Petroleum and Gas in Non-OPEC Developing Countries: 1976–1985

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Developing domestic supplies of energy has become a major concern of oil importing countries. Increased oil prices since 1973 have changed the relative economics of domestic versus imported sources. Before 1973, only ten of the oil importing developing countries (OIDCs) produced commercial quantities of oil. By 1977, 10 additional OIDCs had announced commercial discoveries of oil and gas and began entering the production stage; and exploration activities are intensifying in 35 other OIDCs.

Between 1975-85, the non-OPEC developing countries' demand for oil and gas will continue to grow as incomes grow, but at slower rates than over the past 15 years. The 13 oil exporters among them will double their oil export volumes over this period, oil production is expected to more than double in non-OPEC developing countries and gas production will almost triple. To achieve this target, the annual investments between 1976-85 are estimated at $5,625 million for oil and $1,275 million for gas in 1977 dollars. Chapters I and II of this paper provide updated projections of petroleum production, consumption and associated investment requirements through 1985. Annex I covers in greater detail recent developments in oil and gas by region and by country, covering 90 non-OPEC countries. Annex II classifies these non-OPEC developing countries into categories by income and status of oil and gas development. Annex III consists of regional summary projections of production, consumption and investment requirements to 1985. Annex IV discusses the methodology for the analysis of a country's petroleum resource base.

This paper, which was prepared in November 1977, will be updated as needed by future developments in this field, most likely on a year by year basis.

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PETROLEUM AND GAS IN NON-OPEC DEVELOPING COUNTRIES:

1976-1985

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CONVERSION FACTORS USED IN OIL INDUSTRY

1. American barrel

   = 9702 cubic inches

   = 42 American gallons

   = 34.9726 imperial gallons

   = 5.6146 cubic feet

   = 0.158987 cubic metre (m^3)

1. Cubic metre

   = 1000 litres

   = 264.172 American gallons

   = 219.969 imperial gallons

   = 35.3147 cubic feet

   = 6.28981 American barrels

PETROLEUM SPECIFIC GRAVITIES

Degrees API	Specific gravity	Barrels per tonne*	Long ton*
25	0.904	6.98	7.09
26	0.898	7.02	7.13
27	0.893	7.06	7.18
28	0.887	7.10	7.22
29	0.882	7.15	7.27
30	0.876	7.19	7.31
31	0.871	7.24	7.36
32	0.865	7.28	7.40
33	0.860	7.33	7.45
34	0.855	7.37	7.49
35	0.850	7.42	7.54
36	0.845	7.46	7.58
37	0.840	7.51	7.63
38	0.835	7.55	7.67
39	0.830	7.60	7.72
40	0.825	7.64	7.76
41	0.820	7.69	7.81
42	0.816	7.73	7.85

* Approximate figures at 15.6^{o}C

CHAPTER I

INTRODUCTION

1. Non-OPEC oil importing developing countries 1/ were the hardest hit by oil price increases in 1973-74. Following the quadrupling of oil prices during that period and subsequent increases, CIF costs of crude are now about US$14 per barrel compared with about US$2.50 in 1972. In 1977, the estimated oil import bill for the oil importing developing countries stood at about US$18 billion. The impact of oil price increases on developing oil importing countries in particular is twofold. First, in the short run, because of the inelastic demand for energy and the low rate of short-term substitution, these countries have to continue to borrow to maintain oil imports at the required levels and/or reduce their rates of growth. Second, while the short-term impact has led to increased strain on the balance of payments of developing oil importers, it also has had significant impact on investments in developing new supply sources of energy.

2. Before 1970, the world oil market was characterized by a glut in crude oil supplies mainly from low-cost discoveries in the Middle East. Availability of supplies of low-cost crude oil in effect prevented diversion of resources for investment in high cost supply areas. This virtually prevented many oil importing developing countries from developing their domestic energy resources, although they were eager to do so. Between 1958-68, the period of oil glut in the world oil market, the international petroleum industry incurred total world exploration expenditures of about US$12.3 billion. Of this, less than 7 percent was in the non-OPEC developing countries.

3. Increased oil prices since 1973 have changed the relative economics of domestic sources of supplies of energy. Most of the developing countries since then have put greater emphasis on developing their own sources of energy in general, and oil and gas in particular.

4. Petroleum prospects for non-OPEC developing countries differ markedly. Of the total non-OPEC developing countries, 13 are net exporters of oil, including: Angola, Bahrein, Bolivia, Brunei, Congo, Egypt, Malaysia, Mexico, Oman, Syria, Trinidad and Tobago, Tunisia and Zaire.

5. Before 1973, about ten of the oil importing developing countries produced oil in commercial quantities. Since 1973, new discoveries have been announced in almost all of these countries. In addition, ten more oil importing developing countries, who were non-producers of oil and/or gas before 1973, have announced commercial discoveries of oil and gas and are entering

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1/ Since there are no net oil importing countries in OPEC, this group will be called, in short, "oil importing developing countries" (OIDCs).

the production stage. Furthermore, about 35 oil importing developing countries, which had little exploration before 1973, have intensified these activities. The extent of their success will have significant implications not only for their economic development but also for the world energy balance. The purpose of this paper is, therefore, to assess the prospects for petroleum and gas supply in non-OPEC developing countries through 1985.

6. Annex I contains a set of notes covering details of the most recent developments in oil and gas in non-OPEC developing countries and analyzes individual country supply prospects to 1980 and 1985. Annex II contains a classification of non-OPEC developing countries by category, income and status of oil and gas. Annex III consists of statistical tables by region, summarizing the magnitude of ultimate recoverable reserves of oil and gas and projections of oil and gas production, consumption and investment requirements to 1985. Annex IV discusses the methodology for the analysis of petroleum resource base.

CHAPTER II

PETROLEUM AND GAS IN NON-OPEC DEVELOPING COUNTRIES

7. Energy consumption in oil importing developing countries grew at about 6.5 percent a year from 1960 to 1975 and oil consumption increased at 7.2 percent a year. Current projections indicate that growth in oil consumption will diminish to a rate of 5.6 percent on average over 1976-85. Even with this lower growth in oil consumption, if oil imports are not to increase, substantial efforts are needed by the oil importing developing countries to increase their domestic sources of supplies.

8. Non-OPEC developing countries currently produce only about 6 percent of world oil, although they account for more than 40 percent of the world's total oil prospective areas. Vast sedimentary areas that probably contain 75 percent of all potential petroleum resources of Latin America, 80 percent of those of Africa and 95 percent of Asia and the Far East, are yet to be intensively prospected and developed.

9. Since the increase in oil prices, non-OPEC developing countries made strong efforts to increase their oil and gas production. Production projections up to 1980 and 1985 are based on a continued monitoring and evaluation of these efforts. The projections to 1980 are based on reserves already proven as of January 1977. Projections to 1985 are based on conservative estimates and expectations regarding new discoveries and corresponding increases in proven reserves.

10. The projections of oil and gas production in the non-OPEC developing countries up to 1985 by income group are set out in Table 1, and more detailed projections are given for individual countries of each group in Table 2. According to these projections, oil production in non-OPEC developing

countries would grow at about 9 percent between 1976-85, compared with a historical growth rate of about 7 percent a year. Projection of gas would more than triple between 1976-85 as compared with the previous decade. The net increase in oil production over this period in non-OPEC developing countries amounts to about 1,600 million barrels and in gas production to about 4,600 billion cubic feet. These expected net increases in production of oil and gas reflect the vastly increased efforts in exploration and development of additional oil and gas reserves since 1973.

A. Net Oil Exporters

11. Of the non-OPEC developing countries, 13 non-OPEC net oil exporters produced about 1,000 million barrels of oil in FY76, amounting to about 80 percent of the total production of oil in the non-OPEC developing countries. These countries are projected to produce about 2,000 million barrels of oil in 1985, thereby registering an annual rate of growth of about 8 percent. About 60 percent of the increase in output will be available for export. Gas production in these countries is projected to grow at an annual rate of about 11 percent between 1976 and 1985.

