.00	-0.00	-0.0	2151
2021	0	588	588	0	2762	2762	2174		2174	-0.00	-0.00	-0.0	2174
2022	0	588	588	0	2785	2785	2197		2197	-0.00	-0.00	-0.0	2197
2023													
2024													
2025													
2026													
2027													
TOTALS:													
Million Pesos	73172	85734	90853	80932	144183	88691	8570	9380	8570			8570	8570
Million US$	2710	3175	3365	2997	5340	3285	317	347	317	-0	-0.00	317	317
PRESENT VALUES AT THE DISCOUNT RATES SHOWN:													
8%	33828	3427	37256	13447	18538	31984	-5271	741	-4530	0		0	-4530
10%	29792	2623	32416	12609	14428	27038	-5378	726	-4652	0		0	-4652
12%	26412	2047	28459	11842	11436	23279	-5180	712	-4468	0		0	-4468
13%	24926	1821	26747	11483	10245	21728	-5019	705	-4314	0		0	-4314
14%	23560	1626	25186	11138	9213	20351	-4835	698	-4137	0		0	-4137
16%	21137	1312	22450	10490	7529	18019	-4430	685	-3746	0		0	-3746
ECONOMIC RATE OF RETURN:							2.3%		2.7%				2.7%

(Equalizer discount rate between the coal and geothermal plants).

Table 5 - 500 MW Coal Plant - BOT1

(In January 1993 Prices)

OPTIONS: Coal Plant based on BOT proposal. Coal Cost $45.5/MT and Conversion Factor 0.93

PLANT CAPACITY (MW)	500	EXCHANGE RATE (Pesos/US$)	27.00
Plant Factor	80.0%	Transmission Losses	1.00%
Station Use	4.00%	* Conversion Factor	0.93

O & M EXPENSES (per year)		Maximum Energy Gener. GWh	3504.0
O & M at $31.0 /kWh/Yea	0.1194 PMn	Crude Oil Cost-Bunker C	17.7 $/Bbl
Plant thermal efficiency	36.0%	Oil generation	600 Kwh/Barrel
Coal Heating Capacity	11,400 BTU/lb	Real Incr.Coal Price p.a	1.00%
Coal Price CIF	$45.5 per MT	Real Incr.Oil Price p.a.	1.00%

CAPITAL EXPENDITURES	Plant Cost	Transmission & Infrastr.	Other Cost & Envir.	TOTAL US$/kW
Total Cost/kW	BOT	$110	$0	n.a.
% Foreign Cost	80.0%	80.0%	80.0%	
% Physical Cont.	5.0%	5.0%	5.0%	n.a.
TOTAL COST-Million US$	BOT	58	0	n.a.
TOTAL COST-Million Pesos	BOT	1,559	0	n.a.

YEAR	ANNUAL INVESTMENTS (% of Total)			Energy Sales (% of Max.)
1993	0.0%	0.0%	0.0%	0.0%
1994	0.0%	0.0%	0.0%	0.0%
1995	30.0%	30.0%	30.0%	0.0%
1996	40.0%	40.0%	40.0%	0.0%
1997	20.0%	20.0%	20.0%	0.0%
1998	10.0%	10.0%	10.0%	100.0%
1999	0.0%	0.0%	0.0%	100.0%
2000	0.0%	0.0%	0.0%	100.0%
2001	0.0%	0.0%	0.0%	100.0%
	100.0%	100.0%	100.0%	

Table 5 - 500 MW Coal Plant - BOT1 (Continue)

(Million 1993 Pesos)

