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ABBREVIATIONS AND ACRONYMS

ADB	-	Asian Development Bank
BED	-	Bureau of Energy Development
BEU	-	Bureau of Energy Utilization
BISUDECO	-	Bicolandia Sugar Development Corporation
BOE	-	Board of Energy
BOI	-	Board of Investments
BPD	-	Barrels per (calendar) day
BTU	-	British thermal unit
CASUCO	-	Cagayan Sugar Corporation
CNED	-	Center for Nonconventional Energy Development
DBP	-	Development Bank of the Philippines
EDC	-	Energy Development Corporation
ENERCON	-	Energy conservation (an industry-sponsored energy conservation movement)
ENMAP	-	Energy Management Association of the Philippines
GDP	-	Gross Domestic Product
GNP	-	Gross National Product
GOP	-	Government of the Philippines
GWh	-	Gigawatt hour
ISA	-	International Sugar Agreement
km	-	Kilometers
KV	-	Kilo volt
kWh	-	Kilowatt hour
LPG	-	Liquid petroleum gas
LRMC	-	long run marginal cost
MMBOE	-	Million barrels of oil equivalent
MECO	-	Manila Electric Company
MOE	-	Ministry of Energy
MTOE	-	Thousand tons of oil equivalent
MW	-	Megawatt
NASUTRA	-	National Sugar Trading Corporation
NCA	-	National Coal Authority
NEA	-	National Electrification Administration
NEDA	-	National Economic Development Agency
NGO	-	Non-governmental organization
NPC	-	National Power Corporation
OMS/OMY	-	Output per manshift (output per manyear)
PAEC	-	Philippine Atomic Energy Commission
PANELCO	-	Pangasinan Electric Cooperative
PCCP	-	Philippines Chamber of Coal Producers Inc.
PGI	-	Philippine Geothermal, Inc.
PHILSUCOM	-	Philippine Sugar Commission
PNAC	-	Philippine National Alcohol Commission
PNB	-	Philippine National Bank
PNOC	-	Philippine National Oil Company
R&D	-	Research and Development
SWIP	-	Small-scale water impounding projects
TOE	-	Tons oil equivalent
TPA	-	Tons per annum
USAID	-	United States Agency for International Development
WASP	-	Wien Automatic Systems Program

LIST OF ANNEXES

ANNEX 1

THE OUTLOOK FOR BIOMASS ALCOHOL PRODUCTION

The Outlook for Biomass Alcohol Production

An Overview of the Alcogas Program

1. The "alcogas" program, which was formally launched by the Government in late 1979, is one of several efforts undertaken to reduce the country's heavy dependence on imported energy. As outlined by the Philippine National Alcohol Commission (PNAC), the program seeks to introduce an 80-20% blend of regular and premium gasoline and anhydrous ethanol in the early years of the program and to use ethanol as an industrial feedstock and in pure alcohol engines in later years as production expands. The stated aims of the program are to replace imported fossil fuels to the extent possible with indigenous renewable energy sources and to generate rural job opportunities through the production of energy crops. Hydrous alcohol has been produced from molasses for many years in the Philippines, largely for industrial and potable use, but was used as a liquid fuel during World War II. 1/

2. Targets and organization. The original target for the program was the production of 22 M liters (ltr) of ethanol in 1980, rising sharply thereafter to 925 M ltr in 1988. 2/ The maximum 20% blend of alcohol was to be reached by 1986, with the use of ethanol as a chemical feedstock and in pure alcohol engines in the years thereafter (see Table 1). If gasoline consumption in the Philippines increases to 18.1 M bbl by 1985 and 19.9 M bbl by 1988 as projected, the 20% blend would require some 580 and 630 M ltr, respectively, in those years. Projected ethylene consumption of 238,000 metric tons in 1988 could absorb another 500 M ltr of ethanol.

3. PNAC provides overall policy guidance for the program. This Commission, established in early 1980, is chaired by the Minister of Energy and includes the Chairman of the Philippine Sugar Commission (as Vice Chairman) and the Ministers of Agriculture, Industry, Finance and National Resources as well as a (yet unnamed) representative of the private sector. A small Secretariat of 6-8 technical staff assists in program planning and operational tasks. As of May 1980, many of the operational details of the program were still being developed.

4. The private sector is expected to provide the bulk of the investment and managerial resources in both the industrial and agricultural aspects of the program, although limited public sector involvement is foreseen in early years. The PNAC is to determine the level and nature of

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1/ Anhydrous alcohol, usually at least 99.5% water free, is mixed with gasoline up to a 20% portion to produce "alcogas." Hydrous alcohol, of about 95% purity, is used in specially designed, all-alcohol engines. Capital and operating costs to produce hydrous alcohol are slightly less than production costs for anydrous alcohol because of reduced distillation requirements.

2/ These initial targets were all revised downwards with the publication of the Five-Year Compressed Program in July 1980. By the spring of 1981, PNAC had cut the original estimate for new-sugar hectarage by about 80% from the January 1980 figure, mainly because it had decided to switch most existing molasses exports into domestic alcohol production.

Table 1: THE ALCOGAS PROGRAM AS PROPOSED BY THE PHILIPPINE NATIONAL ALCOHOL COMMISSION

Year	Model I 1/		Model II 2/		Model III 3/		Total Production of Anhydrous Alcohol (M liters)
	Units in Production	Production (M liters)	Units in Production	Production (M liters)	Units in Production	Production (M liters)	
1980	2	22	-	-	-	-	22
1981	4	44	-	-	1	11	55
1982	6	66	1	45	3	33	144
1983	8	88	2	90	6	66	244
1984	10	110	4	180	10	110	400
1985	10	110	6	270	15	165	545
1986	10	110	8	360	20	220	690
1987	10	110	10	450	25	275	835
1988	10	110	12	540	25	275	925

1/ Characterized as small (30-60 ltr/day) distilleries, existing or new and annexed to existing sugar centrals.

2/ These units of 120,000 ltr/day capacity or larger would be either autonomous or annexed to existing sugar mills. These units are expected to come on stream more slowly but would eventually provide the bulk of proposed alcohol production and meet the requirements of larger urban areas.

3/ Autonomous distilleries with capacities of 30,000-60,000 ltr/day. These units would provide the alcohol requirements of smaller regional markets.

incentives to private sector investors in the program. At present, modest incentives are available to participants, the most important of which appear to be a guaranteed purchase price for alcohol and access to credit from public financial institutions for approved projects. All fuel alcohol projects which are consistent with PNAC policy and approved by the Government's Board of Investments (BOI) are given "pioneer status" under the Energy Priorities Program and are eligible for the same investment incentives as other "pioneer" industries. 1/ For loans from local financial institutions, up to 75% of approved project cost is to be financed at 16-18% "effective interest," with a 2-year grace and a 10-year repayment period. Project approval requires that at least 50% of total installed equipment be locally manufactured or fabricated. Distillery projects must meet minimum production performance standards with regard to juice extraction, alcohol recovery, steam consumption and alcohol purity. Distilleries are to have a guaranteed supply for at least 50% of their annual raw material requirements and may not use petroleum-based fuels in processing. They must also conform to environmental standards set by the National Pollution Control Commission and will be encouraged to acquire storage facilities equal to at least 15 days of alcohol production.

5. Alcohol pricing. The PNAC, in consultation with the Philippine Sugar Commission (PHILSUCOM), is to determine in advance the annual national production quota for fuel alcohol as well as the producer price for this product, taking into account program objectives and world prices for sugar and petroleum. Alcohol quotas are to be allocated to participating sugar mills/distilleries. The Government, acting through the Philippine National Oil Company (PNOC), is to purchase all fuel alcohol at the establisned price for resale and allocation to local distributors of petroleum products. Distributors are to pay the same price for alcohol as for gasoline, ex refinery. In-line blending of gasoline and alcohol will take place at tank-truck loading stations. Retail prices for alcogas will be identical to gasoline prices.

6. The alcohol price to producers is to be set at remunerative levels, taking into account the incentive assumed necessary to promote private investment in raw material producing and processing facilities. For the program start-up year, 1980, the guaranteed price for anhydrous alcohol, ex distillery, is ₱ 3.11/ltr. This is estimated to consist of ₱ 2.10/ltr for

1/ In September 1979, the President issued Letter of Instruction No. 953 which includes fuel alcohol production in the Government's Energy Priorities Program. It directs the Central Bank, the Development Bank of the Philippines (DBP) and the Philippine National Bank (PNB) to relax collateral requirements and rediscounting policies for fuel alcohol projects registered under the program. Other provisions include accelerated depreciation, tax exemptions on imported capital equipment, tax deductions on preoperating expenses, deductions of R&D expenses and costs associated with the training of labor.

the raw material, ₱ 0.44 and 0.29/ltr for fixed and variable costs, respectively, and ₱ 0.28/ltr as markup. This price compares with a price for gasoline, ex refinery, of ₱ 2.56/ltr in May 1980. With oil companies paying the same price (₱ 2.56/ltr) for alcohol and gasoline, the PNOC thus incurs a loss of ₱ 0.55 on each liter of alcohol sold to distributors. Subsequent price adjustments for alcohol are to equal 50% of all future price increases for gasoline. In early 1980 this price of ₱ 3.11/ltr represented a premium of 10-20% over the gross returns available to growers if the cane had instead been processed into sugar and molasses. 1/ However, it was not significantly higher than ex-distillery prices being quoted in May 1980 (in the range of ₱ 3.00/ltr) for lower-grade hydrous alcohol. One year later, in May 1981, the world price of sugar had fallen by 40%, while the Government price of alcohol remained at ₱ 3.11/ltr. Thus sugar mills and growers were showing new interest in converting cane to alcohol rather than sugar and molasses. This more favorable price incentive for alcohol had not yet generated any surge of investment in alcohol production, however (see para. 17 for part of the explanation).

7. Some bench and road testing of "alcogas" has been completed in the Philippines. In December 1976 the PNOC initiated a testing program involving the voluntary participation of some 360 automobiles from government fleets and local auto dealers. Both hydrous and anhydrous alcohol blends with premium gasoline in 15-85% ratios were used. 2/ Results with the anhydrous blend were judged as highly satisfactory in all drivability characteristics in a 500-km test run from Metro Manila to Baguio and return. Initial testing of all-alcohol engines is also underway, using automobiles provided by automobile manufacturers in Brazil.

8. By the time of the mission's visit (April-May 1980), a decision had been made by PNAC to initiate fuel alcohol production (and alcogas distribution) in late 1980 in the Province of Negros Occidental. Agreement had been reached with a privately-owned sugar mill in Negros to supply ethanol from an annex distillery which was being rehabilitated for this purpose (para. 38). 3/ Discussions were underway between PNAC and distributors of

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1/ One ton of cane yields about 98 kg of raw sugar and 38 kg of molasses or, alternatively, 68 ltr of alcohol. In early 1980 prices, the sugar-molasses option would gross to cane growers approximately ₱ 120 = 0.65 (98 kg x ₱ 1.66/kg + .038 ton x ₱ 600/ton), while the alcohol alternative would gross ₱ 143 (= ₱ 2.10 x 68). In the Philippines the gross receipts from sugarcane (raw sugar and molasses) are divided between cane growers and millers in the ratio of about 65-35.

2/ See footnote 1 on page 1.

3/ Both annex and autonomous distilleries are proposed for the Philippine alcohol program (para. 10 and Table 1). An annex distillery is attached to a sugar mill and uses molasses or diverted sugarcane juice as the feedstock for alcohol production. Cane delivered to the facility can be processed into either sugar (and molasses) or alcohol, depending on relative prices or production targets. An autonomous distillery is not associated with an existing sugar mill and generally is equipped to process cane supplies only into sugarcane juice for direct fermentation into alcohol.

petroleum products in Negros on procedures for alcogas blending, distribution and sale. PHILSUCOM had also agreed to allocate some sugarcane (and possibly molasses) from three other mill districts and was negotiating with foreign suppliers for the sale and installation of distilleries at these mill sites (paras. 39-41). In general, by April-May 1980, sugarcane producers and millers were not sufficiently familiar with the national alcohol program to have firm judgments on its financial attractiveness. Although the Development Bank of the Philippines reported some interest among private investors in the program, no loan applications for this purpose had yet been received.

The Production System for Alcohol

9. Sugarcane, cassava and sweet potato are viewed as the primary raw materials for the fuel alcohol program, with sugarcane the crop of first choice. Alcohol production in the early years of the program is expected to derive largely from sugarcane or molasses. The influential Philippine Sugar Commission has taken the view that most of the sugarcane to be processed for fuel alcohol should be produced in new areas to minimize any possible disruption of local and export markets for molasses, raw and refined sugar. PHILSUCOM is therefore invested with the authority to approve all sugarcane areas which are to be included in the program. Projections of the PNAC Secretariat call for the development of some 260,000 ha of additional land in 1980-88 for the alcohol program, of which about 210,000 ha would be in sugarcane and the balance would produce cassava or, in accord with recent thinking within the Secretariat, sweet potato.

10. While planning for the design, location and size of distilleries continues to evolve, three basic models have been proposed (Table 2):

<u>Model I</u> -- Some 10 of these small annexed (30,000-60,000 ltr of ethanol/day) distilleries are envisaged by 1984. As new or annexed to existing sugar mills, it is expected that these facilities would provide the first significant quantities of alcohol for the program. Some of these distilleries would utilize molasses as a feedstock.

<u>Model II</u> -- These units of 120,000 ltr/day capacity (or larger) would be either autonomous or annexed to existing sugar mills. While requiring more time to become operational, distilleries of this model are envisaged as eventually producing more than 70% of the alcohol projected for 1985. The program calls for 12 of these units by 1988. Model II is based largely on monoculture (sugarcane) production systems, although some utilization of root crops is also assumed. Output from these distilleries is assumed to supply the larger urban markets.

<u>Model III</u> -- These autonomous distilleries are expected to have an average daily capacity of 30,000-60,000 ltr and to be the major source of alochol requirements for smaller regional markets. The program calls for some 25 units to be in place by 1985, of which

Table 2: CROP LAND REQUIREMENTS OF THE PROPOSED ALCOGAS PROGRAM
(January 1980 Plan -- but see footnote 2, p.1)

Year	Model I: Cassava 1/	Model I: Sugarcane	Model II: Cassava 1/	Model II: Sugarcane	Model III: Cassava 1/	Model III: Sugarcane	Total 2/
	'000 ha						
1980	1.2	5.0	-	-	-	-	6.2
1981	2.4	10.1	-	-	0.6	2.5	15.6
1982	3.7	15.1	2.5	10.3	1.8	7.5	40.9
1983	4.9	20.1	5.0	20.6	3.7	15.1	69.4
1984	6.1	25.2	10.0	41.1	6.1	25.1	113.6
1985	6.1	25.2	15.0	61.7	9.2	37.7	154.9
1986	6.1	25.2	20.0	82.3	12.2	50.3	196.1
1987	6.1	25.2	25.0	102.9	15.3	62.8	237.2
1988	6.1	25.2	30.0	123.4	15.3	62.8	262.8

Note: These land requirements are based on the assumptions that cassava yields 3,600 ltr alcohol/ha/yr while sugarcane yields 3,500 ltr. See Table 1 for description of each model.

1/ Possibly including other root crops such as sweet potato and taro.

2/ Model I: 31,300 ha
Model II: 153,400 ha
Model III: 78,100 ha

Cassava: 51,400 ha
Sugarcane: 211,400 ha

Source: National Alcohol Commission.

10 would be located in the Visayas, 8 in Luzon and 7 in Mindanao. This model is based on the small-farm production systems which characterize much of Philippine agriculture.

11. The land resource. Analysis elsewhere has shown that the economics of producing biomass alcohol are heavily dependent on the economic costs of the raw material (accounting for about two thirds of total production costs). 1/ Raw material costs are strongly influenced by the amount and quality of land available for production. In the absence of comprehensive land use and land capability studies in the Philippines, some uncertainty exists as to the extent, quality and degree of utilization of the country's agricultural lands at present. Despite the fact that expansion of cropped area continues to be an important contributor to growth of output (with the cropped area increasing by just under 5% during 1974-78), there are clear manifestations of growing land scarcity in the Philippines. These include: (i) heavy outmigration from the overcrowded regions of Central Luzon and the Visayas to Northern Luzon and Mindanao; (ii) expanding cultivation of hillsides and the practice of destructive slash-and-burn agriculture; and (iii) declining average size of farm over the past decade. Some 2 M ha of public forest land are under illegal cultivation, frequently in production systems which result in serious degradation of land, timber and water resources. The total degraded area is estimated at about 5 M ha. The good flat lands suitable for rice, corn or sugar were largely occupied years ago, although further intensification of production on those lands is possible. Population density exceeds $125/km^2$ (some 50% greater than the Asian average) and the area per worker is a little over 1 ha.

12. Preliminary data by the Bureau of Soils suggest that about 7.5 M ha in the Philippines are suitable for sustained annual cropping if good management practices are used. 2/ Some 6.8 M ha of this total appear to have been under annual cropping in 1975, suggesting that another 700,000 ha were relatively underutilized at that time. Much of this appears to have been located in the Eastern Visayas and Northern Luzon (Table 3). Growth in the physical cropped area since 1975 may well have pushed the total of

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1/ World Bank, Brazil: Alcohol and Biomass Energy Sector Review, Report No. 3001-BR, IPD, May 1980. Benefits of course are determined largely by the economic value of alternative liquid fuel sources assumed to be gasoline, which in turn is determined by the world price of crude oil. From the national viewpoint--where a judgment is wanted on whether an investment will be advantageous to the economy--calculations are normally made using economic or "shadow" prices, i.e., numbers which are considered to represent the true value of inputs and outputs in the economy. For the cane producers and millers, anticipated market prices are the relevant considerations. Economic and market prices may or may not coincide with each other.

2/ Classes A, B, C and D land. See Table 3 for definition.

Table 3: INDICATIVE ESTIMATES OF LAND SUITABILITY AND LAND USE (1975) 1/

(000 ha)

Region	Land Suitability, by Class 2/ A,B,C,D	M	X	N	Y	Total	Land Use: Agriculture and Fisheries 3/	Urban	A,B,C & D Classes Land in Farmland	Net Availability of Classes A,B,C,D Land for Agriculture 4/	M and X Classes Land in Farmland 5/	Unutilized Classes A,B,C,D Land 6/
Luzon	3,954	6,331	221	2,163	1,462	14,131	3,599	590	2,976	3,364	623	388
I	398	1,467	34	158	98	2,159	379	42	356	356	23	-
II	917	1,305	20	1,388	12	3,642	617	15	617	902	-	285
III	732	1,047	47	-	-	1,826	539	200	532	532	7	-
IV	1,513	1,243	92	548	1,351	4,747	1,110	300	1,110	1,213	-	103
V	394	1,269	28	69	-	1,760	954	33	361	361	593	-
Visayas	1,730	2,350	96	1,151	332	5,659	1,946	130	1,273	1,601	673	328
VI	456	1,690	46	226	4	2,422	783	57	400	400	383	-
VII	245	299	21	522	9	1,096	488	47	198	198	290	-
VIII	1,029	361	29	403	319	2,141	675	26	675	1,003	-	328
Mindanao	2,645	6,303	240	871	119	10,178	3,257	96	2,549	2,549	708	-
IX	641	902	79	217	29	1,868	671	17	624	624	47	-
X	730	1,846	53	124	59	2,812	888	29	701	701	187	-
XI	517	2,229	41	372	-	3,159	855	25	492	492	363	-
XII	757	1,326	67	158	31	2,339	843	25	732	732	111	-
PHILIPPINES	8,330	14,984	557	4,185	1,912	29,968	8,802	816	6,798	7,514	2,004	716

1/ Land classification according to preliminary data from Bureau of Soils. All calculations made at provincial level and then aggregated to obtain regional totals.

2/ Classes A, B, C and D are considered suitable for cultivation. Class definitions are:

Class	Descriptions
A	Very good land which can be safely cultivated.
B	Good land which can be safely cultivated.
C	Moderately good land which must be cultivated with caution.
D	Fairly good land which must be cultivated with extra caution.
M	Steep land which is eroded and/or too shallow for cultivation.
N	Very steep land, excessively eroded and suitable largely for forestry.
X	Land which is wet most of the time and cannot be economically drained.
Y	Very hilly or mountainous land suitable largely for forestry or wildlife.

3/ Includes annual crops, permanent crops, pasture and fishponds. Area is from the 1971 Agriculture Census, projected at 1960-71 annual growth rate for regions where 1971 area is greater than 1960 area. For other regions, the 1975 farmland area is assumed equal to the 1971 farmland area.

4/ Total land in Classes A, B, C and D, less land area in urban use. (This assumes that virtually all urban land is relatively flat, well-drained and suitable for annual cropping.)

5/ Land in agricultural and fisheries, less Classes A, B, C and D land in these uses.

6/ Column 10 less column 9.

Source: Adapted from G. W. Gwyer, "Agricultural Employment and Farm Income in Relation to Land Classes: A Regional Analysis," Technical Paper No. 6, April 1977, NEDA-UNDP/IBRD Regional Planning Assistance Project. The approximate nature of many of these estimates should be emphasized.

Classes A, B, C and D land under crop to over 7 M ha. 1/ The actual cropped area exceeds 12 M ha, reflecting widespread double cropping in the rice areas. Much of the increase in the cropped area in recent years appear to have come from additional double cropping. In many regions of the country, annual cropping has already been pushed to lands which are marginal in terms of slope, soil type and climate.

13. Although there is little room to expand the areas planted to annual crops, there is considerable potential for perennial crops (coconut, fruit trees, coffee, rubber, etc.) on other lands. For most regions of the Philippines, the hillsides represent the agricultural land frontier. Effective use of these increasingly marginal lands (in terms of their agricultural potential) will require investment in land clearing, road construction, terracing and rebuilding of soil fertility, as well as research and extension assistance to develop production systems which can be sustained. The net economic returns from some of these lands may be low in view of their lower inherent productivity in the absence of costly ameliorative measures.

14. Considerable demands will be made in the future on the land resources of the Philippines. Population may grow in excess of 2.5% per annum during the next decade, and by the year 2000 the agricultural sector will be required to provide as many as 2 M additional jobs. While the Philippines is a net exporter of food (largely sugar and coconut oil, but with small exports of rice in very recent years), malnutrition continues to be a problem among low-income groups. 2/ A key issue is whether the agricultural sector can meet future domestic requirements for basic foods, supply the important export market and meet the requirements of a biomass energy program.

15. The land requirements for the proposed alcohol program through 1988 (210,000 ha for sugar; 50,000 for root crops) appear modest when compared with the present physical cropped area (just over 3%), but more substantial when related to the existing sugar area (55%). Because low-cost sugar (and alcohol) production requires relatively good land in terms of soils, topography and climate, marginal lands formerly in sugar may not be suitable for this program (para. 18). It is doubtful that the required additional land can be located in tracts big enough to accommodate the raw material needs of the larger (Model II) distilleries (6,000-8,000 ha/distillery). A question also remains as to whether the relatively unutilized lands of Classes A, B, C and D (para. 12 above) in Northern Luzon and the Eastern Visayas are suited for sugarcane from a climatic viewpoint (erratic rainfall in Northern Luzon; vulnerability to typhoons in parts of the

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1/ At present, just over 8 M ha (in all land classes) of the 30 M ha land area of the Philippines are under annual or permanent crops. About three quarters of this are accounted for by rice, corn and coconuts.

2/ Food consumption and nutrition studies in 1978 indicated that more than 2.8 M households (about 38% of the total) have diets which provide less than 80% of nutrient energy requirements.

Eastern Visayas). Although representatives of the sugar industry and the national alcohol program frequently mention Mindanao as an area with good potential for expanded sugarcane production, available data do not indicate significant underutilized quantities of Classes A, B, C or D land in that region (Table 3). The Bureau of Soils, in a 1975 tentative assessment, indicated that only about 63,000 ha of land in Mindanao were suited for sugar (Regions X, XI, XII). 1/ With the area actually planted to sugarcane in Mindanao (1978-79) totaling about 18,500 ha, some expansion seems possible. However, the security situation in the region may deter private investment. The question of land availability for the national alcohol program clearly requires additional study. The tentative pircutr which emerges is one of considerable scarcity. The sharp downward revision of original plans for bringing new land into sugarcane for alcohol production, and the decision to use the existing molasses supply instead, thus seems sound.

16. The sugar industry. The sugar industry in the Philippines dates from the Spanish colonial period when it played a key economic role in trade with the metropolis. With well over half of production entering world trade, growth of the industry continues to be heavily dependent on development in the export market. Following the United States' break with Cuba in sugar trade, the Philippine export quote to the US was increased, and in response raw sugar production grew from about 1.3 M metric tons (1960) to 3.4 M tons in 1974. With the subsequent slump in world prices, production declined to 2.3-2.8 M tons in recent years. The 1979-80 harvest is expected to total 2.2-2.4 M tons.

17. Exports in recent years have been in the range of 1.0-1.5 M tons, except in 1978 when accumulated stocks and a strong global market permitted shipments of nearly 2.5 M tons. In 1979, Philippine exports of 1.1 M tons represented just under 5% of global sugar exports. 2/ In recent years the country has had difficulty filling its annual export quota (1978-80) of 1.4 M tons. The sugar trade (raw and refined; domestic and export) is the monopoly of the National Sugar Trading Corporation (NASUTRA), a subsidiary of PHILSUCOM. The administered, or "liquidation," price passed to producers is established by PHILSUCOM and represents a blend of prices established for the domestic and export markets (Table 4). In April-May 1980, a period of unusually high world sugar prices, prices paid to Philippine producers were only about half the world price level. 3/ The molasses trade is handled

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1/ "Strategies for Expanding Agricultural Production and Employment Opportunities in the Regions," National Economic Development Authority, undated, Table 8.

2/ This can be compared with 8% of total exports provided that year by Brazil.

3/ On the other hand, during an earlier period (1977-78) of low world prices, prices to local producers generally exceeded the world price. Trading deficits accumulated by NASUTRA during that period reportedly totaled about ₱ 2.7 billion. It is expected that 30-40% of this amount will be recovered by operations in 1980.

Table 4: PRODUCTION, UTILIZATION AND PRICING OF CENTRIFUGAL SUGAR CROP YEARS 1971-80; PROJECTIONS FOR 1985, 1990

Crop Year 1/	Production	Consumption: Domestic	Consumption: Export	Consumption: Total	Reserve	Prices for Raw Sugar: Liquidation Price to Philippine Producers 2/	Prices for Raw Sugar: World Price 3/
	million metric tons					US cents/lb	
1971	2.06	0.68	1.41	2.09	(0.03)	n.a.	4.5
1972	1.82	0.71	1.26	1.97	(0.15)	n.a.	7.3
1973	2.24	0.79	1.37	2.16	0.08	n.a.	9.5
1974	3.44	0.89	1.31	2.20	1.24	n.a.	30.0
1975	2.39	0.87	0.97	1.84	0.55	11.6	20.4
1976	2.82	0.73	0.97	1.70	1.12	10.5	11.5
1977	2.68	1.00	1.47	2.47	0.21	7.8	8.1
1978	2.34	1.00	2.49	3.49	(1.15)	8.7	7.8
1979	2.30	1.10	1.11	2.21	0.09	9.6	9.9
1980 (prelim.)	2.35	1.18	1.14	2.32	0.03	10.7	13.2
1985 4/	3.00	1.43	1.57	3.00	-		25.4
1990 4/	3.54	1.74	1.80	3.54	-		33.9

1/ In most sugar districts in the Philippines, milling normally begins late in the year previous to the one indicated. In addition to centrifugal sugar, a small amount of traditional sugar is produced by boiling of syrup in open pans.

2/ An ex-mill price representing a blend of prices received from domestic and export sales. The liquidation price to the 1980 crop of 10.7 US cents equivalent can be compared with the world price (see Footnote 3 for definition) of February 1980 of 22.7 cents.

3/ FOB, stowed, Caribbean ports, current prices.

4/ Future production depends heavily on government's pricing policy for sugar. As experience in the mid-1970s indicates, Philippino producers expand output rapidly under the stimulus of attractive prices. The Philippine Sugar Commission (PHILSUCOM) is assuming an export quota under the International Sugar Agreement of 1.4-1.5 M tons for 1981-83. The ISA quota is lifted when world prices rise above 16 US cents/lb. PHILSUCOM is projecting total Philippine sugar production of 3.8 M tons in 1985 and nearly 4 M tons in 1990.

Source: Ministry of Agriculture and PHILSUCOM. Price projections are from the World Bank Report No. 814/80, Price Prospects for Major Primary Commodities, January 1980, p. 90.

by the private sector. Sugar production in the Philippines is responsive to price changes and has undoubtedly been restrained in the last year (1979-80) by the low liquidation price (relative to world prices) in the presence of steadily increasing production costs. It appears that the liquidation price in 1980 may be lower than in 1975.

18. Despite a research effort in sugar that dates back many years, yields of cane or sugar per ha in the Philippines have shown little increase in the past decade (Table 5). Average cane yields in 1976-78 were about 75% of the world average and just under 80% of yields in Brazil. Growth in production, when permitted by developments in the world market, have generally come from an increase in planted area, although on increasingly marginal lands. Following the high world sugar prices in 1974-75, the area planted to cane in the Philippines increased to 550,000 ha (1976-77), but has since declined to less than 450,000 ha. Many of the 100,000 ha formerly in sugar appear to have been planted to food crops and cassava, although a significant part consists of lands now largely abandoned and not well suited to intensive sugar production. Since 1977, producers have reduced plantings on marginal lands apparently in response to weak sugar prices and increased production costs (particularly those related to agricultural chemicals and liquid fuels). More than half of the total sugarcane area is in Negros, 27% in Luzon, and the balance in the Eastern Visayas and Mindanao (12%) and Panay (9%). Only about 15% of cane area is irrigated, although yields in irrigated areas appear to be nearly twice the national average.

19. The centrifugal sugar industry in the Philippines is estimated to employ some 430,000 workers on 31,500 farms. 1/ Production tends to be concentrated among the larger farmers, particularly in Negros, although few large-scale plantations (planted areas of more than 1,000 ha under one manager) exist. More than half of all sugar growers operate farms of 5 ha or less but about a quarter of the total cane area is on farms of more than 100 ha (Table 6). In Negros, half of the sugar area is on farms larger than 50 ha. Despite protective labor legislation, field workers in the industry are frequently considered to be among the disadvantaged groups in Philippine society.

20. Cane growing areas are divided into 42 mill districts, each of which is served by a privately owned sugar mill. Eight of the mills were established since 1970 and several of these are operating well below rated mill capacity, largely because of limited cane supplies. Several of the new mills are in financial difficulty ("distressed mills") and are in arrears on loan repayment to Philippine development banks. At the request of the Government, PHILSUCOM has taken over the management of these mills, a few of which are to be equipped with distilleries to produce anhydrous alcohol for the alcogas program (para. 39). Cane shortages reflect several factors, siting of the new mills in areas of, e.g., inadequate soils or rainfall or

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1/ A small amount of traditional, open pan sugar ("moscovado") is also produced throughout the country.

Table 5: CANE AND SUGAR YIELD, BY REGION

Crop Year	Luzon		Paray		Negros		Eastern Visayas and Mindanao		Philippines	
	C	S	C	S	C	S	C	S	C	S
	tons/ha									
1971	38	4.1	48	4.2	65	5.8	62	5.0	49	5.0
1972	42	4.1	42	3.9	49	4.6	46	3.9	46	4.3
1973	37	3.8	50	4.7	63	6.3	43	4.2	52	5.2
1974	49	4.7	54	4.5	63	6.0	45	4.2	56	5.2
1975	40	4.1	36	3.3	56	5.5	46	4.3	48	4.7
1976	49	4.7	51	4.7	56	5.6	53	5.1	53	5.2
1977	39	4.0	40	3.6	64	6.7	58	5.8	53	5.3
1978	44	4.4	48	4.5	59	6.1	49	4.8	53	5.4
1979	51	3.5	53	5.0	64	6.5	53	5.6	55	5.6
Percent of total cane area, 1979	27		10		52		11		100	

Note: C = cane; S = sugar.

Source: Research and Development Office, PHILSUCOM.

Table 6: DISTRIBUTION OF THE SUGARCANE AREA, BY SIZE OF FARM, 1978

Area	Size of Farm (ha)					
	0.01-5.0	5.01-10.0	10.01-25.0	25.01-50.0	50.01-100.0	Over 100
	%					
Luzon	14	10	19	18	14	25
Panay	25	16	19	15	13	12
Negros	6	8	15	21	24	26
Eastern Visayas and Mindanao	17	17	22	13	11	20
Philippines	11	11	17	18	19	24

Source: PHILSUCOM, as reported by the Ministry of Agriculture, Integrated Agricultural Production and Marketing Project.

land scarcity in situations where rice or other crops appear to provide higher net returns/ha. Total mill capacity (tons of cane milled/24 hours) is about 185,000 tons, equal to annual raw sugar production of 3.3-3.4 M tons per year. The utilization rate during the 1978-79 crop year was 80-85%, with wide variation among mill districts. Six of the mills include refineries with a total rated capacity of 51,000 tons of sugar per day.

21. In recent years 800,000-900,000 tons of molasses were produced annually (Table 7). Philippine law requires that 5% of annual molasses output be reserved for use in the local livestock feed industry. About half is exported, mainly to Japan, which offers an active nearby market, while the balance is converted to alcohol in local distilleries. Ex-mill prices for molasses in April-May 1980 were about ₱ 600/ton (US$81), reflecting the strong export market. High molasses prices have contributed to strength in local prices for hydrous alcohol (about ₱ 3.00/ltr, ex-distillery, May 1980).

22. Production of alcohol from molasses in the Philippines is virtually as old as the sugar industry. In the mid-1920s the industry began to use alcohol as a fuel in tractors, and during World War II it became an important liquid fuel elsewhere in the country. Today there are in the Philippines some 20 large-scale distilleries (i.e., daily capacity of 5,000-47,000 ltr). Total installed capacity of 445,000 ltr/day is designed to produce only hydrous alcohol, mostly from molasses (Table 8). About half of this is located in Luzon (where only about a quarter of the country's sugar is produced). Daily production is less than 300,000 ltr, largely for potable and industrial purposes, as strong export markets for molasses in recent years have reduced supplies to local distilleries. 1/ Several of the distilleries are in need of rehabilitation. Other smaller-scale distilleries in the Philippines are used to produce a popular local drink from palm tree sap (para. 27).

23. Cassava and sweet potato. About 200,000 ha of sweet potato and 75,000 ha of cassava are grown annually in the Philippines (together accounting for just over 2% of the country's cropped area). Most of this is in the Eastern and Central Visayas. National average yields of sweet potato are in the range of 6 tons/ha/crop, although only about 3 tons are considered to be of a quality suitable for human consumption. Cassava yields are about 5 tons/ha. Yield data, of questionable accuracy for these two largely subsistence crops, indicate no significant change in yield levels over time.

24. Systematic R&D work on these two crops is at an early stage in the Philippines. National research on root crops began in 1976 with the establishment of the National Root Crop Research Center at the Visayas State College of Agriculture at Baybay, Leyte. The research effort includes work on sweet potato, cassava, the aroids and yams, with the initial emphasis on

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1/ The implied annual output of about 60 M ltr (assuming 200 operating days/year/distrillery) of hydrous alcohol can be compared with the 1988 target for anhydrous alcohol in the alcogas program of 925 M ltr.

Table 7: PRODUCTION AND UTILIZATION OF MOLASSES IN THE PHILIPPINES

Crop Year	World Production	World Exports	Beginning Stock	Production	Total Supply	Exports 1/	Domestic Use: Food	Domestic Use: Feed and Other Nonfood
			-------------	thousand metric tons	-------------			
1971	22,821	4,036	70	844	914	621	72	161
1972	22,959	n.a.	70	655	725	447	69	146
1973	23,788	4,615	63	849	912	575	81	214
1974	25,711	n.a.	42	928	970	557	95	225
1975	26,905	4,812	93	861	954	580	103	204
1976	27,244	n.a.	67	1,079	1,146	665	112	360
1977	29,461	6,070	109	932	1,041	611	102	258
1978	33,494	n.a.	70	882	952	493	109	298
1979	33,483	n.a.	52	850	902	380	110	316

1/ In recent years, the Philippines have accounted for 10-15% of global molasses exports.

Source: Ministry of Agriculture, Integrated Agricultural Production and Marketing Project. World production and export figures are from the U.S. Department of Agriculture.

Table 8: ALCOHOL DISTILLERIES IN THE PHILIPPINES 1/

Location			Rated Capacity (liters/day)
Luzon			
1.	Hind Sugar Central	Manaog, Pangasinan	6,000
2.	Paniqui Sugar Central	Paniqui, Tarlac	10,570
3.	Tarlac Distillery Corp.	San Miguel, Tarlac	40,000
4.	Integrated Sugar Co.	Del Carmen, Pampanga	17,000
5.	Superior Alcohol Ind. Co.	Apalit, Pampanga	12,500
6.	Republic Alcohol Dist.	Calumpit, Bulacan	20,000
7.	Tecson Chemical Corp.	Balagtas, Bulacan	30,000
8.	Berbacs Chemical Corp.	San Pedro, Laguna	22,000
9.	Canlubang Sugar Estate	Canlubang, Laguna	15,000
10.	Central Azucarera de Don Pedro	Nasugbu, Batangas	35,000
11.	Magahis Alcohol Distillery	Lian, Batangas	23,000
		Subtotal	231,070
Negros			
1.	Victorias Milling Co.	Manapla, Negros Occ.	47,200 2/
2.	Talisay-Silay Milling Co.	Talisay, Negros Occ.	26,000
3.	Kooll Company, Inc.	Talisay, Negros Occ.	10,000
4.	Central Azucarera de La Carlota	La Carlota, Negros Occ.	22,500
5.	Binalbagan-Isabela Sugar Co.	Binalbagan, Negros Occ.	30,000
6.	Asian Alcohol Corp.	Pulupandan, Negros Occ.	30,000
		Subtotal	165,700
Iloilo			
1.	Central Santos-Lopez Co., Inc.	Barotac, Nuevo, Iloilo	8,000
Cebu			
1.	Asian Alcohol Corp.	Consolacion, Cebu	30,000
2.	Cebu Alcohol Plant	Mandawe, Cebu	10,000
		Subtotal	40,000
		TOTAL	444,770

1/ Designed to produce hydrous alcohol (95%) mostly from molasses. Some mills are not operating and in need of repair.

2/ Under rehabilitation to produce anhydrous alcohol for the National Alcohol Program. This distillery will be scaled down to a capacity of about 35,000 ltr/day.

Source: Philippine Sugar Commission

the collection and evaluation of germ plasm, plant breeding, crop protection and processing/utilization. Cassava research suffered a serious setback in 1978 with the outbreak of bacterial blight. With the subsequent suspension of all field activities on this crop, the timetable for cassava varietal development was substantially delayed. By April 1980 the Center had released for commercial production three improved cassava and one sweet potato varieties. Under "ideal conditions" the cassava varieties were considered capable of producing 40 tons of fresh roots within 12 months from planting, while the improved sweet potato had potential yields (within 4 months) of 35 tons. The gap between national average yields and yields from improved varieties under good conditions is striking, indicating the task ahead for research and extension efforts. Research staff suggest that sweet potato yields in the 12-18 tons range are possible, using traditional varieties and improved cultural practices, of which proper weeding is one of the most important.

25. Most of the cassava and sweet potato production in the Philippines is consumed as food for humans, although there is growing interest in the industrial utilization of these crops. Some six private firms now process cassava into starch. One converts small quantities of sweet potato to starch, and a few small-scale operations produce dried cassava chips for animal feed. A cassava development program by the DBP offers 2-year production loans of up to ₱ 3,000/ha (US$405) at 12-14% interest per annum. Long-term loans for processing equipment are also available at reasonable terms. 1/ As of May 1980 the DBP had received four loan applications for funding to produce alcohol from cassava, although the requests did not provide enough detail to permit a judgment on the economic viability of the projects. The cassava yields of 20 tons/ha assumed in the applications are considered optimistic by the BOI (which is reportedly reluctant to approve the projects for this reason), although there are a few instances in the Philippines of sustained yields of about that level in commercial operations.

26. Other raw materials. Among other possible raw materials for the alcohol program, cereals, particularly corn, have been suggested. The mission does not consider this to be an attractive alternative because other uses as human or livestock feed are likely to be of higher economic value. Perhaps of greater potential is the sugary sap (12-16% sugar) of certain palm species, particularly coconut and nipah, both of which grow extensively in the Philippines. However, tapping of the coconut tree destroys the inflorescence and reduces nut yields of this economically valuable species. Some of the sap of the wild-growing nipah palm, common in swamp areas of the country, is already collected and fermented to make a traditional local drink. Some of the estimated 20,000 ha of nipah in the country are also used to produce roofing materials, but many of these palms are not utilized and additional planting seems feasible. Plant density in natural conditions varies widely, but may average 7,500 trees/ha of which 30% may be available

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1/ With DBP financing up to 75% of project cost, nominal interest rates of 16-18% and grace periods of up to 3 years.

for tapping at any time. Each tree yields approximately 1 ltr per day and 2,000 ltr of sap may be converted to about 120 ltr of fuel grade (95.5%) alcohol.

27. Numerous small distilleries (more than 200 in Bantangas Province alone) now utilize nipah and coconut sap in the production of a popular alcoholic drink. Costs of these distilleries are in the range of ₱ 5,000-8,000 (US$675-1,080) and capacity ranges up to 1,000 ltr of product (45-55% purity). With upgrading of the distillery (or reprocessing at a central distillery) and careful quality control, a fuel grade (95.5%) hydrous alcohol could be produced. This concept of small-scale distilleries, utilizing raw materials with relatively low economic value and producing fuel alcohol for use in small pure alcohol engines (para. 53), appears to be worthy of further research and development. 1/

Production Costs

28. Costs of raw materials. One of the most important determinants of the economic viability of biomass alcohol production is the value of the feedstock (sugarcane, cassava and sweet potato, in the case of the Philippines). 2/ The economic value of an alcohol feedstock which moves in world trade is the higher of (i) its domestic marginal economic cost of production or (ii) its price (or more appropriately, marginal revenue) in world markets, adjusted for quality, location and, importantly, price effects growing out of project-induced changes in supply and demand of the product. If the feedstock is not traded in the world market because of its domestic price relative to world prices, the existence of trade restrictions, etc., its economic value in alcohol production may be approximated by the economic cost/unit of producing the incremental quantities needed for the program.

29. Sugarcane. Whether the world sugar and molasses markets are feasible alternative outlets for sugarcane destined for an alcohol program in any particular country depends in part on the volume of cane involved. Given the inelasticity of world sugar demand with respect to price, small (relative to total world trade in sugar) incremental quantities of sugar could depress world prices significantly. In the Philippine alcohol program, the projected 211,000 ha of cane for alcohol in 1988 would produce about 1.1 M tons of sugar, equivalent to 3.5% of projected world trade in raw sugar in that year (Table 9). The Bank's world sugar model was run to estimate the effect on the world price under the assumption that these supplies required for the alcohol program were converted to sugar and placed on the world market. Results indicate that this additional tonnage could

1/ Supported by the German Technical Cooperation Agency (GTZ), a group at the University of the Philippines, Los Banos, is conducting a feasibility study of this approach.

2/ Costs of feedstock generally account for about two thirds of total costs of producing biomass alcohol.

Table 9: SUGARCANE FOR ALCOHOL OR THE WORLD SUGAR MARKET?

		National Alcohol Program 1/		
Year	World Trade 2/ (mil. tons)	Sugarcane Acreage (000 ha)	Sugar Production 3/ (000 tons)	Sugar Production as % of World Trade
1980	25.8	5.0	26.0	0.1
1981	26.3	12.6	65.5	0.2
1982	26.8	32.9	171.1	0.6
1983	27.3	55.8	290.2	1.1
1984	27.8	91.4	475.3	1.7
1985	28.3	124.6	647.9	2.3
1986	29.2	157.8	820.6	2.8
1987	30.1	190.9	992.7	3.3
1988	31.1	211.4	1,099.3	3.5

1/ As proposed by the Government in late 1979.

2/ Economic Analysis and Projections Department, April 1980.

3/ Assuming cane yields of 52 tons/ha/year and sugar yields of 0.1 ton per ton cane.

Sources: Economic Analysis and Projections Department of the World Bank and the Philippine National Alcohol Commission (PNAC).

be absorbed without a significant effect on price. 1/ We conclude that the export market could absorb, if policy so dictated, these additional quantities and that the world market is a feasible option for the sugarcane involved. Philippine cane is therefore appropriately valued in alcohol production on the basis of world sugar prices when these prices exceed domestic economic marginal costs of production. 2/ Using this rationale, the economic value of cane at mill in the Philippines is based: (i) on Bank projections of world sugar prices in 1980-84 (a period in which world prices are expected to exceed Philippine marginal production costs); and (ii) on mission estimates of economic production costs for sugarcane in the Philippines in 1985-95, when marginal production costs appear to exceed world prices (Tables 10 and 11).