12. Within the 13 non-OPEC oil exporting developing countries, the share of oil/gas production of 5 High/Upper Middle Income countries amounted to about 64 percent in 1976/77. Their share is projected to increase to 77 percent in 1985, mainly on account of Mexico.

B. Oil Importers

13. In the oil importing developing countries, oil production is projected to grow at an annual rate of about 13 percent between 1976-85, that is about twice the rate of growth of consumption. In absolute terms, oil production in these countries is projected to increase from about 400 million barrels in FY76/77 to 1,200 million barrels in 1985, bringing the share of domestic supply in total consumption up from 22 percent to nearly 40 percent. Likewise, gas production in oil importing developing countries is projected to grow at the very high annual rate of 17 percent.

C. Investment Requirements in Petroleum and Gas

14. The investment requirements for petroleum and gas include exploration, development and production facilities, e.g., crude oil and gas pipelines, and installation of gas-gathering facilities. The investment requirements for gas exclude liquified natural gas (LNG) plants except in the case of Malaysia. The upstream phase of the oil and gas industry accounts for about 50 percent of the total investment requirements of the industry. 1/ The remaining 50 percent, which is not considered here, consists of investments in refining, transportation (including product pipelines) and distribution.

1/ In oil importing countries only.

TABLE 1: NON-OPEC DEVELOPING COUNTRIES: PETROLEUM AND GAS PRODUCTION 1/

1976-85

	1976/77		1978		1982		1985	
	Oil (10^6 barrels)	Gas (10^9 cft)	Oil (10^6 barrels)	Gas (10^9 cft)	Oil (10^6 barrels)	Gas (10^9 cft)	Oil (10^6 barrels)	Gas (10^9 cft)
High and Upper Middle Income								
Net oil exporters	659	1,162	751	1,219	1,093	1,895	1,161	2,429
Net oil importers	242	336	255	371	342	545	510	675
Sub-total	901	1,198	1,006	1,590	1,435	2,440	1,671	3,104
Intermediate Middle Income								
Net oil exporters	206	17	220	20	285	384	315	475
Net oil importers	111	276	118	342	152	251	214	634
Sub-total	317	293	338	362	437	635	529	1,109
Lower Middle Income								
Net oil exporters	150	60	175	63	395	180	550	260
Net oil importers	0.2	2	0.2	2	39.3	76	70.5	125
Sub-total	150.2	62	175.2	65	434.3	256	620.5	385
Low Income								
Net oil exporters	10	-	12	-	20	2	35	5
Net oil importers	78	254.5	90	278.5	191.0	1,734	272	2,097
Sub-total	88	254.5	102	278.5	203.0	1,736	307	2,102
Total: Net Oil exporters *	1,025	1,239	1,158	1,302	1,793	2,461	2,061	3,169
Total: Net Oil importers	431.2	868.5	413.2	993.5	724.3	1,606	1,066.5	3,531
Grand Total: Non-OPEC	1,456.2	2,107.5	1,621.2	2,295.5	2,517.3	5,067	3,127.5	6,700
* Of which:								
High/Upper Middle Income Group	659	1,162	751	1,219	1,093	1,895	1,161	2,429
Others	366	77	407	83	700	566	800	740

Source: Bank estimates

1/ For details regarding income group classification see Annex II.

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TABLE 2: NON-OPEC DEVELOPING COUNTRIES: PROJECTED PETROLEUM & GAS PRODUCTION

1976-85

	1976/77		1978		1982		1985	
	Oil (10^6 barrels)	Gas (10^9 cft)	Oil (10^6 barrels)	Gas (10^9 cft)	Oil (10^6 barrels)	Gas (10^9 cft)	Oil (10^6 barrels)	Gas (10^9 cft)
High/Upper Middle Income								
Net oil exporters								
Brunei	75	255	80	260	90	285	90	300
Bahrein	21	85	21	85	20	75	20	75
Oman	133	-	130	-	130	-	135	-
Mexico	350	800	440	850	780	1,500	850	2,000
Trinidad and Tobago	80	22	80	24	73	35	66	50
Sub-total: Net oil exporters	659	1,162	751	1,219	1,093	1,895	1,161	2,429
Net oil importers								
Argentina	150	263	160	290	180	425	200	495
Brasil	63	20	65	21	130	30	275	75
Yugoslavia	29	53	30	60	32	90	35	106
Others	-	-	-	-	-	-	-	-
Sub-total: Net oil importers	249	336	255	371	342	545	510	675
Total: High/Upper Middle Income	901	1,498	1,006	1,590	1,435	2,440	1,671	3,104
Intermediate Middle Income								
Net oil exporters								
Angola/Cabinda	50	-	55	-	75	-	80	-
Malaysia	65	-	70	-	85	300	100	350
Syria	64	7	65	8	80	10	80	10
Tunisia	27	10	30	12	45	74	55	115
Sub-total: net oil exporters	206	17	220	20	285	384	215	475
Net oil importers								
Barbados	1	0.7	1	0.8	1.5	1.0	2.0	2
Colombia	52	130	53	185	50	275	50	300
Chile	9	125	9	135	13	185	15	250
Peru	27	20	33	21	62	30	70	40
Guatemala	-	-	-	-	5	2	9	2
Turkey	22	-	22	-	20	5	20	10
Others	-	-	-	-	-	-	30	30
Sub-total: net oil importers	111	276	118	342	152	251	214	634
Total: Intermediate Middle Income	317	293	338	362	437	635	429	1,109
Lower Middle Income								
Net oil exporters								
Congo	15	-	17	-	15	5	6	10
Egypt	120	2	150	5	350	50	450	100
Bolivia	15	58	18	58	30	125	40	150
Sub-total: net oil exporters	150	60	175	63	395	180	550	260
Net oil importers								
Cameroun	-	-	-	0.2	5	2	10	5
Ivory Coast	-	-	-	-	7	3	10	5
Philippines	-	-	-	-	12	10	15	25
Thailand	-	-	-	-	5	50	15	75
Morocco	0.2	2	0.2	2	0.3	3	0.5	5
Others	-	-	-	-	10	8	20	10
Sub-total: net oil importers	0.2	2	0.2	2	39.3	76	10.5	125
Total: Lower Middle Income	150.2	62	175.2	65.2	434.3	256	620	385
Low Income								
Net oil exporter								
Zaire	10	-	12	-	20	2	35	5
Net oil importers								
Bangladesh	-	27	-	28	3	100	6	200
Burma	8	0.53	8.5	0.53	12	2	15	5
India	66	47	77	50	140	1,000	180	1,000
Pakistan	4	180	4.5	200	16	300	16	365
Sri Lanka	-	-	-	-	13	73	15	145
Vietnam	-	-	-	-	5	50	20	100
Afghanistan	-	115	-	115	-	190	-	250
Chad	-	-	-	-	2	1	5	2
Tansania	-	-	-	-	-	11	-	15
Others	-	-	-	-	10	7	15	15
Sub-total: net oil importers	78	254.5	90	278.53	191.0	1,734	272	2,097
Total: Low Income	88	254.5	102	278.53	211	1,736	307	2,102

Source: Bank estimates

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15. Investments 1/ per barrel/day of installed capacity vary, not only from region to region and from country to country but also from field to field, depending on individual factors. Available information on the planned investments in petroleum in non-OPEC developing countries between 1977 and 1982 shows that, on the average, in the upstream phase capital costs range from US$7,000 to US$8,000 per barrel/day of installed capacity. It must be noted, however, that this is only a likely magnitude, with a large variance built into this average.

16. In estimating the total investment requirements in the petroleum industry over any period, it is necessary to consider the production profile of the fields currently producing oil. For example, the oil fields currently under production in High and Upper Middle Income countries are already on the decline and more than 70 percent of them require secondary recovery measures. By 1985 from 80 percent to 100 percent of current production capacity will need to be replaced. We have assumed on a general basis that by 1985, 50 percent of 1976 production in all non-OPEC developing countries will have to be replaced by new capacities (Table 3).