MILLION 1993 PESOS

Year	ENERGY GENERATION GWH: Genera-tion	Net Genera-tion	Energy Sales	Coal Econ. Cost P/kWh	--- CAPITAL EXPENDITURES --- * (With a 0.93 Conversion Factor): Plant	Infra-struct.	Other	TOTAL	----OPERATION & MAINTENANCE --: General O & M	* Coal Exclud. Taxes	* Oil Gener.	TOTAL O & M	TOTAL COAL COST	NET DIFF. COAL LESS GEO
1993	0	0	0	0.463	0	0	0	0	0	0	0	0	0	-393
1994	0	0	0	0.468	0	0	0	0	0	0	0	0	0	-1694
1995	0	0	0	0.473	0	461	0	461	0	0	0	0	461	-2761
1996	0	0	0	0.477	0	615	0	615	0	0	0	0	615	-4974
1997	0	0	0	0.482	0	307	0	307	0	0	0	0	307	-2801
1998	3504	3364	3330	0.487	3394	154	0	3548	418	1707	-102	2023	5571	-597
1999	3504	3364	3330	0.492	3302	0	0	3302	418	1724	-103	2039	5341	-509
2000	3504	3364	3330	0.497	3212	0	0	3212	418	1741	-104	2056	5267	-296
2001	3504	3364	3330	0.502	3124	0	0	3124	418	1758	-105	2072	5196	-103
2002	3504	3364	3330	0.507	3039			3039	418	1776	-106	2088	5128	66
2003	3504	3364	3330	0.512	2957			2957	418	1794	-107	2105	5062	216
2004	3504	3364	3330	0.517	2876			2876	418	1811	-108	2122	4998	352
2005	3504	3364	3330	0.522	2798			2798	418	1830	-109	2139	4937	469
2006	3504	3364	3330	0.527	2722			2722	418	1848	-110	2156	4878	580
2007	3504	3364	3330	0.533	2647			2647	418	1866	-111	2174	4821	675
2008	3504	3364	3330	0.538	2575			2575	418	1885	-112	2191	4766	4178
2009	3504	3364	3330	0.543	2505			2505	418	1904	-114	2209	4714	4126
2010	3504	3364	3330	0.549	2437			2437	418	1923	-115	2227	4664	4076
2011	3504	3364	3330	0.554	2371			2371	418	1942	-116	2245	4615	4027
2012	3504	3364	3330	0.560	2306			2306	418	1962	-117	2263	4569	398[illegible]
2013	3504	3364	3330	0.565	2243			2243	418	1981	-118	2282	4525	393[illegible]
2014	3504	3364	3330	0.571	2182			2182	418	2001	-119	2300	4482	3894
2015	3504	3364	3330	0.577	2123			2123	418	2021	-121	2319	4442	3854
2016	3504	3364	3330	0.583	2065			2065	418	2041	-122	2338	4403	3815
2017	3504	3364	3330	0.588	2009			2009	418	2062	-123	2357	4366	3778
2018	3504	3364	3330	0.594	1954			1954	418	2082	-124	2377	4330	3742
2019	3504	3364	3330	0.600	1901			1901	418	2103	-125	2396	4297	3709
2020	3504	3364	3330	0.606	1849			1849	418	2124	-127	2416	4265	3677
2021	3504	3364	3330	0.612	1799			1799	418	2145	-128	2436	4234	3646
2022	3504	3364	3330	0.618	1750			1750	418	2167	-129	2456	4206	3618
2023														
2024														
2025														
2026														
2027														
														MARGINAL COST
TOTAL (MIllion Pesos)					62138	1537	0	63675	10462	48197	-2874	55786	119461	
TOTAL US$ Million					2301	57	0	2358	387	1785	-106	2066	4424	US$/Kwh
PRESENT VALUES AT THE GIVEN DISCOUNT RATES:														
8%	26475	25416	25162		20764	1169	0	21933	3162	14024	-836	16350	38283	0.0564
10%	20736	19907	19708		16588	1096	0	17684	2477	10899	-650	12726	30410	0.0571
12%	16530	15869	15710		13457	1030	0	14487	1974	8627	-514	10087	24574	0.0579
14%	13383	12848	12720		11066	969	0	12034	1598	6941	-414	8126	20160	0.0587
16%	10986	10546	10441		9207	912	0	10120	1312	5666	-338	6641	16760	0.0595

Table 6 - Impact GEF Grant on Comparative Rate of Return Of Geothermal Plant (440 MW) vs Coal Plant (500 MW, BOT1)

GEF Grant (US$ Million): $30
Soft Loan (US$ Million) $0 At an Interest Rate of 0.0% p.a.