30. Reliable and representative production costs for sugar are very difficult to obtain in the Philippines. Although cost data are reportedly collected regularly by PHILSUCOM field staff, these data were not made available to the mission. However, cost of production estimates were obtained from two other sources--a large, well-managed sugar milling operation in Negros Occidental and the Ministry of Agriculture. These independent estimates display considerable similarity and, adjusted to mid-1980 levels, suggest that the average economic cost of producing sugarcane in the Philippines is in the range of US$16-19/ton (millgate). The lower end of this range is probably more typical of present average costs among the better-managed, more efficient sugar farms (as reflected in Table 11). Estimating the marginal cost of production, the more relevant cost for evaluating the additional cane required for the alcohol program, is even more speculative. In view of the scarcity of good land suitable for sugarcane in the Philippines, a plausible assumption is that any significant volume of incremental cane production would take place on lands of limited inherent fertility where unit production costs would be no lower, and possibly higher, than the $16-19 range indicated here. (It was noted that the alcohol program 3/ would have required, by 1988, about a 50% increase in the area

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1/ Specifically, an additional 1.1 M tons of sugar in 1988 would generate a world price which is less than US 0.9 cent/lb, lower than 13.1 cents indicated in Table 9. This would reduce the economic value of cane in that year by just over $1/ton (about 7.5%). The impact of additional supplies on world prices is much smaller in earlier years. Because of slow development of the alcohol program, the actual incremental quantities are likely to be considerably less than those assumed here.

2/ This situation differs from the Brazilian case where the projected quantities of cane for alcohol are relatively much larger--accounting for 39% of world sugar trade in 1985--and could not be diverted to the world market without seriously affecting price, or violating the export quota system of the International Sugar Agreement.

3/ January, 1980.

Table 10: ESTIMATING THE ECONOMIC VALUE OF SUGARCANE ON THE BASIS OF PROJECTED WORLD PRICES

(US$ unless otherwise indicated)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990-95 1/
World Bank price projection 1980 1980 US cents/lb; raw, stowed	17.9	23.8	26.1	23.2	18.2	14.2	12.2	12.0	13.1	14.8	16.4
FOB Caribbean ports, US$/metric ton 2/	395	525	575	511	401	313	269	265	289	326	362
Economic value, FOB, one ton cane equivalent (US$) 3/	39.5	52.5	57.5	51.1	40.1	31.3	26.9	26.5	28.9	32.6	36.2
Less value of molasses (38 kg/ton of cane) 4/	3.3	4.4	4.8	4.3	3.4	2.6	2.2	2.2	2.4	2.7	3.0
Equals FOB value of sugar in cane equivalent, less molasses	36.2	48.1	52.7	46.8	36.7	28.7	24.7	24.3	26.5	29.9	33.2
Less international and domestic transport and handling of sugar in cane equivalent @ 10% 5/	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.9	6.0	6.3
Equals value of sugar in cane equivalent, ex mill	31.2	43.0	47.5	41.5	31.3	23.2	19.1	18.6	20.6	23.9	26.9
Less economic value added of processing cane into sugar 6/	10.9	15.0	16.6	14.5	11.0	8.1	6.7	6.5	7.2	8.4	9.4
Equals economic value of 1 ton of cane, mill gate	20.3	28.0	30.9	27.0	20.3	15.	12.4	12.1	13.4	15.5	17.5

1/ The base case economic analysis assumes an economic value (marginaL revenue) for cane in 1990-95 of $16 to take into account the price effect of placing incremental quantities of Philippines sugar on the world market.

2/ World Bank, Economic Analysis and Projections Department, The World Sugar Economy: An Econometric Analysis of Long-Term Developments (draft), January 1980. The 1980-90 average world price is projected to be 17.4 US cents/lb.

3/ Assuming, as in Philippine conditions, that 10 tons of cane are required to produce approximately 1 ton of raw sugar.

4/ Assuming that the FOB price of molasses on a per ton basis is about 22% of the FOB price of raw sugar. This approximate relationship existed in late 1979 and early 1980.

5/ As of May 1980, international freight charges for moving raw sugar from Caribbean ports to European or Japanese consumption centers were in the range of US$45/ton. A total charge (international and domestic) of US$50/ton of sugar ($5/ton of cane equivalent) is assumed here for 1980, increasing at 2% per annum thereafter in real terms.

6/ Thirty-five percent of the economic value of the sugar in cane equivalent, ex mill. This is the national average mill share of gross proceeds from sales, ex mill, of raw sugar and molasses. Actual financial costs of processing cane into sugar in 1980 were about US$9/ton.

Table 11: INDICATIVE ECONOMIC COSTS OF PRODUCING SUGARCANE IN NEGROS 1/

(₱ per hectare)

	Plant Crop	First Ratoon Crop	Second Ratoon Crop	Three-Year Total	Average per Year
Land Preparation					
Raking and burning trash	14	14	14	42	14
Stubble shoving	-	35	35	70	23
Harrowing, plowing, furrowing	680	-	-	680	227
Planting 2/					
Transportation and cost of planting material	400	-	-	400	
Chemical treatment	51	-	-	51	
Planting	80	-	-	80	
Replanting 3/					
Transportation and cost of planting material	150	150	150	450	
Chemical treatment	19	19	19	57	
Planting	52	52	52	156	
Fertilizing and Liming 4/					
Cost of fertilizer:					
18-46-0	500	-	-	500	
Urea	540	630	630	1,800	
Muriate of potash	455	455	455	1,365	
Cost of lime	210	-	-	210	
Application of materials	119	77	77	273	
Cultivation and Weed Control					
Hand-weeding, off-barring and hilling up	332	332	332	996	
Drainage	49	49	49	147	
Pest Control					
Pesticides	60	60	60	180	
Applicaton of materials	25	25	25	75	
Harvesting					
Cutting and loading of cane	720	576	403	1,699	
Transport to mill, 10 km average distance	1,040	832	582	2,454	
Land Rental 5/	2,000	2,000	2,000	6,000	2,000

(continued ...)

Table 11 (continued)

	Plant Crop	First Ratoon Crop	Second Ratoon Crop	Three-Year Total	Average per Year
Other Expenses					
Repair of harvesting roads and miscellaneous field work	119	119	119	357	119
Administration and overheads	400	400	400	1,200	400
Total (mid-1979 prices)				19,242	6,414
Total (mid-1980 prices) 6/				22,242	7,410
Average cane yield (tons/ha) 7/					63
Economic cost per ton of cane (mid-1980 price) 8/	₱ 118 US$15.89, say $16				

1/ These data, collected in mid-1979, refer to the Victorias Mill District, one of the largest and most progressive in the Philippines. The land is fertile and well suited for sugarcane, with land values and economic rental costs correspondingly high. Average sugarcane yields of 60-65 tons of cane/ha compare with national average yields of 50-55 tons in recent years.

2/ 4,000 seedpieces per ha.

3/ 1,500 seedpieces per ha.

4/ Includes 200 kg of 18-46-0 applied to the plant crop; 300 kg of urea applied to the plant crop and 350 kg to each ratoon crop; 350 kg of muriate of potash applied to each crop; and 3 tons of lime applied to the plant crop.

5/ Assumed to be 8% of the market value (₱ 25,000/ha) of good sugar land in the district.

6/ All costs increased by 10% from mid-1979 levels, except costs of transporting cane to mill which went up by about 50% (i.e., from ₱ 13 to ₱ 20 per ton). The market wage rate for unskilled labor in Negros in mid-1979 was ₱ 7-8/day. Rural labor is relatively scarce in Negros, and the market wage can be taken to be a reasonably good approximation of the economic cost of labor.

7/ Assumes cane yields of 80 tons for the plant crop, 64 tons for the first ratoon and 45 for the second ratoon. A yield figure on a 4-year basis (per unit of cropped area) would be 47 tons/ha.

8/ Some data from Negros suggest very little difference in cane costs of production between small (5 ha) and large farms (100 ha). With costs of transporting cane from farm to mill typically accounting for 15% or more of total production costs, the lowest costs per ton of cane, ex mill, tend to be found on sugar central equipped with rail systems. None of the new mills established since 1970 have these systems.

planted to sugarcane.) A figure of $16/ton is assumed as the marginal economic cost in the base case analysis for the years 1985-95. 1/

31. Cassava and sweet potato. Because of their perishability and bulkiness, fresh cassava roots and sweet potatoes may be considered in the Philippines as essentially nontraded goods for which the economic value in alcohol production is approximated by the marginal cost of local production. As noted, these crops have not, until recently, been the subject of intensive research and development efforts, and reliable data on production costs of these crops are not readily available. Because production systems are rudimentary, yields are low and unit costs are likely to be high. Available information from farm surveys undertaken in the Philippines in 1979-80 suggest that the costs of producing these crops with traditional technology probably exceeds US$30/ton. This figure is roughly consistent with retail prices for these products. Although these prices vary widely in the Philippines, depending on the season and proximity to production zones, they are in the range of ₱ 0.50-1.00/kg (US$68-135/ton, April-May 1980). Costs of producing cassava appear to decline sharply with improved technology and yields and may fall to about half this level if yield of 20-30 ton/ha could be realized (Table 12). Under presently available technology in farm conditions, this would be difficult to achieve and sustain over an extended area. Similar considerations apply to sweet potato, a crop which requires relatively fertile, well-watered land and thereby incurs relatively higher economic costs for land rent.

32. These factors raise doubts about the economic viability of alcohol from cassava or sweet potato under average conditions now prevailing in the Philippines. With vigorous research and development work and yields 4-5 times the present average national level, unit costs of perhaps half the current level of US$30/ton might be possible. Analysis elsewhere suggests that production costs of cassava, at the distillery gate, of no more than about $14/ton are required if alcohol production from this raw material is to be economically viable. 2/

33. Costs of distilleries. Virtually all of the installed distillery capacity is based on imported components with limited local fabrication. There is no experience in the Philippines in the design, fabrication and

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1/ Under present conditions, costs of transporting cane to the mill are estimated to be about $2.70/ton for an average haul of 10 km. On the assumption that new cane for sugar will be produced in areas more concentrated around the mill, a lower transport cost (reduced by, say, $1/ton) helps to offset other increases in marginal production costs.

2/ World Bank, Alcohol Production from Biomass: Potential and Prospects in the Developing Countries, Report No. 3021, June 4, 1980, p. vi. This assumes a price for crude oil, FOB Persian Gulf, of no less than US$31/bbl. With crude oil at $35/bl, cassava prices of no more than $16/ton would produce an economic rate of return of 10%.

Table 12: INDICATIVE PRODUCTION COSTS OF CASSAVA AND SWEET POTATO, 1979-80

Item	Cassava: Traditional Production System 1/	Cassava: High Technology Production System 2/	Sweet Potato: Traditional Production System 1/
	pesos/ha/crop		
Fertilizer	16	305	65
Seed/Cuttings	1	60	85
Other Chemical	1	10	1
Fuel	12	50	3
Labor: Hired	135	1,870	165
Family	320		360
Depreciation of tools, machinery, equipment	150	300	150
Land Rent 3/	300	500	400
Total Costs	935	3,095	1,229
Yield (m.t./ha) 4/	4	30	3
Cost/ton: pesos (₱)	234	103	410
US$	32	14	55 5/

1/ Based on surveys by the Special Studies Division, Ministry of Agriculture. Estimates of land rents have been provided by the mission. Unit production costs will vary greatly, depending on technology employed, level of assumed land rents and yields. The figures in this table are best interpreted as orders of magnitude. No shadow pricing of production inputs has been undertaken in view of the very approximate nature of the underlying data.

2/ Based on technical recommendations by the Philippine Council for Agriculture and Resources Research.

3/ Per crop.

4/ National average cassava yields are estimated at about 5 tons/ha. National sweet potato yields are in the range of 6 tons/ha/crop, although only about 3 tons are considered to be of a quality suitable for human consumption. In terms of biomass suitable for alcohol production, the figure of 6 tons would be more appropriate.

5/ Or about $28 if an average yield of 6 tons is assumed. See footnote 4.

Sources: Special Studies Division and Integrated Agricultural Production and Marketing Project of the Ministry of Agriculture.

installation of large-scale distilleries (greater than about 20,000 ltr/day), although some of this capacity could probably be developed rather quickly if steady demand for this type of equipment became apparent and initial assistance in design and fabrication were provided. Recently, a local firm began designing and fabricating annex distilleries to produce hydrous alcohol (units of about 20,000 ltr each). This company has not designed or constructed autonomous distilleries in the Philippines before, but considers this possible with present knowledge and experience.

34. Despite this encouraging start in developing local capabilities to produce distilleries, it seems probable that the Philippines would have to rely to a considerable extent on imported technology and equipment in the first few years of a national alcohol program. This is likely to result in costs of installed plant and equipment which are moderately higher than those now existing in, e.g., Brazil where a fuel alcohol program is already well developed. 1/

35. Because there is still no experience with the fabrication and installation of such equipment in the Philippines, cost estimates will necessarily embody a greater degree of uncertainty than would such estimates for Brazil. At the time of the mission's visit, no contract had yet been signed to provide new autonomous or annex distilleries for the national alcohol program. Three contracts, all involving PHILSUCOM and foreign suppliers, were being negotiated. Available information suggested that unit costs may be significantly higher than costs for plant of a similar capacity in Brazil. 2/ Brazilian equipment suppliers are active in the Philippines and may be expected to keep costs reasonably competitive as the program develops. Preliminary quotes among foreign suppliers indicate costs/ltr of installed capacity which differ by a factor of almost 2. For the economic analysis (paras. 43-46), and based on rough estimates of foreign suppliers, we assume the "base case" cost for installed capacity of an autonomous distillery of 120,000 ltr/day, equipped to process sugarcane juice (or molasses), to be about US$9.5 M. For the smaller autonomous distillery of 40,000 ltr/day capacity, an installed cost of US$3.9 M is assumed while for the third model, the cost of an annex distillery of 40,000 ltr/day is taken to be $3.12 M,

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1/ See World Bank, Brazil: Alcohol and Biomass Energy Sector Review, Report No. 3001-BR, IPD, May 1980.

2/ The Secretariat to PNAC (not directly involved in the negotiations) informed the mission that plant and equipment costs for a 120,000 ltr/day distillery in the Cagayan Valley (para. 40) were reported to be as high as US$40 M. This was believed to include "front end" equipment to permit the processing of cassava as well as sophisticated facilities to process stillage. This figure may also include some costs for agriculture development and expansion of the existing sugar mill. Prices quoted from Brazilian suppliers suggest that a 120,000 ltr/day autonomous distillery to produce alcohol from sugarcane (or molasses) can be installed in Brazil for about US$7.6 M (October 1979 prices).

i.e., 20% less than that for the autonomous distillery of the same size. 1/ The cost for a locally-designed and fabricated annex distillery of 20,000 ltr/day capacity was quoted at about US$1.9 M equivalent, or about 22% greater than the cost/ltr of installed capacity for this (assumed) foreign-supplied distillery.

Conclusions and Policy Implications

36. The mission's work on the alcogas program was guided by the need to address two basic questions: (i) How feasible are the production targets set out by the Government? and (ii) What can be said of the program's economic viability? Both involve a considerable amount of conjecture at this early stage of the program and depend heavily on assumptions regarding production costs, likely pricing and production policy in the sugar industry and assumptions concerning the medium-term (1980-85) behavior of the world sugar market.

37. Target feasibility. The private sector is expected to install and operate most of the distillery capacity and produce the needed raw materials, although some public sector investment will be undertaken at least in the early years to launch the program. A major determinant of the future volume of alcohol production will be the response of the private sector to program incentives. These will invariably be measured against the alternatives of producing sugar and molasses for the domestic and export markets. The sugar export market is expected to remain strong, at least through 1984, while molasses prices are also likely to stay high. 2/ Assuming that prices paid to cane producers are allowed to reflect these high prices, a key issue in the attractiveness of the program to private investors. This group is not yet sufficiently familiar with the alcogas program to have developed firm judgments on this matter. While some interest has been shown in the program, as reflected in enquiries coming to the BOI and the DBP, present (April-May 1980) price relationships in the Philippines between molasses (about $80/ton, ex-mill), locally-produced hydrous alcohol (₱ 3.00/ltr, ex-distillery) and anhydrous alcohol (P- 3.11/ltr, ex-distillery) appear to provide little incentive to the private sector to invest in the construction or rehabilitation/modification of distillery capacity for anhydrous alcohol. An increase in the guaranteed price for anhydrous alcohol may well be required to increase participation, although this would further increase the alcohol price differential with the present ex-refinery gasoline price (₱ 2.56/ltr, net of

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1/ Costs of annex distilleries are lower because they can utilize already existing cane crushing/milling equipment and steam and power-generating capacity. By May 1981, PNAC had decided to cut back from 15 to 5 the number of autonomous distilleries targeted for 1985 and to rely more on annexed units; this decision also reflects the decision to convert more of existing molasses production to alcohol.

2/ Most of the molasses in world trade is used as an additive in animal feed and, increasingly, as a feedstock in alcohol production. Both of these demands are expected to remain strong.

taxes), and thereby increase budgetary costs of the program. We conclude that with continued high world prices for sugar and molasses, the private sector is likely to be a reluctant participant in the alcogas program in the next 1-3 years. As already noted, however, the recent weakening of world sugar prices was working in favor of increased sugar-mill interest in alcohol production.

38. More can be said with certainty of present government efforts to launch the program. Firm agreement has been reached between PNAC and a private cane miller in Negros Occidental to divert molasses to an existing annex distillery (which is being rehabilitated/modified to produce anhydrous alcohol) of about 35,000 ltr/day capacity. Overhaul of this facility is to be completed in October 1980, and alcohol production should begin with the 1980-81 cane harvest (November 1980-June 1981). The mission assumes 100 days of operation and 1-2 M ltr of alcohol from this facility in 1980, with 250 days/year operation thereafter (8-10 M ltr/year).

39. Much greater production can eventually be expected from each of the three mill districts now designated as suppliers of sugarcane, molasses (or, possibly, root crops) to the alcohol program. These include the Cagayan Sugar Corporation (CASUCO), in Northern Luzon, the Bicolandia Sugar Development Corporation (BISUDECO) in Southern Luzon, and the Tolong Sugar Milling Company (Tolong) in South Negros. All are "distressed" companies, the management of which has been assumed by PHILSUCOM. At the time of the mission's visit, negotiations were at various stages for the purchase and installation of annex distilleries from foreign suppliers through suppliers' credits. Negotiations with CASUCO appeared to be nearing conclusion and called for the installation within 24 months of a distillery capable of producing 120,000 ltr of ethanol/day, using both sugarcane juice (or molasses) and cassava. If this facility were to operate for 100 days in 1982 and 200 days/year thereafter, annual alcohol production would approximate 12 M and 24 M ltr, respectively. Negotiations for distilleries at BISUDECO and Tolong appear to be less advanced. Distilleries of 180,000 ltr/day, utilizing only sugarcane juice or molasses, were being considered. Assuming timely conclusion of negotiations and a 24-month installation period, these facilities might cone on-stream for the 1982-83 cane harvest. Again assuming 100 days of operation at each distillery in 1982 and 200 days annually thereafter, annual alcohol production at each would be about 18 M ltr in 1982 and 36 M ltr thereafter.

40. Considerable uncertainties remain regarding the adequacy of raw material supplies in each of these three mill districts. The mills are relatively new and have been operating well below capacity, although throughput has been increasing. Lack of appropriate climate and soils may be limiting cane production at CASUCO, while scarcity of land has been indicated for BISUDECO. Cane yields in each of these three districts are well below the national average (Table 13). Unless cane yields can be increased and mill throughput expanded, alcohol production from these facilities is likely to be relatively high cost.

41. Initial discussions are underway between PHILSUCOM, PNAC and two other milling/distillery companies. If these negotiations are successful, production of another 10-20 M ltr of alcohol/year could begin in 1982.

Table 13: COMPARISON OF NATIONAL AVERAGE CANE YIELDS WITH YIELDS IN MILL DISTRICTS WHERE ALCOGAS DISTILLERIES ARE PLANNED

Crop Year	Negros		Luzon		National
	Victorias 1/	Tolong	Cagayan 2/	Bicol 3/	Average
	tons of cane/ha				
1971	65	60	-	-	49
1972	58	46	-	-	46
1973	62	62	-	-	52
1974	60	69	-	-	56
1975	58	67	-	11	48
1976	61	67	-	38	53
1977	60	35	-	49	53
1978	56	29	33	30	53
1979	62	40	31	44	55

1/ Victorias Milling Company. Alcohol to be produced from rehabilitated annex distillery using molasses.

2/ Cagayan Sugar Corporation (CASUCO). The first crop was harvested in 1978.

3/ Bicolandia Sugar Development Corporation (BISUDECO). First crop harvested in 1975.

Source: Philippine Sugar Commission (PHILSUCOM).

42. Summing all of these projections, production of anhydrous alcohol for the national program would grow from perhaps 2 M ltr in 1980 to 9 M in 1982 to over 120 M ltr in 1984 and 1985; this is less than 25% of the target set for 1985 (545 M ltr). The tentative character of these figures is obvious. Altered pricing policies for sugar and alcohol and a strong response from the private sector could produce substantially higher figures by the mid-1980s.

43. The economics of alcohol production. Economic rates of return and net present values are estimated for three distillery models assumed to be broadly representative of the national alcohol program: (i) an autonomous distillery of 120,000 ltr/day capacity--essentially the Model II in the proposed program; (ii) an autonomous distillery of 40,000 ltr/day; and (iii) an annex distillery of 40,000 ltr/day. The "base case" analysis for each model embodies the assumptions considered most plausible on the basis of available information. Alternative scenarios (assumptions) are examined in sensitivity testing. Estimated economic rates of return are compared with an assumed real opportunity cost of capital of 10%. Because of uncertainties regarding key parameters such as the economic value of sugarcane and costs of plant and equipment, these results should be considered tentative, subject to confirmation by more detailed investigation.

44. Key assumptions in the base case are:

(i) an economic value of cane at the mill gate which ranges from about \$20-31/ton in 1980-84 (reflecting projected world sugar prices) and \$16/ton in 1985-95 (which is assumed to be the marginal economic cost of production);

(ii) a crude oil price of US\$32/bbl, FOB, Persian Gulf, in 1980, rising at 3% per annum thereafter (with prices of gasoline rising at 2.5% per annum);

(iii) distillery costs of US\$9.5 M (autonomous; 120,000 ltr/day), US\$3.9 M (autonomous; 40,000 ltr/day) and US\$3.12 M (annex; 40,000 ltr/day)--all some 25% above costs of distilleries of similar capacity installed in Brazil;

(iv) investment in distilleries to begin in 1980, with the first alcohol production in 1982;

(v) the mill/distillery operating for 165 days/year;

(vi) the economic value of alcohol produced by 120,000 ltr/day unit discounted 2.5% from the economic value of gasoline to reflect assumed shipping costs from distant alcohol production zones to consumption centers near which gasoline refineries are located; and

(vii) the economic value of gasoline used in blending with alcohol from the 40,000 ltr/day units is discounted 2.5% to reflect assumed shipping costs from distant refineries to consumption centers near alcohol production zones. 1/

45. Sensitivity testing incorporates changes in several key variables from their values assumed in the base case:

(i) adjustments of 25% up or down in the economic value of cane;

(ii) a crude oil price which rises at 5% per annum in real terms in 1980-85;

(iii) adjustments of 10% up or down in the costs of distilleries;

(iv) delayed investment in distilleries until later years (1981-1894) to avoid diversion of sugarcane to alcohol during the early 1980s when the economic value of cane is high because of projected strong world prices for sugar;

(v) extension of the mill/distillery operation to 180 days/year;

(vi) no penalties for transporting either alcohol or gasoline, i.e., assuming equal economic values for both at point of consumption. 2/

46. The results suggest that production of anhydrous alcohol is not economically viable under "base case" assumptions, but approaches viability (an economic rate of return of at least 10% per annum or a positive net present value) under alternative assumptions, viz., (i) a delay in alcohol production until about 1985 (investment beginning in 1983), at which time the world sugar market would provide less attractive alternative outlets for Philippine cane; or (ii) an economic value of cane 25% less than in the base case; or (iii) real prices of crude oil rising at 5% per annum in 1980-85 (Table 14). No scenarios produce an economic rate of return in excess of

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1/ Points (vi) and (vii) imply that the large distilleries are located in areas (e.g., Mindanao) distant from major gasoline consumption centers (e.g., Manila), thereby requiring long-distance transportation of alcohol prior to blending with gasoline from refineries located near the consumption centers. On the other hand, alcohol production from the small distilleries may be used to supply nearby (smaller) consumption centers, thereby requiring the shipment of gasoline (for blending) from more distant refineries.

2/ This assumes that the alcogas consumption point is located roughly midway between the alcohol distillery and the gasoline refinery--a condition which seems plausible in, e.g., Southern Luzon but would not be met where alcohol production and consumption takes place far from gasoline refineries.

Table 14: A PRELIMINARY ANALYSIS OF ECONOMIC RETURNS

Assumptions	Autonomous Distillery (120,000 ltr/day) Economic Rate of Return (%)	Autonomous Distillery (120,000 ltr/day) Net Present Value 1/ ('000 US$)	Autonomous Distillery (40,000 ltr/day) Economic Rate of Return (%)	Autonomous Distillery (40,000 ltr/day) Net Present Value 1/ ('000 US$)	Annex Distillery (40,000 ltr/day) Economic Rate of Return (%)	Annex Distillery (40,000 ltr/day) Net Present Value 1/ ('000 US$)
Base Case 2/	2.8	(9,428)	2.7	(3,534)	3.6	(2,820)
Sensitivity Testing 3/						
Economic value of cane						
Up 25%	Neg.	(19,414)	Neg.	(6,862)	Neg.	(6,148)
Down 25%	10.4	545	9.6	(214)	11.2	499
Crude oil price						
Increases at 5% per annum	8.8	(1,880)	8.5	(888)	9.7	(175)
Costs of distilleries						
Up 10%	1.8	(11,125)	1.7	(4,212)	2.5	(3,435)
Down 10%	3.8	(7,725)	3.9	(2,854)	4.8	(2,214)
Delayed production of alcohol						
Distillery investment beginning: 4/						
1981	5.5	(5,421)	5.2	(2,178)	6.4	(1,466)
1982	7.9	(2,299)	7.4	(1,120)	8.9	(408)
1983	9.6	(389)	8.9	(461)	10.7	251
1984	10.9	944	10.0	3	11.9	717
Extension of lant perations ays:						
180 days	3.5	(8,880)	3.6	(3,293)	4.5	(2,580)
No penalty on transportation of alcohol or gasoline	3.8	(8,170)	1.8	(3,951)	2.6	(3,239)

1/ Discounted at 10%.

2/ See text, para. 44 for assumptions.

3/ From values in the base case.

4/ With alcohol production beginning 2 years later. For these mutually exclusive investment opportunities, the size of the NPV, discounted to 1980, is the relevant decision criterion. The optimum year in which to invest, determined by the year for which NPV is a maximum, was not estimated in this analysis because of uncertainties regarding the future world sugar price.

about 12%. An increase in days of plant operation raises economic returns by about 1 percentage point. A 10% change in distillery costs alters returns to all 3 distillery models by about 1 percentage point in the opposite direction. The elimination of penalties on the transportation costs for gasoline and alcohol increases the return by about 1 percentage point to the large distillery, but reduces it by that amount for the smaller units, i.e., the distribution penalty tends to favor the smaller distilleries. With no assumed distribution penalty, returns to the large distillery tend to be marginally higher than to the smaller autonomous distillery. Reflecting lower capital costs, economic returns to annex distilleries are slightly higher than to autonomous distilleries of the same capacity. Tables 15, 16 and 17 provide base case data for the three distillery models.

47. Another approach to evaluate the economics of biomass alcohol in the Philippines is to estimate the units of domestic currency required to save one unit of foreign exchange through the substitution of locally produced fuel alcohol for imported petroleum. 1/ This ratio can then be compared with the existing exchange rate to provide a rough estimate of the economic costs of import substitution in this activity. A simple, indicative calculation of this type is provided in Table 18. It confirms the conclusion that biomass alcohol production at present relationships between world crude oil prices and local sugarcane costs is not economically viable. The analysis suggests that the domestic resource cost of producing anhydrous alcohol may be 15-20% greater than the cost of importing crude oil and refining an equivalent volume of gasoline. Alternatively stated, the loss to the economy from alcohol production in one distillery of 120,000 ltr/day capacity could be as much as US$1 M annually. Additional analysis is needed to refine and confirm (or refute) these rough estimates. If the foreign exchange content in Philippine biomass production were higher and agricultural productivity lower than the assumptions in this example, the economics of production would be even more unfavorable. On the other hand, a shadow price for foreign exchange higher than the official rate used here would improve the results indicated here.

48. Implications for policy. This review of the national alcogas program indicates that production targets are not likely to be achieved, with shortfalls largest in the early years when strong world prices for sugar (and molasses) are expected to provide attractive alternative outlets for any additional cane which can be produced. Available information also suggests that alcohol production from sugarcane in the early 1980s is not

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1/ This domestic resource cost (DRC) measure must be used and interpreted cautiously as complex definitional and theoretical problems are involved. Among the limitations are the difficulties of placing correct economic values on domestic resources and foreign exchange. Advantages of this approach are its simplicity and the ease with which the results can be interpreted. For a fuller discussion of these points, see World Bank Staff Working Paper No. 394, Methodologies for Measuring Agricultural Price Intervention Effects (June 1980) Chapter IV.

Table 15: BASE CASE ANALYSIS OF AUTONOMOUS DISTILLERY

(120,000 ltr/day)

	1	2	3	4	5	6	7	8	9	10	11	22
ASSUMPTIONS												
OIL PRICE ($/BBL)	32.0	33.0	34.0	35.0	36.0	37.1	38.2	39.4	40.6	41.8	43.0	59.6
GASOLINE VALUE (US C/L)	27.70	28.39	29.11	29.83	30.58	31.36	32.13	32.94	33.77	34.60	35.46	46.51
SUGARCANE PRICE ($/TON)	20.3	28.0	30.9	27.0	20.3	16.0	16.0	16.0	16.0	16.0	16.0	16.0
YIELD (L/TON)	68	68	68	68	68	68	68	68	68	68	68	68
PLANT CAPACITY (000 L/DYS)	120	120	120	120	120	120	120	120	120	120	120	120
PLANT COST ($ 000)	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500
OPERATING DAYS PER YEAR (DYS/YR)	165	165	165	165	165	165	165	165	165	165	165	165
COSTS AND BENEFITS STREAMS												
DISBURSEMENT PATTERN (%)	30	60	10	-	-	-	-	-	-	-	-	-
CAPITAL EXPENDITURES ($ 000)	2,850	5,700	950	-	-	-	-	-	-	-	-	(950)
PRODUCTION COSTS												
CAPACITY BUILD-UP (%)	-	-	60	90	100	100	100	100	100	100	100	100
ETHANOL PRODUCTION (MLN. L)	-	-	11.88	17.82	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80
SUGARCANE REQUIREMENT (000 T)	-	-	175	262	291	291	291	291	291	291	291	291
SUGARCANE COST ($ 000)	-	-	5,408	7,074	5,907	4,656	4,656	4,656	4,656	4,656	4,656	4,656
UNIT OTHER VAR. COST (US C/L)	-	-	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
OTHER VARIABLE COSTS ($ 000)	-	-	209	314	348	348	348	348	348	348	348	348
VARIABLE COSTS ($ 000)	-	-	5,617	7,388	6,255	5,004	5,004	5,004	5,004	5,004	5,004	5,004
FIXED COSTS ($ 000)	-	-	950	950	950	950	950	950	950	950	950	950
TOTAL PRODUCTION COSTS ($ 000)	-	-	6,567	8,338	7,205	5,954	5,954	5,954	5,954	5,954	5,954	5,954
UNIT PROD. COST (US C/L)	-	-	55	47	36	30	30	30	30	30	30	30
WORKING CAPITAL												
WORKING CAPITAL ($ 000)	-	-	1,095	1,390	1,201	992	992	992	992	992	992	992
WORKING CAPITAL BUILD UP ($ 000)	-	-	1,095	295	(189)	(209)	-	-	-	-	-	(992)
REVENUES												
ETHANOL PRODUCTION (MLN. L)	-	-	11.88	17.82	19.80	19.80	19.80	19.80	19.80	19.80	19.80	19.80
ETHANOL VALUE (US C/L)	-	-	28.38	29.08	29.82	30.58	31.33	32.12	32.93	33.74	34.57	45.35
REVENUES ($ 000)	-	-	3,372	5,182	5,904	6,055	6,203	6,360	6,520	6,681	6,845	8,979
NET CASH FLOW ($ 000)	(2,850)	(5,700)	(5,240)	(3,451)	(1,112)	310	249	406	566	727	891	4,967

NET PRESENT VALUE ($ 000) (9,428)

RETURN ON INVESTMENT = 2.775%

Table 16: BASE CASE ANALYSIS OF AUTONOMOUS DISTILLERY

(40,000 ltr/day)

	1	2	3	4	5	6	7	8	9	10	11	22
ASSUMPTIONS												
OIL PRICE ($/BBL)	32.0	33.0	34.0	35.0	36.0	37.1	38.2	39.4	40.6	41.8	43.0	59.6
GASOLINE VALUE (US C/L)	27.70	28.39	29.11	29.83	30.58	31.36	32.13	32.94	33.77	34.60	35.46	46.51
SUGARCANE PRICE ($/TON)	20.3	28.0	30.9	27.0	20.3	16.0	16.0	16.0	16.0	16.0	16.0	16.0
YIELD (L/TON)	68	68	68	68	68	68	68	68	68	68	68	68
PLANT CAPACITY (000 L/DYS)	40	40	40	40	40	40	40	40	40	40	40	40
PLANT COST ($ 000)	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
OPERATING DAYS PER YEAR (DYS/YR)	165	165	165	165	165	165	165	165	165	165	165	165
COSTS AND BENEFITS STREAMS												
DISBURSEMENT PATTERN (%)	30	60	10	-	-	-	-	-	-	-	-	-
CAPITAL EXPENDITURES ($ 000)	1,170	2,340	390	-	-	-	-	-	-	-	-	(390)
PRODUCTION COSTS												
CAPACITY BUILD-UP (%)	-	-	60	90	100	100	100	100	100	100	100	100
ETHANOL PRODUCTION (MLN. L)	-	-	3.96	5.94	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60
SUGARCANE REQUIREMENT (000 T)	-	-	58	87	97	97	97	97	97	97	97	97
SUGARCANE COST ($ 000)	-	-	1,792	2,349	1,969	1,552	1,552	1,552	1,552	1,552	1,552	1,552
UNIT OTHER VAR. COST (US C/L)	-	-	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
OTHER VARIABLE COSTS ($ 000)	-	-	70	105	116	116	116	116	116	116	116	116
VARIABLE COSTS ($ 000)	-	-	1,862	2,454	2,085	1,668	1,668	1,668	1,668	1,668	1,668	1,668
FIXED COSTS ($ 000)	-	-	390	390	390	390	390	390	390	390	390	390
TOTAL PRODUCTION COSTS ($ 000)	-	-	2,252	2,844	2,475	2,058	2,058	2,058	2,058	2,058	2,058	2,058
UNIT PROD. COST (US C/L)	-	-	57	48	38	31	31	31	31	31	31	31
WORKING CAPITAL												
WORKING CAPITAL ($ 000)	-	-	375	474	413	343	343	343	343	343	343	343
WORKING CAPITAL BUILD UP ($ 000)	-	-	375	99	(61)	(70)	-	-	-	-	-	(343)
REVENUES												
ETHANOL PRODUCTION (MLN. L)	-	-	3.96	5.94	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60
ETHANOL VALUE (US C/L)	-	-	29.84	30.58	31.34	32.14	32.93	33.76	34.61	35.47	36.35	47.67
REVENUES ($ 000)	-	-	1,182	1,816	2,068	2,121	2,173	2,228	2,284	2,341	2,399	3,146
NET CASH FLOW ($ 000)	(1,170)	(2,340)	(1,835)	(1,127)	(346)	133	115	170	226	283	341	1,821

NET PRESENT VALUE ($ 000) (3,534)

RETURN ON INVESTMENT = 2.749%

Table 17: BASE CASE ANALYSIS OF ANNEX DISTILLERY

(40,000 ltr/day)

	1	2	3	4	5	6	7	8	9	10	11	22
ASSUMPTIONS												
OIL PRICE ($/BBL)	32.0	33.0	34.0	35.0	36.0	37.1	38.2	39.4	40.6	41.8	43.0	59.6
GASOLINE VALUE (US C/L)	27.70	28.39	29.11	29.83	30.58	31.36	32.13	32.94	33.77	34.60	35.46	46.51
SUGARCANE PRICE ($/TON)	20.3	28.0	30.9	27.0	20.3	16.0	16.0	16.0	16.0	16.0	16.0	16.0
YIELD (L/TON)	68	68	68	68	68	68	68	68	68	68	68	68
PLANT CAPACITY (000 L/DYS)	40	40	40	40	40	40	40	40	40	40	40	40
PLANT COST ($ 000)	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120	3,120
OPERATING DAYS PER YEAR (DYS/YR)	165	165	165	165	165	165	165	165	165	165	165	165
COSTS AND BENEFITS STREAMS												
DISBURSEMENT PATTERN (%)	30	60	10	-	-	-	-	-	-	-	-	-
CAPITAL EXPENDITURES ($ 000)	936	1,872	312	-	-	-	-	-	-	-	-	(312)
PRODUCTION COSTS												
CAPACITY BUILD-UP (%)	-	-	60	90	100	100	100	100	100	100	100	100
ETHANOL PRODUCTION (MLN. L)	-	-	3.96	5.94	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60
SUGARCANE REQUIREMENT (000 T)	-	-	58	87	97	97	97	97	97	97	97	97
SUGARCANE COST ($ 000)	-	-	1,792	2,349	1,969	1,552	1,552	1,552	1,552	1,552	1,552	1,552
UNIT OTHER VAR. COST (US C/L)	-	-	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76
OTHER VARIABLE COSTS ($ 000)	-	-	70	105	116	116	116	116	116	116	116	116
VARIABLE COSTS ($ 000)	-	-	1,862	2,454	2,085	1,668	1,668	1,668	1,668	1,668	1,668	1,668
FIXED COSTS ($ 000)	-	-	390	390	390	390	390	390	390	390	390	390
TOTAL PRODUCTION COSTS ($ 000)	-	-	2,252	2,844	2,475	2,058	2,058	2,058	2,058	2,058	2,058	2,058
UNIT PROD. COST (US C/L)	-	-	57	48	38	31	31	31	31	31	31	31
WORKING CAPITAL												
WORKING CAPITAL ($ 000)	-	-	375	474	413	343	343	343	343	343	343	343
WORKING CAPITAL BUILD UP ($ 000)	-	-	375	99	(61)	(70)	-	-	-	-	-	(343)
REVENUES												
ETHANOL PRODUCTION (MLN. L)	-	-	3.96	5.94	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60
ETHANOL VALUE (US C/L)	-	-	29.84	30.58	31.34	32.14	32.93	33.76	34.61	35.47	36.35	47.67
REVENUES ($ 000)	-	-	1,182	1,816	2,068	2,121	2,173	2,228	2,284	2,341	2,399	3,146
NET CASH FLOW ($ 000)	(936)	(1,872)	(1,757)	(1,127)	(346)	133	115	170	226	283	341	1,743
NET PRESENT VALUE ($ 000)	(2,820)											

Table 18: AN INDICATIVE ESTIMATE OF THE DOMESTIC RESOURCE COST OF PRODUCING ETHANOL AS A SUBSTITUTE FOR IMPORTED GASOLINE IN AN AUTONOMOUS DISTILLERY OF 120,000 LTR/DAY CAPACITY

(prices as of mid-1980)

Item	Foreign Exchange Component (US$)	Local Currency Component (Pesos)	Total (Pesos)	Local Currency Component as Percent of Total
	- - - - - - -	'000 - - - - - -		
Sugarcane Production Costs 1/				
Land preparation				
Labor	1.2	179	188	95
Tractor services	78.0	577	1,154	50
Planting				
Labor	0.9	130	137	95
Chemicals	7.8	28	86	33
Transportation and cost of planting material	27.4	473	676	70
Replant				
Labor	1.8	251	264	95
Chemicals	8.8	32	97	33
Transportation and cost of planting material	30.9	533	762	70
Fertilizing and liming				
18-64-0	76.9	280	849	33
Urea	276.1	1,006	3,049	33
Muriate of potash	209.3	763	2,312	33
Cost of lime	4.9	320	356	90
Application of materials	12.4	370	462	80
Cultivation and weeding				
Hand-weeding, off-barring and hilling-up	11.4	1,603	1,687	95
Drainage	1.6	237	249	95
Pest control				
Pesticides	27.6	101	305	33
Application of materials	3.4	102	127	80
Harvesting				
Cutting and loading of cane	19.5	2,732	2,876	95
Transport to mill	383.1	2,834	5,669	50
Land rent	--	10,164	10,164	100
Repair of harvesting roads and miscellaneous field work	4.1	575	605	95
Administration and overheads	27.4	1,830	2,033	90
Subtotal, sugarcane production	1,214.5	25,120	34,107	74

(continued ...)

Table 18 (continued)

Item	Foreign Exchange Component (US$)	Local Currency Component (Pesos)	Total (Pesos)	Local Currency Component as Percent of Total
	- - - - - - - - '000	- - - - - -		
Mill Processing Costs 2/				
Variable Costs				
Chemicals	46.9	171	518	33
Lubricants	6.8	24	74	33
Electricity	6.8	24	74	33
Fuel	6.8	24	74	33
Other supplies	20.0	148	296	50
Labor and social benefits	17.6	2,460	2,590	95
Contingencies	--	74	74	100
Fixed costs				
Labor and social benefits	30.0	1,998	2,220	90
Maintenance 3/	142.6	1,054	2,109	50
Administration	15.0	999	1,110	90
Insurance	--	444	444	100
Miscellaneous	--	296	296	100
Depreciation on fixed assets 4/	285.0	2,109	4,218	50
Subtotal, processing	577.5	9.825	14,097	70
Total cost of producing 19.8 M ltr of anhydrous alcohol/year 5/	1,792.0	34,945	48,204	72
Total cost of importing 19.8 M ltr of gasoline 6/	4,752.0	5,425	40,590	
Net foreign exchange savings from domestic production of alcohol	2,960.0			
Net expenditure of local currency to realize foreign exchange savings		29,520		
Cost in local currency (pesos) per dollar of foreign exchange saved		9.97, say 10		
Loss to the economy/year/distillery of 120,000 ltr/day:	₱ 7,614,000 7/ US$1,029,000 8/			

(continued ...)

Table 18 (continued)

1/ Assuming 68 ltr of alcohol/ton of cane and cane yields of 63 tons/ha, or about 4,280 ltr of alcohol/ha/yr. Under these generally favorable assumptions, some 4,620 ha of sugarcane would be required to supply a distillery of 120,000 ltr/day capacity which operates 165 days/year. Nursery costs are excluded. Production costs for the 4,620 ha are based on per ha figures of Table 11.

2/ Based on estimated costs in Brazil. See Brazil: Alcohol and Biomass Energy Sector Review, Report no. 3001-BR, May 1980, Annex 7-2, p. 1.

3/ Three percent of investment in plant and equipment.

4/ Six percent of investment in plant and equipment.

5/ 120,000 ltr/day x 165 days/yr. Because of the approximate nature of the underlying figures, no credits are calculated for the value of by-products (stillage and bagasse). This does not significantly violate reality. The economic value of stillage approximates its cost of disposal as a low-nutrient fertilizer returned to the land. Small quantities of excess bagasse might result, although lack of steady supplies throughout the year would make utilization difficult.

6/ A crude oil price of US$32/bbl, FOB, Persian Gulf in 1980 (para. 44 of main text) corresponds roughly to a price of $34.10/bbl, CIF, Philippine ports (US 21.5 cents/ltr of crude), or an ex-refinery cost for gasoline of US 27.8 cents/ltr. Of this total cost, US 24 cents is assumed to be foreign exchange cost, while US 3.8 cents equivalent (Pesos 0.274/ltr) are local currency costs (including refining and inland transportation).

7/ Peso cost of producing 19.8 M ltr of anhydrous alcohol less peso cost of importing/refining equivalent volume of crude.