17. Natural gas production consists of both associated and non-associated gas. The investment for tapping associated gas is a joint cost and has been included under investment requirements for oil by converting natural gas to crude oil equivalent. Therefore, the projections for capital requirements for natural gas consider only non-associated gas. For the aggregate projections the share of the non-associated gas is assumed to be about 40 percent of total natural gas production. However, for individual countries the variance can be quite large and this has been taken into account in the respective projections, e.g., Bolivia, Bangladesh, Pakistan and Thailand which have non-associated gas fields accounting for 85-100 percent of total natural gas production.

18. As a whole, non-OPEC developing countries' investment requirements in the upstream phase of oil and gas between 1976-85 (including 1976 and 1985) amount to US$68,500 million in 1977 dollars or an annual average of about US$5,625 million in oil and US$1,225 million in gas. These are investment requirements to meet our baseline output projections; new and unexpected discoveries could well bring forth additional investments in individual countries.

19. The estimated total investment requirements in the oil and gas upstream phase of the industry of the non-OPEC developing countries, other than High/Upper Middle Income countries, stand at about US$36,000 million (in 1977 dollars) through 1985, or about US$3,600 million annually. Of this, Intermediate Middle Income countries account for 33 percent, lower Middle Income countries for 42 percent and Low Income countries for the remaining 25 percent.

1/ Investment figures are given in constant US 1977 dollars.

TABLE 3: INVESTMENT REQUIREMENTS FOR PETROLEUM AND GAS IN NON-OPEC DEVELOPING COUNTRIES 1976-85 a/

(1977 constant US$)

	Oil b/	Gas c/	Annual Average Oil b/	Annual Average Gas c/
High and Upper Middle Income				
Net oil exporters	25,750	6,750	2,575	675
Net oil importers	10,000	4,500	1,000	450
Intermediate Middle Income	9,500	2,520	950	252
Net oil exporters	2,000	1,520	200	152
Net oil importers	7,500	1,000	750	100
Lower Middle Income	13,500	1,500	1,350	150
Net oil exporters	9,300	500	930	50
Net oil importers	4,200	1,000	420	100
Low Income	7,500	1,480	750	148
Net oil exporters	1,000	100	100	10
Net oil importers	6,500	1,380	650	138
Sub-total: Net oil exporters	22,300	6,620	2,230	662
Sub-total: Net oil importers	33,950	5,625	3,395	563
Grand Total	56,250	12,250	5,625	1,225

a/ Totals include 1976 to 1985

b/ Includes investment requirements in oil and gas exploration, development of oil, production of oil and associated gas, and crude oil pipelines in all non-OPEC developing countries

c/ Refers only to investment in development of non-associated gas and gas pipelines: excludes investment in LNG projects except in Malaysia

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PROSPECTS FOR PETROLEUM/GAS SUPPLIES IN NON-OPEC DEVELOPING COUNTRIES TO 1985

Latin America & Caribbean

1. Taken as a whole, Latin America's energy resource base is strong and, although individual countries may have short/medium-term energy deficits, the long-term prospects for expanding petroleum supplies are excellent. Of the major regions of the world, Latin America depends more than any other on petroleum (80.8 percent) for energy and comes next to the Middle East in importance as an oil supplier. About half of the Latin American countries, including the major ones, produce petroleum, but only Bolivia, Ecuador, Mexico, Trinidad & Tobago and Venezuela have an export surplus.

Latin America's Petroleum Potential

2. The distribution of the prospective onshore and offshore acreage between the various Latin American countries is shown in the table below.

Table 1: LATIN AMERICA'S PROSPECTIVE PETROLEUM AREA

Country	Prospective Area (10^3 square miles) Onshore	Offshore
Brazil	1,480.0	240.0
Argentina	590.0	215.0
Mexico	305.0	170.0
Peru	400.0	9.5
Colombia	350.0	26.0
Venezuela	141.0	33.0
Bolivia	254.0	-
Paraguay	78.0	-
Ecuador	60.0	18.0
Chile	58.0	5.0
Nicaragua	25.0	28.0
Honduras	30.0	20.5
Uruguay	31.0	17.0
Guatemala	33.5	4.8
Panama	14.5	22.0

Source: Table 11, US Geological Survey Bulletin No. 1411

Latin America holds about 19 percent of the world's prospective area for petroleum; yet, it currently produces only 9 percent of the total oil. Much of the Latin America still needs intensive exploration. The drilling density in Latin America is a mere 0.01 wells per square mile compared with 1.17 wells per square mile in the United States. Even in Argentina, Mexico and Venezuela, the drilling density is only about four percent of that achieved in the US.

3. Geologists differ in their opinions in estimating the ultimate petroleum/gas reserves in Latin America. Nevertheless, we can take geologist King Hubbert's estimate of about 190 billion barrels of oil and 550 trillion cubic feet of gas as a lower bound. On the other hand, geologist Bernardo Grossling's estimates of reserves for oil in Latin America, range from 490-1,225 billion barrels for oil, and 2,450-6,370 trillion cubic feet for gas, can be taken as the upper bound.

4. Even if we take the lower bound estimate of 190 billion barrels as the remaining petroleum potential, prospects for Latin America to achieve self-sufficiency in oil through the end of this century appear very bright.

Argentina

5. In 1976 crude oil production in Argentina stood at 397,000 b/d. The total consumption being at 450,000 b/d, Argentina imported about 53,000 b/d at an estimated cost of US$300 million in 1976. Total crude oil reserves were just about 2.3 billion barrels. About half of these would involve secondary recovery for exploitation. At the present rate of production, the reserve/production ratio stands at about 15 years.

6. The Government's oil policy objective is to attain self-sufficiency in oil by 1980 and to create an export surplus from offshore production by 1985. The virtual monopoly of Yacimientos Petroliferos Fiscales (YPF) is coming to an end, with foreign and Argentine private operators invited to participate in exploration and development of new reserves in selected areas, as well as secondary recovery in established fields. Guidelines of the new policy are to allow foreign participation in secondary recovery projects in association with private Argentine firms; and in operations on the continental shelf off the South Coast, also in association with YPF. The Government was committed to a call for offshore bids before the end of 1977, and has formulated regulations on the position of contractor companies prepared to undertake the risks of exploration at their own cost.

7. The position of YPF's existing contractors in its reserved areas on land may also be improved by this policy change. YPF has been empowered to double the areas allocated to these contractors, provided they install modern equipment and guarantee higher output. The Government approved and awarded six petroleum development contracts to Argentine private companies in July 1977 as follows:

(1) Bridas Sapic, Cia, Naviera Perez Companc Sacfimfa and Empresa Constructora Financiera, for the Piedra Clavada area in Santa Cruz province;

(2) Astra Capsa, Sasetru, S.A. and Inaltuce, S.A., for the Candon Seco area in Santa Cruz;

(3) El Carman, S.A., for the Neuqen del Medio area in Neuqen province;

(4) Oluspetrol, S.A., Ingenieria Tauro Saicif, Socma, S.A., Impresit Sidaco, S.A. and James A. Lewis Engineering, for the centenario area in Neuqen province;

(5) Cia. Naviera Perez Companc Sacfimfa and Brides Sapic, for De Mayo and el Medanito areas in La Pampa and Rio Negro Provinces, respectively;

(6) Vial del Sur, S.A. and Servicios Gydar Scott, S.A., for the Medianera area in Rio Negro province.

These six contracts represent a direct investment of US$240 million, or double that amount if working capital is also included. All the contracts are for primary development and secondary recovery and they are expected to increase domestic crude oil production by about 45,000 b/d which, in effect, would enable the country to achieve self-sufficiency at current levels of consumption. In addition to these contracts, in April 1977 the Government also invited bids for exploration and development contracts in the offshore, the awards for which were expected to be announced in December.