Year	GEOTHERMAL PLANT 440 MW Invest-ment Cost	O & M	TOTAL GEO. COST	EQUIV. COAL PLANT 500 MW Invest-ment Cost	O & M	TOTAL COAL COST	NET DIFF. LEYTE LESS COAL	GEF GRANT $30.0 Million	LEYTE LESS COAL PLUS GRANT	SOFT LOAN (MILL.$) $0.0 Million	Inte-rest Cost	Equiv. Const. Prices Million Pesos 1]	LEYTE LESS COAL +GRANT +LOAN
1993	393	0	393	0	0	0	-393	270	-123	0.00	-0.00	0.0	-123
1994	1694	0	1694	0	0	0	-1694	540	-1154	0.00	-0.00	0.0	-1154
1995	3222	0	3222	461	0	461	-2761		-2761	0.00	-0.00	0.0	-2761
1996	5589	0	5589	615	0	615	-4974		-4974		-0.00	-0.0	-4974
1997	3109	0	3..09	307	0	307	-2801		-2801		-0.00	-0.0	-2801
1998	5794	374	6168	3548	2023	5571	-597		-597		-0.00	-0.0	-597
1999	5476	374	5850	3302	2039	5341	-509		-509		-0.00	-0.0	-509
2000	5189	374	5564	3212	2056	5267	-296		-296		-0.00	-0.0	-296
2001	4925	374	5299	3124	2072	5196	-103		-103		-0.00	-0.0	-103
2002	4687	374	5061	3039	2088	5128	66		66		-0.00	-0.0	66
2003	4471	374	4845	2957	2105	5062	216		216	-0.00	-0.00	-0.0	216
2004	4271	374	4646	2876	2122	4998	352		352	-0.00	-0.00	-0.0	352
2005	4093	374	4467	2798	2139	4937	469		469	-0.00	-0.00	-0.0	469
2006	3923	374	4297	2722	2156	4878	580		580	-0.00	-0.00	-0.0	580
2007	3772	374	4146	2647	2174	4821	675		675	-0.00	-0.00	-0.0	675
2008	0	588	588	2575	2191	4766	4178		4178	-0.00	-0.00	-0.0	4178
2009	0	588	588	2505	2209	4714	4126		4126	-0.00	-0.00	-0.0	4126
2010	0	588	588	2437	2227	4664	4076		4076	-0.00	-0.00	-0.0	4076
2011	0	588	588	2371	2245	4615	4027		4027	-0.00	-0.00	-0.0	4027
2012	0	588	588	2306	2263	4569	3981		3981	-0.00	-0.00	-0.0	3981
2013	0	588	588	2243	2282	4525	3937		3937	-0.00	-0.00	-0.0	3937
2014	0	588	588	2182	2300	4482	3894		3894	-0.00	-0.00	-0.0	3894
2015	0	588	588	2123	2319	4442	3854		3854	-0.00	-0.00	-0.0	3854
2016	0	588	588	2065	2338	4403	3815		3815	-0.00	-0.00	-0.0	3815
2017	0	588	588	2009	2357	4366	3778		3778	-0.00	-0.00	-0.0	3778
2018	0	588	588	1954	2377	4330	3742		3742	-0.00	-0.00	-0.0	3742
2019	0	588	588	1901	2396	4297	3709		3709	-0.00	-0.00	-0.0	3709
2020	0	588	588	1849	2416	4265	3677		3677	-0.00	-0.00	-0.0	3677
2021	0	588	588	1799	2436	4234	3646		3646	-0.00	-0.00	-0.0	3646
2022	0	588	588	1750	2456	4206	3618		3618	-0.00	-0.00	-0.0	3618
2023													
2024													
2025													
2026													
2027													
TOTALS:													
Million Pesos	73172	85734	136848	119461	175247	165750	47099	47909	47099			47099	47099
Million US$	2710	3175	5068	4424	6491	6139	1744	1774	1744	-0	-0.00	1744	1744
PRESENT VALUES AT THE DISCOUNT RATES SHOWN:													
8%	33828	3427	37256	21933	16350	38283	1027	741	1769	0		0	1769
10%	29792	2623	32416	17684	12726	30410	-2006	726	-1279	0		0	-1279
12%	26412	2047	28459	14487	10087	24574	-3885	712	-3173	0		0	-3173
13%	24926	1821	26747	13182	9036	22219	-4529	705	-3824	0		0	-3824
14%	23560	1626	25186	12034	8126	20160	-5026	698	-4328	0		0	-4328
16%	21137	1312	22450	10120	6641	16760	-5689	685	-5005	0		0	-5005
ECONOMIC RATE OF RETURN:							8.6%		9.0%				9.0%