8/ At the official exchange rate of US$1 = ₱ 7.4.

economically viable in the Philippines under plausible assumptions regarding world sugar prices, the price of crude oil and the economic value of sugarcane. The medium-term behavior of the volative world sugar market is a key consideration in these conclusions. The economics of alcohol from cassava or sweet potatoes are likely to be even less attractive than returns from sugarcane because of low yields and high costs of these crops. Notwithstanding this rather somber assessment of the program in the short term (1980-83), there is a good possibility that alcohol production from sugarcane will become economically viable in the Philippines by 1984-85 as a result of lower economic opportunity values for cane (as world sugar prices recede) and a projected steady increase in the price of crude oil. In these circumstances the task of government in the interim should be to ensure that the national alcohol program is properly formulated, that technical cadre and relevant institutions are in place and that appropriate technologies for the efficient production and utilization of raw material are available to foster steady expansion of alcohol production as economic conditions permit.

49. These considerations suggest that heavy investment in distillation plant and equipment is not advisable in 1980-82. This reflects in part the unfavorable underlying economics of alcohol production in a period of high world sugar prices. A cautious approach to investment in plant is also warranted at this time because industrial technology in alcohol production is changing and may be significantly different within a few years (improved fermentation and distillation efficiency, enhanced thermal efficiency in plant operations, better procedures for stillage treatment and utilization, etc.). As the program develops, there is need to shop carefully for distilleries and ancillary equipment to ensure that industrial processing costs are kept to a minimum. The PNAC investment guidelines for this equipment appear to be on the high side and may encourage unnecessarily large expenditure if these criteria serve as the basis for obtaining loan finance. 1/

50. Formulation of the national alcohol program should reflect several basic considerations: (i) the relatively high cost of raw materials in the Philippines; (ii) the scarcity of new land suited for sugarcane; and (iii) the island geography of the country and the associated costs of transporting alcohol or gasoline between production and consumption centers. A strong R&D element is needed in the program to take these factors into account. In terms of agricultural research, a basic objective should be to enlarge the supply of low-cost raw materials within existing land constraints. Research should be undertaken to identify and test possible alter native raw materials for alcohol production (e.g., nipah palm, sweet sorghum, cellulosic materials).

1/ These guidelines range from US$125/ltr for annexed distilleries of 120,000 ltr/day capacity to US$237/ltr for smaller (30,000-60,000 ltr/day) autonomous distilleries. These figures can be compared with estimated costs in Brazil of about US$65/ltr for autonomous distilleries of 120,000 ltr/day capacity (October 1979 prices).

51. With some notable exceptions (e.g., parts of Mindanao), few under-utilized areas remain with soils and climate suitable for efficient production of sugarcane. Increasingly, any expansion of the sugarcane area for alcohol production will have to take place on less productive lands or at the expense of other crops. While the land constraint appears to be less binding in the case of sweet potatoes or cassava, there, too, it appears that additional biomass from alcohol must come increasingly from intensification of production on already cropped lands.

52. Average cane and sugar yields in the Philippines are relatively low by international standards and could be increased through stronger research and extension efforts. With a view toward increasing yields and intensifying land use, the technical and economic feasibility of expanding the area under irrigated cane should be examined. Through cane breeding and selection, it may be possible to develop "alcohol-oriented" planting materials with a high content of total fermentable carbohydrates, rather than varietal selection with a view toward sucrose purity and content. There is also a need to improve feeder roads within sugarcane mill districts to reduce increasingly important farm-to-mill transportation costs for cane.

53. Work is needed to develop cropping systems which integrate the production of food crops with energy crops for alcohol. Rotation cropping of legumes with energy crops might be developed to reduce requirements for nitrogenous fertilizers. Development of production systems based on smaller-scale distilleries (in the range of 20,000-40,000 ltr/day capacity) should be given greater emphasis to reflect the realities of land availability in the Philippines, and to minimize internal transport of gasoline and alcohol. Part of this development work should test the feasibility of smaller-scale plants based on new feedstocks and alternative production technologies, e.g., alcohol plants using fresh cassava/sweet potato roots or dried chips as feedstocks and fast-growing wood species for fuel. 1/

54. The island geography of the Philippines and the presence of numerous relatively isolated communities warrant efforts to decentralize supplies of liquid fuels. In addition to the emphasis on smaller-scale distilleries for production of anhydrous alcohol for alcogas production, the R&D effort should examine the merits of small distilleries (e.g., perhaps up to 10,000 ltr/day capacity) to produce hydrous alcohol for use in pure alcohol engines. With proper developmènt, it may be possible to build on existing small-scale distillation technology in the Philippines to produce a localized source of liquid fuel. With upgrading of small distilleries (or reprocessing of their output at a central distillery), a fuel grade (95.5%) hydrous alcohol might

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1/ One interesting possibility involves ipil-ipil (Leucaena leucocephala). Experiments in the Philippines indicate that ipil-ipil can be planted in association with maize with beneficial effect. As the ipil-ipil matures, it fixes nitrogen in the soil, producing a significant increase in maize yields. It also provides fuelwood, and its leaves are a valued source of protein and vitamin A for animal feed.

be produced for alcohol-burning engines which could be used in several common applications in rural areas. 1/

55. In summary, all of these considerations suggest in mid-1980 that some reformulation of the national alcohol program is required. Production targets, in the early years at least, should be scaled down sharply. Appro-R&D should be given more emphasis with a view to reducing raw material costs, diversifying feedstocks and intensifying land use. Pilot plant operations should be an important part of the program's R&D work in the next several years. On the industrial side, greater emphasis should be accorded to smaller-scale distilleries, annexed to existing sugar mills wherever possible to minimize capital costs and enhance operating flexibility (i.e., permitting the production of either alcohol or sugar, depending on relative prices and national objectives). Consideration should be given to including in the national program hydrous alcohol production for use in situations where availability and costs of raw materials and expenses in transporting other liquid fuels makes this option attractive. By the spring of 1981, PNAC appeared to be moving toward many of these same conclusions.

56. The success of the national alcohol program will depend in large measure on the degree of support provided by the sugar industry. Industry participation and interest at present is limited, partly because of attractive alternative markets available for sugar. To ensure future support, there is need to bring cane growers and millers more fully into the design of the program. Indeed, if carefully integrated in terms of both cane production and processing, with emphasis on facilities to permit production of either sugar or alcohol, the national alcohol program could contribute to the market stability which the Philippines sugar industry has frequently lacked.

1/ A Japanese manufacturer recently developed for commercial use small (125 cc displacement; 5 and 10 hp stationary models) engines capable of using hydrous alcohol of 95.5% purity. These engines, available in the Philippines, have been mounted on motorcycles, pedestrian power tillers and 3 kw portable electric generators. They could be adapted easily to power the commonly used motorized trishaw, small outboard boats, irrigation pumps, etc. The major constraint to their use in the Philippines appears to be lack of a regular supply of properly graded fuel.

ANNEX 2

THE COAL SECTOR

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The Coal Sector

1. THE COAL REGIONS

1.01 The coal regions of the Philippines (see map) lie in widely dispersed, small, narrow, structural, depositional basins throughout the Islands, typical of the archipelagic conditions which appear to have characterized the Philippines from Eocene to Recent geological times, when the Middle and Upper Tertiary coal-bearing sediments were deposited under varied conditions. The coals are contained in strata which range in age from Eocene through late Miocene to early Pliocene (57 million years to 7 million years) and are much younger than the coal deposits of the Eastern United States, Eastern Canada, and Western Europe. Because the Philippine coals were deposited along the margin of an unstable shelf, the strata have been folded and faulted, and the shapes and positions of the basins have changed many times during geological time. As a result, the type, texture and composition of the coal-bearing sedimentary rocks vary greatly both laterally and vertically within relatively short distances. As might be expected, the coal beds themselves show similar variability and are nonpersistent, both as to thickness and lateral extent. Through the influence of such agencies as vulcanism, folding and faulting, the coal rank /1 is also more variable than that of coal beds in many other parts of the world. The coals range in rank from high volatile sub-bituminous to lignitic, with some local areas of heat modification to semi-anthracite.

1.02 The regions are described in various published and unpublished reports of Philippine agencies and the Philippine Bureau of Mines. An incomplete list of the Special Project Series on coal is appended (Appendix 1). The last of these documents was published in 1957, since which time no further official publications have been made. There are no comprehensive, up-to-date geological maps for the coal regions showing seam outcrops, provings, shafts, boreholes and test pits, etc., similar to those published in the USA and Europe.

1.03 While the Bureau of Mines still deals with all minerals other than coal under the aegis of the Ministry of Natural Resources, Presidential Decree No. 972 - the Coal Development Act of 1976 gave to the Bureau of Energy Development in the Ministry of Energy the responsibility for collecting, storing, and publishing all geological data and mining statistics relating to coal. Because of the age of the Philippines Geological Survey Reports, and previous conflicting reports which had been received from the Japanese and UNDP with regard to the scale of coal resources, in 1977 the BED took up

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/1 An international classification system ranks coals according to the increasing alteration of their original vegetable matter, increasing carbon content, and increasing fuel value.

an offer by Robertson Research International (a British Geology consultancy) to consolidate all the available information on coal resources. The result was published by that firm in a report dated October 1977, entitled The Philippines: An Evaluation of Coal Resources (Volume 1 "Report" and Volume 2 "Atlas"). Copies of this report are available from the BED (Robertson Research) at $12,500 per copy, a price intended to recover the cost of the study. Not surprisingly, parties interested in coal exploration and exploitation have been somewhat reluctant to purchase copies of this report at this price level. The absence of a firm data base of relatively up-to-date geological maps for each of the coal regions is a major inhibiting factor in evaluating the coal resource potential on a national scale.

1.04 Relatively little detailed geological mapping and investigatory field work has been undertaken in many parts of the Philippines, so that such maps as are available with various publications will necessarily be subject to substantial revision in the future as more data become available.

1.05 The previous geological publications of government agencies have all been preoccupied with discussions about coal resources, as well as with mining which might be carried out relative to different postulated groundwater levels. As discussed later, estimates of measured and economically workable coal reserves (the "bottom line" in reserve estimations) should be made with reference to defined coal mining systems or mining methods; similarly, acceptable groundwater levels can only be defined in the context of present-day pumping equipment intended to be used with a given mining method.

1.06 Because of difficulties in establishing overall meaningful correlation between the regions, the coal occurrences have been grouped together on a regional basis rather than on the basis of their age, rank and structure. Thus deposits which are linked by a common geological history in a given region are discussed together. On the basis of presently available geological information, the nine coal regions defined by the BED can be described as follows (see map):

(a) The Cagayan Region in Northeastern Luzon, contains soft and friable Miocene to Upper Pliocene sedimentary sequences with alluvium forming the uppermost coal overburden. The total thickness of the coal-bearing deposits has not been proved to date, but two seams, average 1 m in thickness, which reach up to more than 2 m respectively towards the center of the basin, occur within a depth of 7 to 10 m from the surface. The seams are relatively flat, or with a very gentle dip, and have been found at various elevations from 39 to 75 m above sea level. They have been proved by extensive test pitting over a considerable area in the Isabela Area of the Region. The seams are lignitic in character, on the boundary of the sub-bituminous C, with BTU ratings averaging from 8,200 to 8,700 as dug, moister contents of the order of 11 to 34% on an undried basis, and with ash contents in the range of 4 to 13%. The topography is of flat lands with gently rolling hills;

(b) The Polillo Island-Batan-Catanduanes Coal Region contains a thick sequence of deep-water marine shales and volcanics. Coal-forming environments are restricted to the base of this sequence around the eastern and southern margins of the basin in Batan Island, Masbate and Samar. In the early Miocene, there are several seams of coal ranging in rank from lignitic to bituminous high-volatile C, with reports that some have coking properties. The structure is complex, with strata dips ranging from 3° to 45°. On Batan Island, Albay, more than 22 coal beds were recognized, 20 of which outcrop in the western part of the Island. Proximate analyses of 'as received' samples give moisture content of 6% to 23%, volatile matter 30% to 50%, fixed carbon 44% to 53%, ash 3% to 16%, and heating values from 8,700 to 1,300 BTU per lb;

(c) The Samar-Leyte Coal Region was formed in environments which occurred in the Oligocene and Lower Miocene, and coal seams have been reported from oil wells drilled in the Middle and Upper Miocene sediments. Exploration work currently being carried out by Marinduque Mining and Industrial Corporation have identified two potential coal areas within the Region, the one at Giporlis with steeply dipping (up to 45°) seams up to 6 m in thickness, of sub-bituminous coal, and a flat, gently undulating deposit in the Bagasa area with relatively high sulphur content (5%). These explorations are proceeding;

(d) The Surigao Coal Region and the Southern Agusan-Davao Basin contains Lower Miocene coal-bearing sediments, which are most clearly defined on the eastern margins of the basin, including the coal-bearing areas of Gigaguit, Bislig, and other deposits in the eastern Surigao Del Sur and Davao Oriental. Coal seams up to 2.5 m in thickness are reported, and the coals in the region are said to be comparable in rank to the Polillo Island-Batan-Catanduanes coals;

(e) The Zamboanga Del Sur Region of Western Mindanao contains widespread coal-bearing horizons in the Lower Miocene which were subsequently covered over large areas by later Miocene and Pliocene volcanics. This widespread igneous activity, with its associated relatively high local heat flows, has metamorphosed the coals to bituminous and anthracitic in some localities. Exploration work in this area has been carried out on behalf of UNDP in the Lumbog-Duplahan Area during the period 1966-70, and it is reported that coking, thermal, semi-anthracite and blending coals have been proved;

(f) The Cebu Coal Region, which is the most extensively mined of the coal regions to date, contains coals in Oligocene and Lower Miocene sediments. Because of the degree of underground mining which is being carried out, the Region has been divided by the BED into North, Central and Southern Sections. Northern Cebu appears to have the simplest geological structure, although much faulted, while Central Cebu is characterized by steep strata inclinations, seam washouts, seam thickening and thinning. These characteristics have led to severe disappointment at what was to have been a model new PNOC mine at Uling. The southern part, in the Argao-Delaquete area, is characterized by some very steep strata dips, up to 70° from the horizontal, with much faulting. There are at least 7 principal coal seams, varying in thickness from 1 m to 5 m. Coal quality is relatively good, and the seams are probably the highest grades of the sub-bituminous coals in the Islands. Typical "as received" analyses are 7% moisture, about 50% volatile matter, 8% fixed carbon, 9% ash, sulphur less than 1%, and 9,000 to 12,000 BTU/lb calorific value. There is a report that some of these coals are suitable for making coke chars;

(g) The Negros Coal Region contains coal beds of Middle and Late Miocene Age. The strata are faulted with steep dips up to 30°-50° from the horizontal. The coals are usually sub-bituminous A rank. In the north of the region, where some underground mining has been carried out, dry mineral matter free analyses are reported as typically 51% volatile matter, 49% fixed carbon, sulphur 1.3%, and heating values up to 12,600 BTU per lb;

(h) The Semirara Region is underlain wholly by sedimentary rocks of Tertiary and Quarternary Age, and the former contains some 23 coal seams, some of which are up to 3 m or so in thickness. The seams dip to the southwest some 15°-25° from the horizontal and the coals are of sub-bituminous C rank. Recent (1979) explorations by Vulcan Industrial and Mining Corporation in the Unong Area in the south of Semirara Island gave the following typical analyses for run of mine sub-bituminous coal: ash up to 10%, moisture about 20%, fixed carbon about 35%, volatile matter about 45%, sulphur less than 1%; and

(i) The Southern Mindoro Coal Region is a northwestward continuation of the Semirara formations. Drilling explorations in the Bulalacao area on the southern part of the area has shown 6 coal seams with a maximum thickness of 3 m. It is thought that coal quality is similar to that in the Semirara Region. Explorations in the south of the region are still continuing.

2. THE PRESENT COAL MINING INDUSTRY

2.01 While the first recorded discovery of coal in the Philippines was in Cebu Island in 1827, first production was derived from an open-pit operation in 1842 in Batan Island. There are records of intermittent production from shallow underground mines and crude open cuts producing nominal amounts in Cebu, Mindoro and Negros up to the end of the nineteenth century. In the early 1900s, the US Army carried out some more formalized underground "room and pillar" mining on Batan Isalnd, and the East Batan Coal Company was producing some 20,000 to 30,000 tons per annum by 1911. Following a period of inactivity during the war years from 1911 to 1916, the Philippine Coal Company renewed working on Batan Island, and produced at the rate of 300 to 500 tons per day in 1921 which is still the established record for daily production from any single mine in the country. From 1921 to 1940, average annual production totalled under 100,000 tons; 150,000 tons were produced in 1941. There was no production from 1941 until 1946, when some 48,000 tons were produced. Output rose steadily to about 191,000 tons in 1956, 163,000 tons in 1963, and then declined to 39,000 tons in 1973. Following the escalation of oil prices after 1974, coal output in the following years was:

1975	105,000 tons
1976	122,000 tons
1977	284,000 tons
1978	255,000 tons
1979	263,000 tons

The Bureau of Mines statistics show that in 1978, coal imports amounted to 21,590 tons (10,000 tons from the US, 11,000 tons from Australia, and very small nominal amounts of special coals from Europe, China and Japan). Total coal consumption for that year amounted to some 277,000 tons.

2.02 The coal producing industry is small, highly fragmented, and widespread, with 33 operators producing the 263,000-ton 1979 production from 36 small underground mines, and one trial open-pit mine. These figures give an average output per operator of under 8,000 tons per annum or about 26 tons per day per 300 working days/year. The 1979 output came from the following localities:

		'000 metric tons	% of total
Cebu Island	(32 mines)	212	81
Batan Island	(1 mine)	19	7
Semirara Island	(1 mine)	5	2
Quezon	(1 mine)	13	5
Zamboanga Del Sur	(2 mines)	14	5
Total		263	100

Details of the 1979 output are set out in Table 1.

Table 1: OVERALL COAL PRODUCTION, 1979 (After Bureau of Mines)

Location and mine	Tons
Cebu Island	
Cebu Coal Mines	15,137
Filipinas Carbon and Mining	12,278
D.G. Sanchez Coal Mines	3,036
New Frontier Mines	707
J.L.B. Coal Mines	173
Argonix	2,804
PNOC-EDC	13,657
Bacaltos Coal	598
Cebu Alpace	2,137
Filipinas Carbon and Mining	24,434
Jeston Mining	4,272
Luvimin Cebu Mining	21,705
Manguerra Mining and Development	7,545
J.D. Almendras Agro Industrial	13,214
Cebu Agro Industrial Corporation	1,363
Deo Drano	11,639
Don Durano	22,565
M. Durano	9,492
J. Elizabeth	23,154
I'l Rey'c Coal Mining	4,405
A. Intengan	3,817
Magallanes Mining and Development	700
J.D. Mining (Fortune Exploration)	112
O. Pua	498
Manto Agro Industrial	5,781
Providence Mining	1,701
Asnar Mining and Development Corporation	618
R. Kintanar	360
Durano-Rodriguez	2,574
PCR	1,189
R. Ibanez	194
Emmanuel Mendez	164
Total Cebu Island	212,023
Batan Island Albay	
J.J. Mining and Development Corporation	19,050
Semirara Island, Antique	
Vulcan Industrial Mining	5,250
Polillo Island, Quezon	
Pilipino Cathay Mining Corporation	13,018
Zamboanga Del Sur	
PNOC-EDC	8,023
II-MDC	5,768
Total Zamboanga Del Sur	13,791
GRAND TOTAL	263,132

2.03 The mining methods are very primitive by western standards. All coal is dug by hand, using pneumatic picks in the larger mines. The main underground transport system is by wheelbarrows, with low capacity electric or motor car engine hoists in the shafts and adits. The industry is at a stage where operators are being phased out of so-called "camote" mining to more systematic, though still labor-intensive, methods. "Camote" or "gopher" mining along individual seam outcrops has been described "as though digging for sweet potatoes" in which the mine workings, because of the limited financial resources of the operators and the crude methods employed, are rarely developed to depths of more than 30 m or so from the surface. The more systematic mining underground is by a primitive room and pillar system from inclined access shafts and adits, up to maximum depths of some 200 to 300 m from the surface. Except for the current nominal output from trial open-pit mining by Vulcan on Semirara Island, all of the present output is mined by underground methods.

2.04 All holders of coal-operating contracts and special operating permits under Presidential Decrees 972 and 1174 are required to operate in accordance with Safety Rules and Regulations published by the Ministry of Energy, the latest of which are dated January 1978. These rules and regulations appear to be based largely on North American standards, and it is clear that if they were strictly policed and enforced, then the greater part of the operations would have to shut down. It would require a number of years and substantial expenditure to bring all present operations into general conformity with these safety standards. Although there are no industry-wide statistics, the accident rate appears, by western standards, to be relatively high.

2.05 Today, the largest mine units produce about 20,000 tons a year. The smallest "camote" units only produce a few tons a day. "Camote" operations, which are not registered with the BED in accordance with the Presidential Decrees No. 972 and 1174 (The Coal Development Acts) are illegal, and are being gradually closed down.

2.06 Because of the paucity of statistical records, particularly with regard to "camote" mining, which probably accounts for 25% to 30% of the current output, there are no precise figures available for manpower employed. The BED considers, however, that the current output per manshift (OMS) is somewhat less than 0.25 ton. Assuming a 300-day working year, this gives about 75 tons per man-year (OMY). If this is applied to the 1979 output of 263,000 tons, the number employed would be of the order of 3,500. If the working year is considered at about 250 working days, then, at 0.25 ton OMS, the OMY would be about 60 tons, which would give a presently employed manpower figure of about 4,400. This gives an estimated current labor force of between 3,500 and 4,400.

2.07 Coal ownership is vested in the State in accordance with Presidential Decrees No. 972 and 1174, which also provide for occupation of surface lands and compensation to disturbed landowners. Coal operators carry out exploration and production activities under a service contract system similar to that which govern oil and gas, and geothermal activities. In coal, exploration blocks of 1,000 ha are granted to applicants, who must post a bond of ₱ 1 million (US$133,000) guaranteeing that they will spend this amount on exploration work each year. Under a production contract, operators are allowed to charge off up to 90% of revenues as production costs; the remaining 10% is split with the Government on a 80/20, 70/30, or 60/40 basis depending on the legal classification of the company. All other mining in the country (i.e. base and precious metal mining) is operated under a leasehold and production-royalty basis, an arrangement most operators would prefer since their front-end costs would be less and their share of profits much larger in good years. Nevertheless, the service contract system does not seem to have dissuaded many companies from entering the industry. We, therefore, see no reason to urge the Government to revert to the earlier leasehold and tonnage-royalty system.

2.08 Present and projected coal mining operations fall under the jurisdiction of the BED, headquartered at the Energy Center, Fort Bonifacio, Metro Manila. The BED is the production-stimulating and regulating unit of the Ministry of Energy. The mine owners and operators are organized in a (relatively new) trade organization called the Philippines Chamber of Coal Producers Inc. (PCCP) whose headquarters are in Manila; there is a branch on Cebu Island, the main coal producing center. An earlier Cebu-based coal-owners' association is being merged into PCCP.

2.09 The current coal output is generally sub-bituminous, and in terms of heating value can be classified in the low to medium range, i.e. between 8,000 to 11,000 BTU per pound. These coals are suitable for steam raising, power generation, and cement manufacture. The latter requires that quality be maintained within ranges of required specification. A list of overall coal utilization for the year 1979 is shown in Table 2. This suggests an apparent overproduction against utilization for the year 1979 of about 25,000 tons. From the mines, the output is either delivered directly to the producer by trucks, or is transported in 500- to 1,000-ton capacity barges by sea throughout the islands, and thence finally delivered by truck. None of the roads from the mine sites to the main highways are paved; some of the main highways themselves are not well surfaced. In some regions, particularly South Cebu Island, the mine access roads are in very bad condition, so that in the wet season (July-November), road transport is virtually at a standstill. Any significant increase in road-borne coal transport to and from the mines, or indeed of other heavy materials, such as cement, or mining timber supplies, will be substantially inhibited unless attention is given to the road system in the coal-mining areas.

Table 2: OVERALL COAL UTILIZATION, 1979

Location	Tons
Power Plants	
Atlas Construction Mining	39,904
Ludo Y Luym Corporation	5,898
Unicemco	16,385
Visayan Electric Company	32,983
Biophil	11,977
Total Power Plants	107,147
Cement Plants	
Apocemco	17,316
Bacnotan Construction Industry	11,551
Pacemco	32,350
Unicemco	64,515
Total Cement Plants	125,732
Sugar Mills	
Victoria Sugar Mills	216
Metallurgical	
Maria Cristina Chemical Industry	4,490
GRAND TOTAL	237,585

2.10 The Government has not traditionally regulated coal prices, which have therefore been geared to local production costs. For at least the last few years, the industry has been only marginally profitable and has experienced cash shortages that have made it difficult to finance expansion or modernization. With the quickening of interest in greater coal use, and the possibility of Australian coal imports being needed to supplement domestic output, prices of domestic producers began to move upwards in early 1980. The movement did not carry domestic producers' prices anywhere near the c.i.f. price of Australian coal which, although still not yet being imported, were becoming a reference price for domestic contracts. By September 1981 the year-old National Coal Authority (NCA) had decided that it would in fact establish minimum and maximum prices for both domestic and imported coal; however, no such prices had yet been set, a delicate process that obviously involves balancing off competing interests.

The Government has also now decided that NCA shall be the sole importer of coal, with domestic customers purchasing such coal from NCA. The Trade in domestic coal is to remain free, however, with private buyers and sellers free to negotiate their own contracts subject only to the floor and ceiling prices established by NCA.

2.11 A key factor in delivering imported coal to the Philippines is the lack of modern unloading facilities for large ships. It could take several weeks to unload a 20,000-ton ship, adding greatly to costs. The domestic interisland coal trade is based entirely on barge transport of 600-1,200 tons, which can be loaded or unloaded with simple equipment and can be used at the characteristic shallow-draft docks.

2.12 Domestic coal prices were being offered at ₱ 230 a ton f.o.b. South Cebu wharves in early 1979. By December, the price had risen to ₱ 260; by mid-spring 1980 the industry price leader had persuaded its large customers to accept a price of ₱ 350 per ton (10,000 BTUs). This is US$46; it compares with Australian coal of 13,500 BTUs (20% ash) at US$55, spot sales, in minimum shipment lots of 30,000 tons. Other Cebu producers were offering at prices about 10% under the industry leader, reflecting in part the lower reliability of their supplies.

3. THE MINISTRY OF ENERGY'S TEN-YEAR PROGRAM FOR COAL (1980-89)

3.01 Based on a targeted demand related to future requirements of present coal users in cement and industrial plants, expected new coal-fired power stations of the National Power Corporation (NPC), and government-encouraged conversion to coal firing in all presently oil-fired cement plants, the Ministry of Energy's ten-year program of January 1980 has a targeted coal production of 6.0 million tons by 1989. This would involve a 22 times increase on the 1979 production of 0.263 million tons.

3.02 Although the Philippine Bureau of Mines' special coal project reports (listed in Appendix 1) have discussed coal reserves and resources on the basis of the US Bureau of Mines definition of "Measured Reserves," "Indicated Reserves," and "Inferred Reserves," the BED have adopted a somewhat different, and in our view less satisfactory, approach and definition, i.e.

"... PROVEN — Sufficiently explored by drilling and tunneling to be included in first- and fifth-year development/production programs.

INDICATED OR PROBABLE	Reasonably explored by drilling and tunneling, but cannot be included in first- to fifth-year development/production program because additional exploration work still has to be done. Projected to be mined from sixth to tenth years.
POTENTIAL	Established by Robertson Research International unless otherwise specified. Based only on outcrops, limited drilling, and tunneling work done, and largely on geological hypothesis. Still has to be proven by detailed exploration ..."

3.03 The BED recognizes the importance of proper coal reserve and resource definitions for both political and production planning purposes, and are working on a standardization publication in conjunction with the Philippine Bureau of Standards. Nevertheless, while the targeted production of 6 million tons per annum by 1989 is related to a "Proven" reserve of 600 million tons which would have to be generated by that date (i.e. an output/reserve factor of 100), there still exists some lack of clarity in relation to both existing and future "Proven" or "Measured" reserves in relation to what can be both physically and economically exploited within the framework of the present mining technology and the country's economic outlook. Total measured (or proven) _in situ_ coal reserves must be directly related to the methods of mining, so that quoted _in situ_ geologic reserves will have, therefore, to be discounted accordingly so as to obtain a figure for measured reserves _which can be economically exploited_. The essential aim for US, European and Australian coal reserve assessment standards is that the density of observation points should be such as to enable the continuity of a coal seam or coal seams to be traced between any two adjacent observations so that any change in coal thickness and quality between such points can _satisfactorily be assumed to be linear_. Thus, it is clear that the more geologically complex and disturbed coal fields, such as those of the Philippines, the closer together must be the observation points in order to generate satisfactory confidence levels in measured reserves. The coal industry's PCCP takes a somewhat more conservative view of the existing "Positive" coal reserves, in relation to the Ministry of Energy's 1979 figure of 150 million "proven" tons; these lower figures probably represent a more realistic appreciation of the current _economically workable_ reserves as at December 1979 (Table 3).

3.04 The targeted coal production increase from 0.263 million tons in 1979 to 6 million tons in 1989 is based on expected demand, with little regard to supply capability. Demand is concentrated in three new coal-fired power stations, the conversion of 14 cement plants from coal to oil firing, as well as the conversion of some other industries to coal firing. The BED figures for targeted conversion for electrical power generation are shown in Table 4.

Table 3: ESTIMATED "POSITIVE" RESERVES (AFTER PCCP)
(As at December 1979)

Location	Positive reserves (BED definition)	Probable reserves (BED definition)	Potential resources /b (After R.R.I)
	(million tons)		
Albay	2.5	1.1	25
Semirara /a	36.3	40.0	100
Catanduanes	-	-	50
Cebu	3.7	3.7	110 to 160
Cagayan	0.5	50.0	300
Leyte	-	-	-
Samar	-	6.0	-
Masbate	-	-	-
Mindoro Oriental	-	-	100
Misamis Oriental	-	-	100+
Negros	-	-	50
Quezon	0.2	0.3	3
Sorsogon	-	-	-
Surigao del Norte	0.8	-	20
Surigao del Sur	-	-	50
Zamboanga del Sur	12.6	2.3	45 to 60
Total	56.6	103.4	953 to 1,018+

/a Since estimated by Vulcan at 30 million tons.
/b Probably *in situ* geologic resources.

Table 4: TARGETED COAL-FIRED ELECTRICAL GENERATING CAPACITY BY REGIONS

Region	1979		1984		1989	
	MW	Coal requirement ('000 tons)	MW	Coal requirement ('000 tons)	MW	Coal requirement ('000 tons)
Luzon	-	-	300	820	600	1,700
Visayas	25	68	185	510	350	960
Mindanao	-	-	60	170	210	580
Total	25	68	545	1,500	1,160	3,240

3.05 The total existing (1979) installed cement production capacity is about 7.1 million tons per year (ADB statistics). Government policy is to convert the present oil-fired plants to coal firing in three phases over a five-year period by the mid-1980s:

Phase 1 - Mindanao Portland
Iligan Cement
Floro Cement
Northern Cement

Phase 2 - Midland Cement
Istand Cement
Filipinas Cement
Rigar Cement
Bacnotan Cement

Phase 3 - Continental Cement
Republic Cement
Hi-Cement
Central Cement
Future Cement

The program is not yet under way because the cement industry does not appear to be comfortable with the arrangements being talked about by the Ministry of Energy with regard to coal contract pricing, the reliability of coal supplies, and the financing necessary to carry out the conversions and other reconstruction/rehabilitation works in the plants. The first major wave of cement-plant conversions is now scheduled to occur in the first half of 1982. When, and if, the conversion program is completed and the installed production capacity of 7.1 million tons is achieved, estimated peak annual coal consumption would be 1.82 million tons.

3.06 On the foregoing targets, the 1989 coal consumption in these key industries would be:

Coal-fired generation stations	3.24 million tons
Cement manufacture	1.82 million tons
Total	5.06 million tons

New cement plants, plus conversions and new plants in other industries, would bring total 1989 coal demand to 6.0 million tons, in MOE target-setting. In our judgment, coal demand is unlikely to reach this figure by 1989, although it can stand as a (very ambitious) target. A more important comment, however, is that the 1989 production target should be based not on the demand outlook but on the coal industry's ability to expand production. The remainder of this annex is concerned with that problem.

4. PROSPECTS AND RECOMMENDATIONS FOR EXPANDING COAL OUTPUT

4.01 The relatively small, fragmented Philippine coal industry has hitherto responded to fluctuations in domestic market demand mainly by not operating its significant "camote" component. These production operations are easy to abandon and, if difficulties arise in their subsequent recovery when the market recovers, the operators simply leave them and move to another location along the coal outcrops. That picture is, however, now changing with the realization that the coal industry might play a significant role in reducing the country's dependence on imported oil and oil products, and in relieving the balance of payments. If, however, the industry is to move into deeper, more systematized, but still labor-intensive, mining, it will not be so easily able to respond to falls in market demand, so that, as necessary, adequate provisions must be made for handling, distributing, and stocking coal output./1

4.02 Because of the previous lack of financial incentives and market outlets for larger-scale mining, and because of the relatively high front-end geological exploration and related costs necessary to evaluate new prospects in difficult geological settings, all existing mining operations are small-scale, the largest having a capacity of about 200 tons per day (60,000 tons per year). The scale of these workings has been small to date, partly because of the disturbed, faulted and folded geology of the coal deposits. Indeed, all the presently available geological evidence suggests that there is little, if any, likelihood of any new underground coal mine with sufficient measured reserves and an appropriate geologic setting to support a mine with an annual output of more than about 240,000 tons (the projected size of PNOC's new Malangas mine), let alone 0.5 to 1 million tons, the size of a medium-size European mine. There are, nevertheless, two open-pit prospects (on Semirara Island and in Northern Luzon's Cagayan Valley) which might be able to produce annual outputs in the latter range, subject to further geological and engineering evaluation. These are discussed later.

4.03 The arrangements made for service contracts in Presidential Decrees Nos. 972 and 1174 (regarding the 1976 Coal Development Act) are still being considered by the coal industry, which is clearly bedevilled with cash-flow and financing problems. The industry would prefer some form of "ad valorem" or royalty basis similar to that hitherto used in the Philippines in the base metal mining industry. The industry recognizes, however, that the service

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/1 An Australian government-sponsored study of needed investment in coal-handling facilities (mainly ports, mixing plants, and ships) was conducted in the spring of 1980. The study, in which the Philippine cement industry was keenly interested, concentrated on facilities needed to handle an expected increase in coal imports.

contract arrangements are directed towards "bona fide" interested parties, and inhibits trading in areas of greater interest. However, all of the more immediately obvious coal exploration and exploitation options have been taken up, with some 35 contracts taken up by 33 operators, with 5 more in the current pipeline. Because the geological setting is unlikely, on present geological information, to sustain underground mining with an annual unit capacity capability beyond the range of 100,000 - 200,000 tons per annum, all of the likely underground mining prospects have been taken up by Philippine concerns, i.e. unlike oil, the coal industry is not attracting much foreign investment./1 Some exploration and reconnaissance contract arrangements have been entered into by foreign operators (e.g. Utah, Barnet and Hallamshire) who are more interested in identifying larger-scale open-pit prospects, with mining potential up to, say, 1 million tons per annum. The large, well-established Philippine base and precious metal mining companies have not moved vigorously into coal production, although some interest has begun to show itself. Benquett Consolidated were interested in a coal mine on Batan Island, but are said to have abandoned their interest because the output potential of 400/500 tons per day was too small for their requirements. Marinduque Mining, however, are prospecting for coal in Samar-Leyte; Atlas is exploring on Mindanao; Vulcan is developing the open-cast mine on Semirara; and CDCP, the largest construction firm in the country, has recently established a special department to evaluate possible coal mining investments.

4.04 As a matter of judgment, the general impression is that interest in coal exploration in the Philippines has plateaued off because of the lack of primary geological data, and relatively high costs of carrying out further large-scale reconnaissance and exploration work.

4.05 There appears to be a greater potential for rapid increases in production from medium- to large-scale open-pit mining (see later discussion) than from underground mining. However, the potential open-pit areas are not yet defined, and present difficulties in financing, communications, and transportation are inhibiting this work. As a matter of policy, therefore, the BED should consider what more it might do to increase reconnaissance geological surveying to define such areas, and what additional incentives might be offered to private firms to accelerate detailed exploration in existing contract areas.

4.06 Exploration and resource identification is inhibited by the absence of appropriately scaled (say 1:50,000 to 1:25,000) base geological/topographical maps. It is recommended that the Government prepare and publish maps

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/1 Some interest in joint ventures has been reported from two or three Korean and Taiwanese firms. Their interest is in exports, a subject on which Government policy has not yet been decided.

similar to those published by the Geological Surveys of North America and Europe, which should be produced as factual material without the subjective discussions on coal resources and groundwater commentaries contained in the ealier (up to 1950s) Geological Special Coal Project Reports published by the Bureau of Mines. Such maps can be devised from existing aerial photography coverage maps supplied with the earlier coal geology reports, augmented by the material and data available from more recent coal prospecting work which is contained in the libraries of the BED and the Bureau of Mines. In the time available to the Mission, it was not possible to fully explore the status of the existing geological data base, and how readily this could be transposed into a series of maps as outlined. It is thought, as a matter of judgment, that the preparation of appropriate base mapping would not take very long or be very costly. Such a program should be fully evaluated, because of its invaluable help to the existing coal industry, as well as in identifying coal resource potential. At the same time as such a map-publication evaluation is made, it is recommended that an appraisal should also be made of unexplored areas which might reveal other strip mining prospects, and for which no exploration service contracts have hitherto been considered. Decisions could then be made whether or not such areas are worth evaluating geologically on a reconnaissance basis, either by PNOC or private industry.

4.07 The target output projections of up to 6 million tons per annum by 1989 have been set too high, for a combination of reasons. Taking the 6 million tons per annum target as being equally split as between open-pit and deep mining potential, these can be considered both as to the general picture as well as to the particular mining system. As to the general, the targeted increase in measured (proven) reserves is not matched by any planned and costed actual overall field effort. The estimated financial requirement (Table 5) does not appear to make anything like sufficient provision for generation of new coal production capacity, let alone for exploration and engineering development work./1 In addition, the targeted manpower new hires per year would be unlikely to be adequate because productivity increases will almost surely be less than assumed. Any rapid expansion of the labor force would be difficult even if training facilities were available now (which they are not) to provide the necessary mine underofficials, electrical, mechanical and other engineers necessary in the lower grades of management.

Open-Pit Mining

4.08 With regard to open-pit mining, which could form the most rapid build-up of output, and which therefore should be regarded as a first priority, only two promising prospects - Semirara Island and the Cagayan Valley on Luzon - have been thus far identified. The initial appraisal of what were originally thought to be promising open-pit prospects in Surigao

/1 Investment figures per ton of annual capacity would run US$50-100 for strip mines and about twice that amount for underground mines.

appear now only likely to yield a total amount up to 70,000 tons at current economic stripping ratios. There appears, however, to be some initial promise in the Marinduque Mining prospecting in Samar-Leyte, but that exploration is still in the very early stages. It is, therefore, essential that the country-wide potential for open-pit mining should be evaluated as soon as possible, and it is recommended that a program to this end should be put in hand forthwith.

Table 5: TARGETED FINANCIAL REQUIREMENTS, 1980-89 ENERGY PROGRAM

Year	Foreign	Local	Total	Target output	Implied capital investment per ton of annual output
	---- (US$	million)	-----	('000 tons)	(US$ approx.)
1980	7.86	5.24	13.10	420	31
1981	9.42	6.27	15.69	1,320	12
1982	6.57	4.37	10.94	1,950	6
1983	8.52	5.68	14.20	2,430	6
1984	8.52	5.68	14.20	2,790	5
1985	8.52	5.68	14.20	3,300	4
1986	8.52	5.68	14.20	3,780	4
1987	8.52	5.68	14.20	4,200	3
1988	8.52	5.68	14.20	5,400	3
1989	8.52	5.68	14.20	6,000	2
Total	83.49	55.64	139.13	31,590	4.4

Source: Ministry of Energy.

4.09 The Vulcan Mining Corporation's open-pit proposals at Unong in the South of Semirara are reaching the final stages of engineering design. Boreholes on a 250 m grid, with a 75 m infill grid, have been used to develop so-called "measured mineable" reserves of 30 million tons. Groundwater drill-hole investigations are currently being carried out to evaluate what engineering steps would be necessary to deal with high-level groundwater (said to be potable) as the mine workings proceed. There is also need to establish the vitally important hydrogeological relationship between nonsaline groundwater and the nearby sea. Very preliminary indications are that, as a matter of judgment, there is either a physical/geological barrier between the relatively high-level fresh-water quality groundwater and the sea, or some regime balance which depends on the seasonal water table and the maintenance of the present geologic environment. Disturbance of such a barrier or balance by relatively deep open-pit mining, to a proposed depth of 150 m below sea level could have very significant implications on the technical and financial viability of the whole project.

4.10 The Austrian consultants to Vulcan - Austromineral (a subsidiary of State-owned Voest Alpine of Austria) submitted their feasibility study in 1980. Because of the overburden and interburden materials are said to be soft, with only three 1-m intermittent sandstones sufficiently well cemented to require blasting, they have recommended four bucket-wheel excavators; these are presently being designed in Austria. The mine is being planned for 1 million run-of-mine tons of coal and 6 million bank cubic meters of overburden/interburden per annum. This is equivalent to about 20,000 cu m of material a day for a 300-day working year, i.e. about 1,000 cu m per hour for 24 hours at a preliminary estimated stripping ratio of 6 to 1. The material is proposed to be conveyed out of pit via a 1.6 m side belt conveyor rated at 1,000 tons per hour capacity. Project plans provide for a 15 MW coal-fired power station for site power, with provision for an additional 35 MW if a suggested cement plant (in the plan) were to go ahead. An electrically operated belt system is proposed to convey the coal to a proposed new pier capable of handling ships of up to 20,000 tons.

4.11 Vulcan considers that the foreign exchange portion for common facilities for the Southern Unong coal project and a second open-pit mine, currently being explored, on the northern end of the island, could be $100 million, with some $70 million for the four bucket-wheel excavators, making a total of $170 million, i.e. about $170 per ton of annual output. It is estimated that the Panian prospect, subject to full geological exploration and evaluation, could add another $80 million, making the total foreign exchange component for the two open-pits $250 million.

4.12 Following submission of the feasibility study by Austromineral, and subject to the outcome of the hydrogeological studies, Vulcan hopes to complete arrangements for funding the proposals, and thence to move into the procurement and installation phase, and to commission the Unong open-pit by 1983. They then hope that the northern Panian pit would come on stream by 1985/86.

4.13 In addition to the, as yet, uncompleted engineering, hydrological and funding exercises, an important aspect of environmental impact remains to be considered. The present engineering proposals provide for dumping the 6 million tons of annual pit waste into the sea. Some field trials with land reclamation by spoil tipping (but not to the planned amounts) have already been carried out by the operators. While the landworks have been satisfactory, the sea has been discolored by a 300/400 m wide yellowish cloud of colloidal material which has not dispersed after some months. It appears that the larger grains of dumped material fall to the sea bed relatively quickly, but the finer fraction remains suspended as a colored colloidal solution. Should the open-pit become operational on the planned basis, the dumping of some 20,000 bank cu m of waste per day for a period of many years could have a very significant effect on the immediate seashore off the island; the Company is sensitive to the problem but it is not yet clear what long-term damage might be caused or what standards the Government will set.

4.14 In addition to the question of funding, no firm discussions have been entered into for marketing the Semirara output. Vulcan says that coal quality is such that the output could be shipped to the proposed power station at Batangas in Luzon, or the Marinduque Mining Corporation nickel refining operations on Surigao, to the cement industry, or could be blended with imported coal. Both Vulcan and Marinduque have some concern over MOE policy on coal pricing. They fear that if they enter into firm contractual commitments on favorable price terms, the Ministry might invoke clauses in the Constitution so as to disrupt the free bargaining position and "tax" or "take out" some of the price benefits. Some large firms (both producers and consumers of coal) complain that NCA /1 sometimes appears to want to act as a broker for all large contracts. This has bred uncertainty as to whether or not private buyers and sellers are free to negotiate their own contracts.