8. Geologists consider the prospects for oil and gas in Argentina to be very good. In 1975 the US Geological Survey revealed that outstanding possibilities for petroluem are present in the Argentine continental shelf. This shelf, with a 200 metre depth, has an area of 306,500 sq. miles. Five sedimentary basins have already been identified including Bahia Blanca, Magallanes, Malvinas, Salado and San Jorge basins. Maximum thickness of sediment ranges from four to seven kilometers, and two of the basins, Magallanes and San Jorge, are seaward continuations of onshore producing basins. The shelf as a whole is four times greater than the U.S. Atlantic shelf, where potential recoverable reserves are estimated at a lower bound between 10 and 50 billion barrels and an upper bound up to 200 billion barrels.

9. The natural gas sector is also set for expansion. Domestic production is running at about 20 millin cubic meters a day. YPF has established a major gas field of San Sebastian in Tierra del Fuego. Development drilling is planned, and Gas del Estado is going ahead with plans for a 205-kilometers line northwards to tie in with the existing gas pipeline system on the mainland of El Condor. It has commissioned R.J. Brown and Associates to construct the 45-km under water section across the Strait of Magellan. The new line will supply gas in 1978 of about three million cu/m/d with an ultimate capacity of 10 mn cu/m/d by 1985.

Brazil

10. Brazil's attempt to excelerate the development of its oil resources is being made to bridge a major gap between consumption and domestic production, necessitating increasing costs of petroleum imports since 1973. In 1976, Brazil's total consumption of petroleum stood at 900,000 b/d. With domestic oil production at 170,000 b/d, 730,000 b/d at a cost of more than US$3,500 million had to be imported. The onshore fields in Bahia and elsewhere that are currently producing oil are in decline and present hopes are directed offshore. Until recently, Petrobras, the state oil company, was the sole agency for oil exploration, development and production, controlling both onshore and offshore. In the offshore Petrobras has three main areas of interest: first, various small fields discovered mostly between 1973-1975, off the north eastern states of Alagoas and Sergipe; second, five major fields identified since 1974 in the Campos basin off the state of Rio de Janeiro; and third, the more recent success off the mouth of the Amazon in the far north.

11. Since 1974, in fact, it is the Campos basin which has called for the biggest investment by Petrobras, offshore. The basin is credited with a production potential of 200,000 b/d of crude and 850,000 cubic meter/d of gas. The area is 80-120 kilometers offshore, with discoveries mostly located in deep water (120 meters or more) and it has been wholly reserved to Petrobras by the Government. Development costs for the fields discovered to end-1975 alone are estimated at US$3.7 billion, but the prospective savings on the country's import bill for a potential annual production of about 75 million barrels will amount to more than US$1,000 million a year.

12. Petrobras has drilled more than 20 wells in the Amazon delta and it struck gas in March 1976. An extension well drilled later established that the discovery is a substantial field with reserves of 25 billion cubic meters. The first oil discovery was made in the Amazon basin in July 1976.

13. In general, the offshore picture is one of many promising finds; its rapid development will, however, demand greater resources then Petrobras alone can provide. The constraint on resources for investment coupled with the necessity of reducing the increasing import bill of oil resulted in the announcement of a new oil policy in late 1975, when it was decided to open up some 60,000 square kilometers to foreign companies for exploration and development under contract. The object is to speed up the search in areas not yet intensively probed, while the state operator concentrates its own efforts on the Campos and Uburana fields.

14. The 10 areas opened comprise one deep in the interior of the Amazon basin and 9 offshore, varying in size from 3,000 to 9,000 square kilometers. There is no doubt that Petrobras' continued successes have stimulated interest. So far, contracts have been signed with BP, Shell Consortium, Elf Aquitaine/AGIP Consortium and Exxon. These deals are essentially risk contracts based on revenue-sharing, which guarantee

reimbursement of outlays on exploration and development only when oil is discovered, with the incentive taking the form of an undisclosed percentage of subsequent production revenues. Further negotiations are required for exclusive gas development. The basic exploration period is three years in each case, renewable for two one-year periods, and minimum outlays are specified (US$10.5 million for BP, US$20 million for the Shell group, US$8 million for Elf/AGIP and US$16 million for Exxon). Full state control is assured by the provision for transfer of operations to Petrobras at the start of production, and its option to develop any discovery which is rated non-commercial by the contractor. In April 1977, Petrobras announced the opening of a second series of search areas for negotiation in September, covering 25 blocks averaging 5,000 square kilometers each, ranging from the Amazon and its estuary in the north to offshore Santa Catarina in the south. Some 35 companies have made preliminary bids for the second round of offshore blocks, available under risk-bearing service contracts.

15. Not taking into account any potential production from these open areas, where exploration will be completed only by 1980, Brazil's medium-term prospects are for an indigenous crude supply of about 600,000 b/d by 1980. This would be supplied from increasing production by secondary recovery in the existing fields and new production from Campos basin, Uburana and other fields of Rio grande do Norte and various small fields of Alagoas and Sergipe. This means that in 1980 Brazil would be able to meet 50 percent of its oil requirements from domestic production. The long-term prospects lie in a continued build-up of offshore potential into the 1980s.

Bolivia

16. The sedimentary basins of Bolivia cover an area of approximately 620,000 square kilometers, or over 50 percent of the entire territory of the country. The three areas of interest for oil prospecting are the Sub-Andean region, the Altiplano and the Chaco-Beni plains. Petroleum has been found in the Sub-Andean region, in the general areas of Santa Cruz and Camari and also in the south, near the Argentine frontier.

17. The production of crude petroleum reached 49,000 b/d in 1974 and natural gas production climbed to 152.2 billion cubic feet. The need to find sufficient reserves to maintain an exportable surplus of hydrocarbons has played a role in shaping the policies which guide the Bolivian oil industry. Exploration activity in Bolivia has been intensified with widespread drilling scheduled by the state oil concern, Yacimientos Petroliferos Fiscales Bolivianos (YPFB) and foreign operators. Since March 1973, more than 20 oil companies or groups of companies have signed 30-year production sharing contracts. These now involve 12 main groups of foreign companies in 15 blocks, covering a total of 37 million acres. Over US$70 million has already been spent by the Canadian, French, Spanish and US companies involved in geological and geophysical surveys. The production-sharing contracts require sucessful contractors to put up all development costs and to

deliver 19 percent of production to the central government, 11 percent to the province concerned and 20 to 25 percent to YPFB. As a result of the contractors' activities and of YPFB's own program, there were some additional discoveries of gas and oil in 1977. Oil production was projected to rise to 50,000 b/d in 1977, from about 37,000 b/d in 1976. Bolivia is a net exporter of crude oil and natural gas. Unofficial estimates place oil production at about 200,000 b/d by 1980. However, a cautious estimate based on the present program for exploration might lead to increased oil supplies from 50,000 b/d in 1977 to about 80,000 b/d in 1980 rising to 120,000 b/d in 1985.

18. Gas discoveries in the contract areas awarded in 1973-1975 have been made by Occidental Oil Company at Tita and Amoco/Amerada Hess at Tucavaca. YPFB has also found gas in the south. As a result of these new discoveries, gas exports to Argentina are expected to rise from 4 million cubic meter/d at present to 8.5 cubic meter/d by 1980, and to 10 million cubic meter/d by 1985. The price per 1,000 cubic meters has risen from US$0.87 to slightly over US$1 since January 1977.

Colombia

Petroleum

19. Declining production in the early 1970s and increasing consumption had turned Colombia into a net importer of petroleum by 1976, when petroleum imports reached US$110 million. If petroleum production from old fields continues to decline with no new discoveries to arrest this decline, and consumption of crude increases at about 5 percent a year, petroleum imports could reach US$1.5 billion by 1985 and US$3.0 billion by 1990. To avoid this potentially heavy burden on the balance of payments, the Government is undertaking a variety of measures to increase petroleum production, reduce consumption and develop alternative energy sources.

20. Petroleum/gas resources of Colombia are concentrated in the 9 geographic basins that constitute a total sedimentary area of about 500,000 square kilometers. Of these, only 7.2 percent of the total sedimentary areas comprising the Middle Magdalena Valley and Catatumba basins have registered active exploration efforts. Thus other basins, particularly the sedimentary areas of Pacifico Atrato, Sabana and Llanos Orientales, accounting for more than half of the total sedimentary areas, remain to be intensively explored.