(Equalizer discount rate between the coal and geothermal plants).

Table 7 - 500 MW Coal Plant - BOT2

(In January 1993 Prices)

OPTIONS: Coal Plant based on BOT proposal. Coal Cost $45.5/MT and Conversion Factor 0.93

PLANT CAPACITY (MW)	500	EXCHANGE RATE (Pesos/US$)	27.00
Plant Factor	80.0%	Transmission Losses	1.00%
Station Use	4.00%	* Conversion Factor	0.93

O & M EXPENSES (per year)		Maximum Energy Gener. GWh	3504.0
O & M at $35.3 /kWh/Yea	0.1360 PMn	Crude Oil Cost-Bunker C	17.7 $/Bbl
Plant thermal efficiency	35.0%	Oil generation	600 Kwh/Barrel
Coal Heating Capacity	11,352 BTU/lb	Real Incr.Coal Price p.a	1.00%
Coal Price CIF	$45.5 per MT	Real Incr.Oil Price p.a.	1.00%

CAPITAL EXPENDITURES	Plant Cost	Transmission & Infrastr.	Other Cost & Envir.	TOTAL US$/kW
Total Cost/kW	BOT	$110	$0	n.a.
% Foreign Cost	80.0%	80.0%	80.0%	
% Physical Cont.	5.0%	5.0%	5.0%	n.a.
TOTAL COST-Million US$	BOT	58	0	n.a.
TOTAL COST-Million Pesos	BOT	1,559	0	n.a.

YEAR	ANNUAL INVESTMENTS (% of Total)			Energy Sales (% of Max.)
1993	0.0%	0.0%	0.0%	0.0%
1994	0.0%	0.0%	0.0%	0.0%
1995	30.0%	30.0%	30.0%	0.0%
1996	40.0%	40.0%	40.0%	0.0%
1997	20.0%	20.0%	20.0%	0.0%
1998	10.0%	10.0%	10.0%	100.0%
1999	0.0%	0.0%	0.0%	100.0%
2000	0.0%	0.0%	0.0%	100.0%
2001	0.0%	0.0%	0.0%	100.0%
	100.0%	100.0%	100.0%	

Table 7 - 500 MW Coal Plant - BOT2 (Continued)