4.15 In the Isabela area of Cagayan, Northern Luzon, Isabela Coal and Energy Corporation of Manila (formerly Systems Consult Inc., a geological and mining consultancy) are in the advanced stages of exploring a fairly flat lignite to sub-bituminous C rank coal prospect which has been identified by test pitting, over some 1,300 ha. Two seams, each about 1 m or so thick, at depths under 10 m have been identified to date. The total depth of the deposit has not been explored, and a detailed core drilling program is required. The average heating value of the coal is 8,200 to 8,700 BTUs per lb. The total reserves necessary for a 300 MW coal-fired power plant are estimated at 40 million tons.

4.16 Isabela Coal are at a stage where they need funding and operational expertise to complete the exploration program and evalute the mining potential, so that discussions can be held with the National Power Corporation (NPC) with regard to siting and size of a power plant and related works. Although no firm arrangements have yet been made, Isabela Coal have entered into exploratory discussions with possible European partners, and it has been very provisionally estimated that the following overall mine costs (1979 estimates) might be involved in bringing an open-pit mine into production (no infrastructure).

/1 Established in November 1980 to take over from PNOC all responsibility for government coal procurement (foreign and domestic) and sales. In May 1981 it was not yet clear if NCA was to be an independent government corporation. A Coal Board, composed of senior government officials, has been appointed to guide NCA policy. Technical assistance is being received from the Australian management consultants who conducted the coal infrastructure study.

		US$ million
1.	Complete exploration works commenced by Isabela Coal	0.70
2.	Engineering feasibility studies of preferred mine siting with further exploration as necessary	1.60
3.	Mine development and equipment to 1.5 million tons per year	69.00
	Total	71.30

4.17 Whether or not this project is a viable proposition should, therefore, be evaluated as soon as possible, because it might be able to support a 300 MW mine-mouth power plant. The inland location makes it unlikely the deposit could be used for any other purpose in the foreseeable future.

4.18 The Marinduque Mining prospecting on Samar-Leyte has shown some initial promise. The Company has a possible intake of coal of the order of 6/700,000 tons per annum for electricity generation and ore roasting, provided the latter can be carried out satisfactorily with pulverized Philippines coal. The Company plan calls for three years or so of coal exploration on Samar-Leyte. If they do not discover by then a significant open-pit or underground mining prospect (they would prefer an open-pit) in the concession areas, they will reconsider the position and will probably seek to enter into short-term contracts with Australian coal suppliers who have told them that they can deliver at about $55 c.i.f.

4.19 The eastern Surigao explorations for open-pit mining have to date been disappointing, with only nominal amounts of strip mining potential (50,000 to 70,000 tons total).

4.20 Against this background, and in the light of the exploration and funding position, and subject to the engineering qualifications, it is likely that the country's open-pit mining output can be of the order of:

Year	Annual output (million tons)
1986	From 0.5 to 1.0
1989/90	$\pm$ 1.5

The likely "mine only" capital costs for such an open-pit output range are of the order of $105 to $150 million, i.e. $70 to $100 per ton of annual output.

Underground Mining

4.21 The BED target, as set out in the Ten-Year Energy Program, is to increase annual deep-mined output from 0.263 million tons in 1979 to 3 million tons by 1989. This target appears too high in the light of the many constraints and technical difficulties which exist. Output could be increased by:

(a) improving productivity and efficiency at existing production units,

(b) providing totally new production capacity, and

(c) a combination of (a) and (b).

4.22 Taking the industry's present (1980) manpower at an average of about 4,000 and the BED estimate of current OMS at 0.25 tons, the annual output would be doubled if the OMS were to be doubled to 0.5 tons, i.e. an annual output of about 526,000 tons. Further, to increase the annual deep-mined output with the existing manpower - which is not envisaged - to the targeted 3 million tons by 1989, would require an overall OMS of about 3 tons, i.e. beyond present European productivity standards, with fully mechanized mining. The BED targeted manpower does involve a total of new hires of 9,258 by the year 1989. However, the figures are not split between deep mining and open-pit mining, each of which must have a different productivity. If a notional 2,500 men are taken off the figure for strip mining, then for the sake of discussion only, the total deep-mine manpower figure by 1989 would be (9,258 - 2,500) + 4,000 = 10,758. If this figure is applied to a 3 million tons deep-mined 1989 target output, the resultant OMY is 280 tons (i.e. an OMS of about 1 ton). The BED recognize that these OMS and OMY productivity figures are likely to be too ambitious, and they accept that a deep-mine OMS of 0.75 tons would be a significant achievement in the ten-year period, but could be considered a realistic target. Because total output is a function of manpower and productivity, the question then arises what manpower and output figures are likely to be realistic, given a target OMS of 0.75 tons. The greater proportion of any deep-mine production increase would come from an expansion of existing capacity, mainly on Cebu Island. The smaller proportion would come from new deep mines, only one of which is identified in the ten-year target. On this basis, and assuming that all the coal would be handfilled, the most significant proportion of increase could be expected from improvements in underground haulage and hoisting capacity in shafts and adits. Because underground haulage would have to be operated under flameproof conditions for safety reasons, this would involve providing electricity to, or generating capacity at, the mine heads. It is generally accepted within the industry that, given the characteristic geology, an optimum average mine output of 300 tons per day can be achieved, using improved haulage and hoisting but essentially existing coal-face technology and existing mining methods (i.e. room-and pillar-working). It is our judgment, however, that the introduction of modified longwall mining methods would permit increased production at the coal-face that could be handled by the modest degree of haulage and hoisting improvements we believe feasible without major reconstructions or heavy investment. We therefore feel justified in using a target average daily production of 400 tons which, with our assumption of 300 working days a year, yields an annual output of 120,000 tons. Without an exhaustive survey of existing mine plant capacity and geological potential of output, which could be reasonably maintained over, say, a 5-10 year period, it is not possible to say which of the existing underground mines could justify and support, both financially and technically, reconstruction of surface and underground haulage facilities on these lines. Certainly the "camote" element of the existing production capacity could not. If the "camote" proportion is assumed to be about one third of the capacity, then some 22 mines could be considered for increasing production capacity by the installation of more adequate underground haulage facilities. The time-frame against which such work could be carried out would depend, inter alia, on:

(a) the provision of electrical power to, and generating capacity at, the mines, in conjunction with the supply of electrical and mechanical equipment;

(b) how the required skilled labor force would be acquired and trained;

(c) road transport facilities to and from the mines;

(d) what additional mine ventilation facilities would be required, including considerations of spontaneous combustions in deeper mine areas with higher rates of extraction;

(e) what additional mine surface facilities would be required;

(f) adequate supplies of mine roof supports; and

(g) strata control and mine water, etc.

4.23 It is probable that of the 22 mines considered against such a technical background, only about 10 existing mines could be considered as prospects for an optimum average output of 120,000 tons per year. Because of geological factors, the remainder would probably contribute only minor, if any, increases in production capacity. The production capacity scenario which emerges from this discussion is:

		Million metric tons per annum
1.	Existing production capacity which is likely to continue without "camote" mining, and without any substantial increase in production capacity, say	0.13
2.	Conjectured production capacity from new and reconstructed mines, say 10 @ 120,000 tons per annum	1.2
	Subtotal	1.33
3.	Deduct item 1 element worked out over 10 years	0.13 /1
	Net deep-mine production	1.2

4.24 If these reconstructions and new capacities could be completed by the mid/late-1980s with an overall OMS of 0.75 tons (212 OMY), then the overall manpower in the ten modernized mines would be about 5,600, i.e. an increase of about 1,600 on the present 4,000 figure, now distributed over the same 22 mines./1 If, however, the productivity can only be increased to 0.5 OMS, with a similar manpower, then the total deep-mined output would be 0.84 million tons. On this basis, the likely range of deep-mine output by the late-1980s would be between 0.8 and 1.2 million tons, say, 1.0 million tons.

4.25 There are major problems in achieving such an output increase in the industry, quite apart from those relating to funding. The major problems include temporary and permanent mining supports, road transport, and skilled manpower training. As to mining timber supports, there appears to be no clear current policy, as between the Ministry of Agriculture and the Ministry of Energy, as to an adequate supply of timber of appropriate specification for roof support and strata control. Indeed, some operators were having to

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/1 Obviously one can make many different assumptions about how many small "unreconstructed" mines may exist in 1989. Their total employment and output would be unimportant in the industry totals.

resort to what are said to be illicit arrangements with timber suppliers for pit props, while others were using coco-palm with an effective pit life of less than 3 months. If the BED safety regulations are to be enforced, and if internationally-accepted mine support safety standards are applied, so as to minimize serious loss of life and limb, it is essential that a proper policy on the use of selected wood for pit props be devised and implemented.

4.26 As to road transport, similarly, a policy needs to be devised as between the Ministry of Energy and the Ministry of Transport as to the provision and maintenance of adequate access roads to and from the mine sites, particularly in such locations as South Cebu, where the maintenance of existing coal output, let alone any increase, is out of the question unless access roads can be improved.

4.27 There are no arrangements for training skilled technicians and underofficials to man any substantial increase in output. The industry fully recognizes this problem, and discussions are proceeding with regard to the formation of a mining school. The establishment of an appropriate facility would, however, be likely to take some years.

4.28 Subject to the overriding questions of mine roof supports, transport, coal distribution, specialized manpower training, and finance, it is very approximately estimated that the cost of deep-mine reconstruction to produce a deep-mine output increase to 1 million tons per annum from the current level of 0.262 million tons, would be of the order of $100 million. To this must be added the cost of further exploration, more surface access roads, etc., and other mine-related ancillary items which would probably add another $50 million. These figures give a total "mine only" (including access roads) cost of $150 million. This works out at a cost of around $150 per ton ($150 million divided by a 1 million ton increase in output).

Summary

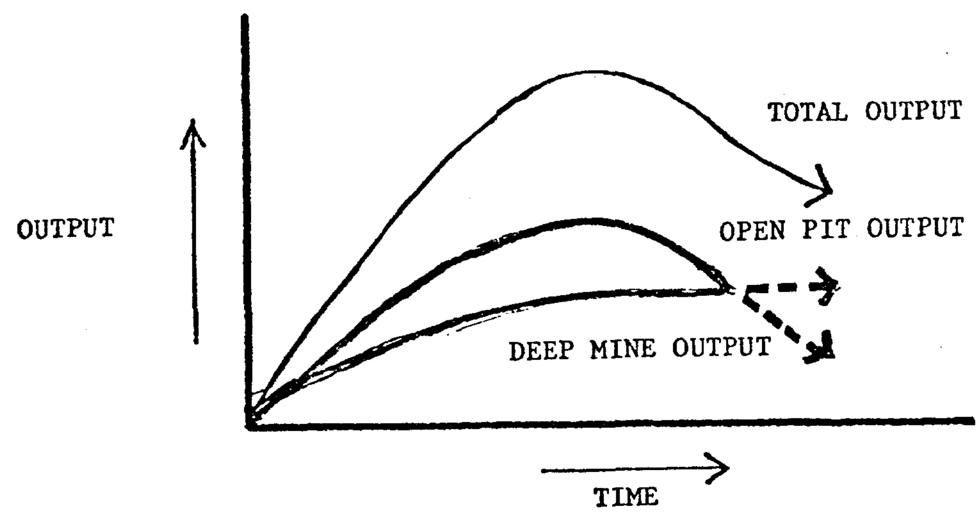
4.29 The picture that emerges with regard to increasing domestic coal production by the mid- to late-1980s, subject to the major constraints discussed, is:

Year	Open-pit mining	Underground mining	Total
	(Million tons per annum)		
1980	-	0.26	0.26
1985	0.5 to 1.0	0.4 to 0.5	0.9 to 1.4
1989	1.5	1.0	(±) 2.5 /1

/1 Events since these estimates were made now seem to justify a somewhat more optimistic projection. The Bank now feels a range of 2.5 to 3.5 mn. tons is reasonable.

The "pit only" (i.e. without infrastructure) open-pit mining set-up costs are likely to be of the order of $105 to $150 million. The "mine only" (i.e. without infrastructure) deep-mine investment costs are likely to be of the order of $150 million, for a total "mine only" cost of $255-300 million.

4.30 Build-up of significant output contribution is likely to be much faster from open-pit prospects than underground mines, as conceptually illustrated in the following diagram.



4.31 It is, therefore, necessary to maximize open-pit potential; to this end, it is recommended that reconnaissance field mapping should be speeded up. It is unlikely that the brunt of this work will be carried by the private sector, although the existing work being done should be fully coordinated.

4.32 Associated with this work should be the preparation of base geological information maps, which could then be readily available to the industry from BED at nominal cost, so that there would be a common, publicly available, low-cost data base, as in North America and Europe.

4.33 The main thrust of output increases from underground mining has to come from reconstruction work on underground haulage and surface hoisting facilities at selected mines. In conjunction with the identification of these prospects, urgent attention would be required on skilled manpower training, timber roof supports, and surfaced (i.e., year-round) road transport to and from the mines.

4.34 The consequent underground mine output increases will be considerably slower than from open-pit strip mining. However, the latter will decline in the mid and long terms if replacement open-pit capacity cannot be identified and brought into commission. On today's geological data, the potential for long-run open-cast mining looks highly questionable.

4.35 Mining production costs from both open-pit and deep-mining are likely to be such that c.i.f. costs per ton of domestically-produced coal will be marginally less than c.i.f. costs of equivalent Australian coals. The Australian Embassy trade representatives make the points that if Philippines domestic coal production is likely to remain below domestic demand in the short and mid terms, they suggest that both PNOC and NPC should plan early contracts abroad for coal imports so that they will not be priced into the much more expensive "spot" market when commitments have to be met suddenly. The Australians are fearful that trade relations problems will arise if relatively large "spot" coal sales are required at short notice. They consider that should Philippine coal imports turn out to be lower than prudent long-term contracts provide, surplus needs should be readily saleable in other countries in the Region. By mid-1981, the Government had acted on this advice and signed an initial long-term (15-year) contract.

PHILIPPINES

ENERGY SECTOR SURVEY

The Philippines Coal Regions Special Project Series (SPS) Geological Maps and Memoirs

SPS No. 1 (COAL) - Geology and coal resources of the Bulalacao region, Mindoro Oriental, by Jose Vergara, Philippine Bureau of Mines, 1955 (printed).

SPS No. 2 (COAL) - Geology and coal resources of the Panganiban region, Catanduanes, by J. Marvin Weller, USGS Geologic Survey, Oscar Crispin and Cezar Ibanez, Philippine Bureau of Mines, 1955 (printed).

SPS No. 3 (COAL) - Geology and coal resources of Batan Island, Albay, by O. Crispin, Philippine Bureau of Mines, 1955, 51p. maps (printed).

SPS No. 4 (COAL) - Geology and coal resources of the Hitoma Manambrag region, Catanduanes, by V. de los Santos, Philippine Bureau of Mines and J.M. Weller, USGS, 1955, 26p. plates (printed).

SPS No. 5 (COAL) - Geology and coal resources of the Gatbo Peninsula, Bacon-Prieto Diaz-Gubat region, Sorsogon, by C.B. Ibanez, Philippine Bureau of Mines, 1955, 16p. plates (printed).

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SPS No. 8 (COAL) - Geology and coal resources of Malangas-Kabasalan region, Zamboanga del Sur, by C.B. Ibanez, I.S. Antonio and Luis Santos-Ynigo, Philippine Bureau of Mines, and Harley Banes, USGS, 1956 Part I (Text) 73p. Part II (plates), (printed).

SPS No. 12 (COAL) - Geology and coal resources of the Calatrava-Toboso region, Occidental Negros, by M. Melendres, Jr., Philippine Bureau of Mines and H. Banes, USGS, 1957, 50p. plates, (printed).

SPS No. 14 (COAL) - Geology and coal resources of the Bislig-Lingig region, Surigao, by J. Vergara, Philippine Bureau of Mines and F.D. Spencer, USGS, 62p. plates (printed).

SPS No. 15 (COAL) - Geology and coal resources of Polilio, Quezon, by Victor de los Santos, Philippine Bureau of Mines and F.D. Spencer, USGS, 1968. plates (printed).

SPS No. 20 (COAL) - Coal resources of the Philippines (Progress Report) by F.D. Spencer, USGS, and J.F. Vergara, Philippine Bureau of Mines, 1957, 52p. plates (printed).

ANNEX 3

PETROLEUM: EXPLORATION AND PRODUCTION

Table of Contents

Petroleum: Exploration and Production

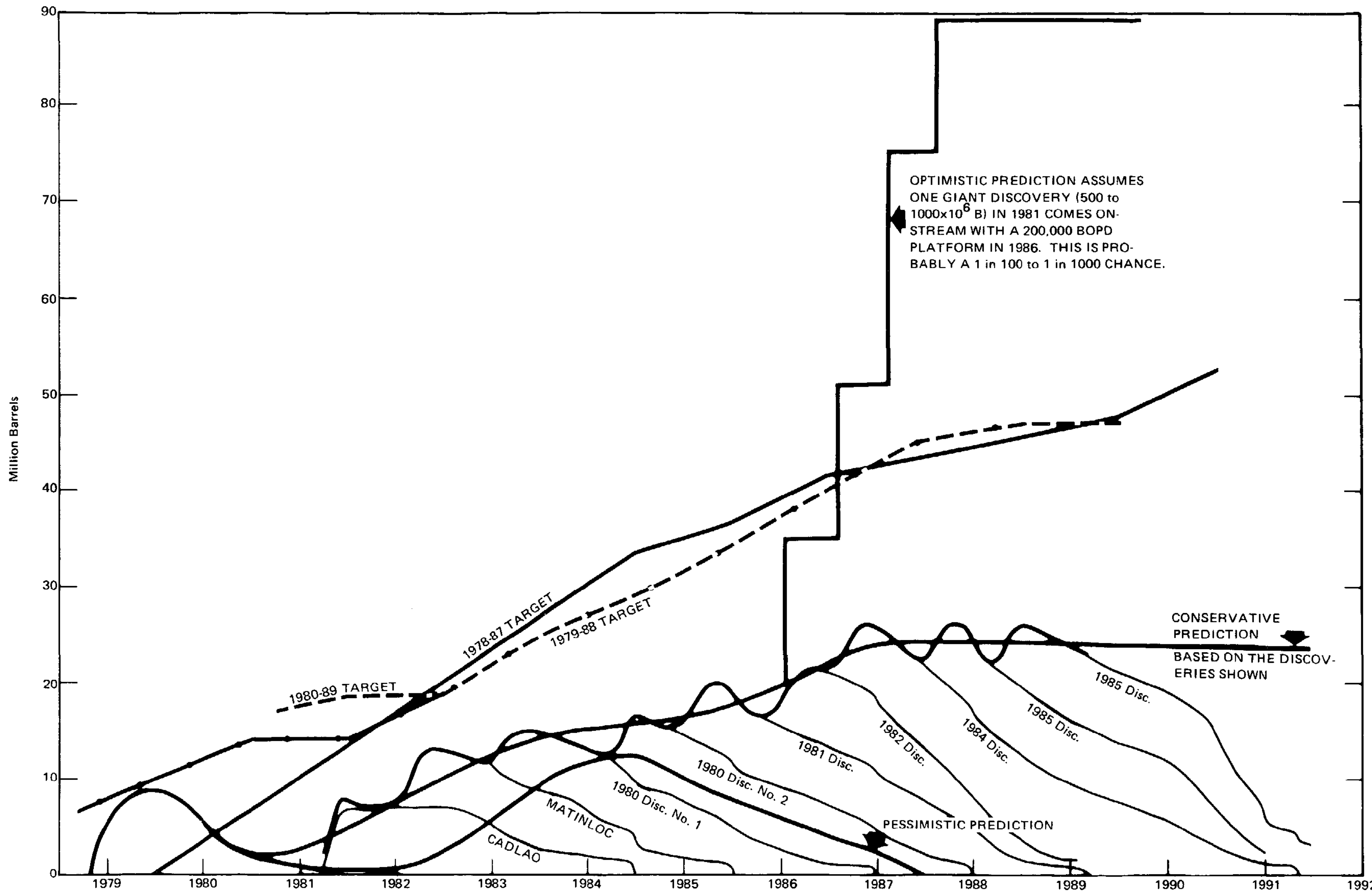
Introduction

1. After more than 80 years of exploration and the drilling of over 300 wells by dozens of companies, the country's first significant oil finds were made in the late 'seventies - on the Nido, Cadlao, and Matinloc offshore reefs west of Palawan Island. The first wells at Nido were brought into production in 1979. After achieving a peak production level of 40,000 barrels per day in late 1979, production had to be cut back to 14,000 barrels per day in early 1980 due to excessive water at the higher pumping rate. By mid-1981 the field was no longer producing. This experience reflects the type of deposits which are most likely to be found and brought into production under the geological conditions in the country, i.e., good possibilities for a continuing series of relatively productive but small and thus short-lived fields.

2. Recent evidence suggests that the Philippines have relatively certain undiscovered hydrocarbon reserves equivalent to 100-500 million barrels of recoverable oil. Discovered, as yet unproduced, recoverable reserves are about 30 million barrels. These figures translate into a rise in domestic production from today's 14,000 barrels per day to an average sustainable level of 65-70,000 barrels per day from about 1987 onwards. This appears as the conservative prediction in Figure 1, which shows four projections of petroleum prospects in the Philippines over the next decade. This most probable level of production, however, is only 50-55% of the Ministry of Energy's projection in its Ten-Year Energy Program of 125-130,000 barrels per day by the end of the decade, a projection the Ministry has since abandoned. Even so, an end-of-decade production level of 65-70,000 bpd assumes discoveries of 1-2 small reef fields every year. As for the other projections shown in Figure 1, the pessimistic one assumes no further discoveries, while the optimistic one assumes a giant discovery of some 0.5-1.0 billion barrels around 1981.

3. The Bank's estimates are based on broad probabilities indicated by a review of the recent geological evidence, the country's policies, and the industry's organization and absorptive capacity. The main explanation for the somewhat disappointing "most probable" projection is geologic. That is, the nature of the country's sedimentary rocks is such that the probability of petroleum resources on the scale assumed in the Ten-Year Energy Program is less favorable than the Program assumes. The geological basis and potential of the petroleum sector is discussed in more detail below, as is its overall organization and operation. Attainment of even the 65-70,000 barrels per

Figure 1
TARGETS BY YEAR
OF
THE PHILIPPINE TEN-YEAR ENERGY PROGRAM
VERSUS
REALIZED, PESSIMISTIC, CONSERVATIVE AND
OPTIMISTIC PREDICTIONS



Source: 1978-87, 1979-88, 1980-89 Targets—Ministry of Energy
Optimistic, Conservative, Pessimistic Predictions—Bank Staff Estimates

World Bank—22074

day level of production is predicated upon substantial exploration efforts and investment requirements as well as certain modifications in technical and procedural approaches recommended below.

Geological Basis and Potential

4. The Philippine archipelago forms part of the western rim of the Pacific Ocean. The eastern chain of islands has the form of a typical island arc, with complex geology and much seismic and volcanic activity. Some of the western islands are geologically somewhat older and more stable, but nevertheless are still complex in structure. The land area of the archipelago is some 300,000 square kilometers, but the total area of "economic interest" is much greater, about 1.5 million square kilometers. At least 11 separate sedimentary basins, in which petroleum may have been formed, have been identified (see map); these cover a total area of about 760,000 square kilometers. Only about half of this total is at present regarded as prospective from the petroleum exploration viewpoint, of which some 63,000 square kilometers (under 20%) is on land and the remainder offshore.

5. Oil and gas seepages are relatively common in the Philippines, having been reported from Cebu, Leyte, Luzon, Panay, Mindanao, and Mindoro. Asphalt saturated sands occur on Leyte and have been exploited for road surfacing material. As a result of these petroleum manifestations, the Philippines has a long but, until recently, unsuccessful history of oil exploration. The first commercially exploitable discovery was the Nido field offshore the northwest coast of Palawan in 1977.

6. The relative lack of success of petroleum exploration in the Philippines up to 1976 was due to a number of factors. Onshore operations are slow and costly due to broken terrain, heavy rainfall, and heavy vegetation cover; the geology is complex, and there is a lack of good reservoir rocks other than fossil limestone reefs, which are difficult to detect in the subsurface. At pre-1973 prices, this relatively poor onshore geologic potential meant that any hydrocarbon discoveries would be noncommercial. For some years subsequent to the Second World War, exploration by international companies was inhibited by a petroleum law which required 55% Filipino participation in any exploration concession. Since local capital was not available on the scale needed to finance serious exploration, activity was confined to areas in which shallow wells could encounter shows of oil and gas which were used to encourage stock-market speculation but never led to sustained commercial production. Only when the petroleum law was changed in 1972 and offshore technology was applied could the existing commercial discoveries be made in the late 'seventies.

7. Petroleum Geology. The sedimentary basins of the Philippines are generally narrow and commonly very deep, containing thicknesses of 2,500 meters to as much as 8,000 meters of sediments of Tertiary age. The basement rocks from which these sediments were derived are predominantly

basaltic, lacking in free silica; the section is therefore composed mostly of shale with only a few thin argillaceous sandstones having poor reservoir characteristics, except in the Mindoro-Palawan area. Reef limestones grew around the margins of most of the basins and have provided the reservoir rocks for all significant oil and gas discoveries to date. However, in many cases it seems that these reef limestones, for a number of reasons connected with the geological history of the area, never contained hydrocarbon accumulations. In other cases the accumulations which once existed have been destroyed by subsequent tectonic activity and erosion. In the later stages of the formation of the Philippine archipelago, volcanism was extensive especially on the eastern or Pacific side where active volcanoes still exist (Mount Makiling, Mayon). The great thickness of extrusive volcanic rocks which resulted from this activity are not favorable either for the formation or the accumulation of hydrocarbons.

8. While the presence of oil and gas seepages indicates that these substances have been formed in the sediments at some period in their history, those shales which have been analyzed seem to have a relatively low organic content, which would indicate a poor source-rock potential. The evidence available so far indicates that gas formation is more likely than oil. However, evidence is scanty and further work on source-rock analysis is necessary.

9. Structural deformation in many of the Philippine basins is fairly intense and is made more difficult to interpret by the probable occurrence of submarine slumping at the time of deposition, and by the likelihood of shale diapirism, for which some field evidence exists. These factors complicate exploration work and reduce the likelihood that large oil accumulations will be found.

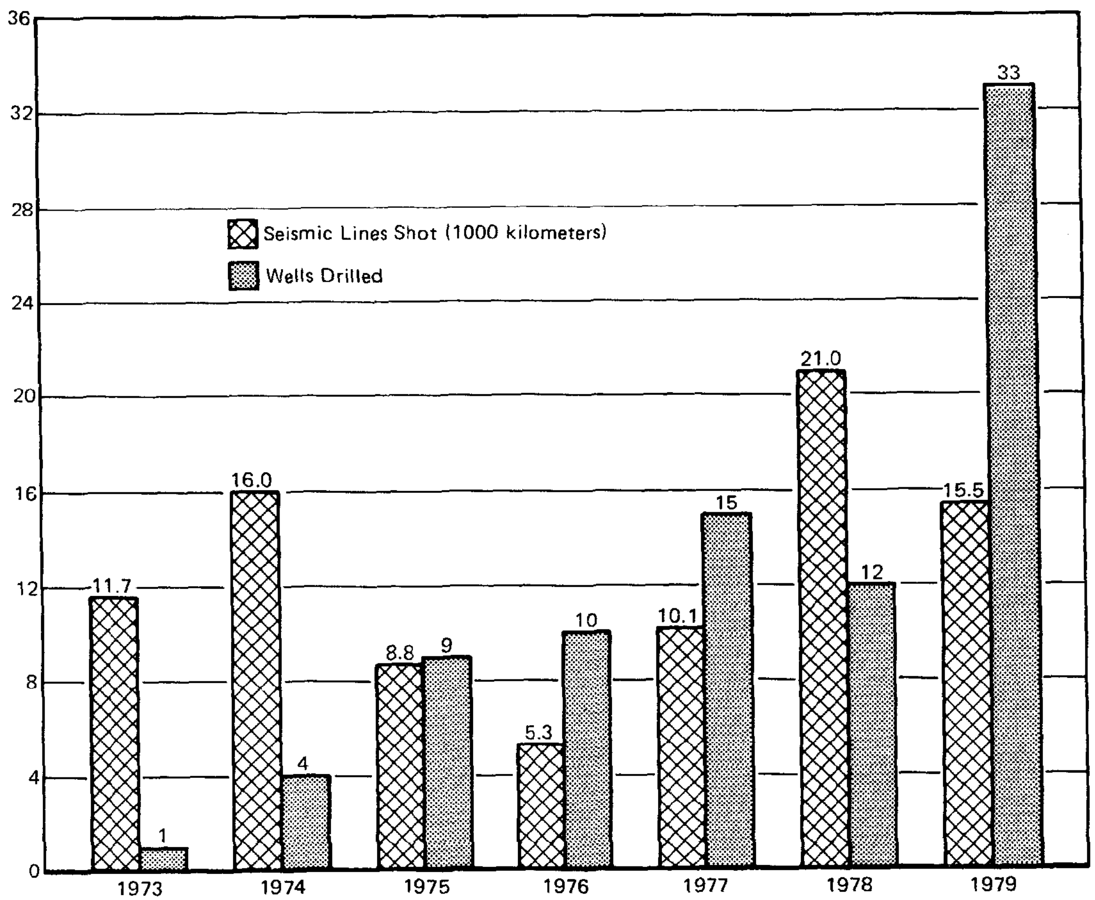
10. Occurrence of Oil and Gas. As mentioned above, seepages of oil and gas are common in the Philippines, and early exploration efforts commencing around 1890 were directed toward drilling near them, without finding commercial production. Modern exploration using geophysical surveys was begun after the Second World War, with exploration wells being drilled on a number of the islands. The only discovery of note was a then noncommercial accumulation of gas found in 1958 in the Ipil-1 well at a depth of 1326 meters, located in the Cagayan Valley of northern Luzon. After extensive testing during which the well produced at the rate of 400,000 cubic meters per day, the companies involved (Mobil and Exxon) decided that recoverable reserves amounted to only 68 million cubic meters, which at that time did not justify development, and the well was abandoned. Some doubt exists about the accuracy of the reserves estimate, however, and an offset well is presently being drilled by PNOC. A small gas show was also found in the Abaca-1 well, 105 kilometers north of Ipil-1, by the same company group in 1959. The reservoir rock in the Ipil-1 well was a reef limestone about 12

meters thick; it seems reasonable to expect that other such discoveries might be made in the Cagayan Valley using modern seismic survey techniques.

11. During the 'sixties exploration in the Philippines was inhibited by the earlier lack of success, the low price of crude oil on the international market, and a petroleum law unfavorable to foreign oil companies. In the early 'seventies the law was changed, and Petroleum Exploration Concessions were issued to a number of foreign company groups. All such Concessions were converted to Production Sharing Service Contracts by the end of 1976, or relinquished. As a result of the changes in the law, exploration activity by non-Filipino companies was renewed, concentrated for the most part off the west coast of Palawan, where it was believed that an extension of the North Sabah offshore basin might be found. Although geological conditions turned out to be different, exploration was successful in 1976 when a group headed by Cities Service Oil Co. discovered oil in the Nido-1 wildcat, 40 kilometers offshore northwest Palawan. The well flowed 1,440 barrels of 32° API oil per day from a reef limestone reservoir, but only 5 meters of the reservoir were oil saturated. Although this well was regarded as noncommercial, subsequent drilling nearby at South Nido and South Nido West was successful, and production rates of 7,000-9,000 barrels of oil per day per well were reported. In 1977 a group headed by Amoco reported that the Cadlao-1 wildcat had tested oil at 2,800 barrels per day. All of these wells produced from similar limestone reservoirs. Other noncommercial oil shows were reported from wells drilled in the Reed Bank area of the South China sea, some of which produced from sandstone reservoirs. Following the Cities Service Nido discovery, interest in onshore exploration revived, and in 1978, 12 wildcat wells were drilled, of which seven were offshore and five onshore; the number of wells drilled climbed to 33 in 1979. Cities Service made another oil discovery off Palawan in 1978, when the Matinloc-1 well, located 57 kilometers north of Nido-1, flowed 8,150 barrels per day from a limestone reservoir. In 1978, 21,000 line-kilometers of seismic surveys were shot, double the amount shot in 1977. Figure 2 summarizes petroleum exploration efforts in the Philippines since 1973.

12. Despite the relatively high flow rates recorded from the wells, proven recoverable reserves are very low (about one-tenth) compared with those normally needed to justify international offshore development. Initially recoverable reserves of the Nido fields were estimated to be 45 million barrels, but these have been revised downward after drilling dry wells nearby, and in light of the production history of the wells, which have gone to water sooner than expected. They are now estimated to be around 13-17 million barrels. Recoverable reserves at Cadlao are estimated to be in the range of 10-20 million barrels, and at Matinloc around 10 million barrels. Because of the low recoverable reserves, extensive renegotiation of the concession terms in favor of the companies was necessary before they would

Figure 2
OIL AND GAS
SEISMIC LINES SHOT AND WELLS DRILLED
UNDER SERVICE CONTRACTS, 1973–1979



Source: Ministry of Energy, Ten–Year Energy Program 1980–89

World Bank–22075

agree to develop the fields. The Nido complex (South Nido and South Nido West) was placed on production in January 1979 using two production platforms; by September 1979 oil production had reached a level of 40,000 barrels per day from five wells, but in October 1979 the field started to produce salt water. The oil is not of very good quality, being 27° API with 2% sulphur, while the associated gas contains 3,600 ppm of hydrogen sulphide. By April 1980, oil production was down to 14,000 barrels per day; one well had gone completely to water, one was producing 26% water, and three wells were producing clean oil. Cumulative production to April 15, 1980 was 10.2 million barrels of oil.

13. The reservoir rocks in both the South Nido and South Nido West fields are small fossil reefs of early Miocene age resting on a limestone base of late Eocene or Oligocene age. The cap is provided by some 1,500 meters of shale of medial Miocene age. The limestone reef reservoir is very porous and extensively fractured, leading to high individual well production rates. The oil column in the South Nido reservoir is 84 meters thick, while in South Nido West it is 190 meters thick, with no gas cap in either case. The rapid increase in water production noted in para.12 must result from water migrating up the fractures into the wells and by-passing the oil, as a result of the high production rate. A lower producing rate would undoubtedly increase the total recovery of oil, but would prejudice the economics of the development program. Since it is likely that other fields offshore Palawan will have similar producing characteristics, serious consideration should be given to using alternative and less costly production methods, such as the system employed offshore Spain; this might be more economical than the fixed platform system employed at Nido.

14. The Cities Service Group spent about US$50 million on exploration and appraisal of the Nido fields, and producing facilities cost another US$42 million. 7.7 million barrels of oil were produced in 1979 and sold to the Government. The value of this oil was US$129 million, of which the companies received US$104 million and the Government US$25 million, so that even in the first year of production the Government received some 20% of the total revenue. Had the Government been willing to defer this income to a later stage, it might have been possible to reduce the initial production rate from the field, and thereby postpone the initiation of water production and increase the total recovery of oil from the field. This is an issue which the Government should study carefully, since it may well be in its long-term interest to maximize oil production rather than tax revenue.

15. The Matinloc (Cities Service) and Cadlao (Amoco) discoveries seem to be of the same size and to have the same reservoir characteristics as Nido. The Government needs to examine closely the various options by which development of such relatively small offshore discoveries can be made

economically beneficial both to the Filipino economy and to the operators. PNOC and BED will probably need external assistance in this task.

16. Future Prospects. The geology and exploration history of the Philippines indicate that there are good possibilities of finding other relatively small accumulations of oil and gas both onshore and offshore. The chance of making a major discovery cannot be totally discounted given the history of oil accumulations in reef limestone reservoirs elsewhere in the world, but exploration is going to be difficult and expensive. A quantitiative risk analysis indicates that there is about an 80% chance of finding small reef-type fields such as Nido, both onshore and offshore, having a cumulative recoverable reserve of the order of 100 million barrels of oil equivalent (i.e., 8-10 new fields). The chances of finding a larger number of fields than this, or of finding larger fields than have so far been discovered, is much lower, lying in the range of 1 to 20% and representing a cumulative reserve of 500 million barrels of oil equivalent. The chance of finding a major field in the one billion barrel reserve class is rated in the range of 0.1 to 1% possibility. Although further oil exploration in the Philippines is clearly justified, the indications are that the results will be modest and the possibility of achieving self-sufficiency in oil production is not very great.

Organization and Operation

17. Presidential Decree No. 1206 of October 1977, amended in June 1978, created the Department/Ministry of Energy (MOE) and established the current organization of the energy sector in the Philippines (see Chart 1 in main text). The Bureau of Energy Development (BED), under the direct supervision and control of the Ministry, and the Philippine National Oil Company (PNOC), a state enterprise attached to the Ministry for policy and program coordination, are the institutions within this framework primarily concerned with exploration, development, and production in the petroleum sector.

18. BED is charged with the administration of a national program for the encouragement, guidance, and regulation of activities of exploration, exploitation, development, and extraction of all fuels and energy resources. It is divided into six functional divisions, one each for oil and gas, coal and uranium, geothermal, and nonconventional energy resources as well as one for legal aspects and negotiations and another for monitoring service contract compliance; it also operates an energy research laboratory (see Chart 3 in main text). In the area of petroleum, therefore, BED negotiates, regulates, and oversees contracts for exploration, development, and production on behalf of the Ministry, as specified under various Presidential Decrees, and serves as a data repository for the sector.

19. PNOC was created at the onset of the energy crisis in 1973, under Presidential Decree No. 334 (later amended), with the following purposes: (a) to provide and maintain an adequate supply of oil and petroleum products for domestic requirements, and for that purpose to engage in, supervise, and regulate all aspects pertaining to the production, distribution, and sale of crude oil, refined petroleum, and petroleum products, local and imported; and (b) to promote the exploration, exploitation, and development of local oil, petroleum, and other energy resources. A fully owned Government corporation, PNOC is the Government's main executing agency in the petroleum sector. It consists of a large number of subsidiary companies which carry out the full spectrum of exploration, development, transport, refining, and marketing activities in the petroleum industry in the country (see Chart 5 in main text). PNOC and its subsidiaries contract with the Government much as would any oil company, and enter into joint ventures with the international companies operating in the Philippines. Through its subsidiary group of energy development companies, it has been particularly active in onshore exploration, in which it hopes to attract more foreign interest. PNOC operates an onshore seismic crew under contract, which it cooperatively loans to partners upon request; Amoco and Total are presently joint venturing with PNOC in onshore exploration.

20. Contractual Arrangements. The present Production Sharing Service Contract, pertaining to drilling and seismic activities, was initiated in 1972 under Presidential Decree No. 87; its basic terms and conditions are given in Table 1. BED negotiates the specifics of the Contracts, subject to the approval of the Minister of Energy. The negotiation of the percentage of recovered funds available for the contractor from which to recover costs is an Indonesian type contract and is familiar to the petroleum industry. In the case of Nido, for example, it is reported that after recovery of exploration and development costs, 20% of the proceeds will meet current production costs and 7.5% will go to the consortium for including Filipino partners (Cities Service 52.5% and four partners 47.5%); the balance will be divided 62.5% to the Government and 37.5% to the consortium. Because of the feeling of success following the Nido discovery, the Government's share under new contracts in the offshore Palawan area will be higher, perhaps as high as 70%. Other terms of the contracts were also reportedly tightened, such as dropping of the bonus for Filipino participation.

21. In view of the relatively small size of petroleum finds to date, this action appears to have been somewhat premature on the part of the Government, and may partly account for the rather small share of the prospective area now under Service Contracts. It may be advisable for the Government to settle for a smaller share of the profits for the present, in order to encourage more drilling. Other aspects of the present Service Contract deserving review are (a) the mixing of good and bad prospects,

Table 1: EXPLORATION AND PRODUCTION
TERMS OF PRODUCTION-SHARING SERVICE CONTRACTS

Exploration

Duration:	Seven years, extendable to ten, plus an extra year possible for delineation of a discovery.
Relinquishment:	25% of the acreage after five years, and another 25% after seven years if the contract is being renewed.
Obligations:	The contractor must spend a required amount in exploration during the course of the contract, and must drill the minimum agreed footage of test wells (current contracts call for an average of three wells per year for offshore contracts and two for onshore contracts); the contractor must assume all obligation risks without reimbursement unless a discovery is made.

Production

Duration:	25 years from expiration of 10-year exploration contract; renewable for 15 years.
Obligations:	All crude oil found is to be sold on behalf of the Government; the contractor is reimbursed for operating expenses up to 70% of gross income in any year.
Special Incentives for Contractor:	These include exemption from tariff duties and compensating taxes for machinery imports, repatriation of capital and retention of profits, bonus for Filipino participation.
Profit-Sharing:	Government receives at least 60%, perhaps as much as 70%, of net profits; contractor receives at most 40%, perhaps as little as 30%.

which experience elsewhere suggests is generally not successful, and (b) the US tax problem, which is reportedly near resolution./1 All in all, the basic Service Contract is quite favorable to industry and well-suited to the present situation in the Philippines. A total of 30 such Contracts have been awarded to international and domestic oil companies to date; 20 of these are still in effect (see map).

22. The basic Service Contract is supplemented by two contracts for seismic studies: a Geophysical Survey Contract, an exclusive document, and a Geophysical Permit, a nonexclusive document. The Geophysical Contract allows a single oil company to block exploration by others for a period of time and can seriously delay data acquisition. Its use for onshore exploration may be quite appropriate, as the time and effort expended in seismic work can be considerable. Offshore, however, where seismic exploration can be executed relatively quickly and cheaply, its use makes less sense, and may be unnecessarily delaying further exploration efforts; the Geophysical Permit may be more appropriate in this situation. A total of 21 Geophysical Contracts and 10 Permits had been awarded to May 1980, with 14 and 6, respectively, still then in effect (see map).

23. Manpower. The overall system and basic concepts and documents underlying the petroleum exploration/production program in the Philippines are generally well-conceived and effectively executed. Availability of trained manpower, however, remains a problem, as in many parts of the world. The existing staff is sincere, hardworking, and dedicated but in short supply. As of March 30, 1980, for example, only 134 positions in BED, out of 208 authorized positions shown in its organization chart, were filled. The PNOC manpower report as of December 31, 1979, showed a total of 540 vacancies out of a possible 4,126 positions. Although this is considerably better than BED's situation, some of the vacancies are in crucial areas; the PNOC Exploration Corporation, for example, has a staff of 38 people, and positions for 58, and yet exploration is one of PNOC's major areas of operation.

24. Moreover, available staff need further training and education, both on the job and in industrial and academic institutions. Adequate on-the-job training in PNOC is impossible to achieve for many years. Such training in the industry is generally provided by new graduates working with men with 1-4 years of experience, supervised by others with 5-10 years of experience. The cadre of experienced personnel in PNOC is still too small for this. Some training might be achieved through joint ventures with international oil companies, by requiring them to provide a certain amount of on-the-job training for Filipino technicians in their offices. Limited use of consultants working side-by-side with Filipino technicians and new graduates may also help to fill the void. Expatriate consultants in the petroleum sector may be needed for another five years or so.

/1 By early 1981, this problem had been solved.

25. Salaries for Government and national oil company personnel are also part of the manpower problem in the Philippines. Regular civil service salaries are still extremely low, making it difficult for MOE to attract and retain qualified professional staff. PNOC, a Government corporation, is also subject to salary limitations but the levels are somewhat higher. The subsidiaries of PNOC, on the other hand, are subject to no official limitations, leaving them free to offer salaries competitive in the market. Consequently, most PNOC employees are, in fact, employees of one of its functional subsidiaries. Moreover, a sizable proportion of MOE's staff is employed by and seconded from PNOC; for example, some 74 out of BED's staff of 134, particularly senior staff, are actually employees of PNOC. The impression this creates on the private sector companies who are regulated by the Ministry and are to compete with PNOC, as well as difficulties in sorting out salaries paid and agencies paying, is indeed a problem with this approach, particularly in the longer term. Nevertheless, it appears to be a pragmatic means to resolve the situation for the present, while further efforts are directed toward raising civil service salaries to levels sufficient to attract and retain the technical and managerial staff required to deal with the country's energy problems. Although salaries are a first consideration, further decentralization and delegation of authority in both BED and PNOC might also help to attract and keep good personnel, and at the same time, improve their overall operations.

Exploration and Development Program

26. Exploration in the Philippines to date has progressed through cycles of seep drilling in the 1890s, onshore surface anticlines in the 1950s-60s, and offshore reef drilling since 1970; it will probably next proceed to a stratigraphic-trap drilling cycle, among others. As geological and geophysical knowledge improves, it appears that much of the early seep drilling is of little statistical value, and that relatively little of the seismic work of the 'fifties and 'sixties is worth interpreting today. Thus, only about 144 valid exploratory tests, of a total of 377 wells, have been drilled in the Philippines; the rest were too shallow, prematurely abandoned, or off-structure. This is approximately one valid exploratory well per 2,800 square kilometers of the "probably prospective" sedimentary area. Exploration is thus relatively immature in comparison to most countries with proven hydrocarbons, although efforts have been stepped up significantly in recent years, as demonstrated by the exploration record in Figure 2. A total of 84 wells have been drilled and 88,445 kilometers of seismic lines shot in the seven years since the inception of the Service Contract system. In 1979, 33 wells were drilled, including five development wells and a significant discovery well.