21. Realizing the impact of the heavy potential burden of oil imports in 1976, the Government announced an oil policy to associate foreign investment in a massive oil exploration and development program during the next decade. The aim is to achieve at least self-sufficiency. Although it is too early to assess the impact of the new petroleum policy, the oil companies have responded very favorably so far. Prospects for discovery of new oil are good, although the new fields to be discovered may be smaller than those previously discovered. A sustained program of oil exploration and development should at least result in self-sufficiency in oil by 1985.

Natural Gas

22. Although Colombia has a deficit in petroleum supplies, its reserves of natural gas increased with Texaco's recent discoveries of Guajira gas fields. Proven reserves at the beginning of 1977 amounted to about 5,225 billion cubic feet. The exploration activity in the La Guajira area and commercial gas discoveries made there so far account for about 3,300 billion cubic feet of proven gas reserves. The gas development program in the newly discovered Guajira region will be taken up in two phases by the state oil company, Ecopetrol, in equal partnership with Texaco.

23. Phase I of the gas development program has envisaged drilling about 40 wells between 1977-1979 at an estimated development expenditure of US$25 million to be shared equally between the two partners. The initial production of gas at the rate of 100-150 million cubic feet started from the second half of 1977. Phase II aims at doubling the initial production to reach 400 million cubic feet. The second phase of gas development could commence in 1978 if the gas utilization programs are finalized. Texaco is hopeful of discovering additional gas reserves offshore.

Chile

24. Crude petroleum output in Chile has declined since 1964, falling rapidly since 1971, when production dropped more than 30 percent from 34,000 b/d to just under 23,000 b/d in the first half of 1976, causing imports to rise from about 60,000 b/d in 1971 to nearly 80,000 b/d in 1974. However, imports fell slightly to about 70,000 b/d in 1975.

25. To arrest the decline in production and to reduce the increasing oil import bill, the Government issued a decree in July 1975 authorizing the state oil entity, ENAP, to enter into service contracts with foreign oil companies for exploration and development. Active interest in such contracts has already been shown by 42 foreign companies, mainly from Canada, France, Holland and the US.

26. Following the enactment of the petroleum decree ENAP established seven zones totalling about nine million hectares (including three offshore), where foreign oil companies were invited to tender for oil exploration and development under the new contract system. By March 1976, of 40 companies showing interest, 23 were selected.

27. The seven zones assigned to the foreign companies are: Interior of Antofagasta Province (2.6 million hectares); Continental Shelf off Chanco, North of Concepcion (1.1 million hectares), Continental Shelf off Vadivia (1 million hectares), Osorno region (1.3 million), Continental Shelf around the Taitao Peninsula, Aysen Province (1.6 million hectares); Cerro Palomares, north of Punta Arenas (600,000 hectares) and 600,000 hectares in Tierra del Fuego.

28. In addition to foreign participation, ENAP has begun offshore work in the Strait of Magellan. Its 3-year program is expected to include the drilling of 40 exploratory wells to an average depth of 1,700 meters. So far, ENAP has drilled nine wells. Since September 1976, 5 discoveries have revealed the presence of considerable oil reserves in the area, estimated by ENAP at 200 million barrels, and commercial production is expected to come on stream by 1979.

Peru

29. Peru launched an intensive exploration drive between 1971-1976. At the height of this campaign about 18 companies were involved spending over US$700 million. As a result, Petroperu, the state oil entity, and Occidental Petroleum Company succeeded in establishing commercial production in 12 fields with a potential of about 90,000 b/d. Until 1977, offshore operations were confined to the area of Talara, where Belco Petroleum has made 15 discoveries since 1971 and is currently producing 30,000 b/d. As a result of these discoveries proven reserves of Peru reached about 750 million barrels as of January 1977. Crude oil production reached an all time high of about 98,000 b/d in May 1977. This comprised about 56,000 b/d by Petroperu in the northeast and Corrientes fields, 12,000 b/d by Occidental Company in the interior and 30,000 b/d by Belco Company offshore.

30. In the beginning of 1977, Peru decided to launch a more vigorous exploration by opening up a vast offshore area stretching some 1,500 miles along the coast south of Talara and awarding more flexible ground rules for exploration and production contracts. This would allow companies to move in or out of any work stage (exploration, drilling or development), and to late cash payment for their share of production if desired. In May 1977, Petroperu invited negotiations on new operations contracts for 25 offshore blocks of 400,000 hectares each and 47 blocks of one million hectares each in the interior. It has also called for tenders on secondary recovery operations at three established oil fields in the northwest. Petroleum supplies, even on a conservative estimate, are expected to rise from the present 98,000 b/d in 1977 to 170,000 b/d in 1980 and to some 190,000 b/d in 1985.

Mexico

31. Mexico has a total prospective area of petroleum of about 475,000 square miles, thereby having the third largest prospective area in Latin America, next only to Argentina and Brazil. The Mexican oil industry, nationalized since 1938, was run on a modest scale until the major discoveries of 1972-1973. The extensive and rapid development of the Reforma fields allowing the major discoveries of 1972-1973 has turned Mexico into a net exporter of oil since September 1974. Mexico's proven reserves have undergone considerable additions with new discoveries since 1974, rising from 6.4 billion barrels in 1975 to 11 billion barrels by 1976. Nearly 10 new discoveries in the first half of 1977 resulted in increasing the

total proven reserves as of July 1977 to 14 billion barrels. Pemex, the state oil entity, claims that seismological data suggest a considerably greater potential with up to a third of Mexico's surface area and continental shelf reckoned favorable for exploration. Probable reserves of oil and natural gas are unofficially estimated at no less than 60 billion barrels of oil equivalent.

32. Mexico's 6-year development program, announced in December 1976, aims to increase production from 830,000 b/d in 1976 to about 2.2 million b/d by 1982. Gas production currently running at 2.2 billion cubic feet will be increased to 4 billion cubic feet. In August 1977, six US companies, El Paso Natural Gas Company, Florida Gas Transmission Company, Southern Natural Gas Company, Tenneco Incorporated, Texas Eastern Transmission Corporation and Transcontinental Gas Pipeline Corporation signed agreements with Pemex for the first major purchase of natural gas from the huge Reforma fields of Chiapas and Tabasco on the Yucatan Peninsula. The contract is for the delivery of 2 billion cubic feet a day of natural gas through a 750 miles 48 inch pipeline to be built by Pemex from the field to the US border near Reynosa, where the sale and purchase will take place. Based on current prices, the Mexico gas would cost about US$2.60 to US$2.70 per thousand cubic feet.

Table 2: MEXICO - OIL SUPPLY AND EXPORT FORECAST

(Million barrels/day)

	1977	1978	1979	1980	1985
Crude Oil Production	950	1,200	1,500	1,700	2,300
Domestic Consumption	800	900	950	1,000	1,300
Export Surplus	150	300	550	700	1,000

Source: Bank estimates

Guatemala

33. A geological structure starting from Tabasco near the Gulf of Mexico and crossing Peten State lends support to the theory that there are undiscovered reserves in Guatemala. By the second half of 1974, some 40 firms had shown interest in prospecting for oil. The need to encourage foreign investment in oil became very pressing when oil price increased

the oil import bill from just under $400,000 in 1973 to an estimated US$12 million in 1976. The need to curb and eventually eliminate the pressure of oil imports resulted in increased exploration and production activities based on service contracts for new areas in addition to the existing 933,000 acre concession area.

34. In the late 1960s a modest exploration program was begun by Basic Resources International around Tortugas, to the south of El Peten area, considered more promising. Limited success was reported by the company in mid-1972 with a discovery well flowing 35° gravity crude at a rate of 1,300 b/d from a depth of about 2,400 feet. In early 1973, Shenandoah Oil and Norway's Saga Petroleum joined Basic Resources in exploring and developing its 943,000 acres of concession area. In September 1976, Saga Petroleum withdrew, leaving ownership shared between Basic Resources (62 1/2 percent) and Shenandoah (37 1/2 percent). Saga, with a major share in the North Sea, will retain a small interest in net proceeds from future production, initially one and one-quarter and later five percent.