MILLION 1993 PESOS

Year	ENERGY GENERATION GWH Genera-tion	Net Genera-tion	Energy Sales	Coal Econ. Cost P/kWh	--- CAPITAL EXPENDITURES --- * (With a 0.93 Conversion Factor) Plant	Infra-struct.	Other	TOTAL	----OPERATION & MAINTENANCE -- General O & M	* Coal Exclud. Taxes	* Oil Gener.	TOTAL O & M	TOTAL COAL COST	NET DIFF. COAL LESS GEO
1993	0	0	0	0.479	0	0	0	0	0	0	0	0	0	-393
1994	0	0	0	0.483	0	0	0	0	0	0	0	0	0	-1694
1995	0	0	0	0.488	0	461	0	461	0	0	0	0	461	-2761
1996	0	0	0	0.493	0	615	0	615	0	0	0	0	615	-4974
1997	0	0	0	0.498	0	307	0	307	0	0	0	0	307	-2801
1998	3504	3364	3330	0.503	3164	154	0	3318	476	1763	-102	2137	5455	-713
1999	3504	3364	3330	0.508	3078	0	0	3078	476	1780	-103	2154	5232	-618
2000	3504	3364	3330	0.513	2994	0	0	2994	476	1798	-104	2171	5165	-399
2001	3504	3364	3330	0.518	2912	0	0	2912	476	1816	-105	2188	5100	-199
2002	3504	3364	3330	0.523	2833			2833	476	1834	-106	2205	5038	-24
2003	3504	3364	3330	0.529	2756			2756	476	1853	-107	2222	4978	133
2004	3504	3364	3330	0.534	2681			2681	476	1871	-108	2240	4920	275
2005	3504	3364	3330	0.539	2608			2608	476	1890	-109	2257	4865	398
2006	3504	3364	3330	0.545	2537			2537	476	1909	-110	2275	4812	514
2007	3504	3364	3330	0.550	2468			2468	476	1928	-111	2293	4761	615
2008	3504	3364	3330	0.556	2400			2400	476	1947	-112	2311	4712	4124
2009	3504	3364	3330	0.561	2335			2335	476	1967	-114	2329	4665	4076
2010	3504	3364	3330	0.567	2271			2271	476	1986	-115	2348	4619	4031
2011	3504	3364	3330	0.573	2210			2210	476	2006	-116	2367	4576	3988
2012	3504	3364	3330	0.578	2149			2149	476	2026	-117	2386	4535	3947
2013	3504	3364	3330	0.584	2091			2091	476	2046	-118	2405	4496	3908
2014	3504	3364	3330	0.590	2034			2034	476	2067	-119	2424	4458	3870
2015	3504	3364	3330	0.596	1979			1979	476	2088	-121	2443	4422	3834
2016	3504	3364	3330	0.602	1925			1925	476	2108	-122	2463	4388	3800
2017	3504	3364	3330	0.608	1872			1872	476	2130	-123	2483	4355	3767
2018	3504	3364	3330	0.614	1821			1821	476	2151	-124	2503	4324	3736
2019	3504	3364	3330	0.620	1772			1772	476	2172	-125	2523	4295	3707
2020	3504	3364	3330	0.626	1723			1723	476	2194	-127	2544	4267	3679
2021	3504	3364	3330	0.632	1676			1676	476	2216	-128	2564	4241	3653
2022	3504	3364	3330	0.639	1631			1631	476	2238	-129	2585	4216	3628
2023														
2024														
2025														
2026														
2027														MARGINAL
TOTAL (MIllion Pesos)					57919	1537	0	59456	11910	49784	-2874	58820	118276	COST
TOTAL US$ Million					2145	57	0	2202	441	1844	-106	2179	4381	US$/Kwh
PRESENT VALUES AT THE GIVEN DISCOUNT RATES:														
8%	26475	25416	25162		19354	1169	0	20523	3600	14486	-836	17249	37772	0.0556
10%	20736	19907	19708		15462	1096	0	16558	2819	11258	-650	13427	29985	0.0564
12%	16530	15869	15710		12543	1030	0	13573	2247	8911	-514	10644	24217	0.0571
14%	13383	12848	12720		10314	969	0	11283	1820	7170	-414	8576	19858	0.0578
16%	10986	10546	10441		8582	912	0	9494	1494	5853	-338	7009	16503	0.0585

Table 8 - Impact of GEF grant on the comparative rate of return of the Geothermal Plant (440 mw) vs Coal Plant (500 MW, BOT2)

GEF Grant (US$ Million): $30
Soft Loan (US$ Million) $0 At an Interest Rate of 0.0% p.a.