27. The historical commercial success ratio in the Philippines to date is 4 in 144 or 1 in 36. Increased knowledge of the Philippines and its prospective areas, as well as advances in prospecting technology, has led to higher success rates in recent years. The offshore Palawan region has a success ratio of 1 in 3, while the present overall success ratio for offshore reef wells is 1 in 5 and the commercial success ratio 1 in 10. The latter compares to a worldwide average of 1 in 25, although it should be recognized that the future success ratio in the Philippines may decline as the best prospects are drilled first.

28. Physical Targets. The Government's Ten-Year Energy Program has targeted 200 exploratory wells, 51 onshore and 149 offshore, for 1980-89. This calls for drilling an average of 20 wells per year. A total of some 61,000 kilometers of seismic lines, distributed over the ten years, is also planned. To meet these targets, the award of some 26 new Service Contracts, at the rate of 2-3 per year, is foreseen by the end of the decade. The Government has since projected an even more ambitious program of 32 wells for 1980, as shown in Table 2. Eliminating some of the programmed wells as unlikely, about 9 onshore and 16 offshore wells can be expected to be drilled in 1980. Even this program, however, is less than the optimum required for a satisfactory level of exploration in the Philippines.

29. Assuming a constant commercial success ratio of 1 in 10 and 16 offshore wells per year, three fields should be discovered every two years. This scenario, combined with the recent geological evidence (particularly the nature of the new discoveries discussed above) leads to the Bank's conservative projection, shown in Figure 1, of production rising from 14,000 barrels per day in 1980 to an average sustainable level of about 65,000-70,000 barrels per day from 1987 onwards. Hence, this would appear to be the most probable projection of oil production for the Philippines. As observed above (para. 2), however, this is only slightly more than half the production level targeted by MOE in its Ten-Year Energy Program. The Ministry has since abandoned its earlier projection and now expects much lower output, perhaps even lower than the Bank's estimate.

30. Attainment of higher production levels in the years ahead in the Philippines requires accelerated exploration. Although nearly 77,000 sq km are presently awarded under drilling contracts, this is only about one fifth of the probably prospective area (see map). Exploration in other areas, moreover, is somewhat blocked by the exclusive Geophysical Contracts. Although it may be difficult to sustain a higher onshore drilling rate, the offshore activity should be higher. The key to increased exploration effort by private companies is greater incentives, especially in the case of small oil fields and gas development; aeromagnetic surveys and group or speculative seismic surveys might also serve to clarify prospects.

31. Investment Requirements. MOE in its Ten-Year Energy Program assessed the financial requirements of oil and gas exploration and develop-

Table 2: MINISTRY OF ENERGY, BUREAU OF ENERGY DEVELOPMENT
1980 DRILLING PROGRAM

Contractor/operator	1st Qtr.			2nd Qtr.			3rd Qtr.			4th Qtr.			Total
	J	F	M	A	M	J	J	A	S	O	N	D	
Onshore													
PNOC-ECI (Cagayan)					C							C	2
PNOC-ECII (Cagayan)							C		C				2
PODCO (Panay)				C									1
Multi-natural (Balabac)					C			C					2
Amoco/Houston (Central Luzon)											P		1
Interport (S. Mindoro)	X												1
SEDCO I (Bondoc)					C								1
SEDCO II (Mindoro)												P	1
Subtotal		1			4			3			3		11
Offshore													
Phillips (S.W. Palawan)					P		P						2
Total/Signal (N.W. Palawan)									C				1
Amoco (N.W. Palawan)								D		D			2
Total/Vulcan (N. Cagayan)												P	1
PECTEN/BASIC (N.W. Palawan)			X				P						2
Cities Service (N.W. Palawan)		X		C				P			P		4
Salen (Reed Bank)										C			1
POGEI (Visayan Sea)												P	1
PECTEN (S.W. Palawan)				C	C								2
Phillips (Visayan Sea)	X									C			2
Phillips (Samar/Leyte)								C			C		2
Bow Valley (Sulu Sea)												P	1
Subtotal		3			4			6			8		21
Total		4			8			9			11		32

Notes: X = completed well
D = development well
C = committed well
P = programmed well

ment in the ´eighties to be some US$935 million (in 1979 prices - see Table 3). This amounts to 6.7% of the total expenditures projected for the package of energy development activities, and 44% of that for the exploration and development of all energy resources. It is comprised of US$803 million (86%) in foreign exchange and US$132 million (14%) in local currency. Foreign capital would likely be mobilized in the form of investments from developed countries with advanced energy technologies; local funds might be likewise supplied through private investments, and through the Government in the form of direct-equity participation or guaranteed loans from foreign and local banking institutions. As shown in the table, the annual requirements would be expected to vary from year to year, the major variable being installation of new production facilities for proven commercial reserves.

Table 3: MINISTRY OF ENERGY - TEN-YEAR ENERGY PROGRAM
FINANCIAL REQUIREMENTS
(million US Dollars, 1979 price level)

Year	Oil and gas			Resource exploration & development	Overall energy program
	Foreign	Local	Total		
1980	71.60	12.64	84.24	179.24	1,062.58
1981	94.89	14.38	109.27	252.11	1,460.02
1982	64.00	11.30	75.30	219.81	1,666.48
1983	89.94	13.52	103.46	258.46	1,527.53
1984	77.88	13.73	91.61	243.37	1,399.61
1985	86.21	12.86	99.07	225.44	1,412.20
1986	78.80	13.91	92.71	206.52	1,311.81
1987	97.80	14.91	112.71	226.08	1,448.52
1988	66.56	11.75	78.31	172.76	1,295.29
1989	74.71	13.19	87.90	138.46	1,398.73
Total	802.39	132.19	934.58	2,122.25	13,982.77

32. MOE´s most recent projected drilling program for 1980 (para. 28), as well as the suggestion that the exploration program should be accelerated (para. 30), indicates investment requirements of the oil and gas sector might be even higher. At the same time, the reduced expectations as to production (para. 29) suggest a possible reduction in production facilities investment. Further details on the investment requirements of the present

Energy Program are needed before MOE's estimates can be fully evaluated and the impact of these adjustments quantified. The overriding problem which remains is attracting the financial resources to support the Program.

Recommendations

33. A major thrust of the recommendations set forth below is the stimulation of intensified and more effective petroleum exploration and development in the Philippines in the immediate future. The recommendations are broadly divided into institutional and technical considerations, with notable overlap between the two. Finally, they are somewhat general in nature as more detailed review of license documents, requirements, and decrees, and further exploration data such as logs, seismic, and magnetic data, are needed to make them more specific.

34. Institutional recommendations include the modification of contract terms and conditions, the improved implementation of contracts, the alleviation of manpower constraints, and the clarification of the objectives and responsibilities of PNOC and BED.

(a) Certain modifications in the terms and conditions of contracts should help to stimulate petroleum exploration, the most important being (i) awards with more flexible terms - e.g., rather than requiring drilling more than one well in an onshore license, perhaps it would be better to require drilling one well within 12-18 months, with the option of retaining the acreage through additional drilling or dropping it altogether (the Geophysical Contract is another possible solution but generates less drilling); and (ii) awards with more limited area and time conditions - e.g., awarding smaller size blocks in highly prospective areas and making compulsory the 25% relinquishment after three years (or maybe five) and the additional 25% relinquishment after five years (or maybe seven). Another possibility might be the introduction of a yearly rental commencing a year or two after payment of the presently negligible one-time rental. In the interest of expediting contract negotiations, it is recommended that the Government's holding out for a slightly higher share and efforts to include the bad with the good (e.g., linkage of poorly prospective onshore oil areas with good geothermal areas) be reduced./1 From a monitoring standpoint, it is proposed that a yearly review of contract terms versus yearly drilling, acreage under lease, and new discoveries, be made to determine the need for modifying the terms in light of on-going experience.

(b) In the interests of improving contract implementation, it is suggested that (i) a more competitive system of setting one

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/1 By 1981 this no longer appeared a problem.

company's offer against another's, perhaps by gazetting, be used, (ii) long-standing issues which have resulted in serious delays in reaching agreements with contractors, such as the tax problem which puts US oil companies at a disadvantage and the right to cancel the license clause (Presidential Decree 1585) which tends to alienate companies, be resolved; and (iii) conversion and repatriation of pesos received for oil payment be accelerated. To ensure more rapid and thorough exploration, the use of the Geophysical Contract offshore should be reduced, and the right of the Government or PNOC to take over and operate a field facility, which a contractor wants to abandon before the Government does, should be established. Recognizing the benefits accruing to both Filipino and international oil companies and the sector as a whole, joint ventures should continue to be encouraged. To cover BED's costs, a contract application fee of some US$5,000 for Service and Geophysical Contracts might be established.

(c) Alleviation of manpower constraints on all levels is important to the development of the petroleum sector. At the middle technical level in BED and PNOC, for example, it is suggested that petroleum consultants be used to provide training, assistance, and knowledge until a group of Filipino technicians with 8-10 years experience is developed; PNOC and its subsidiaries may additionally benefit from joint ventures with international firms. Management training is also needed in such areas as use of schedules or job modules to increase motivation and use of job rotation or other means to improve job-to-job interactions. As individuals develop and prove their capability, additional units of the organization can be properly staffed, and more authority delegated to each unit.

(d) BED should recognize that its primary role in the development of the petroleum sector in the Philippines is one of initiation and coordination. It performs these functions through formulation and negotiation of well-balanced Service Contracts, collection and issuance of relevant data, and regulation of producing fields so as to reflect national goals and at the same time maximize production efficiency and economy, strengthen the industry, and provide consistent employment and revenue. Included among these functions might be such diverse activities as encouraging the investigation of new avenues of exploration like the shallow gas industry, promoting the use of a drilling fund or other approaches to encourage the entry of private Filipino capital while at the same time striking a balance in the number of private oil companies formed, and establishing a fund from production payments for removal of platforms after a field is abandoned.

(e) As for PNOC, clarification of its short, intermediate, and long-term objectives in exploration is needed, as efforts to date have been largely confined to onshore work. Also important is careful consideration of the selling off of its drilling company to the private sector. Experience elsewhere in the world suggests Government drilling companies prove to be considerably more expensive than private ones, and tend to restrict the growth of private companies; moreover, it is generally difficult to incorporate a drilling company successfully into an oil company./1 The continued close connection, particularly in terms of personnel, between BED and PNOC and any potentially adverse effects should be appraised as well.

35. Technical recommendations include the alleviation of informational constraints, the introduction of new techniques, the utilization of past exploration data, and the improvement of PNOC's seismic activities.

(a) Alleviation of informational constraints through improved collection, processing, and dissemination of technical and other data is vital to the promotion of the exploration effort. It is recommended that exploration data become part of the public domain after three years (five may be soon enough) and that it be sold by BED at the cost of reproduction and handling. Other suggestions include development of a set of presentation maps, initiation of an annual technical review to which experts are invited for exchange of opinions and knowledge, and use of postmortem appraisals after drilling dry holes. To further assist future exploration efforts, it is proposed that (i) BED obtain 100 grams of washed sample and 1 kg of unwashed sample from every well at 10 meter intervals from the time of first returns to target depth as long as returns allow, (ii) at least one fourth of the entire core be submitted to BED for permanent storage (nondestructive use) and perhaps one fourth for study storage (destructive use), and (iii) BED sponsor or assist the establishment of a sample splitting company.

(b) As for the introduction of new techniques to attract private capital for further exploration, BED should consider using, or encourage the use of, aeromagnetic surveys to define the thickness of sedimentary areas offshore, group or speculative seismic shots, and sonobuoys. Geochemical studies may be of use to PNOC in guiding exploration efforts toward more interesting basins, areas, and zones.

(c) Reassessment of only a relatively limited portion of past exploration efforts in the Philippines is considered to be war-

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/1 PNOC has since moved part way towards the above recommendation by "spinning off" its drilling activities as a separate division that is now required to operate as an independent profit-center.

ranted. Although the onshore back-arc basins explored in the 'fifties were generally assessed as having poor source potential and too low sandstone porosity to be prospective, there are some exceptions. Reprocessing a major part of the Cagayan Valley seismic data is particularly recommended, probably utilizing a processing center outside the Philippines with a PNOC geophysicist assisting the processing specialist. Moreover, localized porous zones have recently been found on Central Luzon, suggesting detailed geologic analysis may be warranted in other basins as well; the finding of clean sandstones on Mindoro and the existence of Palawan as a micro continent also suggest their further exploration.

(d) Some rather detailed suggestions which PNOC might consider in their future seismic work include: (i) using synthetic seismograms; (ii) cementing pieces of casing, with appropriate identification welded thereon, in seismic shot holes every 5-10 km; (iii) recording some experimental work with 1 ms, and using the seislog technique where 1 or 2 ms data have been recorded; (iv) using a pre- and postdrafting check list; (v) making changes in their in-house seismic sections, including addition of a horizontal scale in bar form, inclusion of the year of shooting in the line designation, placement of the white space at the top of the profile rather than at the bottom, and addition of weathering and elevation profiles; (vi) replacing their electrostatic plotter with a better display; (vii) comparing the label on their seismic sections with that from other companies to see if improvements can be made; (viii) using supplementary techniques for reef exploration such as static corrections to a near surface datum and isotime maps; and (ix) hiring a programming consultant to assist them in improving their processing package.

ANNEX 4

THE ELECTRIC POWER EXPANSION PROGRAM (1980-89)

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Preface

This Annex is primarily concerned with the Energy Sector Mission's analysis of the power program put forward in the January, 1980, Ten-Year Energy Program (referred to as "the proposed program"). The Bank felt that program considerably larger than needed to meet expected load growth, and not needed for accelerated retirement of oil-fired capacity, since this objective was not strongly justified at then-existing oil prices. The Bank recommended a more modest program ("the recommended program"). Higher domestic oil prices were introduced in 1980; this change added urgency to the Government's oil-replacement objectives and led NPC to propose in August, 1980, an Accelerated Power Program (essentially the Ten-Year Program compressed into five years). Further reviews led to the announcement, in mid-1981, of an Adjusted Power Program. The Annex does not discuss the Accelerated and Adjusted Programs. However, during the summer of 1981 the Bank established an internal Task Force to analyze these and other program options. The results of the Task Force's work are summarized in paragraphs 3.11-3.13.

The Electric Power Expansion Program (1980-89)

1. ENERGY RESOURCES FOR THE POWER SECTOR

1.01 Electric power is the most capital-intensive segment of the public sector in the Philippines. It absorbs approximately 45% of all infrastructure investment covered by the national development plan and accounts for almost 1.0% of Gross National Product (GNP), although it employs less than 0.3% of the labor force.

1.02 Electricity generation is the fastest growing of the various forms of energy production. Its share of total energy demand is expected to rise from 31% in 1979 to around 36% by the end of this decade. Recent annual growth of electric power (8.9%) has been almost double the rate for the energy sector as a whole (4.5%). In 1979 electricity generation totalled 17,100 GWh, including self-generation by industry, equivalent to some 4.4 million tons oil equivalent (MMTOE); it is estimated to reach about 34,000 GWh in 1989, a growth some 20% slower than in the seventies.

Table 1: PRIMARY ENERGY SOURCES FOR POWER GENERATION
In million tons oil equivalent (MMTOE)

	1979		1989	
	MMTOE	%	MMTOE	%
Hydro	0.86	19.6	2.02	22.3
Oil	3.15	71.9	2.37	26.2
Coal	0.05	1.2	1.60	17.7
Geothermal	0.32	7.3	2.04	22.6
Nuclear	-	-	1.01	11.2
Total	4.38	100.0	9.04	100.0

1.03 The electricity sector is heavily dependent on oil imports (72%) to supply its thermal plants, accounting for about 22% of total oil consumption. The Government's goal of speeding up the development of the country's own energy resources - hydroelectric, geothermal and coal - with the object of reducing its oil imports over the long-term is basically sound. This policy of partial substitution of an expensive imported energy source (oil) by cheaper imported energy (nuclear) and stepped-up development of indigenous resources was initiated a few years ago, as a consequence of the oil crisis at the end of 1973, except for the harnessing of the hydroelectric resources of Luzon and Mindanao which had begun much earlier.

Geothermal Resources

1.04 The Philippines is at present one of the world's leading countries in potential geothermal resources. Up to 1979 a total of about 140 wells had been drilled in four areas (two in Luzon and two in Visayas), with an electricity generation capacity equivalent to some 560 MW. The two geothermal fields in southern Luzon, which have been in commercial operation since 1979, are Tiwi and Mak-Ban. The exploration, development and operation of these fields is the responsibility of Philippine Geothermal, Inc. (PGI), a subsidiary of Union Oil Company of California (USA), under a contract with NPC. Construction and operation of the geothermal power stations and electricity generation is by NPC. The service contract between NPC and PGI, covering the supply and purchase of steam and drawn up at the end of 1971, is for 25 years and renewable for a similar term at the option of PGI.

1.05 NPC bears 55% of the investment costs of exploration and development of the geothermal fields of Tiwi and Mak-Ban monthly as incurred, and after development pays PGI a monthly rate in US mills per kWh produced. The rate varies each month according to the wholesale price index for the United States published by the IMF. The PGI rate consists of two components: (a) a Service Fee, which covers the expenses for royalties, taxes, etc.; and (b) a Recovery Fee, which covers investment costs incurred by PGI (45%) for development of the geothermal resources. The rate in December 1979 was some US mills 16.4/kWh and that at the beginning of the year US mills 15.2/kWh. The installed generating capacity in these two fields was 220 MW in 1979, with another 220 MW under construction for entry into commercial service between 1980 and 1981. In addition, a further 110 MW is planned to come on stream in 1982. This will provide a total geothermal capacity in Luzon of 550 MW by that date.

1.06 The areas with the largest geothermal resources in the Visayas are located on the islands of Leyte and Negros. Exploration and development of the fields (Tongonan in Leyte and Palimpinon in Negros) is the responsibility of PNOC - Energy Development Corporation under a service contract with NPC. The Tongonan field has a very high steam output, with one well reaching 26 MW equivalent, considered today to be the highest output of any well in the world. In this field about 12 wells are required for every 110 MW of electricity capacity, in addition to three reserve wells per plant and about three wells to dispose of the brine effluent. The exploration carried out up to now indicates that the output of this field very probably exceeds 450 MW. A pilot geothermal plant has been in operation since 1977, through which NPC is meeting part of the electricity demand in Ormoc city. NPC is now installing a 3 x 37.5 MW geothermal generating plant which will enter into commercial service in 1982/83. This will supply electricity to a copper smelter, now under construction, with a final electricity demand of some 60 MW and possibly also a fertilizer project which might be located on Leyte. It is the Government's policy to decentralize industry and the island of Leyte is a particularly attractive location for heavy industry because of its good electric power potential and abundance of water.

1.07 With the object of exploiting the geothermal resources to the fullest, NPC is studying, with the assistance of consultants, the technical and economic feasibility of interconnecting the transmission systems of several of the islands of Visayas (Cebu, Negros and Panay); NPC should also study the possibility of supplying Cebu from Leyte by means of a submarine cable (see para. 3.21). Another possibility under study is interconnection between Leyte and Luzon with a 330 km overhead transmission line, with about 21 km of undersea cable across the San Bernardino strait. Development of the hydroelectricity resources in the northern part of Luzon (Gened and Chico IV) will call for an extra high voltage transmission system (400-500 kV); it is therefore recommended that consideration be given in the feasibility study to: (a) the possibilities for multiregional interconnection (Luzon-Leyte and Mindanao, Luzon-Leyte, and Leyte-Mindanao), with a view to optimizing the utilization of local energy resources; and (b) determining whether these interconnections would be economically feasible and, if so, in what year their construction would be justified.

1.08 The Palimpinon /1 geothermal project is located in the southeastern part of the island of Negros and has a production capacity of some 115 MW. The field, located in a very difficult mountainous area, is in an advanced stage of development. NPC is in process of installing two pilot 1.5-MW units which will be completed in 1981 and plans to build three 37.5 MW units for commissioning in the mid-'80s. This region offers a very important potential electricity market because of the existence of a number of mines which generate their own electricity, of which the Marinduque Mining Corporation is the largest, generating about 130 GWh a year largely from oil fired units.

1.09 In June 1978, Government Decree No. 1442, which regulates geothermal activities in the Philippines, was promulgated as a law. The new law introduced the system of service contracts for geothermal operations, under the supervision of the Bureau of Energy Development. Under this system the contractor provides all the necessary services, including the technology and financing, for the development of the geothermal fields. The contractor is authorized by this law to receive as compensation for his services a payment not exceeding 40% of the gross value of the geothermal resources after deducting operating expenditures. Since NPC does not contribute funds for development of the Tongonan and Palimpinon fields, it is estimated that the price of the steam will exceed that paid at present to PGI. It is also assumed that the charge for the steam would be all in Pesos.

/1 Sometimes spelled with an "n", i.e., Palinpinon.

Hydroelectric Resources

1.10 The Philippines is well-endowed with hydroelectric resources in Luzon and Mindanao. The economically-harnessable hydroelectricity potential is estimated at over 7,000 MW, of which only 11% (803 MW) is at present developed. With the assistance of consultants, NPC has prepared an inventory of potential hydroelectric resources comprising more than 30 possible developments; at present it has about 10 prefeasibility studies either in preparation or completed, some of which have reached the advanced feasibility and basic engineering design stages. The Bank has financed a number of these studies through the loans for the Fifth and Sixth Power Projects (Loans 809-PH and 1034-PH). ADB has also provided technical assistance for the study of part of the hydroelectric potential in Mindanao (Loan 291-PH).

1.11 Mindanao has a hydroelectric potential in excess of 2,000 MW, with a high utilization factor, which would permit an annual production of firm energy of the order of 10,000 GWh. Most of the potential hydroelectric stations are of the run-of-river type, with a low unit cost (average US$700/kW) and with construction times of not more than five years. Because of these highly favorable conditions the system of electricity generation in Mindanao will have to be based, in the medium-term, almost exclusively on this type of plant, supplemented by some thermal capacity to back up the system during the dry season. This is not the case in Luzon, where most of the hydroelectric projects are of the multipurpose type (irrigation, flood control, water supply, etc.), with a high capital cost for the electricity component (about US$2,000/kW) and with long construction periods (up to eight years). Generally speaking, most of these projects have low utilization factors (around 31%) and small reservoirs, and electricity production would be limited by irrigation. Most of the Luzon projects could serve only as peaking plants; their justification will depend not on their simple availability as a domestic substitute for oil units but on a comparison of their generating costs with the costs of alternative peaking units. The supply of peaking power from storage hydro can be very costly unless the high capital costs of dams can be shared with non-electricity purposes.

Coal Resources

1.12 The Government's goals in its ten-year energy plan (1980-89) provide for coal production of 6 million tons a year from 1989 onwards. Production was 270,000 tons in 1979, 329,000 in 1980, and about 370,000 in 1981. If achieved, the projected coal production in 1989 would be more than sufficient to cover the needs of the domestic market, including conversion of the cement plants to burn coal (1.8 million tons), and to supply the coal-fired electricity plants programmed by NPC (1,025 MW using about 2.6 million tons of coal in 1989). However, the mission's analysis suggests that a production target of 2.5 million tons by 1989 would be more realistic./1 Accordingly, the Government would have to import a substantial part of the coal needed to supply the electricity sector. In any event, since the price of imported bituminous coal is expected to remain 30-40% below the price of heavy residual for the same calorific value, the Government will gain an important saving in foreign exchange through the subtitution of oil by imported coal.

/1 Subsequent developments suggest that the mission's mid-1980 estimate may turn out to be on the low side; a range of 2.5-3.5 million tons by 1989 now seems possible.

The present price of local coal, with an average calorific value of 4,750 kcal/kg, is US$40.00/ton, which is about equal to the c.i.f. price of Australian coal with a calorific content of 6,500 kcal/kg (US$55/ton).

Uranium

1.13 Exploration of uranium resources began in the Philippines in 1976 following a decision by the NPC to build its first nuclear power plant. The exploration activities are concentrated mainly in the area of Larac, Camarines Norte, southern Luzon and the island of Samar (Visayas). The drilling program, was started in Larac, under license by two private enterprises, Getty Mining and Benguet Consolidated under the supervision of the Bureau of Mines. A reserve of 500,000 tons of ore with a very low mineral content, equivalent to about 200 tons of uranium has been identified. The reconnaissance operations in Samar, which are at a less advanced stage, have also indicated the possible existence of uranium ore with a potential superior to that of Larac. Other areas of the country, Ilocos Norte and Davao, will also be explored. The Government expects to obtain technical and financial assistance from the Australian Government for implementation of an exploration program.

1.14 The 620-MW nuclear power plant, located in Bataan-Luzon, was originally scheduled to come on stream at the end of 1982. The work was suspended in June 1979 after a decision by the Government to re-examine the safety aspect of the power station; following this the US Nuclear Regulatory Commission suspended the export license until last May. As a result, the entry of the power station into commercial service is now scheduled for the beginning of 1986. The revised cost, including transmission lines, initial fuel loading, contingencies and interest during construction would now be of the order of US$1,800 million compared to the original estimate of US$1,050 million.

1.15 The Philippines is paying a very high financial price for its first nuclear development. The possibility should not be discarded, however, of other nuclear power plants being built in the second half of the decade if, as we think likely, nuclear energy proves less costly than fossil energy in the Philippines.

2. EXISTING FACILITIES

(a) Grids and Interconnections

2.01 The electricity facilities of the Philippines consists of eight isolated subsystems: one in Luzon, where practically 85% of the networks are interconnected; six in Visayas in an early stage of development (Samar, Leyte, Bohol, Cebu, Negros and Panay), and one in Mindanao, where less than 30% of the region is interconnected. NPC is primarily responsible for the development of electricity generation and transmission in the country. The franchise for distribution of power in the greater Manila area is held by

MECO. Power distribution in the rest of the country is undertaken by privately or municipal government-owned utilities and some 120 electric cooperatives organized under the aegis of NEA.

Luzon Grid

2.02 The interconnected system of Luzon includes more than 95% of the installed capacity of the region and generates about 80% of the electrical energy produced in the country. NPC's network covers practically all areas of the region, with the exception of the Cagayan Valley and a few mountainous provinces in northern Luzon, some of which will be integrated into the interconnected network in 1981/82 when work on the transmission system now under construction is completed. NPC supplies almost all of the electric power in Luzon since it acquired the majority of the power plants of MECO at the end of 1978; the remainder is supplied by small private electricity enterprises and electricity cooperatives. The total installed capacity in Luzon was about 3,000 MW in 1979: hydro plants 540 MW (18%), steam and diesel thermal plants 2,230 MW (74.6%) and geothermal plants 220 MW (7.4%).

Visayas Grid

2.03 The Visayas region consists of six main islands - Cebu, Negros, Panay, Leyte, Samar and Bohol - and a number of small islands. The power development of the region has been markedly slow; with the exception of Cebu, where annual per capita electricity consumption is 198 kWh, the islands have a marginal electricity consumption: Bohol 9 kWh, Negros 17 kWh, and Leyte 23 kWh. Electricity service in the region has been provided mainly by small local electricity enterprises which serve the larger urban centers. Also, the sugar mills and the mining enterprises provide electricity service to the neighboring communities.

Mindanao Grid

2.04 NPC supplies approximately 45% of the electricity consumed in Mindanao; the remaining 55% is supplied by small electricity enterprises, cooperatives and industrial captive plant at high costs. NPC serves 26 customers; including 10 electricity enterprises and cooperatives and 16 industrial enterprises. Demand in the region is presently restricted and there is an urgent need for NPC to expand its generating and transmission facilities so that an adequate supply of energy can be provided.

(b) Electricity Generation

2.05 At the end of 1979 the installed generating capacity of the public sector was about 4,039 MW, comprising 19% hydro, 75% oil-fired steam and diesel and 6% geothermal. Electricity generation was almost 15,300 GWh, of which 72% was generated by oil-fired steam and diesel stations. NPC generated 91% of the energy and operated 86% of the sector's installed capacity. Captive generating plant (industries, mines and sugarmills) accounted for 600 MW or more; captive plus private utility capacity is about 30% of NPC capacity.

Table 2: SECTOR INSTALLED CAPACITY AND POWER GENERATION (1979)

	Capacity (MW)				Generation (GWh)			
	Hydro	Thermal	Geo-thermal	Total	Hydro	Thermal	Geo-thermal	Total
1. Public Service	811	2,920	223	3,954	3,512	10,967	800	15,279
NPC	807	2,061	223	3,091	3,500	9,582	800	13,882
MECO	-	305 /a	-	305	-	-	-	-
Cooperatives	-	182	-	182	-	557	-	557
Other utilities	4	372	-	376	12	828	-	840
2. Self-Producers	-	600 /b	-	600	-	1,799	-	1,799
3. Total	811	3,520	223	4,554	3,512	12,766	800	17,078
Percentage (%)	17.4	77.8	4.8	100.0	20.6	74.8	4.6	100.0

/a The Rockwell power station is operated by NPC.

/b Estimated to be operated by industries and sugar mills.

2.06 NPC's generating capacity expanded rapidly from November 1978 with the transfer of ownership of all the steam power stations of MECO (1,700 MW), with the exception of the oldest power station, Rockwell (305 MW), which NPC has taken on lease and will operate until 1983. According to NPC, the nominal capacity of some of these power stations is reduced by more than 30% because of improper preventive maintenance in the past and boiler problems. During 1979 the frequent withdrawal from service of some of these units resulted in the introduction of electricity rationing in the Luzon system. Consequently, NPC has started a program of rehabilitation of these power plants, which is expected to be completed in 1982. This program will yield a substantial improvement in terms of continuity and reliability of the service.

2.07 The following table summarizes NPC's installed generating capacity by region and type of plant. Details are shown in Appendix 1.

Table 3: NPC - INSTALLED GENERATING CAPACITY (1979)
MW

	Luzon	Visayas	Mindanao	Total	%
Hydro	543	2	262	807	26
Oil thermal	1,925	-	-	1,925	62
Coal thermal	-	10	-	10	-
Diesel	5	88	33	126	5
Geothermal	220	3	-	223	7
Total	2,693	103	295	3,091	100
Percentage (%)	87	3	10	100	

(c) Transmission

2.08 The electricity transmission system in the Philippines belongs to NPC, with the exception of the few lines owned by the private electricity enterprises and those that the electricity cooperatives have built in the areas where NPC is not yet providing the electricity service. In 1979 NPC had about 5,200 km of transmission lines in operation as shown below. A further 3,760 km of line between 69 kV and 230 kV is under construction and will enter into service during 1980 and 1981.

Table 4: NPC TRANSMISSION LINES (km)

	Luzon	Visayas	Mindanao	Total	%
230 kV	1,526	-	-	1,526	29.5
115/138 kV	500	78	490	1,068	20.7
69 kV	1,713	350	503	2,566	49.8
Total km	3,739	428	993	5,160	100.0

3. THE TEN-YEAR POWER EXPANSION PROGRAM (1980-89) /1

3.01 The electric power expansion program for 1980-89, which forms part of the ten-year energy program of the Ministry of Energy, calls fòr a drastic reduction in oil dependance (72% of generation from oil in 1979 to 20% in 1989). This would be achieved through accelerated development of the country's own energy resources: coal, geothermal and hydro; the use of cheaper imported energy (coal and nuclear), and early withdrawal from service of some of the oilburning steam plants that NPC acquired from MECO at the end of 1978. In addition to the ongoing projects, the program includes the installation of a substantial coal-fired thermal and geothermal capacity in Luzon and Visayas and hydro capacity in Mindanao to handle the base load, in addition to operation of the multipurpose hydro plants in Luzon to meet peak loads.

3.02 The program of expansion of electricity generating facilities provides gross additions of 6,868 MW, comprising the projects under construction (3,004 MW), new projects (3,864 MW) and the withdrawal from service of some 1,460 MW of thermal capacity in Luzon and of a number of diesel sets in Visayas and Mindanao. Included in the new projects is the incorporation of some 405 MW in small 3-MW "dendro-thermal" plants and mini-hydro plants between 10 kVA and 1,000 kVA to be installed by NEA. The following table shows the proposed increase in installed capacity, by regions, up to 1989:

/1 This section is presented by comparing the power program contained in the Ten-Year Program of January 1980 (the one being proposed at the time of the mission) with the program recommended by the mission on the basis of a detailed review of system needs and investment alternatives. As noted in para. 3.14, the original program has been superceded by two major revisions -- an Accelerated Program published in mid-1980 and an Adjusted (accelerated) Program issued in the summer of 1981.

Table 5: PHILIPPINES - PROPOSED ADDITIONAL CAPACITY (1980-1989)

	Luzon	Visayas	Mindanao	Total
Hydro	1,992	108	1,145	3,245
Diesel	-	183	202	385
Steam/coal	600	275	150	1,025
Geothermal	660	528	-	1,188
Nuclear	620	-	-	620
Subtotal	3,872	1,094	1,497	6,463
Nonconventional	324	61	20	405
Total (MW)	4,196	1,155	1,517	6,868
Percentage (%)	61	17	22	100
Retirements (MW)	1,355	46	59	1,460
Net Added (MW)	2,841	1,109	1,458	5,408

About 60% of the added capacity would be installed in Luzon, 17% in Visayas and 23% in Mindanao.

3.03 NPC's program for expansion of its transmission networks up to 1989 includes the construction of some 9,422 km of new transmission lines as detailed below:

Table 6: PHILIPPINES-PROPOSED EXPANSION OF TRANSMISSION (1980 - 1989)

	EHV	230 kV	115/138 kV	69 kV	Total
Luzon	387	2,455	190	1,403	4,435
Visayas	-	-	812	1,253	2,065
Mindanao	-	-	1,525	1,397	2,922
Total	387	2,455	2,527	4,053	9,422

3.04 The electric power expansion program would require capital expenditure of US$9.3 billion at 1979 prices, of which 72% would be in foreign currency. The power sector would absorb 67% of the total capital expenditure provided for in the Energy Development Plan for this decade, estimated at some US$13.3 billion. The planned investment of the electric power sector up to 1989 does not include the initial capital expenditure on electricity projects scheduled to enter into service during the early years of the next decade. Since NPC is primarily responsible for implementation of this ambitious electric power expansion program, it is going to have to bear a heavy technical and financial burden during this decade.

3.05 The mission's comments /1 on the proposed program are summarized as follows:

(a) The early withdrawal from service of certain oil-fired steam plants recently acquired from MECO for replacement by other types of generation for the sole purpose of reducing oil imports (see para. 3.01 above) is not recommended, since it is not a least-cost solution. Year-by-year computer analysis of system options shows that it will be cheaper to retain these existing oil-fired units in service, operating them at progressively higher points on the load curve as NPC's already-planned new non-oil-fired units come on stream during the decade. The gradual reduction in use of today's oil-fired units will result in about 25% less oil use in power generation in 1989 compared to 1979 (see Table 1 and para. 3.11 ff.);

/1 These comments were made in mid-1980 on the basis of oil prices being paid by NPC as of January, 1980. Subsequent increases in the price of oil have modified the statements made in sub-paragraphs (a) and (b). For the Bank's updated judgment, see paragraphs 3.11-3.12 below.

(b) In addition to being uneconomic (i.e. not a least-cost solution), an acceleration in NPC's investment program solely to permit early retirement of oil-fired units in the Luzon grid would seriously hurt NPC's already precaurious financial situation. NPC is not yet able to service even its existing debt; it appears unable to make any contribution of its own to the financing of even those new investments to which it is already committed. Additional investment in retirement-motivated generating capacity, and in the additional extra high voltage transmission network that would have to go with it, could only worsen NPC's weak financial situation;

(c) The optimization study of the next voltage level for the extra high-tension transmission system (400 kV or 500 kV) in Luzon should also cover the technical and economic feasibility of interconnection with Leyte and Mindanao in order to optimize the future development of the huge geothermal and hydro resources of those regions. In the event that those interconnections are justified, the study should define the optimum timing for them;

(d) NPC should adopt a horizon of at least 15 years for definition of the ten-year investment program, bearing in mind that: (i) some of the projects to be executed in the future will take about 10 years between the decision-making and implementation; and (ii) projects that will enter into service in the early or middle 1990s will call for initial capital expenditures in the mid-1980s; these costs should be included in the annual capital expenditure program;

(e) Exploration of the potential geothermal fields on Luzon should be stepped up since, if they are commercially productive, NPC could have available from 1987/88 an additional geothermal capacity which would enable it to meet any increase in demand above that now foreseen;

(f) The possibility should not be rejected of installing further nuclear power plants in Luzon in the 1990s to meet part of the base load of the system. The present proven geothermal resources of the region are equivalent to only one nuclear power plant of the size now under construction (620 MW), and the country's coal resources would not suffice to meet the needs of the planned coal-burning thermal plants. In addition, if the present trend of the prices of fossil and nuclear fuels continues unchanged, it is almost certain that nuclear energy will be cheaper than either oil or coal (see Appendix 2). However, capital costs for future nuclear plants will need to be much more closely controlled than the first plant;

(g) The technical and economic feasibility should also be studied of an interconnection between Leyte (to harness the abundant geothermal resources there) and Cebu, with a view to tieing the islands of Cebu, Negros and Panay together by 1985-86; and

(h) Finally, with the object of achieving economies of scale from the investments and obtaining maximum benefits from the joint operation of the systems, NPC and NEA should maintain a permanent working group to study, and agree on the geographical areas of the country in which non-conventional plants (dendro and mini-hydro) would be most economical. At the beginning, the installation of such plants should be discouraged in those areas of Luzon that now have electricity service or where it is planned to provide it soon; their construction should be considered in other regions that do not yet have electricity service.

The Recommended Program

3.06 The ten-year plan for power as published in the MOE's Ten-Year Energy Program was subsequently overtaken, in 1980, by more detailed planning by NPC and extensive discussions between NPC and the Bank. The latter reached substantial agreement on the composition and timing of all major projects in NPC's generating program; this is referred to as "the recommended program", shown in outline in Table 7 and in detail in Appendices 3, 4 and 5. The "proposed program", with which the recommended program is compared, refers to the program as published in the 1980 edition of the Ministry's Ten-Year Energy Program. The recommended program would add some 2000 MW less new capacity to the NPC system and will save the country some US$2.8 billion in capital costs. In mid-1981, NPC's continuing interest in reducing oil consumption led to new calculations on the desirability of interconnecting Luzon and Leyte to gain early access to the Tongonan geothermal resources. The result was the proposal of a new Adjusted Power Program, substantially larger than the previously-agreed "recommended program". The Bank set up an internal Task Force to review the new proposals; its conclusions were that the economic (i.e., least-cost) differences among five programs tested were negligible and that the choice of investment program ought to be made on financial, managerial, and technical considerations (essentially those reflected in para. 3.05 above). Continuing discussions to define an agreed investment program will take place in 1982 as part of an energy component in an expected Structural Adjustment Loan. The capacity of the nonconventional plants has not

Table 7: RECOMMENDED GENERATING EXPANSION PROGRAM (1980-1989)
(MW)

	Luzon	Visayas	Mindanao	Total
Hydro	672	77	714	1,463
Diesel	-	193	225	408
Steam/coal	600	220	-	820
Geothermal	330	265	-	595
Nuclear	620	-	-	620
Total	2,222	745	939	3,906
Retirements	305	55	59	419
Net added	1,917	690	880	3,487

been included in this program because it is analyzed in Annex 7. Separate analyses are given below of each of the regional power systems, including comparisons between the NPC proposed (1/80) and the Bank-recommended program.

Luzon Grid

3.07 Electricty consumption in Luzon grew rapidly in the 1960s, at an average annual rate of 13.5%; the growth rate since 1969 has declined. Average annual growth of demand was 8.1% between 1969 and 1973, practically zero between 1973 and 1974 and up again to 8% between 1975 and 1979. Over the period 1970-79, the average rate was 7% a year. The slow down in the growth of electricity demand was due in part to the adverse affects of the oil crisis in 1973-74 on the country's economy, and to the Government's policy of promoting the location of new industry on the other islands.

3.08 NPC has projected the average growth of demand over the period 1980-89 at 7%. Maximum demand is expected to rise from 1,960 MW in 1979 (corrected to take account of rationing during that year) to some 3,850 MW in 1989, and electricity generation from 12,010 GWh to 23,740 GWh. The expansion program up to 1989 is therefore based on these demand and energy estimates. However, MECO estimates that the growth of demand would be slightly higher (about 8%) because industrial demand would be greater than expected by NPC and the load factor would be lower than the 70% figure assumed by NPC. In any event, taking into account the energy conservation measures recently adopted by the Government (rate increases of 31% and a progressive tax on residential consumption above 650 kWh), growth of electricity demand will very probably remain less than 8%. However, NPC should review jointly with MECO its demand estimates from time to time in order to adjust planned investment to the development of the power market.

3.09 The proposed expansion program /1 includes the construction of new generating plants totalling 3,872 MW (geothermal plants 660 MW; coal-fired thermal plants 600 MW; nuclear plant 620 MW; and hydro plants 1,992 MW) and the withdrawal of 1,355 MW in oil-burning thermal plants, giving a net incremental capacity of 2,517 MW. About 1,620 MW of the total of 3,872 MW is under construction and scheduled to come on stream between 1980 and 1986. The NPC ten-year construction program (1980-89) is as follows:

/1 I.e., the January, 1980, Ten-Year Program.

Table 8: PROPOSED LUZON GRID-NPC GENERATING EXPANSION PROGRAM 1980-1989

Year	Project	Type	Capacity (MW)
	(a) Projects Under Construction (1,622 MW)		
1980	Tiwi 3-4	Geothermal	110
	Mak-Ban 3-4	Geothermal	110
1981	Masiway	Hydro	12
1982	Tiwi 5-6	Geothermal	110
1983	Kalayaan 1-2	Pumped storage	300
1984	Magat 1-2	Hydro	180
1984	Magat 3-4	Hydro	180
1986	PNPP-1	Nuclear	620
	(b) Proposed Additions (2,250 MW)		
1984	Steam 1	Coal	300
1985	Geothermal 1-4	Geothermal	220
1986	Steam 2	Coal	300
	Magat 5-6	Hydro	180
1987	San Roque 1-2	Hydro	260
1988	Geothermal 5-6	Geothermal	110
	Gened 1-3	Hydro	300
1989	Gened 4-6	Hydro	300
	Kanan	Hydro	280
	(c) Proposed Retirements (1,355 MW)		
1983	Rockwell 1-8	Oil-fired steam	305 /a
1984	Gardner 1-2	Oil-fired steam	350
1986	Snyder 1-2	Oil-fired steam	500
1989	Tegen 1-2	Oil-fired steam	200

/a MECO's power plant.

The program also provides for expansion of the transmission networks by a total of some 4,400 km of transmission lines of various voltages and the expansion and installation of new substations with a transformer capacity of nearly 4,600 MVA (see Table 6).

3.10 The proposed expansion program for Luzon,/1 which reflected the Government's policy of reducing oil consumption and making maximum use of indigenous energy reoources, was extremely costly and practically impossible to implement fully by the scheduled dates. Apart from the geothermal plants under construction (Tiwi 3-4 and Mak-Ban 3-4, scheduled for completion in 1980, and the expansion of Tiwi 5-6, scheduled for 1982), it was planned to construct an additional 220 MW of geothermal by 1985 and another 110 MW by 1988 at unspecified locations. Since the exploratory work in the various areas of the region having prospects of commercial geothermal resources was in the initial stages, the installation of the additional geothermal capacity by 1985 was not considered possible. Also, implementation of the San Roque multipurpose hydroelectricity project (260 MW) by the end of 1986 was considered to be very difficult since the area has a wet season of at least seven months a year and the proposed rock-filled dam, with a volume of almost 50 million cu m (the third largest in the world), would have an impervious core of some 11.0 million cu m which can only be placed in the dry season.

3.11 The attractiveness of retiring existing oil-fired steam plants has been quite delicately balanced around relative fuel prices, which have changed significantly over the past two or three years. For example, two years ago NPC stated its intention to retire the following base-load oil plants: Gardner 1-2 (350 MW) in 1984, Snyder 1-2 (500 MW) in 1986, and Tegen 1-2 (200 MW) in 1989. These were to be replaced by new coal-burning, thermal, geothermal, or hydro plants, all involving major investments. The attractiveness of such accelerated replacement at then-existing prices appeared questionable, however. The reason is that even though the cost of fuel per kWh for the oil-fired plants was approximately 1.80 times the cost of burning coal, and 1.87 times that of geothermal steam, the total cost of the system over the long term (capital costs plus operating costs) would have been lower if the existing oil-fired units had been retained in service, gradually moving to higher positions on the load duration curve (and hence reducing their oil use) as new non-oil plants were added to the system to meet load growth. These relationships are shown below in Table 9, constructed on the basis of prices in effect on January 1, 1980.