35. In July 1974, the consortium successfully discovered a commercial oil field of Rubelsanto, with 4 producing zones tested at rates varying from 3,200 to 9,500 b/d. Proven recoverable reserves are estimated at 20 million barrels. Geological and seismic work on the concession in Peten on the Mexican border has defined ten major structures.

36. In July 1976, Basic Resources and the Government of Guatemala confirmed that oil from Rubelsanto was available to local users at the estimated rate of 3,200 b/d, compared with total domestic requirements of some 20,000 b/d. By March 1977, a French firm tendered to construct a gathering system, 12-inch pipeline and tanker loading facilities and was accepted. The pipeline will be built at a cost of US$30 million, and is scheduled for completion by mid-1978 with design capacity of 50,000 b/d.

37. The Rubelsanto discoveries are on the same trend as Mexico's Reforma discoveries to the northwest and are only a few miles from the Tortugas Salt dome, the site of an earlier discovery by Basic Resources in 1972. Both features point to the fact that Guatemala will at least be self-sufficient in its forthcoming oil supplies. The chances of Guatemala becoming a net oil exporter, however, depend on the intensity of future exploratory efforts and the rate of new commercial discoveries.

Other South American Countries

38. Paraguay and Uruguay lack indigenous oil production but since 1975 exploration has been revived.

39. The oil prospective areas in Paraguay cover an estimated 35 million acres distributed in 5 sedimentary basins. Exxon and Texaco have planned exploratory drilling operations in the Chaco area. Marathan Oil Company also

took a 50 percent interest in 1976 in Texaco's 7.7 million acre concession area in northwest Paraguay. Other companies active in the country include Petrolera del Chaco, Repsa and Trend Resources.

40. Uruguay's government-owned petroleum company, ANGAP, expressed confidence in drilling prospects on the continental shelf in early 1976 and claims that fields already indicated by surveys could make the country self-sufficient in oil. Uruguay imports all its oil requirements; totalling about 40,000 b/d in 1975 costing some US$160 million. In 1975, Uruguay granted service contracts to Chevron Oil Company and signed an agreement with Argentina's YPF for geophysical work in the onshore Santa Lucia basin. In 1976, YPF completed a seismic survey and the Government invited bids in September 1976 for exploratory drilling in the Santa Lucia river basin.

Caribbean

Trinidad and Tobago

41. Trinidad is an important oil and gas producer. In 1971, new offshore areas were brought into production. Since then, the most active operators are Trinidad Tesoro Petroleum, the state oil company, Amoco, Trinidad Oil Company and the Trinmar Consortium. The Amoco fields have been termed "major discoveries", but development has been held back by serious sanding problems, now being solved. The area also contains sizable gas structures: the gas reserves, mostly offshore, are estimated at 12 trillion cubic feet. Trinidad's second producing area is the Gulf of Paria where the Trinmar Consortium continues developing the Soldado field. In 1976, Trinmar undertook development of additional pools in Soldado. The balance of Trinidad's production comes from a large number of smaller fields located in the southern portion of the island and mostly operated by Texaco and Trinidad Tesoro. A vigorous program of well workovers revived a number of these fields, and onshore oil output is also increasing.

42. In addition, the geological prospects of finding large new fields, especially in the south eastern part of the island, are considered encouraging. As such, on a conservative estimate, it is possible to maintain at least the present production rate of 200-220,000 b/d of oil through 1985.

Barbados

43. Barbados' indigenous oil production of about 345 b/d accounted for 30 percent of its consumption requirements in 1975. The Government decided to resume development drilling in the second half of 1977 to assess the viability of the marginal output. The aim is to double the current output to about 600 b/d.

Other Caribbean

44. Other Caribbean countries initiating oil prospecting programs since the oil crisis are Dominican Republic, Haiti and Surinam.

45. In Surinam, the Venezuelan company, Las Mercedes, in early 1977 contracted to explore and develop a 120,000 hectare area about 60 kilometers from Paramaribo, where the Government claims recoverable oil reserves total about 270 million barrels. Dominican Republic has completed geological studies which indicate 7 possible oil-bearing zones covering a total of 17,500 square kilometers. The Government has granted exploration permits to Las Mercedes of Venezuela and two US firms, Cariboil of Texas and Whiteshields Corporation. In July 1977, two more companies, Canadian Superior and Eastern Petroleum Company (Houston), signed exploration agreements to explore Lake Enriquillo in the southwest near the Haitian border.

46. Haiti has granted a 1.8 million acre concession held jointly by Mapco Oil, Sundance Oil and United Canso Oil and Gas Company, and wildcat drilling is already in progress both onshore and offshore.

Africa

47. Africa's oil potential remains one of the world's great unexplored areas. Africa and Madagascar together have some 4.7222 million square miles of sedimentary areas, accounting for 18 percent of the total sedimentary areas in the world.

48. There are ten African countries currently producing oil, four of which, Algeria, Gabon, Libya and Nigeria are OPEC members; the other seven are Angola, Congo, Egypt, Morocco, Tunisia and Zaire. Of the rest, nearly 25 countries have issued petroleum exploration permits as of August 1977. Among the non-oil states, the most active geological exploration programs have been carried on in Kenya, Somalia and Tanzania, while most drilling has been taking place in Western Africa around Cameroon, Chad, Guinea, Ivory Coast, Mali and Niger.

Status of Oil Exploration and Production in Non-OPEC Western Africa as of August 1977

People's Republic of the Congo

49. Prospecting for oil in the Congo dates back to 1957 when this country was still one of the four territories of French Equatorial Africa. Elf, the French company, found the Point Indienne oil and gas field in the onshore coastal area, and by 1960 the newly independent People's Republic of Congo was producing 52,000 tons/year of crude oil. The following table shows production and exports of crude oil from 1969-1975 in the Congo.

TABLE 3: CONGO - PRODUCTION AND EXPORTS OF CRUDE OIL

(Million metric tons)

Year	Total Petroleum	Of Which Offshore	Exports
1960	0.052	-	0.034
1961	0.103	-	0.093
1962	0.123	-	0.135
1963	0.109	-	0.101
1964	0.083	-	0.079
1965	0.071	-	0.071
1966	0.062	-	0.065
1967	0.050	-	0.038
1968	0.043	-	0.055
1969	0.024	-	0.032
1970	0.019	0.019	0.017
1971	0.014	0.014	0.020
1972	0.336	0.336	0.296
1973	2.019	1.696	2.050
1974	2.455	1.870	2.450
1976 /a	2.010		1.900

/a Estimated

Source: UN Energy Series J 20

50. France's Elf, its subsidiary Elf Congo and Italy's state-owned AGIP are active companies engaged in oil exploration and production in the Congo. In 1969, Elf Congo, operating in partnership with AGIP (Elf 65 percent, AGIP 35 percent) found the Emeraude (Emerald) field at a depth of 1,900 feet in 200 feet of water some 12 miles offshore near the Congo frontier with the Cabinda enclave of Angola. A total of 22 wells have been drilled in the field, which has estimated reserves up to 1,000 million metric tons of very heavy 22° API Crude. Emeraude is served by a 16-inch sealine which takes output from 2 producing platforms to the Djeno terminal some 15 miles away.

51. A new field, the Loango, is now being prepared for production by AGIP, with Elf holding a 35 percent interest. The pay zone, at between 2,300 and 3,000 feet, was found in 1972. Although Loango is estimated to contain less oil than Emeraude, it is hoped that it will be easier to produce, and output of up to 50,000 b/d is envisaged, with water injection being used from the outset. The field is being linked to the Djeno terminal by an 18-inch, 60-mile sealine. Loango is expected to start production by 1977 when Loango is fully productive, and the Congo may have a total output of up to five million tons of crude oil a year. As the country yet has no refinery, all production is exported as crude oil. But a one million ton/year refinery is being built at Point Noire by Belgium's Sybetra, which will process a surplus of oil products for export.