Year	GEOTHERMAL PLANT 440 MW Invest-ment Cost	O & M	TOTAL GEO. COST	EQUIV. COAL PLANT 500 MW Invest-ment Cost	O & M	TOTAL COAL COST	NET DIFF. LEYTE LESS COAL	GEF GRANT $30.0 Million	LEYTE LESS COAL PLUS GRANT	SOFT LOAN (MILL.$) $0.0 Million	Inte-rest Cost	Equiv. Const. Prices Million Pesos 1]	LEYTE LESS COAL +GRANT +LOAN
1993	393	0	393	0	0	0	-393	270	-123	0.00	-0.00	0.0	-123
1994	1694	0	1694	0	0	0	-1694	540	-1154	0.00	-0.00	0.0	-1154
1995	3222	0	3222	461	0	461	-2761		-2761	0.00	-0.00	0.0	-2761
1996	5589	0	5589	615	0	615	-4974		-4974		-0.00	-0.0	-4974
1997	3109	0	3109	307	0	307	-2801		-2801		-0.00	-0.0	-2801
1998	5794	374	6168	3318	2137	5455	-713		-713		-0.00	-0.0	-713
1999	5476	374	5850	3078	2154	5232	-618		-618		-0.00	-0.0	-618
2000	5189	374	5564	2994	2171	5165	-399		-399		-0.00	-0.0	-399
2001	4925	374	5299	2912	2188	5100	-199		-199		-0.00	-0.0	-199
2002	4687	374	5061	2833	2205	5038	-24		-24		-0.00	-0.0	-24
2003	4471	374	4845	2756	2222	4978	133		133	-0.00	-0.00	-0.0	133
2004	4271	374	4646	2681	2240	4920	275		275	-0.00	-0.00	-0.0	275
2005	4093	374	4467	2608	2257	4865	398		398	-0.00	-0.00	-0.0	398
2006	3923	374	4297	2537	2275	4812	514		514	-0.00	-0.00	-0.0	514
2007	3772	374	4146	2468	2293	4761	615		615	-0.00	-0.00	-0.0	61[illegible]
2008	0	588	588	2400	2311	4712	4124		4124	-0.00	-0.00	-0.0	4[illegible]
2009	0	588	588	2335	2329	4665	4076		4076	-0.00	-0.00	-0.0	40[illegible]
2010	0	588	588	2271	2348	4619	4031		4031	-0.00	-0.00	-0.0	403[illegible]
2011	0	588	588	2210	2367	4576	3988		3988	-0.00	-0.00	-0.0	3988
2012	0	588	588	2149	2386	4535	3947		3947	-0.00	-0.00	-0.0	3947
2013	0	588	588	2091	2405	4496	3908		3908	-0.00	-0.00	-0.0	3908
2014	0	588	588	2034	2424	4458	3870		3870	-0.00	-0.00	-0.0	3870
2015	0	588	588	1979	2443	4422	3834		3834	-0.00	-0.00	-0.0	3834
2016	0	588	588	1925	2463	4388	3800		3800	-0.00	-0.00	-0.0	3800
2017	0	588	588	1872	2483	4355	3767		3767	-0.00	-0.00	-0.0	3767
2018	0	588	588	1821	2503	4324	3736		3736	-0.00	-0.00	-0.0	3736
2019	0	588	588	1772	2523	4295	3707		3707	-0.00	-0.00	-0.0	3707
2020	0	588	588	1723	2544	4267	3679		3679	-0.00	-0.00	-0.0	3679
2021	0	588	588	1676	2564	4241	3653		3653	-0.00	-0.00	-0.0	3653
2022	0	588	588	1631	2585	4216	3628		3628	-0.00	-0.00	-0.0	3628
2023													
2024													
2025													
2026													
2027													
TOTALS:													
Million Pesos	73172	85734	132628	118276	177097	163380	45914	46724	45914			45914	45914
Million US$	2710	3175	4912	4381	6559	6051	1701	1731	1701	-0	-0.00	1701	1701
PRESENT VALUES AT THE DISCOUNT RATES SHOWN:													
8%	33828	3427	37256	20523	17249	37772	517	741	1258	0		0	1258
10%	29792	2623	32416	16558	13427	29985	-2430	726	-1704	0		0	-1704
12%	26412	2047	28459	13573	10644	24217	-4242	712	-3530	0		0	-3530
13%	24926	1821	26747	12355	9536	21891	-4856	705	-4151	0		0	-4151
14%	23560	1626	25186	11283	8576	19858	-5327	698	-4629	0		0	-4629
16%	21137	1312	22450	9494	7009	16503	-5946	685	-5262	0		0	-5262

ECONOMIC RATE OF RETURN: 8.3% 8.7% 8.7%
(Equalizer discount rate between the coal and geothermal plants).