/1 Again, see fn. 1, p.14.

Table 9: THERMAL POWER PLANTS
Annual Cost (US$/kW-year)

Plant factor %	0	25	50	57	75	81
Hours	0	2,190	4,380	5,000	6,570	7,100
Coal-fired units	129.8	173.6	217.4	230.1	261.2	271.8
Geothermal units	135.0	177.0	219.0	230.9	261.1	271.3
Existing oil-fired units /a	14.6	104.8	194.9	220.4	285.0	306.8

/a Capital costs are considered to be "sunk" or fully paid for; they are therefore excluded.

3.12 One year later (January 1, 1981) the situation had changed significantly. All costs had increased, but the increase in the cost of oil was much greater than those for coal or for the capital costs of replacement facilities. The new cost relationships are shown in the table on p.2, Appendix 2, in this Annex. Whereas Table 9 shows existing oil-fired plants yielding lowest system costs up to an operating rate of just over 60% (significantly higher than the average plant factor of thermal stations over their normal life), the Appendix table shows that by January, 1981, existing plants held their attractiveness only up to a plant factor of about 45%, significantly lower than average lifetime utilization rates for base-load steam plants. Thus, on the basis of generating costs alone, the "second oil shock" of 1979 (which did not get reflected in NPC's oil costs until after January 1, 1980) converted what appears to have been a poorly- into a better-justified economic case for accelerated retirement of existing oil-fired plants.

3.13 Static comparisons of generating costs alone are not sufficient to justify an investment program, however. In the fall of 1981 the Bank carried out a present-value analysis of alternative power programs, using not only generating but total system costs. The result showed no significant difference in the present-value costs of the five leading investment programs tested (discount rates of 12 and 14% were used). This result showed that the investment decision should be made on grounds of financial, managerial, and technical considerations, because the normal least-cost analysis had not identified any clearly-preferable alternative.

3.14 As noted in the Preface to this Annex, NPC's Ten-Year-Plan investment program was superceded in August, 1980, by an Accelerated Program; this was in turn superceded a year later by an Adjusted Program. The latter still cannot be considered firm (see paras. 4.01-4.02).

The Recommended Power Expansion Program for Luzon Grid

3.15 The suggested program,/1 which constitutes the least cost solution to meet the increased demand of the system up to 1989, is based on keeping in service all of the existing oil-fired plants except Rockwell, only two 300 MW coal-fired steam power plants, to enter into service in 1987 and 1989 respectively, plus the already-committed geothermal, hydro and nuclear plants (see Appendix 3). The site selected by NPC in Batangas for the first two coal plants is suitable and will require only a relatively low investment to connect the generating stations to the network (US$16 million).

3.16 The two new coal-fired plants would have a capital cost of some US$450 million, with a foreign-exchange component of approximately US$350 million and a local currency component of US$100 equivalent, at 1980 prices. NPC's basic power expansion program calls for the construction of two 300 MW coal-fired plants to be commissioned in 1984 and 1985 and the expansion of Magat hydro plant by the addition of two 90 MW units in 1985 (Magat 5 and 6), plus already-committed projects (2,250 MW). NPC has recently agreed not to install Magat 5 and 6 until both the future Gened hydro project (600 MW) and its associated extra high voltage system are built. The contribution of energy from Magat 5 and 6 will be small, but the related transmission system required to interconnect it to the grid would cost more than US$40 million. The early commissioning of the two coal-fired units is now justified in the light of oil price increases that have occurred since January, 1980 (about 20%).

Visayas Grid

3.17 In the mid-1970s, NPC began to participate in a regional electricity program in furtherance of the Government's objective of stepping up the industrial development of the region and extending electricity service to the rural areas. The initial program consisted of the installation of a centralized electric power system on each island, with diesel units to meet the growth of demand of the existing consumption centers and for the development of new areas. These systems would be expanded in due course with the installation of geothermal and coal-burning plants in order to make maximum use of the abundant local energy resources.

3.18 The region's total installed capacity is some 240 MW, shared almost equally among NPC, the cooperatives and the private enterprises. NPC's sales have grown very rapidly since 1976, from 10 GWh in that year to 24 GWh in 1979; however, they are still low in relation to the region's total consumption (870 GWh) because of insufficient generating capacity and transmission facilities. The analysis of the regional electricity market, prepared by NPC, projects an average annual increase of 15% for power demand and 15.5% for energy over 1980-89. Peak demand, which was 150 MW and 870 GWh in 1979, would rise to some 610 MW and 3,810 GWh by the end of the decade.

/1 I.e., as worked out in mid-1980. Based on prices ruling in January, 1980, it aims only at meeting load-growth, with no extra investment to accelerate retirement of oil-fired units.

3.19 The Ten-Year Program provides for the construction of a total of 23 electric power stations with an aggregate capacity of 1,093 MW; geothermal plants, 528 MW, coal-burning plants, 275 MW, diesel plants, 182 MW; and hydro plants, 108 MW; and the withdrawal of 46 MW in diesel plants (see Table 10). The Program includes the construction of some 360 km of 138 KV transmission lines and 1,274 km of 69 KV lines, in addition to interconnection of the subsystems of Panay, Negros and Cebu with some 300 km of overhead 138 KV lines and 23 km of submarine cable.

3.20 At the beginning of 1980 NPC revised the expansion program and eliminated certain projects which are not required to meet the projected demand up to 1989. The new program provides for the construction of a total of 17 power plants with an aggregate capacity of 802 MW (geothermal plants, 303 MW, coal-burning plants, 275 MW, diesel plants, 184 MW, hydro plants, 40 MW, and the withdrawal of 38 MW in diesel plants. The revised expansion program shown in Appendix 4 is adequate to meet the growth of electricity demand up to 1989.

Table 10: VISAYAS GRID - PROPOSED GENERATING EXPANSION PROGRAM
1980-1989

Projects Under Construction (466 MW)				Proposed Additions (627 MW)			
Year	Project	Type	Capacity (MW)	Year	Project	Type	Capacity (MW)
Cebu				Cebu			
1980	Naga I	Coal	55	1984	Naga II	Coal	55
1981	Cebu II	Diesel	54				
1982	Power Barge	Diesel/a	32				
Negros				Negros			
1981	Power Barge	Diesel	32	1985	Negros I	Coal	55
	Palimpinon	Geo	3	1987	Bago HE	Hydro	60
1982	Sipalay	Diesel	36	1988	Negros II	Coal	55
1983	Palimpinon	Geo	112.5	1989	Mambucal	Geo	37.5
Panay				Panay			
1980	Dingle	Diesel	29.2	1984	Panay I	Coal	55
Samar-Leyte				Samar-Leyte			
1981	Power Barge/a	Diesel	32	1984	Tongonan 4-5	Geo	75
1982	Tongonan 1-3	Geo	112.5	1985/87	Tongonan 6-8	Geo	112.5
				1987	Catubig	Hydro	30
				1988/89	Tongonan 9-10	Geo	75
				Bohol			
				1988	Upper loboc	Hydro	17.5

Proposed Retirements (46 MW)

Year	Central	Type	Capacity (MW)
1981	VECO	Diesel	9
1983	VECO	Diesel	13
1984	Bocolod	Diesel	9
1988	VECO	Diesel	15

3.21 Since the electricity systems of Cebu, Negros and Panay would be interconnected in 1985, it is recommended that NPC also study the feasibility of connecting those networks with Leyte by means of a 138-kv undersea cable in order to take advantage of the high surplus geothermal potential in Tongonan, with the consequent reduction in oil consumption. This would also permit the Tongonan geothermal plant to operate with a more uniform load, thereby reducing the fluctuation to which it would be subjected during the initial years owing to the fact that the major load in Leyte would be that of the copper smelter (60 MW).

Mindanao Grid

3.22 Over the period 1972-78 NPC energy demand grew at an average annual rate of 19%. In 1978 maximum demand reached 174 MW, and generation 1,045 GWh. At the beginning of 1979 NPC estimated the average annual rate of growth of demand up to 1989 at 17%, assuming that in the future it would be responsible for all electricity supply in Mindanao. It was estimated that over the period 1979 to 1989 maximum demand would increase from 239 to 1,183 MW and electricity generation from 1,437 to 7,577 GWh. In order to meet the expected demand growth, NPC's electric power expansion program, as shown in the Ten-Year Energy Program for the years 1980-89, provides for the construction of some 1,517 MW in generating capacity and some 2,900 km of transmission lines. The generating capacity program comprises the addition of 1,145 MW in hydro plants, 150 MW in coal plants, and 202 MW in diesel sets. The program also provides for the withdrawal of diesel plants totalling 59 MW (see Table 11). The transmission system includes about 1,500 km of 138 kV line and about 1,400 km of 69 kV line. Upon completion of the program in 1989, an extensive transmission network would be in operation in Mindanao, with almost all load centers interconnected.

The Recommended Program

3.23 Energy demand in 1979 was lower by 20% than that projected: 195 instead of 239 MW, and 1,138 instead of 1.437 GWh in part due to delays in construction of the power facilities. NPC, recently revised the energy forecast up to 1989, adopting an annual rate of growth of 15%, on the assumption that industrial development would be less rapid and that some industrial enterprises to be located in the region would have their own generating facilities. The program of expansion of electricity generating facilities that the mission recommends is reduced to the current projects under construction (916 MW) included in Table 11. This program as shown in Appendix 5 is derived from the hydrological conditions for firm power and energy from the hydro stations and the demand forecasts assumed by NPC. The mission has recently revised the expansion program for Mindanao using the latest version of the WASP Program (WASP III) supplied by the International Atomic Energy Agency (IAEA) in October, 1981. The study has been extended to 1995; the result shows that with the current projects under construction

(916 MW) the system would not require additional capacity in this decade, either for the load forecast adopted by the Bank or the higher load forecast adopted by NPC in its revised power expansion program (basic program), as shown below.

THE REVISED POWER EXPANSION PROGRAM
1980-1989

Year 1989	Bank	NPC
Maximum demand (MW)	804	915
Installed Capacity (MW)	1,211	1,211
Available capacity (MW)	1,124	1,119
Maintenance space (MW)	320	204
Reserve capacity (MW)	320	188
Reserve system (%)	39.8	20.5

Electricity Loads not Provided for in NPC's Forecast

3.24 In 1979, Reynolds Aluminum (USA) discussed an agreement with the Government for the installation in Mindanao of an aluminum smelter which would have an initial production capacity of 70,000 tons from 1983 onward and a final capacity of 140,000 tons from 1984. The electricity demand would be approximately 125 MW and 985 GWh for the first stage and 250 MW and 1,950 GWh a year for the final stage. The price proposed by Reynolds of US$mills 20/kwh would be subject to approval by NPC. This industrial load was not included in the revised forecasts of electricity demand.

Table 11: MINDANAO GRID - PROPOSED GENERATING EXPANSION PROGRAM 1980-1989

Year	Project	Type	Capacity (MW)
Projects Under Construction (916 MW)			
1980	Davao	Diesel	36
	Aplaya II 1-3	Diesel	56
	Agus II	Hydro	120
1981	Aplaya II 4-6	Diesel	56
1982	General Santos 1-3	Diesel	22
	Power Barge 1-4	Diesel	32
1983	Agus VII	Hydro	54
	Agus I	Hydro	80
1984	Agus V	Hydro	55
	Agus IV	Hydro	150
1985	Pulangui IV	Hydro	255
Proposed Projects (581 MW)			
1986	Steam	Coal	150
1987	Agus III	Hydro	225
1988	Pulangui III	Hydro	136
1988	Pulangui II	Hydro	70
1989			
Proposed Retirements (59 MW)			
1985	DLPC	Diesel	59

3.25 The aluminum production timetable as stated above looks much too optimistic for both the initial and ultimate targets. For a production of 70,000 tons of aluminum a year, no additional generating capacity would be needed up to 1990. On the other hand, for an annual production of 140,000 tons, the system would have to be expanded in 1988 by about 150 MW (probably thermal) in view of the high utilization factor (90%) of the aluminum plant. NPC should carefully study the location of such a future thermal plant in order to reduce the capital investment in transmission and to minimize losses in the system.

4. CONCLUSION

4.01 As noted, during the past two years the Government has announced at least three different power investment programs for the 'eighties. While this degree of flexibility reflects a laudable determination to find an optimum expansion-path for the industry, there is considerable room for improvement in NPC's approach to system planning. The Government is aware of some of the weaknesses in its power programming, and is attempting to overcome them. It is also true that in the Philippines, as in most countries, power-system planning has become more difficult as a result of the rapid and large changes in energy prices during the past decade. The situation in the Philippines is made doubly difficult by the relatively rapid rate of discovery of new domestic resources (mainly geothermal and coal) that must be evaluated and taken into account in developing a least-cost power investment program. The changes in both the international and national circumstances have surrounded long-term plans with considerably more uncertainty than they have had in the past.

4.02 System planners can deal with the new uncertainties if they recognize the three main elements that underlie sound planning in any public power system. These elements are: (i) the setting of objectives, (ii) deciding how much money will be made available (fixing the investment budget), and (iii) preparing a list of specific projects that appear most attractive at the time the list is drawn up (the list will change somewhat as new possibilities are identified and as major price changes redefine least-cost programs: the only firm projects in a long-term program are those for which irrevocable investment decisions have been made). It is easier to identify the key elements in planning than it is to get governments and banks to produce clear answers to the questions they raise. Part of the difficulty is that the questions must be answered simultaneously, because "everything depends on everything else." The choice of sector objectives (e.g. just meeting load growth, or meeting load growth plus accelerating the displacement of oil-based units, or increasing system reliability) may depend in part on how much money the sector is given. The investment budget, in turn, may depend on how strongly the Government wishes to pursue certain objectives, both within the sector and in relation to needs in other sectors. And the number and types of projects put into the investment program will depend, in part, on the objectives that are established and on the size of the investment budget. Once the objectives have been agreed and the size of the investment budget has been established, then the selection of projects for the program is logically determined by calculations (often difficult and controversial despite the help of computer programs) to identify the least-cost combination of projects for meeting the objectives and using up the investment budget. Integrating these parallel or simultaneous tasks to produce an agreed power program is not a tidy and straightforward task. Many agencies and many disciplines are involved. The process has to proceed as a series of iterations, both technical and political, that gradually produces an acceptable result, a result that necessarily involves compromises and judgments. The Government and the Bank are continuing their extended dialogue on an optimum power program for the 'eighties; prospects appear reasonably good for reaching substantial agreement within the near future. The key problems continue to be the size and phasing of the investment budget and the strengthening of NPC's finances so that power consumers will be making a reasonable contribution to the cost of expanding the system and can relieve the Government of having to subsidize NPC investments in the form of equity contributions taken from general revenues.

ELECTRIC POWER EXPANSION PROGRAM

NPC Existing Generating Facilities as of December 31, 1979

Type	Station name	Unit size (MW)	No. of units	Installed capacity (MW)	Year commissioned
(a) Luzon Grid					
Hydro	Ambuklao	25	3	75.0	1956
	Binga	25	4	100.0	1960
	Angat	50	4	218.0	1967
		6	3		
	Pantabangan	50	2	100.0	1977
	Caliraya	32	1	32.0	1945
	Botocan	8	2	16.0	1948
	Buhi-Barit	1.8	1	1.8	1957
	Cawayan	0.4	1	0.4	1959
	Subtotal			543.2	
Thermal	Bataan 1	75	1	75.0	1972
	Bataan 2	150	1	150.0	1977
	Malaya 1	300	1	300.0	1974
	Malaya 2	350	1	350.0	1979
	Snyder 1	200	1	200.0	1971
	Snyder 2	300	1	300.0	1972
	Gardner 1	150	1	150.0	1968
	Gardner 2	200	1	200.0	1970
	Tegen 1	100	1	100.0	1965
	Tegen 2	100	1	100.0	1965
	Rockwell 1-5/a	25	5	125.0	1955
	Rockwell 6-8/a	60	3	180.0	1963
	Subtotal			2,230.0	
Geothermal	Tiwi 1 & 2	55	2	110.0	1979
	Mak-Ban 1 & 2	55	2	110.0	1979
	Subtotal			220.0	
Total Luzon (MW)				2,993.0	

Type	Station name/ (island)	Unit size (MW)	No. of units	Installed capacity (MW)	Year commissioned
(b) Visayas					
Hydro	Loboc (Bohol)	0.4	3	1.2	1957
	Amlan (Negros)	0.4	2	0.8	1961
	Subtotal			2.0	
Diesel	Naga (Cebu)	7.3	7	51.1	1977
	Amlan (Negros)	5.5	2	11.0	1978
	Tagbilaran (Bohol)	5.5	2	11.0	1978
	Dingle (Panay)	7.3	2	14.6	1979
	Subtotal			87.7	
Geothermal	Tongonaw (Leyte)	3.0	1	3.0	1978
Total Visayas (MW)				92.7	
(c) Mindanao					
Hydro	Agus IV	-	-	200.0	1953-77
	Agus II	60.0	1	60.0	1979
	Agusan	-	-	1.6	1979
	Subtotal			261.6	
Diesel	Aplaya 1	5.5	2	11.0	1978
	Gen. Santos	7.3	3	21.9	1979
	Subtotal			32.9	
Total Mindanao (MW)				294.5	

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

Main Assumptions

Exchange Rate

Official	- January 1, 1980	US$1 = ₱7.50
Shadow rate	- January 1, 1980	US$1 = ₱9.15

Conversion Factors

Standard conversion factor	- 0.82;	Labor (average) :	0.85
Construction conversion factor	- 0.83;	Opportunity cost of capital:	15%
Consumption conversion factor	- 0.87;		

Investment Costs	At Market Price (01/01/80)	At Border Prices
	(US$/kW)	
300 MW coal fired units	750	717
300 MW oil fired units	607	580
55 MW geothermal units	816	750
620 MW nuclear	1,082	1,020
300 MW combined cycle	412	370
San Roque Hydro (260 MW)	2,208	1,990
Gened Hydro (600 MW)	1,278	1,154
Magat Hydro (180 MW) 5 & 6	223	201
Chico IV (360 MW)	1,000	900

Operational Cost Factors	Fuel			
	Coal	Oil	Geo-thermal	Nuclear
Fuel cost US$/$10^6$ Kcal	8.62	15.78	4.73	2.51

Operation & Maintenance

Power Station	Combined cycle	Coal	Oil	Geo-thermal	Nuclear	Hydro
Fixed O&M US$/KW-year	5.00	10.56	7.68	7.74	9.48	4.32
Variable O&M US$/MWh	0.13	0.23	0.13	0.13	0.05	-

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future Power Plants

Prices Referred to January 1, 1981

	Size (MW)	Fuel Cost US$/Unit	Fuel Cost US$/$10^6$ Kcal	Heat Rate Kcal/KWh	Fuel Cost US¢/KWh	Invest- ment Cost US$/KW	Operation and Maintenance Fixed US$/KW	Operation and Maintenance Variable US$/KWh	Fuel Inventory US$/KW	Annual Capacity Cost US$/KW	Energy Cost US¢/KWh
Coal-Fired Units	300	70.0/tn	10.77	2,300	2.48	852	11.76	0.23	2.41	147.3	2.50
Geothermal Units	55	25,000/GWh	6.19	4,031	2.50	933	7.80	0.20	-	160.1	2.52
Nuclear Units	620	25/pound	2.51	2,500	0.63	1,360	10.80	0.06	19.50	242.6	0.63
Oil-Fired Units	300	30.9/barrel	21.31	2,260	4.82	745	8.55	0.12	5.17	129.9	4.83
Existing Oil-Fired Units	-	30.9/barrel	21.31	2,600	5.54	-	10.20	0.14	5.98	18.7	5.55
San Roque Hydro	390	-	-	-	-	982 /a	5.30	-	-	155.2	-
Gened Hydro	600	-	-	-	-	1,278	4.30	-	-	199.4	-

Screening Curve: ------------------Total Annual Cost (US$/KW-Year)------------------

Plant Factor %	0	35	50	57	75	81
Hours	0	3066	4380	5000	6750	7100
1. Thermal Generating Stations						
Coal-Fired Units	147.3	235.4	269.9	284.8	326.2	330.1
Geothermal Units	160.1	248.9	283.6	298.7	335.6	344.3
Nuclear Units	242.6	264.8	273.5	277.3	287.7	288.7
Oil-Fired Units	129.9	300.2	366.8	395.5	456.0	483.1
Current Oil-Fired Units	18.7	212.6	290.9	323.9	415.8	424.6

2. Hydroelectric Projects

San Roque - $155.2 /a @ 38% Plant Factor (900 GWh)
Gened - $199.0 @ 22% Plant Factor (1,153 GWh)

/a Power Sector's share (56%) of multipurpose project's total cost.

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

300 MW - Coal Fired Steam Power Station Annual Cost at Market Prices (01/01/81)

		US$/KW
A. Plant Investment		852.0
B. Annual Capacity Cost		
	(%)	
I. Fixed Charges		
Discount rate	15.00	
Depreciation (30-year; S.F.)	0.23	
Insurance	0.25	
Taxes	0.00	
Total Fixed Charges	15.48	131.90
II. Annual carrying cost of fuel inventory		2.41
III. Fixed operating costs		
O&M		11.76
Administration and general expenses		1.23
Total Annual Capacity Cost		147.30

	US¢/KWh
C. Energy-Variable Operating Cost	
I. Operating & maintenance	0.023
II. Energy fuel (2,300 Kcal/KWh x 8.62 US$/$10^6$ Kcal/10^4)	1.983
Total Energy Cost	2.006

Screening Curve

Plant factor (%)	0	35	50	75	81
Hours	0	3,066	4,380	6,570	7,100
US$/KW-year	147.3	235.4	269.9	326.2	330.1

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

55 MW - Geothermal Power Station
Annual Cost at Market Prices (01/01/81)

		US/KW US$/KW
A. Plant Investment		933.00
B. Annual Capacity Cost	(%) (%)	
I. Fixed Charges		
Discount rate	15.00	
Depreciation (20-year; S.F.)	0.97	
Insurance	0.25	
Taxes	0.00	
Total Fixed Charges	16.22	151.40
II. Annual carrying cost of fuel inventory		-
III. Fixed operating costs		
O&M		7.80
Administration and general expenses		0.90
Total Annual Capacity Cost		160.1
		US¢/KWh
C. Energy-Variable Operating Cost		
I. Operating & maintenance		0.020
II. Energy fuel (4,031 Kcal/KWh)		2.50
Total Energy Cost		2.52

Screening Curve

Plant factor (%)	0	35	50	75	81
Hours	0	3,066	4,380	6,570	7,100
US$/KW-year	160.1	248.9	283.6	335.6	344.3

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

620 MW - Nuclear Power Station
Annual Cost at Market Prices (01/01/81)

		(%)	US$/KW
A.	Plant Investment		1,360.00
B.	Annual Capacity Cost		
I.	Fixed Charges		
	Discount rate	15.00	
	Depreciation (30-year; S.F.)	0.23	
	Insurance	0.30	
	Taxes	0.00	
	Total Fixed Charges	15.53	211.2
II.	Annual carrying cost of fuel inventory (US$/KW 130)		19.50
III.	Fixed operating costs		
	O&M		10.80
	Administration and general expenses		1.10
	Total Annual Capacity Cost		242.6

		US¢/KWh
C.	Energy-Variable Operating Cost	
I.	Operating & maintenance	0.006
II.	Energy fuel (2,500 Kcal/KWh)	0.630
	Total Energy Cost	0.636

Screening Curve

Plant factor (%)	0	35	50	75	81
Hours	0	3,066	4,380	6,570	7,100
US$/KW-year	242.6	264.8	273.5	287.7	288.7

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

300 MW - Oil-Fired Steam Power Station
Annual Cost at Market Prices (01/01/81)

		(%)	US$/KW
A.	Plant Investment		745.00
B.	Annual Capacity Cost		
I.	Fixed Charges		
	Discount rate	15.00	
	Depreciation (30-year; S.F.)	0.23	
	Insurance	0.25	
	Taxes	0.00	
	Total Fixed Charges	15.48	115.3
II.	Annual carrying cost of fuel inventory		5.17
III.	Fixed operating costs		
	O&M		8.55
	Administration and general expenses		0.88
	Total Annual Capacity Cost		129.9
			US¢/KWh
C.	Energy-Variable Operating Cost		
I.	Operating & maintenance		0.014
II.	Energy fuel (2,260 Kcal/KWh		4.82
	Total Energy Cost		4.834

Screening Curve

Plant factor (%)	0	25	50	75	81
Hours	0	3,066	4,380	6,570	7,100
US$/KW-year	129.9	300.2	366.8	456.0	483.1

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

Existing Oil-Fired Steam Power Plants
Annual Operating Costs

	US$/KW
A. Fixed Charges	
Fixed O&M	10.20
Annual carrying cost of fuel inventory	6.0
Administration (including insurance)	2.5
Total Annual Fixed Charges	18.7
	US¢/KWh
B. Energy-Variable Operating Cost	
Operating & maintenance	0.014
Energy fuel (2,600 Kcal/KWh)	5.540
Total Energy Cost	5.554

Screening Curve

Plant factor (%)	0	35	50	75	81
Hours	0	3,066	4,380	6,570	7,100
US$/KW-year	18.7	212.6	290.9	415.8	424.6

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

Hydro Power Plants
Annual Cost at Market Prices (01/01/81)

		San Roque (260 MW)	Gened (600 MW)
A. Plant Investment US$/KW		982.0 1/	1,278.00
B. Annual Capacity Cost			
Fixed Charges	(%)		
Discount rate	15.00		
Depreciation (50-year S.F.)	0.01		
Insurance	0.25		
Total Fixed Charges	15.26	149.9	195.02
Operation & Maintenance		5.3	4.32
Total Annual Cost		155.2	199.34
Energy production (GWh-year)		900	1,153
Annual cost (US$ million)		60.8	119,604
Energy cost (US¢/KWh)		6.75	10.37

1/ NPC's share of total investment cost.

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

Cost Estimates at January 1980 Price Levels
300 MW - Coal Fired Steam Power Plant

(W/O SO_2 Removal System)

Description	Local /a	Foreign	Total
		US$/KW	
Land	7.50	-	7.50
Structures and improvements	49.50	33.00	82.50
Boiler plant equipment	26.25	236.25	262.50
Turbine plant equipment	14.25	128.25	142.50
Electric plant equipment	5.05	47.45	52.50
Other	29.20	79.50	108.70
Engineering services	15.00	22.50	37.50
Subtotal	146.75	546.95	693.70
Contingencies (physical)	14.67	41.63	56.30
Total	161.42	588.58	750.00
(%)	21.50	78.50	100.00

/a US$1 = ₱7.50

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

San Roque Hydropower Project

Investment Cost at 1980 Price Levels

	Local	Foreign	Total
	₱ '000		
First Stage (260 MW)			
Civil works	1,785,480	1,505,941	3,291,421
Equipment	69,222	328,160	397,328
Engineering & admin.	182,329	56,840	239,169
Contingencies	220,428	158,659	379,087
Total First Stage	2,257,459	2,049,600	4,307,059
Second Stage (130 MW)			
Civil works	3,965	1,960	5,925
Equipment	20,252	97,328	117,580
Engineering & admin.	5,661	5,029	10,690
Contingencies	1,598	2,307	3,905
Total Second Stage	31,476	106,624	138,100

Investment Cost at Market Prices

	Local	Foreign	Total
First Stage (260 MW)			
Cost in ₱/KW	8,682	7,883	16,565
Cost in US$/KW	1,158	1,051	2,209
Second Stage (130 MW)			
Cost in ₱/KW	242	820	1,062
Cost in US$/KW	32	109	141

Annual Investments in Million ₱

Year	1	2	3	4	5	6	7	Total
First Stage								
Civil Works								
- Local	122.0	195.2	369.7	449.0	465.2	462.4	123.2	2,186.7
- Foreign	51.5	147.8	281.1	324.8	387.5	421.1	91.8	1,705.6
Equipment								
- Local	-	-	-	18.3	24.4	18.3	9.8	70.8
- Foreign	-	-	33.6	89.6	112.0	78.4	30.2	343.8
Total								
- Local	122.0	195.2	369.7	467.3	489.6	480.7	133.0	2,257.5
- Foreign	51.5	147.8	314.7	414.4	499.5	499.5	122.0	2,049.6
Total 1st Stage	173.5	343.0	684.4	881.7	989.1	980.2	255.0	4,307.1

Year	1	2	Total
Second Stage			
Local	12.0	19.5	31.5
Foreign	48.2	58.4	106.6
Total	60.2	77.9	138.1

ELECTRIC POWER EXPANSION PROGRAM

Luzon Grid: Comparative Generating Costs of Existing and Future NPC Units

Gened Hydropower Project
Investment Cost at 1980 Price Levels

	Local	Foreign	Total
	₱ ´000		
Reservoir - resettlement	142,418	-	142,418
Temporary facilities	115,761	50,025	165,786
River diversion	497,110	278,989	776,099
Dam and spillway	1,140,855	799,084	1,939,939
Intake and tunnels	397,886	253,394	651,280
Powerhouse	230,501	636,787	867,288
Operator´s village	9,299	2,881	12,180
Access road	43,596	73,501	117,097
Administration & engineering	147,210	106,905	254,115
Subtotal	2,734,636	2,201,566	4,926,202
Contingencies	267,864	228,434	496,295
Total	2,992,500	2,430,000	5,422,497
(in US$´000 equiv.)	399,000	324,000	723,000
Cost in ₱/KW	4,987.5	4,050.0	9,037.5
Cost in US$/KW	665	540	1,205
Transmission system E.H.V. Cost in US$/KW	25	48	73
Total Cost at Market Prices (US$/KW)	690	588	1,278
Cost at border prices (US$/KW)	566	588	1,154

Disbursement Schedule (in ₱ million)

Year	1	2	3	4	5	6	7	8	9	Total
Local	149.7	329.2	359.1	478.8	598.5	658.4	209.4	119.7	89.7	2,992.5
Foreign	72.9	170.1	194.4	437.4	486.0	486.0	413.1	121.5	48.6	2,430.0
Total	226.6	499.3	553.3	916.2	1084.5	1144.4	622.5	241.2	138.3	5,422.5

Luzon: Recommended Expansion Program

Year of Comm.	Plant addition	Installed Capacity (MW) Hydro (H)	Geo-thermal (Geo)	Oil (O)	Coal (C)	Nuclear (N)	Total	At Peak Condition Dependable capacity MW	Peak demand MW	Mainte-nance space(MW)	Reserve capacity MW	Reserve capacity %	LOLP/c
1980	Tiwi 3-4 (Geo) 2x55 MW	541	330	2,155	-	-	3,026	2,779	2,100	679	519	25	0.15
1981	Mak Ban 3-4 (Geo) 2x55 MW Masiway (H) 12 MW	553	440	2,155	-	-	3,148	2,891	2,240	651	441	20	0.27
1982	Kalayaan 1-2 (P.S) 2x150 MW Tiwi 5 (Geo) 1 x 55 MW Retire Rockwell (O) 3 & 5 2x25 MW /b	853	495	2,105	-	-	3,453	3,211	2,400	811	625	26	0.04
1983	Tiwi 6 (Geo) 1x55 MW Magat 1-4 (H) 4 x 90 MW Retire Rockwell 6-7-8 (O) 3x60 MW	1,213	550	1,925	-	-	3,688	3,453	2,565	888	752	29	0.01
1984		1,213	550	1,925	-	-	3,688	3,453	2,745	708	572	21	0.06
1985		1,213	550	1,925	-	-	3,688	3,453	2,940	513	377	13	0.29
1986	PNPPI (N) 1x620 MW	1,213	550	1,925	-	620	4,308	3,853	3,145	708	538	17	0.21
1987	Coal Thermal I 1x300 MW	1,213	550	1,925	300	620	4,608	4,280	3,365	915	745	22	0.13
1988		1,213	550	1,925	300	620	4,608	4,373	3,600	773	571	16	0.56
1989	Coal Thermal II 1x300 MW	1,213	550	1,925	600	620	4,908	4,673	3,850	823	574	15	0.56

/a The projects are supposed to be on stream at the beginning of the year.

/b Units 1, 2 & 4 (3x25 MW) were retired from service at the end of 1979.

/c LOLP: Loss of Load Probability in days/years.

NATIONAL POWER CORPORATION (NPC)

Luzon: Recommended Expansion Program

Year.	Energy Dispatch (GWh) Hydro (H)	Geothermal (Geo)	Oil (O)	Pumped sto. (PS)	Nuclear (N)	Coal (C)	Energy Requirement (GWh) System load	Pumping	Total
1979									
1980	2,051	2,075	8,588				12,714		12,714
1981	2,100	2,750	8,710				13,560		13,560
1982	2,098	4,320	8,120	15			14,554	22	14,576
1983	3,201	3,438	8,896	6			15,541	9	15,550
1984	3,202	3,438	9,992	25			16,657	35	16,692
1985	3,206	3,488	11,180	87			17,911	126	18,037
1986	3,205	3,428	9,736	58	2,697	-	19,124	84	19,208
1987	3,203	3,378	7,929	81	3,861	2,038	20,490	117	20,607
1988	3,210	3,407	8,940	87	4,173	2,092	21,909	125	22,034
1989	3,209	3,413	8,413	153	4,161	4,170	23,519	220	23,739

ELECTRIC POWER EXPANSION PROGRAM

Visayas: Recommended Expansion Program

Installed Capacity (MW) and Energy Dispatch (GWh)

Year	Hydro		Geothermal		Coal		Diesel /a		Total	
	Capacity MW	Energy GWh	Capacity MW	Energy GWh	Capacity MW	Energy GWh	Capacity MW	Energy GWh	Capacity MW	Energy GWh
1979	2	12	3	20	10	61	137	611	152	704
1980	2	12	3	20	10	61	199.6	954	214.5	1,047
1981	2	12	6	30	65	342	308.6	976	381.6	1,360
1982	2	12	81	83	65	398	308.6	942	456.6	1,435
1983	2	12	231	774	65	398	295.1	1,114	593.1	2,298
1984	2	12	231	1,107	120	735	286.1	1,008	639.1	2,862
1985	2	12	231	1,146	175	1,072	286.1	966	731.6	3,196
1986	9	34	268.5	1,205	230	1,409	286.1	787	793.6	3,435
1987	74	212	268.5	1,179	230	1,409	286.1	780	858.6	3,580
1988	79	271	268.5	1,132	285	1,746	271.1	584	903.6	3,733
1989	79	274	306	1,399	285	1,746	271.1	461	941.1	3,880

/a Including some facilities from private utilities connected to NPC grid.

ELECTRIC POWER EXPANSION PROGRAM

VISAYAS: Recommended Expansion Program

Year of Comm.	Plant addition	Installed Capacity (MW) Hydro	Geo-thermal	Coal	Diesel	Total	At Peak Condition Dependable capacity MW	Peak demand MW	Mainte-nance space(MW)	Reserve %	Genera-tion GWh
	I. Cebu Grid										
1979	Existing			10	100.4	110.4	83	87	(4)	(4.5)	590
1980				10	100.4	110.4	83	115	(32)	(27.8)	775
1981	Cebu II-D (3x18)			65	145.4	210.4	183	150	33	22.0	1,030
	Naga I-C (1x55)										
	Retire VECO-D (9.0)										
1982	Power Barge 2-D (4x8)			65	177.4	242.4	215	155	60	38.7	1,075
1983	Retire VECO-D (13.5)			65	163.9	228.9	202	165	37	22.4	1,120
1984	Naga 2-C (1x55)			120	163.9	283.9	256	210	46	21.9	1,470
	II. Negros Grid										
1979	Existing	0.8			11.0	11.8	11.0	21	(10)	-	100
1980	Talisay Diesel (14.6)	0.8			48.0	48.8	47	22	15	68.1	110
	Bacolod-D (22.4)										
1981	Palimpinon Geo (2x1.5)	0.8	3.0		80.0	83.8	80	24	56	133.3	120
	Power Barge D (4x8)										
1982		0.8	3.0		80.0	83.8	80	27	53	96.3	130
1983	Palimpinon Geo (3x37.5)	0.8	115.5		80.0	196.3	190	115	75	65.2	790
1984	Retire Bacolod (9)	0.8	115.5		71.0	187.3	182	125	57	45.6	835
	III. Panay Grid										
1979	Existing				14.6	14.6	13	24	(11)	(45.8)	120
1980	Panitan Diesel (11)				40.2	40.2	36	26	10	38.5	130
	Dingle (D) 3&4 (14.6)										
							36	29	7		140
1981					40.2	40.2	36	29	7		155
1982					40.2	40.2	36	29	7		170
1983					40.2	40.2	36	29	7		190
1984					40.2	40.2					
	IV. Cebu-Negros-Panay Interconnected										
1985	Interconnection	0.8	115.0	175	275.1	568.4	528	415	113	27.2	2,795
	Negros Therm - C (55)										
1986	Panay Therm - C (55)	7.8	115.5	230	275.1	628.4	578	439	139	31.7	2,965
	Bago II H (2 x 3.5)										
1987	Bago I H (2 x 15)	37.8	115.5	230	275.1	658.4	615	454	161	35.5	3,070
1988	Negros Therm - C (55)	37.8	115.5	285	260.1	698.4	650	483	167	34.6	3,200
	Retire Veco - D (15)										
1989	Mambucal Geo (37.5)	37.8	153.0	285	260.1	735.9	685	508	177	34.8	3,325

ELECTRIC POWER EXPANSION PROGRAM

VISAYAS: Recommended Expansion Program

Year of Comm.	Plant addition	Installed Capacity (MW) Hydro	Geo-thermal	Diesel	Total	At Peak Condition Dependable capacity MW	Peak demand MW	Mainte-nance space(MW)	Reserve %	Genera-tion GWh
Visayas - Leyte - Samar Grid										
1979	Existing		3.0		3.0	3	14	(11)	-	47
1980			3.0		3.0	3	15	(12)	-	52
1982	Power Barge (4 x 8)		3.0	32	35.0	34	16	18	125.0	57
1982	Tongonan Geo 1-2; (2 x 37.5)		78.0	-	78.0	72	17	55	235.0	63
	Retire of Barge									
1983	Tongonan Geo-3; (1 x 37.5)		115.5	-	115.5	111	45	66	146.7	203
1984			115.5	-	115.5	111	63	48	76.2	352
1985			115.5		115.5	111	71	40	56.3	391
1986	Tongonan Geo-4 (1 x 37.5)		153.0		153.0	147	76	71	93.4	450
1987	Catubig H (30)	30.0	153.0		183.0	170	83	87	105.0	490
1988		30.0	153.0		183.0	170	87	83	95.4	508
1989		30.0	153.0		183.0	170	91	79	86.8	530
Visayas - Bohol Grid										
1979	Existing: D (2 x5.5) + (3 x 0.4)	1.2		11	12.2	11.2	4.2	7.0		11
1980		1.2		11	12.2	11.2	4.6	6.6		12
1987	Upper Loboc H (1 x 5)	6.2		11	17.2	15.2	9.0	6.2		24
1988	Upper Loboc H (1 x 5)	11.2		11	22.2	19.0	10.0	9.0		26
1989		11.2		11	22.2	19.0	11.0	8.0		29

Mindanao: Recommended Expansion Program

Year of Comm.	Plant addition	Installed Capacity (MW)			At Peak Condition				Energy Dispatch (GWh)		
		Hydro	Diesel	Total	Dependable capacity (MW)	Peak demand (MW)	Maintenance space (MW)	Reserve %	Hydro	Diesel	Total
1979	Existing (MW)	265	48	313	304	195	109	55.8	1,002	136	1,138
1980	Agus II (2x60) DLPC (D) 58.7) Aplaya II (D) (3x18.65)	385	162	547	523	310	213	68.7	1,838	35	1,873
1981	Aplaya II (D) (3x18.65)	385	218	603	574	335	239	71.3	1,945	72	2,016
1982	Gen. Santos D.(3x7.3) Power Barge D (4x8)	385	272	657	623	355	268	75.5	2,003	137	2,140
1983	Agus VII (G) (2x27) Agus I (H) (2x40)	519	272	791	751	380	371	97.6	2,252	28	2,280
1984	Agus V (H) (2x27.5) Agus IV (H) (3x50)	724	272	996	949	425	524	123.3	2,560	-	2,560
1985	Pulangi IV (H) (3x85) Retire DLPC (D) (58.7)	979	213	1,192	1,140	480	660	137.5	2,882	-	2,882
1986		979	213	1,192	1,140	535	605	113.1	3,212	-	3,212
1987		979	213	1,192	1,140	600	540	90.0	3,600	-	3,600
1988		979	213	1,192	1,140	670	470	70.1	4,025	-	4,025
1989		979	213	1,192	1,140	750	390	52.8	4,412	98	4,510

ANNEX 5

THE OUTLOOK FOR REDUCING PETROLEUM DEMAND IN THE TRANSPORT SECTOR

Table of Contents

The Outlook for Reducing Petroleum Demand in the Transport Sector

Introduction

1. Throughout the world, economic development has brought charges in the structure of production and distribution, and in the modes of transport, that have resulted in a rate of growth for transport fuels greater than the growth of economic activity in the country (i.e. greater than the growth in Gross Domestic Product, GDP). This relationship applied even more strongly to the growth of demand for liquid petroleum fuels, as the share of transport powered by the internal combustion engine increased over coal-driven engines. This worldwide phenomenon was true of the Philippines where, until the first radical increase in oil prices in 1974, the demand for liquid fuels for transport use had been growing faster than GDP. The arithmetic expression of this phenomenon is an elasticity of transport fuel demand greater than 1.0, i.e. the percentage growth in transport demand for liquid fuel divided by the percentage growth in GDP yielded a figure greater than unity. Since the radical change in fuel prices, however, the historical relationship appears to have dropped to a long-term value substantially lower than 1.0. The total amount of transport fuels used in 1980 was almost exactly the same as it was in 1973, i.e. zero growth over a seven-year period in which GDP had grown by more than one-third. Total gasoline consumption was down by 5.3 million barrels, total diesel consumption /1 up by 4.6 million barrels, with aviation fuels up 0.5 million barrels (see Table 1.2, p.5, Main Report). The reduction in energy intensity recorded in these figures reflects the cumulative effect of a large number of energy-saving practices throughout the transport sector. The pronounced change in the fuel-elasticity figure is not something that is likely to be repeated: the "easy" changes have now largely been made, in response to the "shock effect" of sharply higher fuel prices. Future gains will probably be smaller, slower in coming, and more difficult to bring about.

2. The production and distribution of goods and services in any country requires a certain amount of transport, expressed in ton-km, and passenger-km. of transport services. A growing economy will require a growing amount of transport, although there is no need for the two activities to grow at the same rate. There is clearly a limit, however, below which the growth of transport services cannot fall without endangering, or slowing, the growth of the economy. If one assumes unchanged patterns of economic activity, unchanged shares in the contributions from road, rail, air and sea transport, and unchanged vehicle capacities, fuel consumption, and efficiency of vehicle use, then there would be a 1:1 relationship between the growth of GDP and the growth of transport services. But in reality there is much flexibility in all these main variables, so that it is difficult to make precise projections about the future growth of transport requirements or - what is our main interest - about the future growth of the demand for petroleum-based transport fuels. Shifts of traffic among the transport modes, shifts from gasoline to diesel engines, shifts in the size of vehicles, changes in the efficiency with which vehicles are used (e.g. their loading, scheduling, routing, congestion delays, and turnaround times at destinations), changes

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/1 Assuming a constant percentage of diesel was used for transport (its main use) over the period.

in the efficiency of fuel consumption per ton-km. or passenger-km., or substitutions of nonpetroleum for petroleum liquid fuels - all these variables will influence the demand for petroleum-based transport fuel. The foregoing variables are all physical; the prime mover that drives people to look for, develop, and to take advantage of such changes is the price system, i.e. the relative costs of buying (or providing) transport services of one kind rather than another.

3. The MOE figures for past and future demand for transport fuels in relation to GNP are shown in Table 5. These show a target growth in demand for liquid transport fuel of 2.9% for the ´eighties, a figure that is projected to start off at around 2.1% for the first half of the decade and then rise, under the pressure of a more dispersed structure of production, to around 4% during the second half of the decade. GNP is assumed to grow at an average rate of 6%. These numbers result in a demand elasticity for transport fuels (initially 0.35, rising later to around 0.7) that are remarkably low by historical and world standards. What are the potential changes in transport and fuel efficiency that may permit the realization of these optimistic forecasts? What steps can Government and the private sector take to achieve such efficiencies? How likely are they to occur?