52. The Congo is experiencing difficulties in production of its offshore oil because of its complex formations and sluggishly flowing oil, as well as deep water. Plans have been announced to establish a state organization to control crude oil production rates by foreign companies.

53. The Government and the Elf-AGIP Association began negotiations on new concession terms in February 1976. Their terms called for a 14.5 percent royalty and 47 percent tax with 20 percent Congo Government financial participation, not entitling it to crude. Production in 1975 entirely from the Elf-discovered offshore Emeraude field, was 1.7 million tons. This was not expected to rise above 1.8 million tons in 1976 since AGIP's Loango discovery was not expected to go into production until 1977.

54. Since the Congo's economic plan was based on projected oil revenues that did not materialize, Elf and AGIP (65-35 partners) made an advance payment totalling some US$20 million in 1975 to the Government of Congo as compensation. Repayment of this will start in mid-1978 at the latest.

Cameroon

55. Several foreign oil companies are actively engaged in Cameroon's oil exploration and development (Aracca Petroleum, Dawson, Dixel Resources, Elf/Serepca, Gulf, Mobil, Oceanic, Oxoco International, Peyco Exploration and Serepca/Shell).

56. Oceanic Exploration Company has been granted an exploration license covering about 1.6 million acres onshore and offshore. A French concern, which had previously explored this area, drilled four oil and gas discovery wells on the peninsula extending into Manoka Bay, and Oceanic plans to redrill to establish production. The company holds two other offshore Cameroon blocks covering 1.78 million acres.

57. Elf Serepca (operator and 60 percent partner with Shell holding 40 percent) is planning to drill development wells to bring on stream the offshore Biboundi structure where oil was discovered in 1974 in the Rio-del-Rey Concession. A natural gas discovery made near Douala 20 years ago is to start commercial production in 1977 at a rate of 5 to 6 million cubic meters a year.

58. In 1975 a US group won oil rights on the Nigerian border, adjoining Gulf Oil and Shell acreage, to 300,000 acres onshore and its offshore block is about 40 miles east of Nigerian production. The operating company Dawson holds a 50 percent share, and the other partners Dixel Resources hold 25 percent, Aracca Petroleum 12.5 percent, Peyto Exploration 7.5 percent and Oxoco International 5 percent.

59. Development drilling was started in 1976 in the Kole offshore oil discovery by the partnership of Elf and Shell, since a well drilled in 1975 extended the Kole discovery and proved the reserves of commercial significance. In 1975 Shell increased its stakes in 2 offshore permits held jointly with Elf-Serepca to 40 percent, from 20 percent in a 365,000 acre permit. The Kole offshore oil discovery, in addition to two other finds at Biboundi and Rio-del-Rey, is now being commercially developed, and oil is likely to be processed in 1978.

Chad

60. Drilling for oil in land-locked Chad began in December 1973, after three years of intensive exploration. Continental Oil Company is the operator and 25 percent partner in a group whose other members are Shell (50 percent) and Chevron (25 percent). The group holds two concession areas: the Lake Chad Basin Permit, now reduced as a result of relinguishments to some 29,000 square miles in the west central part of the country, and the Chari Basin Permit in the south, totalling some 38,000 square miles. Terms of licenses were for five years with options of two further five-year renewals. The companies were committed to a total expenditure of at least $5.67 million in the first five years, but had in fact spent over $18 million within four years of starting work.

61. Continental's first significant discovery was made in April 1975 when it struck oil in the Miandown well in the Chari Basin block. Continental's second commercial discovery was made a little to the south of the Kanem field, north of Lake Chad. Because of the geological complexity of the reservoir, additional drilling is needed to determine commercial potential. If the recent finds in Chad prove commercial, the prospects of achieving self-sufficiency in oil, with consumption at just about 1,400 b/d, seems certain.

Ghana

62. Ghana's oil exploration is being undertaken by foreign oil companies: Amoco, Mesa, Oceanic, Oxoco, Phillips, Signal and Zapata Exploration Company (Zapex). Zapex of Texas has announced that a flow of dry gas has been tested at 3.7 million cfd in an offshore exploratory well in 340 feet of water 17 miles south of Cape Three Points. Zapex shares a 30 percent interest in the venture with Phillips Petroleum (50 percent) and Mobil (20 percent). In 1975, Amoco, as operator and in partnership with Oceanic Exploration, started drilling in the Tano Basin, 18 miles offshore in about 200 feet of water.

Guinea

63. The Guinean Government offered participation to foreign companies for oil and gas exploration and exploitation in Guinean waters in mid 1974. A consortium called SOGUIP (Societe Guineenne des Petroles) has been formed with a sole foreign partner, Buttes Resources.

64. Buttes Gas and Oil has signed a 25-year exploration agreement covering all Guinea's offshore territory. Buttes Gas and Oil has a 51 percent share in SOGUIP which it has formed in partnership with the Government to undertake exclusive exploration in Guinea's offshore waters. The state will receive 65 percent of the company's profits.

65. Buttes Gas and Oil planned in June 1976 to spud its first offshore wildcat by end-1976, after selecting 2.5 million acres from the original 10 million awarded 2 years ago. When mapping and analysis of specified deep water areas are completed, Buttes will have the added option of selecting two more blocks of 1.25 million acres each. In January 1977, Japan Guinea Petroleum joined Buttes gas to drill for oil in a 10,000 square kilometers offshore concession. Now the shares in that offshore concession are: Buttes 70 percent, Naftagas 20 percent and Japan Guinea Petroleum 10 percent.

Ivory Coast

66. Italy's ENI, Spain's Hisspanoil and US independents Getty Oil and Phillips Petroleum have taken equal shares in an 18,000 square kilometers offshore exploration area in which the Government has a 10 percent equity option. Water depths extend beyond 200 meters. Exxon's local affiliates, in partnership with Esso AG and Shell have found hydrocarbons with 3 offshore wells, two of them 18 miles southeast of Abidjan and the third some 10 miles to the east. Phillips, partnered by state-owned Petroci, Getty Oil, AGIP and Hisspanoil, has discovered gas offshore 40 miles from Abidjan.

Mali

67. The companies active in Mali are Global, Murphy, Sun and Texaco Mali. Across Mali's unmarked desert frontier, Texaco was awarded a 270,000 square kilometers exploration permit covering the eastern Taoudeni Basin in 1970 and Exxon has now, with the approval of Mali Government, acquired a half share of it.

68. Global Energy Company and Mali Sun Oil Company have been exploring in eastern Mali, and at the end of 1975, Murphy Mali Oil Company, Sunningdale Oils and Comoro Exploration signed an exploration agreement covering territory in the area of northwest Mali.

Mauritania

69. The companies actively prospecting for oil in Mauritania are AGIP (Italy), and AGIP in partnership with World Energy Development Company (Japan), Planet Oil and Mineral Corporation, Shell/Maurex and Texaco/Exxon.

70. In 1971, Texaco Mauritania Inc. was awarded a 37-million acre exploration permit in the Taoudni Basin of eastern Mauritania and has since carried out extensive geophysical work there. The western part of the permit area was relinguished in 1972. Under an agreement approved by the Mauritanian Government, Exxon has acquired an equal interest in the permit and additional joint exploration has now started.

71. AGIP is exploring onshore in Mauritania and holds a 75 percent interest in two concessions totalling about 39 acres north and south of the Texaco/Exxon territory; the other 25 percent interest is held by World Energy Development Company (Japan).

Niger

72. Bishop, Conoco, Sunoil and Texaco (associated with Esso and Shell) hold exploration permits in Niger. Exxon has taken a half-share in a 95,000 square mile exploration concession in the eastern part of Niger, which Texaco acquired in 1970. Exxon and Texaco have, in addition, each acquired a 30 percent interest in a 38,000 square mile concession which Global Energy Company acquired in northeast Niger in March 1970, and in which it retains a 30 percent interest. Global's concession agreement calls for the drilling of a well before 1976. Texaco has found hydrocarbon shows in a well drilled on a concession held jointly with Exxon in the Tin Toumna region of the Sahara Desert about 300 kilometer north of Lake Chad.