Philippines

Leyte-Luzon Geothermal Project

Procurement

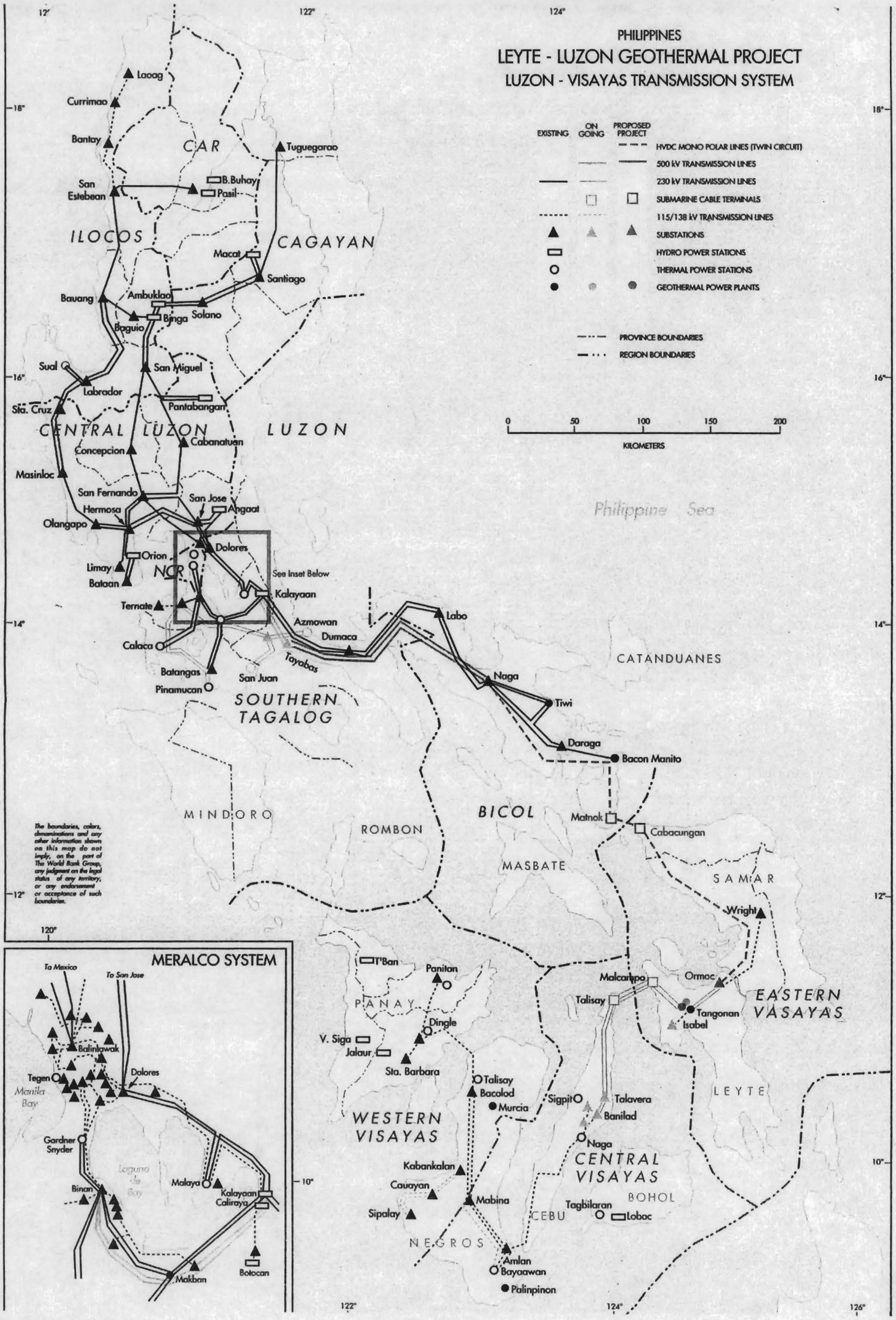
1. PNOC-EDC procurement procedures are satisfactory. NPC has improved its procurement systems by delegating decisions, rotating personnel in award committees and standardizing the general conditions on the bidding documents. Except as noted below, all contracts for materials or the supply and erection of equipment financed by the grant, would be awarded on the basis of international competitive bidding (ICB) in accordance with the Bank's procurement guidelines. The Bank's standard bidding documents will be used and the price of fixed-cost contracts would be increased with an inflation index when the bid validity period is extended. Procurement following ICB procedures is expected to aggregate to US$67.3 million (US$65.5 million is shared with the Bank loan to NPC) and would include about US$16.3 million of the GET grant. A margin of preference equal to 15% of the CIF bid price of imported goods or the actual customs duties and import taxes, whichever is less, will be allowed for domestic manufactures.