4. The demand for liquid fuels for transport is overwhelmingly dominated by road motor vehicles. These account for approximately 87% of total transport fuel consumption, with shipping accounting for 7%, aviation for 5%, and the country´s 850 km of railway accounting for less than 1% (source: data supplied by the Bureau of Energy Utilization). Opportunities for fuel savings are not distributed proportionally among the modes, however, since it is easier and cheaper to adapt to higher fuel prices in certain modes than in others. In particular, it appears considerably easier to achieve fuel savings in road transport than in shipping, where individual investments are larger and renewal of the fleet slower than for motor vehicles, thus scrapping less efficient for more efficient vehicles. Thus, while marine transport and railways are much more fuel efficient than road vehicles - giving many more ton-miles of transport per barrel of oil - it is the road transport sector that both uses the largest share of the country´s transport fuel and offers the greatest opportunities for fuel savings. The remainder of this annex will therefore be limited to road transport. The key variables examined are:

(a) growth and composition of the vehicle fleet;

(b) traffic growth;

(c) efficiency of vehicle use (average loads or work done per trip, time required per trip, turnaround time per trip);

(d) shifts to more efficient modes;

(e) fuel efficiency of engines; and

(f) fuel substitution.

The above variables represent what must occur, singly or in combination, if road transport is to reduce further the intensity of its demand for liquid petroleum fuels. Governments can ifnluence each of these variables in greater or lesser degree, with various possible combinations of direct regulations (e.g. import controls on vehicle sizes, restrictions on the size of engines that can be manufactured, fuel rationing, forced car pooling), improved physical conditions for transport operation (e.g. reducing urban congestion through systematic traffic management or staggering working hours to reduce rush-hour pressures), and using the pricing system (including taxation of vehicles and fuels) to exert pressure on, or to create incentives for, changes in behavior which are within the control of vehicle owners. To date, the Philippine Government has relied almsot entirely on the use of the pricing/taxing system to secure fuel-savings rather than on direct controls or the introduction of improved traffic flows that reduce fuel consumption per trip taken.

Growth and Composition of the Vehicle Fleet

5. The growth-rate of the vehicle fleet, or the rate of motorization, is one of the strongest influences on the growth of demand for transport fuels. The available figures are shown in Table 4. The quality of these registration data is believed to be only fair, which may explain the large variations in annual growth rates. Over the 15-year period, the car/jeep and truck/bus/jeepney fleets have grown at the same average rate (9%). However, the two groups showed very different reactions to the post-1973 increases in fuel prices: the growth-rate for cars and jeeps dropped by 50% while that for trucks and jeepneys increased by 50%. It remains to be seen how the 120% increase in gasoline prices since mid-1979 will affect demand for car ownership (two large dealers are expecting 1980 sales to be 5% lower than in 1979, mainly because of higher fuel prices. No one knows how long this influence will last). It is reasonable to expect that the growth of the total fleet (excluding tricycles and motorcycles) will be considerably below the historic 9% rate, perhaps falling to around 5%, with the greater drop occurring among private cars. Any more drastic drop (especially anything much lower than, say, 7% in the commercial fleet) would risk transport shortages that would interfere with the desired rate of economic growth. Such figures are very imprecise, however.

Traffic Growth (Vehicle Use)

6. Traffic counts on intercity roads have shown growth rates of 3-15% over the past five years, with no abnormal downward trend. There does appear to have been a marked reduction in trips in the vicinity of major cities, however, suggesting that higher fuel prices were having an impact on discretionary driving. Discussions with commercial operators revealed rising interest in reducing the number of trips through consolidation of loads, better scheduling and routing, and avoiding empty trips. There is no evidence that higher transport costs have yet caused any reduction in the demand for transport services nor led to any loss of truck cargoes to coastal

shipping./1 Railway traffic has increased substantially during the past two years but the rail network is so small that it cannot significantly affect modal shares in the national transport volume.

Increasing the Efficiency of Vehicle Use

7. When any given vehicle makes a trip, it can economize on fuel use per ton-km or per passenger-km if the vehicle is carrying an optimum load, if it travels by the optimum route, if it travels at an optimum speed, and if it does not experience the delays which result from congestion. The first three determinants of vehicle fuel-efficiency are largely within the control of owners and drivers. "Fine-tuning" of these variables occurs primarily in response to market factors such as the strength of competition and the pressure of key prices. There is qualitative evidence that higher fuel prices are producing a considerable tightening up in vehicle use to achieve fuel economies. For example, average truck loads appear to be rising, so much so that overloading is becoming an increasing problem. Car-pooling appears to have spread among those who make the journey to work by private cars. The contribution to fuel saving which can be made by decongestion remains for the future, however. We estimate that a halving of congestion fuel losses in Metro Manila might save as much as 2-3% of total vehicle fuel consumption and would amount to $20-30 million savings in imported fuel costs per year. But decongesting Manila's traffic will be a long, complex task that will require additional investments in grade separations, in more and better-trained traffic police, in studies, and in gaining acceptance of new controls designed to speed up traffic flows.

Shifting Traffic to More Energy-Efficient Modes

8. Railways, coastal ships, and mass transit vehicles can move traffic with lower energy consumption per km than airplanes, trucks, jeepneys, and cars. Opportunities for making such shifts appear relatively few in the Philippines. The country's one railway line is so limited in extent that no change in relative transport costs can increase its traffic enough to affect the "modal split" of the nation's traffic (it can affect the split, to a small extent, in Southern Luzon). Some travelers may switch from air to sea or bus travel as air fares rise in response to higher fuel prices, but this price-elasticity effect is likely to be offset by the influence of rising incomes on the ability to afford air travel. Since 1973, domestic aircraft movements have increased by 1% p.a. while passenger movements have grown at 7%, despite sharp increases in fares. So far as freight traffic is concerned, truckers report no shift of traffic to coastal shipping where that might be an alternative. Mass transit in the two largest cities (Manila and Cebu) continues to be dominated by flexible but fuel-heavy jeepneys, with relatively light use of buses on many routes. There is talk

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/1 Marine freight traffic has been growing faster than road freight for several years and by 1976 had overtaken the latter in terms of ton-kms. Inter-modal competition has not been an important factor in this shift, however.

of introducing a surface electric railway on one unused right-of-way in Manila; its potential contribution to decongestion appears extremely small and its cost-effectiveness extremely doubtful. Farm mechanization has not progressed very far as yet, so the possibilities for saving fuel by returning to animal power are insignificant. But high fuel prices may slow future shifts from traditional sources of energy for doing farm work and transporting crops.

Improved Engine Efficiencies

9. Everywhere in the world, manufacturers of internal combustion engines have stepped up their efforts to develop more fuel-efficient engines. Considerable progress appears to be possible and, when engine improvements are combined with the lightening of vehicle weights, reductions in fuel consumption of 30-50% per km seem reasonable. Gains of this size are unlikely to be generally available until the middle of the decade, and their spread will be governed by the turnover of the different vehicle stocks (cars, buses, trucks, etc). We expect this source of fuel savings to be the largest single source of transport fuel savings during the 'eighties; it should, for example, contribute three or four times as much to fuel savings as anything that could be expected from decongesting Metro Manila's traffic.

Fuel Substitution

10. The Government has been strongly attracted by the worldwide interest in producing alcohol to mix with gasoline to make the 20-80% mixture known in the Philippines as "alcogas." The outlook for this program is evaluated separately in Annex 1. The general conclusion of that analysis is that, at present, the economics of alcohol production look doubtful and the rate at which the program is likely to develop will be considerably slower than initially announced. A strong research and development (R & D) program is nevertheless felt justified. Alcohol is not suitable for use in diesel engines, i.e. it does not mix satisfactorily with diesel fuel. There is some promise, however, that suitably processed coconut oil can be mixed with diesel oil to yield an acceptable fuel for diesel engines. Other oil-bearing palms may also yield a usable diesel substitute or extender (full substitution would depend on engine adaptations which have yet to be achieved). If the technical problems can be solved, the economics of producing a palm-oil liquid fuel may be better than for alcohol in view of the strong comparative advantage which Philippine agriculture has in palm tree crops. The mission was unable to learn much about the state of the R & D effort on palm-oil fuels; our impression is that the effort deserves a higher priority than it has so far been given.

11. Another possibility for saving liquid fuel is the re-introduction of charcoal or wood-burning gasifiers to power conventional diesel engines. Charcoal gasifiers had been used in the Philippines, as elsewhere, during World War II. Improved technology has overcome the loss of power associated

with earlier charcoal-powered systems. It is estimated that a 12-passenger jeepney could reduce its fuel costs from ₱ 250/day to ₱ 50/day at 1981 prices for diesel and charcoal (extra investment requirements have a payback of around 10 months).[1/] In May 1981, a special project in the Office of the President had ordered 100 demonstration jeepneys which were to tour the country to advertise the feasibility and economy of charcoal as a vehicle fuel. If a third of the 100,000 jeepneys in Manila should convert to charcoal fuel by 1990, this would save about as much crude petroleum as the alcogas program (perhaps more). The technology also looks promising for fishing boats and irrigation pumps.

Summary

12. The principal factor that has limited the growth of demand for imported transport fuels has been the 9-14-fold increases in price since 1972 (9-fold for diesel, nearly 14-fold for regular-grade gasoline). Government taxes have been increased somewhat more rapidly than the ex-refinery product price, reflecting a policy of keeping pressure on consumers (much stronger on private-car owners than on the diesel commercial fleet). These price increases have led to a dramatic reduction in the demand for both regular and premium gasoline and to a pronounced shift to diesel engines so far as the commercial fleet is concerned (but not among private cars). A major shift in the GDP elasticity of demand for transport fuel has occurred, from well above 1.0 to well below that figure. The overall demand for fuel, which was about the same in 1980 as in 1973, is expected to start rising again, however; indeed, it must do so unless there are much more radical technological changes than anyone now expects. The Government has projected that transport fuel consumption will rise at only 2.1% a year, 1980-84. This seems to us too low; we would expect growth to be about one-third faster, i.e. close to 3.0%. We would then expect this figure to nearly double during the second half of the decade, reflecting the rising pressure of higher incomes, and an increasingly dispersed industrial structure, on the demand for transport. These expected growth rates are considerably lower than pre-1974 and will require continuing strong conservation measures. There is little hope of much substitution against petroleum fuels by either alcogas or coconut oil (a potential diesel supplement) until late in the decade, if then. The economics of alcohol production in the Philippines look doubtful at present, and the technology of using coconut oil as a diesel extender is still undergoing trials. The prospects for charcoal-fueled (commercial) vehicles are unclear but promising. Continuing research and development work on substitute fuels deserves expanding support. The most important source of fuel savings during the decade is likely to be the spread of more fuel-efficient engines around the world by the automobile industry. Fuel savings of 10-20% seem likely, depending on the rate of adoption of improved technologies. The next most promising opportunity for fuel savings - one more within Government control - is improved traffic management to reduce congestion; savings in the key Metro Manila region could amount to 2-3% of total transport fuel consumption, a gross annual saving of about $70 million in oil imports.

1/ The sponsors' optimistic figure. Others put the figure at 30-35 months.

Table 1: PAST AND PROJECTED ENERGY CONSUMPTION

Year	Total energy consumption: In million barrels of oil equivalent	Total energy consumption: Annual growth	Total energy consumption: Average annual growth (%)	Transport sector share /a: Percent of total energy consumption	Transport sector share /a: In million barrels of oil equivalent	Transport sector share /a: Annual growth	Transport sector share /a: Average annual growth (%)
1973	72.03			43.7	31.5	-	
1974	68.59	-4.8		42.3	29.0	-7.9	
1975	80.13	16.8	4.5	38.4	30.8	6.0	1.5
1976	82.87	3.4		37.5	31.1	1.0	
1977	88.41	6.6	3.1	34.4	32.2	3.5	
1978	91.59	3.6		36.4	33.5	4.0	
1979	94.25	2.9		36.3	34.2	2.1	
			7.4				2.1
1984	134.75		7.0	28.1	37.9		2.9
			6.5				3.8
1989	184.62			24.6	45.4		

/a These figures on oil consumption in the transport sector are believed to include 4-6 million bbls. of diesel fuel used in industry to generate electricity. For this reason the figures are not the same (i.e. for 1979 84-89) as those used in Table 5.2 on p. 39 of the main report.

Source: Data provided by Ministry of Energy, April 1980.

Table 2: DEVELOPMENT OF DOMESTIC TRANSPORT VOLUME IN TON-KM AND PASSENGER-KM, 1970-85

	1970 Ton-km		1976 Ton-km		1970-76	1980 Ton-km		1976-80	1985 Ton-km		1980-85
	(million)	(%)	(million)	(%)	Average annual increase (%)	(million)	(%)	Average annual increase (%)	(million)	(%)	Average annual increase (%)
Freight											
Road	3,520	57	4,438	43.6	3.9	7,170	44.0	8.3	11,200	46.5	9.4
Interisland shipping	2,510	41	5,433	53.4	13.7	8,740	53.7	8.2	11,900	49.4	6.3
Railway	150	2	286	2.8	11.3	360	2.2	3.9	970	4.0	22.0
Aviation	10	-	13	0.2	4.5	23	0.1	10.0	39	0.1	11.1
Total	6,190	100	10,170	100.0	8.4	16,293	100.0	8.2	24,109	100.0	8.2

	1970 Pass-km		1976 Pass-km		1970-76	1980 Pass-km		1976-80	1985 Pass-km		1980-85
	(million)	(%)	(million)	(%)	Average annual increase (%)	(million)	(%)	Average annual increase (%)	(million)	(%)	Average annual increase (%)
Passenger											
Road	15,650	82	20,562	79.4	4.7	31,440	78.2	7.3	46,000	77.7	7.9
Interisland shipping	1,570	8	2,462	9.5	7.8	3,740	9.3	7.2	5,080	8.6	6.3
Railway	1,210	6	1,261	4.9	0.7	1,710	4.3	5.2	3,050	5.1	12.3
Aviation	780	4	1,610	6.2	12.8	3,290	8.2	12.7	5,085	8.6	9.1
Total	19,210	100	25,895	100.0	6.5	40,180	100.0	7.6	59,215	100.0	8.1

Source: 1970 and 1976 - Estimated jointly by Government and Consultants for the National Transportation Planning Project.
1980 and 1985 - National Economic Development Authority.

Table 3: PAST AND PROJECTED TRANSPORT FUEL CONSUMPTION
(In million barrels)/a
(Parentheses indicate negative growth)

Year	Regular gasoline	Growth rate (%)		Premium gasoline	Growth rate (%)		Total gasoline	Growth rate (%)		Diesel and bunker fuel/b	Growth rate (%)		Avgas Avturbo	Growth rate (%)		Annual total	Growth rate (%)	
1973	12.3			4.2			16.5			12.8			2.2			31.5		
1974	10.4	(9.7)		4.2	9.4		14.6	(3.5)		12.2	2.9		2.2	1.3		29.0	(0.3)	
1975	10.1		(7.8)	5.1		7.8	15.2		(2.3)	13.2		5.0	2.4		4.1	30.8		1.4
1976	9.3			5.5			14.8			14.0			2.3			31.1		
1977	8.8			6.1			14.9			14.8			2.5			32.2		
1978	8.4	(6.0)		6.8	6.8		15.2	(1.0)		15.6	6.6		2.7	6.9		33.5	3.2	
1979	7.8			6.7			14.4			17.0			2.8			34.2		
		(8.0)			2.8			(2.1)			4.7			5.2			2.1	
1984	5.3		(6.9)	7.6		2.6	12.9		(1.4)	21.4		5.2	3.6		5.1	37.9		2.8
		(5.8)			2.2			(0.6)			5.7			5.1			3.7	
1989	4.0			8.5			12.5			28.3			4.6			45.4		

/a 1 barrel equals 159 liters.

/b These figures are believed to include about 3% of total diesel sales for nontransport uses, e.g. farm machinery, mining, construction, fishing, sugar milling.

Source: Information provided by Philippine National Oil Company (PNOC), dated April 1980.

Table 4: DEVELOPMENT OF THE VEHICLE FLEET

Year	Cars and jeeps	Growth rate			Trucks buses, jeepneys	Growth rate			Tricycles & motorcycles	Growth rate			Total	Growth rate		
1965	150,445	16.4			122,858	10.3			30,238	33.3			303,541	15.6		
1966	175,170	25.6			135,462	4.9			40,299	60.9			350,931	21.6		
1967	219,956	12.9	13.1		142,092	16.0	7.9		64,825	27.8	24.9		426,873	16.2	12.6	
1968	248,328	9.6			164,889	5.7			82,846	3.1			496,063	7.2		
1969	272,183	2.6			174,229	2.8			85,423	7.8			531,835	3.5		
1970	279,172	3.7			179,115	3.4			92,065	3.7			550,352	3.6		
1971	289,381	7.9		9.0	185,189	10.2		9.0	95,486	34.8		16.5	570,056	13.1		10.0
1972	312,137	6.4			204,049	17.2			128,750	16.6			644,936	11.9		
1973	332,233	19.7	7.4		239,114	14.1	8.7		150,155	9.5	13.9		721,502	15.3	9.0	
1974	397,603	0.5			272,889	0.0			164,484	7.5			834,976	1.7		
1975	399,574	0.7			272,505	6.6			176,751	0.6			848,830	2.6		
1976	402,328	9.5			290,619	12.9			177,882	13.0			870,829	11.3		
1977	440,466	12.1	6.0		327,976	12.8	11.0		200,923	17.3	9.0		969,365	13.4	8.2	
1978	493,668	2.3			369,846	10.9			235,756	5.9			1,099,270	5.9		
1979	504,895				410,199				249,558				1,164,652			

Percentage of total vehicles, 1979

Cars and jeeps	43.4
Trucks, buses, jeepneys	35.2
Tricycles and motorcycles	21.4

Percentage of total vehicles in Metro Manila, 1979

41%

Shares of diesel and gasoline-powered vehicles

	Cars, jeeps		Trucks, buses, jeepneys	
	Diesel	Gasoline	Diesel	Gasoline
1978	1%	99%	31%	69%
1979	1%	99%	45%	55%

Table 5: FUEL CONSUMPTION OF THE TRANSPORT SECTOR AND RELATED VARIABLES

Historic and Projected

	Growth rate of transport fuel consumption	GNP growth rate		Transport volume growth rate		Vehicle fleet growth rate		Ratio /a growth of petroleum consumption/ growth of GNP	Ratio growth of transport fuel consumption/growth of GNP
		Annual	Average	Ton-km	Pass-km	Annual	Average		
Historic									
1973	n.a.	9.6				11.7		1.13	-
1974	-8.0	6.0				15.9		1.00	-
1975	6.0	6.3	6.6%	8.3%	6.9%	1.3	7.0%	1.03	0.95
1976	1.0	6.1				2.6		0.98	-
1977	3.5	6.1				11.4		1.00	0.51
1978	4.0	6.3				10.7		0.98	0.63
1979	2.1	5.8				4.9		0.98	0.36
Projected									
1980									
1981	2.1%		6.0%	8.2%	8.1%		5.0%	0.80	0.35
1982									
1983									
1984									
1985									
1986									
1987	5.4%	7.0%	7.0%					0.63	0.77
1988									
1989									

/a Data provided by Ministry of Energy.

Table 6: DEVELOPMENT OF FUEL PRICES AND LEVIES
(₱ per liter)/a

Regular gasoline

End of year	Oil company take /b	Duty and taxes	Wholesale price	Price increase (%)		Consumption (million liters)	% change Annual	% change Average annual
1971	0.2200	0.0800	0.3000					
1972	0.2200	0.0800	0.3000	0		1,908.8		
1973	0.2870	0.1400	0.4270	40		1,955.7	2.4	
1974	0.6580	0.3250	0.9830	130		1,653.6	-15.1	
1975	0.7800	0.3350	1.1150	13	38%	1,605.9	-2.9	-7.8
1976	0.9710	0.3590	1.3300	20		1,478.7	-8.5	
1977	1.0000	0.5850	1.5850	19		1,399.2	-5.1	
1978	1.0000	0.5850	1.5850	0		1,355.6	-4.5	
Aug 1979	1.6250	1.0580	2.6830	69		1,240.2	-7.0	
Feb 1980	2.8030	1.3480	4.1510	55		-		
Jan/Feb 1979						220.7		-23.0
Jan/Feb 1980						179.0		

Premium gasoline

End of year	Oil company take /b	Duty and taxes	Wholesale price	Price increase (%)		Consumption (million liters)	% change Annual	% change Average annual
1971	0.2750	0.0800	0.3550					
1972	0.2750	0.0800	0.3550	0		611.0		
1973	0.3420	0.1400	0.4820	37		667.8	8.5	
1974	0.7130	0.3250	1.0380	115		667.8	0.0	
1975	1.0680	0.3350	1.2100	17	38%	810.9	22.7	8.4
1976	1.1328	0.3590	1.4270	18		874.5	7.9	
1977	1.0670	0.6650	1.7320	21		969.9	10.3	
1978	1.0670	0.6650	1.7320	0		1,081.2	12.0	
Aug 1979	1.7290	1.1530	2.8800	66		1,065.3	-2.6	
Feb 1980	2.8600	1.4830	4.3430	50		-		
Jan/Feb 1979						191.4		-15.0
Jan/Feb 1980						166.5		

Diesel

End of year	Oil company take /b	Duty and taxes	Wholesale price	Price increase (%)		Consumption (million liters)	% change Annual	% change Average annual
1971			0.2521					
1972			0.2521	0		1,904.9		
1973			0.3596	42		2,035.2	6.4	
1974			0.7870	119		1,939.8	-4.2	
1975			0.8910	13	30%	2,098.8	8.3	5.0
1976			1.0710	20		2,226.0	6.0	
1977			1.1143	4		2,353.2	5.8	
1978			1.1143	0		2,480.4	5.0	
Aug 1979			1,5820	42		2,703.0	8.9	
Feb 1980	2.0400	0.2100	2.2500	42		-		
Jan/Feb 1979						449.0		4.8
Jan/Feb 1980						470.0		

Fuel oil

End of year	Oil company take /b	Duty and taxes	Wholesale price	Price increase (%)		Consumption (million liters)	% change Annual	% change Average annual
1971			0.1629			3,734.8		
1972			0.1629	0		4,499.7	17.0	
1973			0.2129	31		4,308.9	-4.1	
1974			0.5661	166	33%	4,849.5	12.6	5.5
1975			0.6505	15		5,088.0	4.9	
1976			0.7555	16		5,819.4	14.2	
1977			0.7905	5		5,978.4	2.9	
1978			0.7905	0		6,137.4	2.6	
Aug 1979			1.1240	42				
Feb 1980	1.4474	0.0824	1.5300	36		-		
Jan/Feb 1979						1,103.0		4.7
Jan/Feb 1980						1,155.0		

/a 1 barrel equals 159 liters.
/b Includes crude cost equalization differential.

Source: Information provided by Philippine National Oil Company (PNOC), dated April 1980.

Table 7: FUEL COST COMPONENTS AS OF FEBRUARY 8, 1980
(₱ per liter)

	Regular gasoline	Premium gasoline	Diesel	Fuel oil
Oil company take	2.0260	2.1220	1.9710	1.3865
Crude cost equalization differential	0.7770	0.7380	0.0690	0.0610
Specific tax	0.9100	1.000	0.1750	0.0450
Special fund	0.2480	0.2930	0.0350	0.0375
Energy development impost	0.1900	0.1900	-	-
Total taxes	2.1250	2.2210	0.2790	0.1435
Wholesale price (ex-refinery)	4.1510	4.3430	2.2500	1.5300
Retail price	4.3000	4.5000	2.4000	- /a

/a Price varies according to bulk and contracts.

ANNEX 6

THE INDUSTRIAL DEMAND FOR PETROLEUM FUELS
(Including Prospects for Conservation and Conversions)

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The Industrial Demand for Petroleum Fuels
(Including Prospects for Conservation and Conversions)

Introduction

1. The industrial demand for liquid fuel, consisting mostly of fuel oil and diesel fuel, today takes up 36% of total supplies. In 1979, industry overtook transport as the largest oil-consuming sector in the economy (Table 1). Oil use in industry is highly concentrated in a small number of energy-intensive industries, notably cement, the metallurgical industries, and mining (see Table 1). Those three industries use more than half of all fuel oil consumed in the sector. All of them are large-scale industries with professional management; in all, fuel is an important part of total costs. Consequently, these are the industries in which it should be both easiest and most important to achieve energy savings through conservation or substitution. Understandably, these, pluse a few others, are the industries on which the Government has concentrated its attention.

2. In the recent past (1975-79), demand growth has slowed: compared to a 6.7% annual increase in the sectoral value added, fuel oil use in industry expanded by 5.1% p.a., and diesel fuel use by 4.7% p.a. This slow increase in demand is chiefly due to price upheavals (33% annual increase in product prices vs. 14% in the consumer price index), despite the efforts to slightly moderate increases in fuel oil and diesel fuel prices. Although further cost escalation might restrain demand and improve returns on conservation measures, high prices alone will be insufficient to fully harness fuel savings potential. This is because in many industries energy is a relatively insignificant cost item and gets little attention.

3. An energy conservation /1 program has already been launched to deliberately help improve fuel efficiency. Such a program can work well when fuel prices are high enough to become a source of management concern. An organizational effort at the grass-roots level is required, involving the continuous and effective backing of senior management; a strong conservation unit within establishments which seriously consider adopting the program; and significant changes in operational practices so that energy use is constantly monitored. The practice thus becomes part of employees' duties and work habits, and achievements and failures are reflected in the normal reward system. The issues surrounding conservation and industrial demand for liquid fuel are reviewed in the ensuing paragraphs, with supportive data given in the attached six tables.

/1 We define conservation as reduction in energy use per unit of output.

Conservation Program

4. Industries vary widely in the amounts of energy they use per unit of output, in the specific ways they use energy, and in their potential for conservation./1 There are four or five principal energy used in industry, i.e. lighting, self-generation of electricity (8sing either boiler steam or diesel engines), process steam for heat-transfer, and use of energy as a chemical feedstock in reduction and chemical transformation processes. The main sources of savings are (i) reducing waste through better "housekeeping", (ii) conversion from higher-cost to lower-cost forms of energy, and (iii) making greater use of heat before it is finally discharged into the atmosphere. The latter two sources of improved efficiency always involve some degree of investment in order to realize the energy saving; they thus involve calculations of the trade-off between these additional expenditures and the expected energy savings. Thus, the amount of energy "that can be saved" depends as much on economic as on technical factors (technical factors determine the possibilities for savings, economic factors determine which possibilities are worth pursuing). An industrial energy program can provide a systematic approach to these problems and lead to the identification of savings opportunities that would otherwise be overlooked; often such opportunities can be highly profitable for both the company and the country. The Government has already mounted an industrial energy program, which is still in the early stages of implementation.

5. The Program. BEU has based its program on a selected list of measures, proposed by some 90 firms who have responded to a Presidential directive./2 These firms, using about one-third of the energy supplied to the industrial sectors, could curtail 18% of their current level of energy consumption through the proposed measures. The program includes measures for improved housekeeping, waste recovery, cogeneration (use of process steam to generate electricity), conversion to alternative fuels, and process changes or innovations. Tables 5 and 6 classify these proposals by industry and by types of measures. A notional estimate of the internal rate of return of the investment needed to realize these savings is 40% (Table 7). The estimated average payback period is just over two years (Table 6).

6. Since improved housekeeping costs little and is lucrative, it has become BEU's first choice, particularly since the organizational response (para. 3) fits well into the program. In conducting its training courses, BEU has therefore focussed on energy management tools, techniques, and practices, as well as on the creation of a pool of specialists. Many

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/1 See: Potential Fuel Effectiveness in Industry, by Gyftopoulos, Lazaridis, and Widmer. Ballinger Publishing Co., 1974.

/2 See: Letter of Instructions No. 825 (July 7, 1979), which requires establishments consuming at least ₱ 3 million of fuel and electricity per year to submit to BEU an energy conservation program and quarterly reports for monitoring its progress.

industrial firms have also organized ENERCON /1 units for improved housekeeping and other conservation works. BEU has provided them with limited advisory services, an effort deserving greater support than currently possible.

7. Improved housekeeping normally covers measures such as furnace maintenance, adjustment of lighting, and fixing leaky steam pipes. The term is broadly applied here. It includes, for example, better control devices (suitable meters and gas analyzers), as well as fuel and raw-material additives for improved performance. These, and other measures for improving boiler performance, are included in the program.

8. Since boilers consume a large part of industrial fuels, their performance is central to conservation efforts. The boiler efficiency can be observed and regulated by monitoring the conditions of flue gas (carbon dioxide and oxygen) and combustion air (quantity and temperature). For conserving heat, the flue gas leaving the furnace must also have the lowest possible temperature. Since fuel additives which improve combustion are available, research and testing are necessary to assess benefits and costs. Similarly, suitable changes in product or raw-material mix need research work. Thus the use of natural pozzolena in cement, currently being considered by some Filipino firms, is one of many possibilities for changing the input-mix to reduce energy use. Modification of the manufacturing process is another area deserving investigation. BEU has, for example, estimated that a 5% fall in the moisture content of the slurry in cement manufacture, would save 60,000 bbl of fuel oil annually. Six cement factories, which currently employ wet processes, are studying ways of reducing the water content (the moisture currently ranges between 35-37.5%).

9. A related program is waste recovery. Large amounts of heat energy are wasted in flue gases which leave boilers or furnaces. The temperature of raw material feed, boilerwater, and combustion air can be raised by air heaters and economizers,/2 which capture a part of flue gas energy. BEU estimates that the use of air heaters and economizers would improve boiler efficiency by 6-10%./3

/1 The Energy conservation (ENERCON) movement, started in late 1975, has relied on creating public awareness, with a focus on the industry and transport sectors. The establishment of fuel utilization standards and guidelines on energy usage have been its main areas of activity.

/2 Whereas air heaters heat the combustion air, the economizers heat the feedwater before entering the boiler.

/3 Generally every 100°F increase in air temperature raises boiler unit efficiency by 2%, and every 25°F increase in water temperature improves the boiler efficiency by 2%.

10. BEU seems to have neglected the possibility of cogeneration in its current program, probably because of policy and institutional constraints. According to its estimates, some 10 industrial establishments, using about 6% of liquid fuels in the sector, could save annually 783,000 bbl ($24.5 million) of fuel oil by combining heat and electricity production. Indeed, cogeneration is both possible and cost effective when industries require substantial amounts of process steam. Industrial units needing process steam can generate cheap power as a by-product of process steam. The process utilizes various steam grades to perform different tasks. Thus the very high pressure steam, after generating electricity, would be cascaded for use in industrial processes, requiring lower steam temperature. The savings in fuel could be substantial. Since 28% of commercial energy is transformed into process heat in the Philippines, the possibilities for cogeneration would appear to be substantial. BEU needs, however, to prepare a cost-effective cogeneration program, and resolve issues for feeding the surplus power into the national grid, including agreements on criteria that determine the bulk rate applicable to such surplus electricity.

11. In contrast to cogeneration, the fuel conversion program has received a great deal of attention. Alternative fuels include coal, bagasse, firewood, and coconut husk and shell. The scope for a switch from liquid to solid fuels is considerable./1 The cement, the pulp and paper, the sugar, and the wood industries have already proposed conversion schemes, requiring about $69 million in investment. The cement industry alone will require $48 million for a conversion scheme which it has been directed to adopt (the only such case).

12. Cement offers much the largest opportunity for oil-to-coal conversion. The country's 16 cement plants presently consume 3.3 million bbls. of oil a year, about 17 percent of total fuel oil consumption by the industrial sector. By the firms' own estimates well over half this oil could be replaced by coal, if available at an economic price and at the consistent qualities which cement kilns must have. The Government has issued an instruction that all cement plants are to convert to coal in accordance with a program and a schedule to be worked out by the Philippine Cement Industry Authority. In February, 1980, the Ministry of Energy undertook to guarantee the supply of coal to cement plants at a maximum price no greater than 65% of the price of bunker fuel oil (on a BTU basis). The industry will have to spend around US$50 million to make the conversion, which will have an average payback period of 1.5 years in 1979 prices. Most of the money would have to come from a government development Bank (the Development Bank of the Philippines). In mid-1980, there were still many problems to be worked out (technical, financial and logistical) and no conversions had yet been made.

/1 Both because of the existing market for liquid fuel and also because of the availability and cost of alternative fuels: bagasse (9.5 mn bbl of oil equivalent, p.a.), firewoods and coconut husk and shell (600-800 thousand tons of charcoal equivalent, p.a.)

But if the program moves as now projected, the cement industry will need 629,000 tons of coal (9,500 BTU/lb) in 1982 and twice that amount by 1983. If the coal has to be imported, the foreign exchange savings would obviously be far less than if domestic coal could be used; the savings would still be substantial, however./1

13. Generally, a fall in capacity utilization increases the energy-output ratio, and rapid industrial growth, through investment in plants and machinery, reduces the ratio./2 The long life of machinery also means that only a small portion of the capital stock is replaced each year and old plants, such as cement factories, experiencing frequent breakdowns, waste a lot of fuel. Rehabilitation and changes in production processes can, therefore, significantly enhance fuel efficiency./3 MOI has already been considering a program to convert wet process to dry process in cement manufacture. According to BEU, the saving from such a conversion would be about 2.7 million bbl of oil equivalent, p.a./4 Table 6 also lists some other innovative schemes: the solar drying of ore and fibers, and the introduction of new mining techniques.

14. Organizational Issues. BEU has recently created a conservation division to carry out the tasks envisaged in the Presidential directive./5 Because of the low government pay-scales, the division has had difficulty in

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/1 The reason is that coal is a cheaper form of energy than oil, for which people are willing to pay a sustantial premium because of its relative convenience, cleanliness, and versatility. Speaking very roughly, many oil-importing countries can import BTUs in the form of coal at half the price of oil BTUs. But a switch to imported coal will require new investments in infrastructure and coal-handling equipment which will reduce the savings on energy costs alone.

/2 See: Saving Energy in Manufacturing: The Post-Embargo Record, John G. Myers and Leonard Nakamura. Ballinger Publishing House, 1978.

/3 There are many possibilities for changing industrial processes. In some industries alternative production processes are available, with differing energy output ratios; the design of new factories and machinery can also be changed to improve energy efficiency; also processes can be integrated by, for example, locating pulping operations next to paper and paper-board manufacturing units, or entirely new production processes can be introduced that use less energy. These possibilities deserve continuous review.

/4 Wet process needs 8-10 million BTU/metric ton, and dry process 5-7 million BTU/metric ton.

/5 Letter of Instructions No. 825.

attracting sufficient expertise. It has, however, arranged and paid for training courses: for the past two years the BEU, working with the Development Academy of the Philippines and using some technical assistance from the Asian Productivity Center, has conducted more than 20 "Energy Management Seminars" (about 40 participants for five eight-hour days). Moreover, the division can call on the voluntary services of fellow associates /1 for consulting work. About 80 energy audits have been conducted for companies that have requested them.

15. Technical possibilities for fuel savings mean little unless industry is willing to spend the money needed to achieve these savings. Although average incentives (payback period, rate of return) look highly attractive, management may be reluctant, unable, or unwilling to make such investments. The Government can publicize, educate, provide occasional technical assistance, assure that financing is available, offer incentives, and, above all, keep price pressure on industry by charging them the full cost of the energy they use. Government must also make clear whether or not industries are free to negotiate their own contracts for coal supplies (domestic or foreign) or will be expected to draw from national supplies contracted for by the National Coal Authority. In mid-1981, this question was still unresolved.

16. In June 1981 the Government decided to introduce fiscal incentives to encourage investment in energy-saving by industry (LOI No. 1152). The decision will extend to energy-saving investments the same incentives now available to industry under the existing Investment Priorities Plan.

Demand Projections

17. According to the official projection, the industrial demand for liquid fuel will grow at 4.5% a year in the 1980s. The Bank estimate, which assumes an effective conservation program, is farily close to the official forecast (cf. Tables 2 and 3). The validity of the two projections depends largely on the coal conversion scheme. Without coal the industrial demand for liquid fuel would grow 2.5 percentage points faster (= 50% faster) than the official estimates. Also, without an expanded and effective conservation program, including coal conversion, the rate at which demand would increase approximates 8%, rather than the 4-4.5% range; the former figure represents the expected rate of growth of the manufacturing sector in the 1980s. Hence, the importance of coal conversion and a comprehensive energy conservation program.

/1 The Energy Management Association of the Philippines (ENMAP) has been formed from about 400 participants of the Energy Management Training Course. One of the main objectives of the association is to invite experts, in consort with BEU and the Development Academy of Philippines, to provide consulting services on conservation techniques to the various industrial establishments.

Table 1: INDUSTRIAL DEMAND VIS-A-VIS OTHER DEMANDS FOR PETROLEUM FUELS, 1975-79
(In million barrels)

	1975	1976	1977	1978	1979	Annual growth rate 1975-79 (%)
Power Generation Demand	14.0	14.5	17.1	18.2	18.2	6.8
Fuel oil	13.5	14.0	16.6	17.8	17.8	7.2
Diesel oil	0.5	0.4	0.5	0.4	0.3	-12.0
Other products	0.0	0.1	0.0	0.0	0.1	-
Manufacturing & Mining Sector Demand	23.2	24.5	26.8	26.7	28.3	5.1
Fuel oil, uses in:	15.9	16.7	18.6	18.4	19.4	5.1
Steel, metal & nickel	(2.8)	(3.0)	(4.2)	(3.6)	(3.6)	(6.5)
Cement	(3.6)	(3.3)	(3.1)	(3.3)	(3.4)	(-1.4)
Mining	(1.8)	(1.7)	(2.2)	(2.3)	(2.6)	(9.6)
Lube refining	(1.4)	(1.2)	(1.4)	(1.4)	(1.6)	(3.4)
Paper	(1.1)	(1.6)	(1.4)	(1.4)	(1.5)	(8.1)
Textile	(0.9)	(0.9)	(1.0)	(1.0)	(1.0)	(2.7)
Glass	(0.6)	(0.6)	(0.8)	(0.8)	(0.8)	(7.5)
Coconut & vegetable oil	(0.3)	(0.5)	(0.5)	(0.6)	(0.8)	(27.0)
Sugar	(0.9)	(0.8)	(0.7)	(0.6)	(0.6)	(-9.6)
Others	(2.5)	(3.1)	(3.3)	(3.4)	(3.5)	(8.8)
Diesel oil, uses in:	5.2	5.6	5.8	5.8	6.2	1.5
Mining	(0.8)	(0.7)	(0.9)	(0.8)	(1.1)	(8.3)
Logging & wood	(0.9)	(0.9)	(0.9)	(0.9)	(1.1)	(5.1)
Fishing	(0.5)	(0.5)	(0.6)	(0.6)	(0.7)	(8.8)
Contract services	(0.6)	(0.6)	(0.6)	(0.7)	(0.9)	(10.7)
Sugar, coconut & vegetable oil	(0.4)	(0.5)	(0.5)	(0.5)	(0.6)	(10.7)
Others	(2.0)	(2.4)	(2.3)	(2.3)	(1.8)	(-2.6)
Gasoline	1.3	1.3	1.3	1.3	1.2	-2.0
Kerosene	0.3	0.3	0.4	0.4	0.5	13.6
LPG	0.1	0.2	0.3	0.4	0.4	41.0
Others	0.4	0.4	0.4	0.4	0.6	10.7
Commercial & Residential Demand	5.1	4.9	5.1	5.5	5.4	1.4
Kerosene	2.9	2.9	3.0	3.2	3.0	0.9
LPG	2.2	2.0	2.1	2.3	2.4	2.2
Transportation Demand	24.3	24.7	25.6	27.1	27.1	2.8
Petroleum Products Used for Energy	66.6	68.6	74.6	77.5	79.0	4.4
Fuel oil	30.5	32.0	36.6	37.6	38.6	6.1
Diesel oil	13.2	14.0	14.8	15.6	17.0	6.5
Gasoline	15.3	14.9	14.9	15.2	14.4	-1.5
Kerosene	3.2	3.2	3.4	3.7	3.5	2.3
LPG	2.1	2.2	2.4	2.6	2.7	6.5
Avturbo/avgas	2.3	2.3	2.5	2.8	2.8	5.0

Source: PNOC data provided to the mission.

Table 2: DEMAND FORECAST FOR PETROLEUM FUELS
(In million barrels)

	1979	1985	1989	Annual growth rate (%) 1979-89
Power generation demand	18.2	11.8	4.2	-15.8
Manufacturing and mining sector demand	28.3	36.7	44.1	4.5
Commercial and residential demand /a	5.4	7.5	9.0	5.2
Transportation demand	27.1	34.2	41.3	4.3
Total	79.0	90.2	98.6	2.2
Fuel oil	38.6	42.6	42.6	1.0
Diesel oil	17.0	22.6	28.3	5.2
Gasoline	14.4	12.5	12.5	-1.4
Kerosene	3.5	4.7	5.3	4.2
LPG	2.7	3.9	5.2	6.8
Avturbo/avgas	2.8	3.9	4.7	5.3

/a Commercial and residential demands for power and transportation, excluded from this category, are classified under suitable captions.

Source: MOE data provided to the mission.

Table 3: INDUSTRIAL DEMAND FOR COMMERCIAL ENERGY
(In million barrels of oil equivalent)

	1979	1985	1990	Annual growth rate (%) 1979-90
Electrical Energy /a	16.2	23.1	32.2	6.4
NPC-supplied power	11.5	21.4	30.9	9.4
Coop-supplied power /b	0.1	0.3	0.8	20.8
Captive power supply	4.6	1.4	0.5	-22.3
Coal,/c Uses in:	0.8	8.0	13.7	29.5
Cement industry	0.5	4.5	8.6	29.5
Other industries	0.3	3.5	5.1	29.4
Petroleum Products	28.3	32.2	43.9	4.1
Fuel oil /d	19.4	19.7	27.0	3.1
Diesel oil /e	6.2	8.3	10.8	5.2
Other liquid fuels /f	2.7	4.2	6.1	7.7
Total	45.3	63.3	89.8	6.4

/a Assumes an improved heat rate, energy consumption per kWh falling from 12,000 BTU in 1979 to 11,000 BTU in 1990.

/b About 21% of coop sales went to industries in 1979; the figures under this heading assume that industries will get 25% of coop generation in 1985 and 30% in 1990.

/c The 1990 coal projections reflect official estimates. However, the 1985 figures, while including the revised official program for the cement industry, reduce the level of conversion for other industries by one third.

/d The fuel oil estimate assumes that through conservation the consumption level can be cut back by 10%. After this adjustment, the growth of fuel oil consumption corresponds to the expected growth of the manufacturing sector (8.0% p.a.). The coal to be substituted for fuel oil is, then, subtracted from fuel oil projection to arrive at the final results.

/e The demand for diesel fuel originates chiefly from the mining, fishing, logging, sugar, coconut and vegetable oil industries and contractors. The fuel is mostly used for energizing diesel plants to generate motive power and electricity. Mission projections assume that the 1975-79 growth in consumption by mining, logging, fishing, and contractors will remain undiminished, that other industries will be able to conserve 10% of their diesel fuel demand and that the bulk of the projected decline in captive generation in industry is diesel-based and must, therefore, be subtracted from the total.

/f Other liquid fuels, consumed by industries, increased by 0.97% for every one percentage point rise in value added in the manufacturing sector during 1975-79. The projection assumes that this relationship remains unchanged.

Source: Mission projections.

Table 4: THE WHOLESALE PRICES OF PETROLEUM PRODUCTS
(Centavos/liter)

Part 1: In Absolute Prices (Centavos/liter)

Year	Gasoline Pre-mium	Gasoline Reg-ular	Fuel oil	Diesel oil	Kero-sene	LPG	Wholesale price index, /a 1972 = 100
1970	33.0	27.5	13.8	21.0	24.0	27.0	90
1972	35.5	30.0	16.3	25.2	24.0	31.2	100
1973	48.2	42.7	21.3	36.0	32.7	37.3	133
1974	103.8	98.3	56.6	78.7	75.8	68.0	311
1978	173.2	158.5	79.1	114.3	106.3	92.2	452
1979 (March)	213.7	197.6	93.3	133.1	129.6	116.4	575
1979 (August)	288.0	268.3	112.4	158.2	156.7	146.3	731
1980 (February)	434.3	415.1	153.0	225.0	227.0	212.1	1,037
Annual price increase (%), 1972-80	36.8	38.9	32.3	31.5	32.4	27.1	34.0

/a All products used for energy and nonenergy purposes.