2. For the PNOC component of the grant, since there are very limited suppliers of specialized equipment for high-temperature geothermal development, limited international bidding procedures would be used for PNOC's contracts costing less than US$2 million each and aggregating to no more than US$14.8 million under the GET grant (financed by US$13.2 million of the grant). Prior Bank review of bid documents and approval of contract awards would be mandatory for all contracts expected to cost the equivalent of US$3 million or more. This would cover over 95% of total contract value of Bank-financed procurement.

3. Schedule B summarizes the procurement arrangements and amounts expected to be financed by the GET Grant. The main contracts under the PNOC grant component involve: (a) about three contracts for technical services related to well drilling; and (b) a turnkey contract for the pilot CO_2 reinjection system. The NPC's component of the grant include one turnkey contract for the HVDC transmission line.

4. Consultants would be engaged following Bank guidelines. Under the GET grant NPC would engage two advisers to strengthen the Environment and Social Engineering Departments.

MAP SECTION


PHILIPPINES
LEYTE - LUZON GEOTHERMAL PROJECT
LUZON - VISAYAS TRANSMISSION SYSTEM
EXISTING
ON GOING
PROPOSED PROJECT
HVDC MONO POLAR LINES (TWIN CIRCUIT)
500 kV TRANSMISSION LINES
230 kV TRANSMISSION LINES
SUBMARINE CABLE TERMINALS
115/138 kV TRANSMISSION LINES
SUBSTATIONS
HYDRO POWER STATIONS
THERMAL POWER STATIONS
GEOTHERMAL POWER PLANTS
PROVINCE BOUNDARIES
REGION BOUNDARIES
0 50 100 150 200
KILOMETERS
Philippine Sea
Laoag
Currimao
Bantay
CAR
Tuguegarao
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CENTRAL LUZON
LUZON
Concepcion
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Kalayaan
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CATANDUANES
Naga
Tiwi
Daraga
Bacon Manito
MINDORO
ROMBON
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To San Jose
Balintawak
Tegen
Dolores
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Gardner Snyder
Laguna de Bay
Malaya
Kalayaan
Caliraya
Binan
Makban
Botocan
T'Ban
Panitan
PANAY
Dingle
V. Siga
Jalaur
Sta. Barbara
Malcampo
Talisay
Ormoc
Tangonan
Isabel
EASTERN VASAYAS
Talisay
Bacolod
Murcia
Sigpit
Talavera
Banilad
LEYTE
WESTERN VISAYAS
Naga
CENTRAL VISAYAS
Kabankalan
Cauayan
Mabina
Sipalay
Tagbilaran
Loboc
BOHOL
CEBU
NEGROS
Amlan
Bayaawan
Palinpinon
IBRD 25290
APRIL 19