Part 2: In Index Numbers (1972 = 100)

Year	Gasoline Premium	Gasoline Regular	Fuel oil	Diesel oil	Kero-sene	LPG
1970	93	92	85	83	100	87
1972	100	100	100	100	100	100
1973	136	142	131	143	136	120
1974	292	328	347	312	316	218
1978	488	528	485	454	443	296
1979 (March)	602	659	572	528	540	373
1979 (August)	811	894	690	628	653	469
1980 (February)	1,223	1,384	939	893	946	680

Source: PNOC.

Table 5: POTENTIAL OIL SAVINGS BY INDUSTRY AND SOURCE OF SAVINGS PLUS INVESTMENT COST OF SUCH SAVINGS

	Investment	Energy savings, p.a. Value	Energy savings, p.a. Quantity
	(Mln 1979 pesos)		('000 bbls)
I. Industries			
Cement	760	238	1,497
Mining	8	23	146
Lube refining	n.g.	1	7
Rubber tires	4	2	17
Pulp and paper	165	135	847
Steel/metal processing	2	8	52
Sugar	...	16	103
Textile	3	7	41
Ceramics	2	2	14
Wood	4	3	16
Glass	28	7	44
Coconut/vegetable oils	1	1	4
Food processing	1	1	4
Chemical/chemical products	5	2	16
Total	983	446	2,802
II. Source of Savings			
1. Replacement/Modification:	42	34	212
Tunnel kiln modification (3) /a	1	1	6
Revamp electrical system (2)	1	1	9
Power capacitors (23)	5	12	77
Boilers (4)	1	1	4
Rolling/steam condensate piping/ desuperheaters, evaporators (6)	2	10	61
Compressor plant, piping system, fresh water supply (13)	4	2	11
Redesign old furnace to regenerative type (2)	28	7	44
2. Conversion to Nonpetroleum Fuels:	518	375	2,359
Coal (12)	360	236	1,484
Woodwaste, firewood, sawdust, bagasse (5)	158	139	875
3. Others:	423	37	231
Fluidized bed coolers, cooling tower construction (5)	2	2	14
Recycling/recovery of used oil (21)	1	3	19
Phase out pit mining to block caving (3)	5	13	79
Solar drying - ores, fibers (7)	2	11	70
Waste heat recovery (15)	11	5	32
Reinsulation program (8)	2	3	17
Reduction of water content of slurry (2)	16	...	...
Process conversion: wet to dry (2)	384	...	...
Total (90) /a	983	446	2,802

/a Number of firms interested in the process.

Source: MOE.

Table 6: CONSERVATION: INVESTMENT AND ENERGY SAVINGS BY INDUSTRIES AND ENERGY-SAVING MEASURES
(In million 1979 pesos)

Industry:	Cement	Mining	Lube refining	Rubber tires	Pulp & paper	Steel/ metal processing	Sugar	Textile	Ceramics	Wood	Glass	Coconut/ vegetable oil	Food processing	Chemical/ chemical products	Total
I. Replacement/Modification:															
1. Power capacitors, rectifiers															
Investment	-	0.4	-	0.3	0.6	1.5	-	1.0	-	-	-	-	0.7	0.3	4.8
Savings	-	0.6	-	0.4	0.5	7.0	-	2.8	-	-	-	-	0.6	0.3	12.2
2. Evaporators, desuperheaters, condensate piping, burners, tunnel kiln															
Investment	-	-	-	-	2.0	...	-	-	1.1	-	28.0	1.2	-	0.7	33.0
Savings	-	-	-	-	9.7	1.1	-	-	0.9	-	7.0	0.7	-	0.3	19.7
II. Conversion to Solid Fuels:															
1. Coal conversion															
Investment	360.0	-	-	-	-	-	-	-	-	-	-	-	-	-	360.0
Savings	236.0	-	-	-	-	-	-	-	-	-	-	-	-	-	236.0
2. Utilization of bark, firewood, bagasse, sawdust for heat generation															
Investment	-	-	-	-	154.0	-	...	-	-	3.9	-	-	-	-	157.9
Savings	-	-	-	-	122.3	-	15.0	-	-	1.8	-	-	-	-	139.1
III. Others:															
1. Reinsulation program															
Investment	-	-	-	0.8	0.5	-	...	-	0.6	-	-	-	-	-	1.9
Savings	-	-	-	0.6	1.4	-	0.5	-	0.2	-	-	-	-	-	2.7
2. Waste heat recovery															
Investment	-	-	-	2.8	6.0	-	...	1.1	0.8	-	-	-	-	3.9	14.6
Savings	-	-	-	0.7	...	-	0.7	2.5	1.2	-	-	-	-	1.7	6.8
3. Recycling/recovery of used oil, process cooling water, oil sludge															
Investment	0.2	0.4	0.2	-	1.5	...	...	-	-	0.1	-	-	-	0.6	3.0
Savings	2.1	0.2	1.1	-	0.7	0.2	0.1	-	-	0.7	-	-	-	0.2	5.3
4. Reduction of the water content of slurry															
Investment	16.0	-	-	-	-	-	-	-	-	-	-	-	-	-	16.0
Savings	...	-	-	-	-	-	-	-	-	-	-	-	-	-	...
5. Process conversion from wet to dry															
Investment	384.0	-	-	-	-	-	-	-	-	-	-	-	-	-	384.0
Savings	...	-	-	-	-	-	-	-	-	-	-	-	-	-	...
6. Phase out pit mining in favor of block caving															
Investment	-	5.4	-	-	-	-	-	-	-	-	-	-	-	-	5.4
Savings	-	12.6	-	-	-	-	-	-	-	-	-	-	-	-	12.6
7. Solar drying of ore, fibers															
Investment	-	1.6	-	-	-	-	-	0.3	-	-	-	-	-	-	1.9
Savings	-	9.9	-	-	-	-	-	1.2	-	-	-	-	-	-	11.1
Total															
Investment	760.2	7.8	0.2	3.9	164.6	1.5	...	2.4	2.5	4.0	28.0	1.2	0.7	5.5	982.5
Savings	238.1	23.3	1.1	1.7	134.6	8.3	16.3	6.5	2.3	2.5	7.0	0.7	0.6	2.5	445.5

Source: MOE.

NONCONVENTIONAL RENEWABLE ENERGY

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Nonconventional Renewable Energy

Introduction

1. Nonconventional energy is a vague term that covers a wide range of potential energy sources that are not yet in widespread use. It therefore refers to sources of energy, and means for their conversion and use, that are often still in the R&D stage, whose technical and economic viability is still unproven or unrecognized and which have therefore not yet come into widespread use in either commercial or non-commercial settings. The central focus of nonconventional energy activities throughout the world is the development of useable energy from primary sources that are either free (e.g. sun, wind, water) or that are in relatively plentiful local supply, either as little-used waste products (e.g. rice hulls or coconut husks, sawdust at lumber mills, waste-wood in forestry operations, animal or human excreta) or as agricultural or forestry crops that can be grown for energy use (e.g. sugar, cassava, or trees). The Philippines' energy program reflects the worldwide surge of interest in nonconventional renewable energy. The Survey did not pay as much attention to nonconventional energy as it would have liked, partly because the Federal Republic of Germany had just had a major two-month mission in the country and had covered the ground.

I. THE CENTER FOR NONCONVENTIONAL ENERGY DEVELOPMENT

2. The MOE began work in nonconventional energy in 1977, assigning responsibility to the Nonconventional Energy Resources Division of the BED. The Division developed a program of R&D activities, most of which were contracted out. Three of the major early possibilities - alcohol production from biomass products, mini-hydro and dendro-thermal power generation - have since been "spun off" to other organizations (the first to the PNAC, the latter two to NEA). The program is now concentrating its attention on a fairly wide variety of potential solar applications (e.g. hot water heating, refrigeration and ice manufacture, village electrification, crop drying, industrial process heat, water pumping), some work on wind and biogas, the pyrolitic conversion of agricultural wastes into charcoal and liquid fuels, the improvement of domestic stoves to use less fuelwood and more waste products, and public education. The largest single ongoing project is the testing of a local invention capable of permitting an ordinary internal combustion engine to run on either gasoline or on low-quality (hydrous) alcohol. In 1979 the program's administration was taken out of the BED and elevated to the status of a semiautonomous Center for Nonconventional Energy Development (CNED). In mid-1981, it had been decided to end the Center's semiautonomous status and to incorporate it into PNOC as a research department on nonconventional energy. In 1980, the

Center had a total budget of about US$3.5 million equivalent, 75% of which was funded by the United States and Federal German Governments. Total staff numbers about 75 people, spread over seven line and three staff divisions. CNED recently completed its own headquarters building, at the Diliman Campus of the University of the Philippines. The building will permit CNED to do more of its work in-house, a somewhat doubtful advantage.

3. CNED has been criticized for not yet having developed a well-thought-through set of priorities in its program, resulting in excessive "ad-hocism" or "technological tinkering" without having developed much capacity for evaluating the acceptability and economic viability of the technology it helps develop. In order to bring its program into better focus, CNED would have to devote more resources to identifying and analyzing energy needs that hold promise of being met by nonconventional sources and devices. The completion in 1980 of a contracted study of rural energy needs, organized by the MOE with CNED funding, may help overcome the present lack of clear program focus. But unless CNED can build a considerably stronger staff under its highly-regarded senior administrators, and can attract somewhat stronger support from senior MOE officials than it now appears to be getting, its contribution to the development of alternative local energy production is likely to fall considerably short of its potential. The mission suggests that the Center consider the following activities as its major priorities for at least the next two years:

(a) prioritizing tasks, i.e., identifying more clearly the high-priority energy-using needs of rural and small-town populations (we suspect that hot water and electrification will not rank high; we would expect domestic cooking, crop drying, and fuel for small moters would rank much higher);

(b) pyrolisis: Devoting much more resources to the pyrolitic conversion of biomass wastes into charcoal and liquid fuels;

(c) analysis of cooking fuels: A major study of the roles of fuelwood, kerosene, and charcoal as domestic cooking fuels is needed, in both rural and urban households. The aim should be to test the proposition that fuelwood and kerosene should both be discouraged while charcoal should be encouraged. This may not be true: it might, for example, be more economical to encourage barangay firewood plantations instead of trying to develop charcoal production. But charcoal may make more sense in urban areas;

(d) fuel interchangeability: Development of a device that will permit small engines to operate satisfactorily on multiple liquid fuels would have wide application, particularly in remote locations. Surely the best way to develop and test such a device is not in-house but - after securing patent protection - to develop an R&D program with one or more major manufacturers (in Japan, Brazil, or the United States); and

(e) cooking efficiency: With a large fraction of Philippine households dependent on buying their fuel for domestic cooking, this cost is heavy for many (perhaps 8-10% of cash incomes). A stove that uses less fuel would therefore serve both private and public interests. A 3-4 year technological/sociological effort to develop and introduce such devices would seem worthwhile.

4. CNED is by no means the only Philippine agency interested in nonconventional energy, although it is the largest. The country is one of seven Asian countries that is participating in a USAID-funded three-year study of "Energy for Rural Development" that is being coordinated by the Resource Systems Institute at the East-West Center in Hawaii. Country Coordinators have been appointed to organize the work in each country; the Philippine Coordinator is a senior official in the Ministry of Human Settlements. The project began in April 1979 and requires each country to conduct village sample surveys on energy use. We do not know the relation of these surveys (if started) to the work on rural energy needs that has already been done, and is now being analyzed, by the Policy Services Group in the MOE. The US Peace Corps is also conducting a survey of energy patterns in some 25 villages as part of a five-country Peace Corps project. Thus some kind of a data-base on rural energy appears to be in the process of establishment; we have no judgment on its adequacy, however.

5. The most thorough study of the country's rural energy needs of which we are aware is that prepared by a team of 5-6 experts from the Federal Republic of Germany who visited the country for two months, in March-April 1980. That mission will report to the German Government which may in turn make proposals, mainly addressed to rural energy needs, to the GOP. One area in which the German team is known to be interested is the potential role of non-governmental organizations (NGOs) in spreading the use of nonconventional energy forms. The mission would strongly endorse any program to engage NGOs (which often have greater flexibility, greater knowledte of field conditions, and stronger commitment than official agencies) in the promotion of nonconventional energy. With the German Government supporting CNED plus the diffusion of biogas technology by one NGO, the Philippines is already a "cooperating country" in the German Government's multi-country program for the development of alternative energy sources.

II. NATIONAL ELECTRIFICATION ADMINISTRATION

6. Program of Electrification. The program of electrification of the National Electrification Administration (NEA) is based largely on the Government's objective of total electrification of the ocuntry, to be attained between 1987 and 1990. The original deadline, which was set at 1990, was brought forward to 1987 in 1979, but NEA is considering reverting back to 1990. Either date will require a massive effort.

7. NEA's current program of construction envisages 450,000 new connections in 1980 and 500,000 in each of the succeeding years until 1990. NEA maintains that its implementation capability in 1979 was adversely affected by a leadership change in 1978-79./1 The number of connections made during the year was only about 273,000. However, NEA is now properly geared for implementing the proposed program and aims to step up the rate of connections from 273,000 to 450,000 during 1980 and maintain it at 500,000 in each of the succeeding years./2

8. NEA has discussed this program with the various co-ops and has given them indicative plans and targets for achievement over the next few years. The program is thus not necessarily based on the plans and implementation capacity of individual co-ops but on the targeted date.

9. It should be noted that as the electrification effort moves away from centers of population towards the interior of the country, consumer density would decline and the incremental amount of physical construction required to make additional connections will correspondignly increase. Thus, even though the number of connections to be made annually would remain the same (at 500,000), the amount of construction work and implementation effort to be undertaken for these connections will increase. NEA's physical planning does not appear to have sufficiently considered the increasing incremental cost of construction of primary and secondary lines over the years. There is, therefore, need for NEA to review its program of construction taking into account the implementation capacity of the individual co-ops and the realistic assessment of the additional work that will be needed.

10. In view of these considerations, the number of connections NEA is likely to achieve over the next few years is considerably less than its target; these could likely average around 300,000 in the initial two years, 1980 and 1981, and around 350,000 per year thereafter. This would increase the total number of connections from about 1.1 million in December 1979 to about 3.8 million in 1987 (about 75% of NEA's declared target).

Demand Growth

11. NEA's sales of electricity in 1978 and 1979 amounted to 520 and 859 GWh respectively; maximum demand on NEA's distribution networks totalled 176 MW and 283 MW for these two years. Projections of power demand growth for 1980-87 are given in Appendix 1.

12. Energy sales and power demand growing at an annual average rate of 21% and 20% respectively during 1980-87 appear to be very optimistic. For the reasons indicated earlier, the program of new construction is likely to

/1 NEA was transferred from the Office of the President to the Ministry of Energy in December 1977. In February 1979, it was reinstated under the Office of the President.

/2 The numbers of newly energized households from January to April 1980, averaging about 20,000 a month, were well below target.

achieve much smaller number of connections than envisaged under NEA's program. Moreover, as the electrification penetrates deeper into rural areas, per capita consumption is likely to be lower than in areas closer to the towns and barrios. This general trend is likely to be aggravated by conditions of rapidly rising prices of energy in general and electricity in particular. In this context, NEA's forecasts of energy needs must be regarded as optimistic and may need to be substantially scaled down.

Program of Generation

13. In October 1979, the President directed that all co-ops should attain self-sufficiency in power generation /1 by 1987. A Presidential Decree (PD 1645) was also issued authorizing NEA to undertake development of power generation projects of up to 5 MW capacity. Under the said Decree, the powers and functions of NEA were expanded. NEA is now empowered to: (a) invest in and/or grant loans for the development of power generation industries or companies including dendro-thermal and mini-hydro power plants and associated facilities; and (b) organize wholly or partly owned companies for the purpose of operating power-generation and distribution systems and other related activities, as well as for manufacturing materials and equipment for power-generating systems.

14. Pursuant to the directive on self-sufficiency, NEA has prepared a comprehensive program (Appendix 2) for developing by 1987 total generating capacity of 555 MW from 70 dendro-thermal plants (capacity: 200 MW) and 239 mini-hydropower plants (capacity: 310 MW) and 45 additional MW from mini-hydro plants at 205 sites in conjunction with Small-scale Water Impounding Project (SWIP) schemes. This capacity would be about 45% of projected demand in 1987.

15. To undertake this fairly substantial program of generation, NEA has set up a task force (ECO-BLISS, an acronym) composed mostly of officers drawn from co-ops. Eventually, this task force may develop into a separate entity. Details of individual components of this program of generation are given below; funding requirements for the ECO-BLISS task force, including assistance expected from Britain, France, and China, are given in Appendix 3.

Dendro-Thermal Power Plants

16. The basic model for this program is a 3 MW wood-fired steam thermal plant. The requirement of wood, estimated at 100 dry tons per day will be met by developing ipil-ipil plantations in areas of about 1,000 ha each. The plantations will be developed and harvested in such a manner that about one-fourth of the area will be used for wood supply every year after the 4-year crop cycle is established. The cost of generation is estimated at about ₱ 0.40/kWh in 1980 prices. Each dendro-thermal power plant is estimated to replace 25,000 bbls of oil (= $750,000 to $1 million with oil at $30-40/bbl).

/1 In 1979 NEA generated 23% of energy required while it purchased the balance from the National Power Corporation (NPC). By 1987, NEA expects to generate 64% of its expanded energy requirements (see Appendix 1).

17. NEA proposes to develop each of these plantations in 10 modules of 100 ha each run by a farmers' association comprising 10 to 15 farmers. This would require 100-150 farmers to be engaged in the plantation activity. Combining power with rural development and settlement objectives, NEA proposes to settle "kaingineros" (slash-and-burn cultivators) on many of the plantations. These farmers will be given loans initially for financing their settlement (including housing), tree-planting and living costs. The plantations and power plant will be supervised and managed by the rural co-op through separate corporations established for this purpose. Participation in the share capital of these corporations by the co-ops, farmers' associations and NEA will be at about 50%, 30% and 20%, respectively.

18. NEA regards power generation as only one aspect of its dendro-thermal program and emphasizes its impact on rural employment, reforestation, watershed improvement, and human settlement. NEA also expects that the program will provide many nuclei for rural industrialization and development all over the country. The program appears imaginative, complex and probably difficult to implement.

19. Major considerations that may constrain the development of this program as planned, may be summarized as follows:

(a) Technical. Assumptions regarding development of ipil-ipil plantations and their growth and yields per hectare are based probably on sound reasoning but limited field-level experience. The assumptions, particularly on crop cycle management and yield may or may not be realized all over the country. Even the choice of ipil-ipil for plantation, according to some observers, may not be suitable for all the locations in the country.

On power plant operations, while the steam-thermal technology involved is fairly routine and well-established, practically no operating experience exists in the Philippines of wood-fired plants in the proposed size-range of 1 to 3 MW. Experience elsewhere is also limited. These issues are not insurmountable, but in the initial years they may produce operating and maintenance problems which could limit the pace of program implementation.

(b) Institutional. Probably the most critical problems in the dendro-thermal program will be institutional. Strong organizational support is required to promote farmers' associations, to provide them technical know-how and implements, to finance and settle them in the initial years, and to prepare them for the cooperative sharing of their work and incomes. Moreover, settlement of "slash-and-burn" cultivators in these associations, may have its own unique (cultural?) problems in addition to those usually encountered in settlement projects in general.

It is not clear how the massive institutional effort can be provided by the ECO-BLISS task force and the co-ops as planned by the NEA. The ECO-BLISS group, which has the primary responsibility for monitoring and executing this program through co-ops, is less than one year old and is not yet well staffed. This group, in fact, has the responsibility for the entire generation program which appears excessive in relation to its current resources. At the field level, individual projects are to be organized and managed by the co-ops. The majority of the co-ops are still young and many are still struggling with their own initial organizational and operational problems. The development of their capabilities in tackling the above problems cannot be taken for granted.

(c) Other Issues

20. Cost of Power. Assumptions used in establishing economic feasibility of the dendro-thermal plants do not appear fully justified. The estimated power generation cost of ₱ 0.40/kWh is based on a load factor of 60% and on the price of wood at ₱ 125/ton. The above load factor is considerably higher than the current one of around 35%. It also appears that the assumed price of wood to be offered by the co-ops to participating farmers is below the prevailing market price; there could be continuous problems between the co-ops and the farmers' associations over the procurement and pricing of wood. At more realistic assumptions of load factor of 40% and wood price of ₱ 150/ton, the cost of power works out at about ₱ 0.50 kWh. With more conservative assumptions on yield/ha, the energy costs would still be higher. The NEA Administrator has given assurances that NEA does not intend to build supplies whose costs will be higher than the cost of buying power from NPC, in locations where this is possible.

21. In consideration of the various factors mentioned above, it appears that the implementation of the dendro-thermal program may proceed much more slowly than envisioned by NEA. Against the planned construction of 70 such plants for an aggregate capacity of 200 MW by 1987, a more likely number of plants in operation by that time may be around 20-25 for a total capacity of about 70 MW. By mid-1981, 70 dendro sites had been identified, at 50 of these tree-planting had started, and for 17 the power plants had been ordered.

Mini-Hydro Program

22. NEA's mini-hydro program is based on desk studies which have identified about 850 potential sites for development. Of these, stream-gauging records and hydrology estimates have been made for 147 sites while in the case of 37 sites, architecture and engineering work is in progress or soon will be.

23. The mini-hydro program can be expected to be implemented with fewer difficulties than the dendro-thermal program. They do not present the same institutional and "people" problems. It is likely, however, that owing to

the socio-political appeal of the dendro-thermal program as envisaged, NEA may devote considerable time and attention to that program while the effort and organizational support required to accomplish preparation and implementation of mini-hydro projects may be delayed. The major constraint in the implementation of mini-hydro program as proposed is likely to be inadequacy of efforts from NEA.

24. In addition to local manufacturers, the program also obtains considerable support from bilateral and multilateral sources, as seen in Appendix 3. It appears that the development of mini-hydro projects may lead to problems of standardization and maintenance. As the designs of the plants vary considerably in sophistication, estimates of kWh costs are about ₱ 0.25 to ₱ 0.27/kWh for PROC and ₱ 0.30 to ₱ 0.32/kWh for the British and French models.

25. In view of the above, it appears that the implementation of the mini-hydro program may also be slower than envisioned; by 1987 it is likely that the program could complete about 100 plants for a total of 150 MW capacity.

Small-scale Water Impounding Projects (SWIP)

26. This program will construct small catchment basins and impounding reservoirs for the control of water against flood and erosion and to provide water for irrigation and domestic use as well as for power generation. The program is overseen by a committee with membership from several government agencies, including the Ministries of Public Works, Agriculture, and Human Settlements, and NEA. The choice of the lead agency for each site is usually based on the dominant objective and the area to be affected.

27. The major considerations for project selection are (a) economically depressed regions; (b) flood-prone areas; and (c) multi-purpose projects which include measures for environmental protection and enhancement.

28. The construction and development costs are to be shared by the agencies involved under the following arrangements: (a) cost for the dam and appurtenant structures shall be financed out of NEA's SWIP funds; and (b) specific cost of works that clearly serve a single purpose, i.e., power, irrigation, and water supply shall be funded by the respective agencies as determined by the SWIP Committee.

29. The program envisions the commissioning of 205 sites allocated to NEA responsibility for a total capacity of 38 MW by 1987. Presently, there are six actual sites allocated to NEA, none of which has been commissioned. It is likely that interagency collaboration of SWIP sites will involve a considerable amount of time-consuming administrative and logistic difficulties that will lead to slippage.

30. As SWIP projects vary considerably in extent of construction and costing, no typical cost per kWh is available. Funding for SWIP operations for the 1980-87 program will be derived from government funds (primarily NEA and the Ministry of Public Works).

Other Considerations

31. In view of the above considerations, it seems likely that NEA's generation program will proceed much slower than envisioned and NEA will not obtain its objective of 64% self-generation by 1987. On the overall program, the advisability of energy self-sufficiency for each co-op needs to be carefully considered. The bulk of NEA's system is or will soon be on the NPC grid. Development of self-generation for different co-ops at various points from the grid could create problems for system operations and stability. Moreover, to the extent self-generation is successful, NPC's facilities will serve mainly for stand-by use by rural co-ops./1 In view of this, it would be advisable that self-sufficiency should be considered on a selective basis. In 1981 there was some indication that NEA was taking a more selective approach than earlier.

32. There is an obvious need for coordination between NEA and NPC to prevent duplication of investment. Formal coordinating mechanisms have been weak, although an increasing amount of informal contacts appear to be lessening the danger of duplication. The main problems of coordination are on Luzon and Leyte: on all other islands NPC either is not present (it operates on only 7 of the 200 islands where electricity is needed), or NEA has no plans for building generating capacity because it knows it cannot compete (e.g. on Mindanao), or NPC presently operates high-cost diesel sets and would welcome lower-cost supplies from NEA.

III. HOUSEHOLD ENERGY CONSUMPTION, BY REGIONS (1977)

33. Appendix 4 presents details on the amounts and form of household consumption of energy in 1977 in each of the country's 13 administrative regions. The figures come from a sample survey conducted by consultants engaged by the MOE. While the figures are subject to many questions and reservations, they constitute the best data currently available on household energy consumption. Some of the more interesting points suggested by the table are the following:

/1 In the case of one specific site visited (Pangasinan Electric Cooperative, PANELCO), NPC supplies are brought to co-op by a 69 KV transmission line over a distance of 70 km. This transmission line was constructed by NPC in 1975 exclusively to serve this co-op. When PANELCO's plans of self-generation materialize, usefulness and economics of this NPC facility would be considerably affected.

(a) Taking the country as a whole, biomass material (firewood plus wood wastes, charcoal, and agricultural wastes) accounts for two-thirds of total household energy;

(b) In more than half the regions, firewood accounts for more than 50% of household energy use. At the other extreme, firewood use is practically zero in Metro Manila;

(c) Within Metro Manila, electricity supplies nearly three-fourths of total household energy. The rest is accounted for by the two other main forms of commercial energy, LPG and kerosene, used in almost equal proportions;

(d) Outside Metro Manila, kerosene supplies much more household energy than either LPG or electricity. The only regions for which this statement does not hold are III and IV; and

(e) In half the regions, kerosene provides more household energy than electricity. In one-third of the regions, LPG also provides more household energy than electricity. The important role played by kerosene and LPG, particularly outside Metro Manila, undoubtedly reflects the low level of electrification of rural areas today and suggests that these products (particularly kerosene?) will be vulnerable to electrification.

NATIONAL ELECTRIFICATION ADMINISTRATION

Power Load and Demand Forecast (1980-87) /a

	Actual 1979	1980	1981	1982	1983	1984	1985	1986	1987	Annual growth rate (%) 1979-87
Philippines										
Generated (GWh)	256	333	425	656	901	1,233	1,678	2,243	2,872	35.3
Purchased (GWh)	860	1,325	1,680	1,885	2,106	2,146	2,123	1,931	1,609	8.1
Sales (GWh)	859	1,354	1,763	2,195	2,597	2,996	3,370	3,701	3,973	21.1
Maximum Demand (MW)	293	446	558	680	791	912	1,019	1,118	1,202	19.8
Luzon										
Generated (GWh)	41	68	101	258	462	762	1,070	1,460	1,915	61.7
Purchased (GWh)	678	924	1,121	1,187	1,238	1,089	1,000	812	533	(3.0)
Sales (GWh)	539	781	990	1,214	1,428	1,629	1,821	1,999	2,154	18.9
Maximum Demand (MW)	185	276	328	389	444	502	564	617	667	17.4
Visayas										
Generated (GWh)	157	194	240	297	321	373	394	503	641	19.2
Purchased (GWh)	68	133	196	251	327	384	456	420	339	22.2
Sales (GWh)	183	281	384	493	583	681	765	831	882	21.7
Maximum Demand (MW)	66	86	116	144	170	198	218	238	252	18.2
Mindanao										
Generated (GWh)	58	71	84	101	118	98	214	280	316	23.6
Purchased (GWh)	114	268	363	447	541	673	667	699	737	26.3
Sales (GWh)	137	292	389	488	586	686	784	871	937	27.2
Maximum Demand (MW)	42	84	114	147	177	212	237	263	283	26.9

/a Revised as of May 31, 1980.

ANNEX 7
Appendix 2

NATIONAL ELECTRIFICATION ADMINISTRATION

Program of Generation Development (1980-87) /a
(MW Capacity)

	1980	1981	1982	1983	1984	1985	1986	1987	Total
Dendro	-	12	18	24	27	33	39	47	200
Mini-hydro	4	16	29	40	45	55	59	61	310
SWIP	-	2	3	5	7	8	10	11	45
Total	4	30	50	69	79	96	108	119	555

/a Revised as of May 31, 1980.

ANNEX 7
Appendix 3

NATIONAL ELECTRIFICATION ADMINISTRATION

ECO-BLISS Foreign Exchange Funding Requirement (1980-87) /a
($ million)

	1980	1981	1982	1983	1984	1985	1986	1987
Sources								
Inventory, beginning	-	-	2	5	7	9	5	3
Funding								
Committed by external agencies	-	25/b	36/c	19/d	8/e	9/e	3/e	-
Projected			11	40	60	75	123	170
Total	-	25	49	64	75	93	131	173
Uses								
Dendro	-	11	18	27	32	43	54	71
Mini-hydro	-	12	26	30	34	45	74	97
Total	-	23	44	57	66	88	128	168
Balance								
Inventory, Ending	-	2	5	7	9	5	3	5

/a Revised as of May 31, 1980.

/b France - $18 million; UK - $5 million; PROC - $2 million.

/c France - $28 million; UK - $6 million; PROC - $2 million.

/d UK - $12 million; PROC - $6 million; France - $1 million.

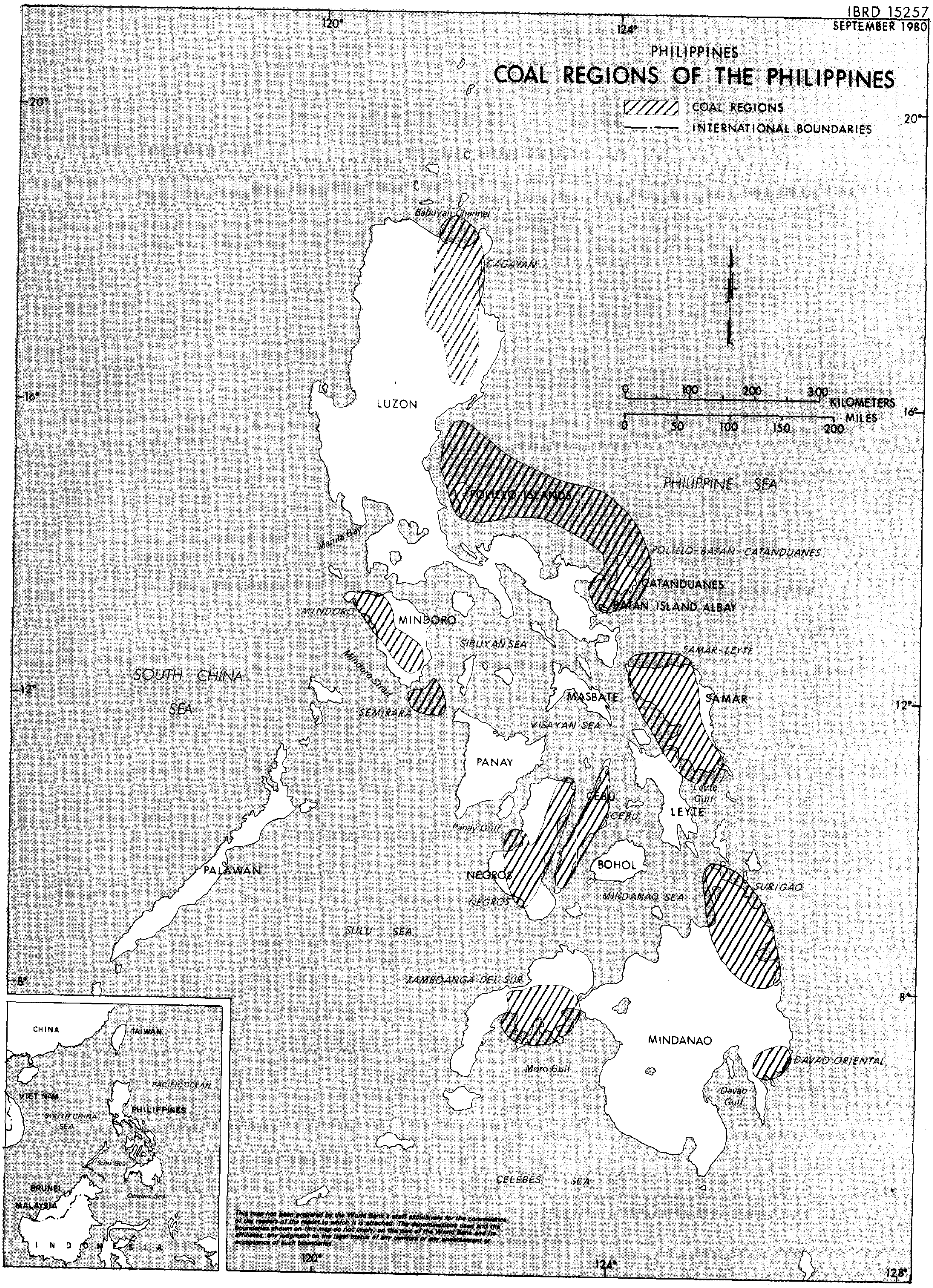
/e PROC - Total of $20 million.

Household Consumption of Selected Energy Items By Region - 1977

(In Thousand Barrels of Oil Equivalent)

	Region	Electricity		L P G		Kerosene		Firewood		Wood wastes, charcoal, coco-shells, etc		TOTAL
		Qnty.	Percent	Qnty.	Percent	Qnty.	Percent	Qnty.	Percent	Qnty.	Percent	
I	Ilocos Region	468.7	15.8	172.312	5.8	319.9	10.8	1,549.3	52.1	465.58	15.6	2,975.78
II	Cagayan Valley	12.2	2.0	68.575	11.1	96.14	15.5	286.71	46.4	154.77	25.0	618.27
III	Central Luzon	863.2	26.1	429.496	13.0	264.9	8.0	1,038.56	31.4	706.35	21.4	3,302.51
IV	Metro Manila	3,300.5	71.9	658.314	14.3	617.4	13.5	11.44	0.2	1.42	Neg.	4,589.02
V	Bicol Region	24.4	1.9	67.76	5.2	230.5	17.8	349.82	27.1	619.69	48.0	1,292.11
VI	Western Visayas	395.3	12.2	152.525	4.7	277.6	8.6	2,042.82	63.0	374.44	11.5	3,242.66
VII	Central Visayas	108.1	6.9	130.662	8.4	229.3	14.7	805.78	51.6	286.97	18.4	1,560.71
VIII	Eastern Visayas	3.7	0.3	33.784	2.6	209.3	16.3	760.42	59.2	278.03	21.6	1,285.25
IX	Western Mindanao	60.2	2.3	36.553	1.4	113.6	4.3	2,149.34	80.4	312.78	11.7	2,672.42
X	Northern Mindanao	156.0	5.9	56.687	2.1	206.5	7.8	436.12	16.5	1,782.85	67.6	2,638.17
XI	Southern Mindanao	16.3	2.1	119.969	15.4	252.6	32.4	301.78	38.7	89.47	11.5	780.07
XII	Eastern Mindanao	83.7	6.4	1.980	0.2	57.2	4.4	801.91	61.2	366.26	27.9	1,310.97
XIII	Southern Tagalog	675.1	11.5	312.4	5.3	376.0	6.4	1,778.98	30.4	2,709.48	46.3	5,851.96
	Total Philippines	6,167.4	19.2	2,240.999	7.0	3,251.03	10.1	12,684.67	39.5	8,148.09	25.4	32,119.90
	Excluding Region IV	2,866.9	10.4	1,582.68	5.7	2,633.63	9.6	12,673.23	46.0	8,146.67	29.6	27,530.88

Source: Ministry of Energy.



IBRD 15257
SEPTEMBER 1980
PHILIPPINES
COAL REGIONS OF THE PHILIPPINES
COAL REGIONS
INTERNATIONAL BOUNDARIES
0 100 200 300 KILOMETERS
0 50 100 150 200 MILES
120°
124°
128°
20°
16°
12°
8°
Babuyan Channel
CAGAYAN
LUZON
PHILIPPINE SEA
POLILLO ISLANDS
Manila Bay
POLILLO-BATAN-CATANDUANES
CATANDUANES
BATAN ISLAND ALBAY
MINDORO
MINDORO
SIBUYAN SEA
Mindoro Strait
SOUTH CHINA SEA
SEMIRARA
SAMAR-LEYTE
MASBATE
SAMAR
VISAYAN SEA
PANAY
Leyte Gulf
CEBU
CEBU
LEYTE
Panay Gulf
BOHOL
NEGROS
NEGROS
SURIGAO
MINDANAO SEA
PALAWAN
SULU SEA
ZAMBOANGA DEL SUR
MINDANAO
DAVAO ORIENTAL
Moro Gulf
Davao Gulf
CELEBES SEA
CHINA
TAIWAN
PACIFIC OCEAN
VIET NAM
PHILIPPINES
SOUTH CHINA SEA
Sulu Sea
BRUNEI
MALAYSIA
Celebes Sea
INDONESIA
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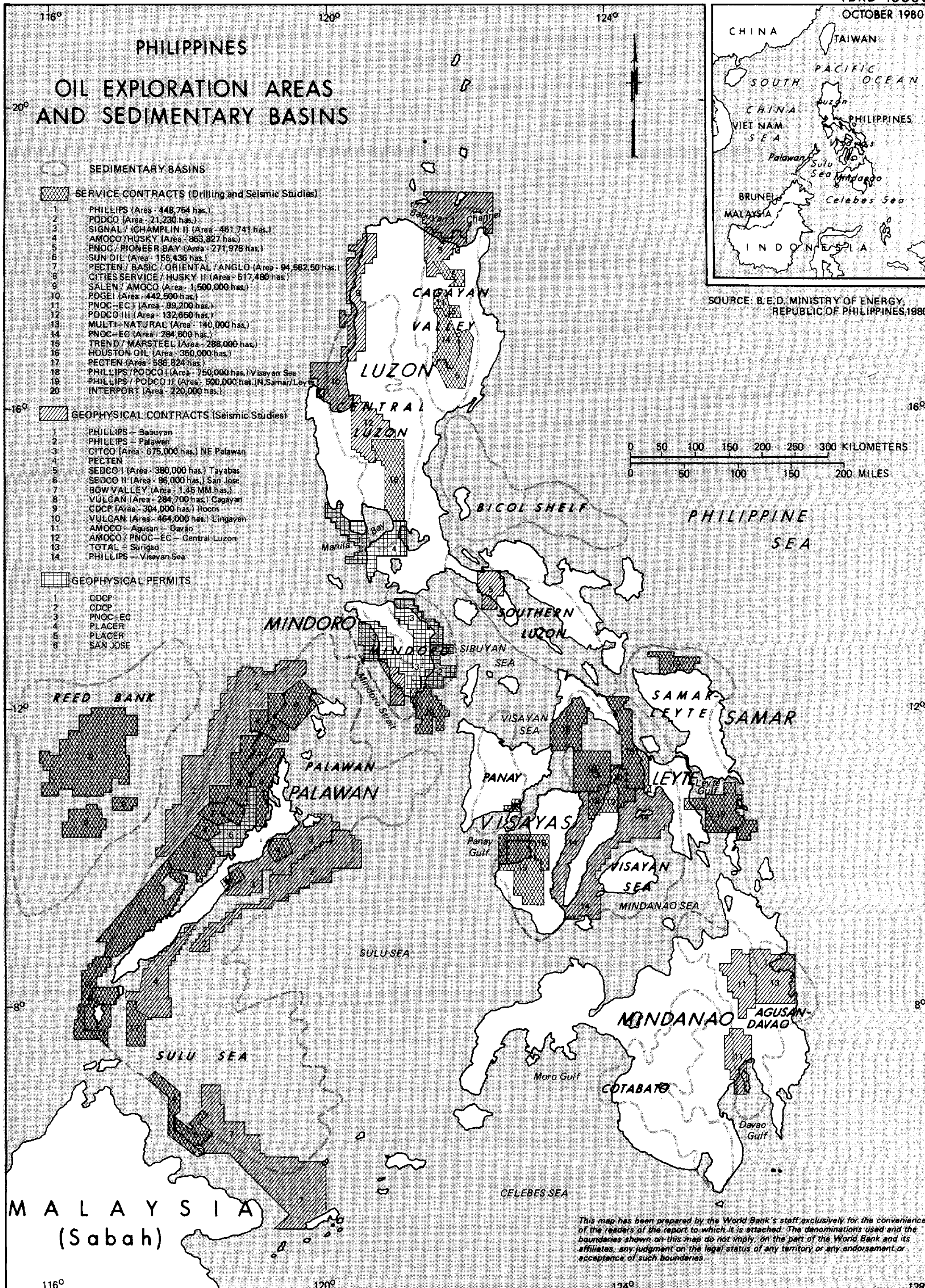
IBRD 15330



OCTOBER 1980
PHILIPPINES
OIL EXPLORATION AREAS
AND SEDIMENTARY BASINS
SEDIMENTARY BASINS
SERVICE CONTRACTS (Drilling and Seismic Studies)
1 PHILLIPS (Area - 448,754 has.)
2 PODCO (Area - 21,230 has.)
3 SIGNAL / (CHAMPLIN I) (Area - 461,741 has.)
4 AMOCO /HUSKY (Area - 863,827 has.)
5 PNOC / PIONEER BAY (Area - 271,978 has.)
6 SUN OIL (Area - 155,436 has.)
7 PECTEN / BASIC / ORIENTAL / ANGLO (Area - 94,582.50 has.)
8 CITIES SERVICE / HUSKY II (Area - 517,480 has.)
9 SALEN / AMOCO (Area - 1,500,000 has.)
10 POGEI (Area - 442,500 has.)
11 PNOC—EC I (Area - 99,200 has.)
12 PODCO III (Area - 132,650 has.)
13 MULTI—NATURAL (Area - 140,000 has.)
14 PNOC—EC (Area - 284,600 has.)
15 TREND / MARSTEEL (Area - 288,000 has.)
16 HOUSTON OIL (Area - 360,000 has.)
17 PECTEN (Area - 586,824 has.)
18 PHILLIPS /PODCO I (Area - 750,000 has.) Visayan Sea
19 PHILLIPS / PODCO II (Area - 500,000 has.)N.Samar/Leyte
20 INTERPORT (Area - 220,000 has.)
GEOPHYSICAL CONTRACTS (Seismic Studies)
1 PHILLIPS — Babuyan
2 PHILLIPS — Palawan
3 CITCO (Area - 675,000 has.) NE Palawan
4 PECTEN
5 SEDCO I (Area - 380,000 has.) Tayabas
6 SEDCO II (Area - 86,000 has.) San Jose
7 BOW VALLEY (Area - 1.45 MM has.)
8 VULCAN (Area - 284,700 has.) Cagayan
9 CDCP (Area - 304,000 has.) Ilocos
10 VULCAN (Area - 464,000 has.) Lingayen
11 AMOCO — Agusan — Davao
12 AMOCO / PNOC—EC — Central Luzon
13 TOTAL — Surigao
14 PHILLIPS — Visayan Sea
GEOPHYSICAL PERMITS
1 CDCP
2 CDCP
3 PNOC—EC
4 PLACER
5 PLACER
6 SAN JOSE
CHINA
TAIWAN
PACIFIC OCEAN
SOUTH CHINA SEA
VIET NAM
PHILIPPINES
Luzon
Visayas
Palawan
Sulu Sea
Mindanao
BRUNEI
MALAYSIA
Celebes Sea
INDONESIA
SOURCE: B.E.D. MINISTRY OF ENERGY, REPUBLIC OF PHILIPPINES,1980
0 50 100 150 200 250 300 KILOMETERS
0 50 100 150 200 MILES
Babuyan Channel
CAGAYAN VALLEY
LUZON
CENTRAL LUZON
BICOL SHELF
PHILIPPINE SEA
Manila
Bay
SOUTHERN LUZON
MINDORO
SIBUYAN SEA
Mindoro Strait
REED BANK
SAMAR-LEYTE
SAMAR
VISAYAN SEA
PALAWAN
PANAY
LEYTE
Leyte Gulf
VISAYAS
Panay Gulf
VISAYAN SEA
MINDANAO SEA
SULU SEA
MINDANAO
AGUSAN-DAVAO
Moro Gulf
COTABATO
Davao Gulf
CELEBES SEA
M A L A Y S I A
(Sabah)
116°
120°
124°
128°
20°
16°
12°
8°
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