Other African Countries

Angola

73. Angola has total estimated reserves of 1,300 million barrels of crude oil and 1.5 trillion cubic feet of natural gas. In 1976, Angola's production stood at about 110,000 b/d. Its present production capacity is about 175,000 b/d. The production potential to 1980 may reach about 200,000 b/d and about 250,000 b/d by 1985.

Zaire

74. Zaire has become the continent's tenth oil producing country. As at the end of 1976, Zaire's proven reserves stood at about 500 million barrels. Gulf Oil Corporation and its partners are producing 25,000 b/d from two fields in Atlantic waters on Zaire's short coast. The Gulf group is currently developing the offshore fields found in 1971 and 1973. Zaire's production could reach about 50,000 b/d in 1980, rising to 100,000 b/d by 1985.

North Africa

75. The supply prospects for oil and gas in the countries of North Africa appear to be very promising. Algeria and Libya are already OPEC members. Egypt and Tunisia are commercial producers and net exporters of oil. Morocco, although not a commercial producer, has good prospects of becoming one.

Egypt

76. Since the beginning of 1973, Egypt has launched a ten-year program for oil exploration, development and production. Egypt's state-run Egyptian General Petroleum Corporation (EGPC) has envisaged the drilling of 400 exploratory wells in Egypt's 500,000 square kilometers of prospective territory. As of June 1977, more than 40 production-sharing agreements have been signed with American, Brazilian, European and Japanese oil companies covering more than half of the prospective territory. These agreements have resulted in exploration investments totalling above US$825 million. The concessions cover 629,275 square kilometers, over two-thirds of the whole of Egypt. By the end of 1974, the Gulf of Suez area was totally covered by offshore agreements. By 1976, attention had been directed toward the area of the Mediterranean offshore and the Sinai Peninsula, where a number of production sharing agreements were concluded.

77. The exploration program resulted in a number of new discoveries in the Gulf of Suez basin and around its area, as well as in the northern part of the Nile delta. Egypt's proven reserves reached some four billion barrels of oil by July 1977. Gas reserves are estimated at 100 billion cubic meters. Egypt's production rose from just under 145,000 b/d in 1974 to about 327,000 b/d in 1976. The Government has set a target of production at one million b/d by 1980 However, allowing for delays in development and further additions to reserves, production could reach 700,000-800,000 b/d in 1980 and about 1.0 to 1.2 million b/d by 1985.

78. The basic features of these agreements are that the foreign company pays a signature bonus and undertakes to spend a certain minimum amount on exploration for up to 8-12 years. The production period is usually between 20 and 30 years. If a commercial operation is undertaken, then the company and EGPC form a joint venture. The partner company takes 40 percent of output to cover its costs. However, if the value of 40 percent exceeds the actual costs in a given year, then the excess goes to EGPC. The remaining 60 percent of production is shared between 75:25 to 85:15 in EGPC's favor. EGPC pays all taxes and royalties but is spared any prospecting, development and production expenses.

Tunisia

79. In recent years the Government has been encouraging foreign oil companies to step up the search for oil and gas in Tunisia. As a result, the areas under exploration rose from 86,000 square kilometers in 1970 to 183,000 square kilometers in early 1973 and by the end of 1973 stood at just under 200,000 square kilometers--92,000 on land and 104,000 offshore. Some exploration areas in Tunisia's extensive continental shelf stretch as far as 150 miles from the coast in the direction of Malta, and also north of the Tripolitanian coast of Libya. A dispute between Tunisia and Libya over the division of the continental shelf is still outstanding. In 1976, Tunisia's production stood at about 73,000 b/d. In early 1977, a group consisting of Amoco, CFP and ENI had signed an agreement to put offshore

Isis field, which was discovered in 1974, into production. Tunisia's production could reach about 130,00 b/d in 1980 and to 150,000 b/d by 1985.

Morocco

80. Morocco's oil production has declined to less than 700 b/d. However, the country's state-owned Bureau de Recheres et de Participations Minieres (BRPM) has hopes that intensified exploration both onshore and offshore will turn up some oil/gas prospects. The offshore potential has drawn a large number of foreign operators to the area, including American, Burmah Oil, Exxon, France's Aquitaine, Petrofina, Sun Oil, Standard Oil of California and others. In 1976, Phillips Petroleum (operator), Getty Oil and AGIP took equal shares in two offshore exploration areas covering some 10,000 square kilometers between Agadir and Essaouira.

81. Morocco has prospects of shale deposits. The potential of recoverable oil from shale deposits is put at about 13 billion barrels. Studies undertaken so far point to the possibility of production of 440,000 b/d of shale oil.

East Africa

82. Less activity has been seen on the eastern side of the continent. Some interest was aroused in 1973 when a group consisting of Chevron, Tenneco, and Texaco found a 35 MMcfd gas well in the Ogaden region of Ethiopia. However, further exploration by the foreign companies has been very slow. There has been extensive seismic work and a little drilling in Kenya, Somalia and Tanzania. Interesting gas strikes have been made in the Red Sea off Sudan by American Pacific International and Standard Oil of California.

Non-OPEC Middle East

83. The non-OPEC Middle East countries can be classifed into three groups. The first consists of those which are currently oil exporters with favorable prospects of supplies. Oman comes under this group. The second group consists of those which are oil producers and exporters at present but with dwindling supplies in the future. Bahrain and Syria come under this group. The third group consists of other non-OPEC Middle East countries such as Lebanon and Jordan, where prospecting is still going on.

Oman

84. Oman's first oil discovery was made in 1963. Oman's fields are operated by Petroleum Development Limited (Oman--60 percent share) with Royal Dutch Shell, Compagnie Francaise des Petroles and partners sharing the remaining 40 percent.

85. The state oil company is exploring in Dhofar and Oman has encouraged foreign companies to prospect for oil. In early 1977, the Government decided to offer for exploration all open offshore acreage, adjoining two-thirds of its 1,100 mile coastline. As of July 8, 1977, more than half a dozen companies were prospecting for oil in Oman's onshore and offshore fields.

86. Oman's present proven oil reserves amount to about 5,900 million barrels. Its natural gas reserves stand at 2,000 billion cubic feet. Nearly 80 percent of current production comes from fields discovered before 1970 and they are already in decline. However, the long-term prospects on the basis of presently proven reserves give Oman a reserve/production ratio of 25 years at current rates of production of 365,000 b/d.

Syria

87. Syria's petroleum industry is owned and operated by the state. However, Russian technicians have been active in assisting in oil exploration and development. Syria's crude oil reserves are estimated at 2.2 billion barrels and gas reserves are set at 1.24 trillion cubic feet. To step up the level of reserves further, in 1975 the Government adopted an open door policy toward foreign exploration companies. Syria has opened all its offshore and 11 onshore tracts covering more than half of its land area to foreign exploration under production-sharing contracts. The terms specified by the Government included company costs to be recovered from 40 percent of production, minimum exploration commitments, and negotiable production-sharing agreements. However, efforts so far have not been very successful either onshore or offshore. In the absence of any substantial new discoveries, production could reach about 200,000-220,000 b/d through 1985.

Bahrain

88. Bahrain, an island Shaikhdom in the Persian Gulf, has a single onshore oil field and shares production of one offshore field Bahrain's oil production peaked at about 70,000 b/d in 1972. In 1976, it had fallen to about 58,000 b/d. The prospects of new fields being discovered are not very bright. Therefore, output is expected to continue to fall to 50,000 b/d by 1985.

South Asia

89. In the aggregate, four countries of South Asia together imported in 1976 about 500,000 b/d of oil, at an estimated import bill of US$2,500 million. Since the oil crisis in 1973, these countries have launched a multipronged energy policy to relieve the pressure on their imports: first, stepping up the exploration efforts by opening up their prospecting areas to international companies; second, increasing domestic recovery measures;

third, reducing the demand for petroleum by substituting domestic coal and/or natural gas. Within three years, these policies have been successfully pursued in India, Pakistan, Bangladesh and Sri Lanka and the results point to the fact that these countries will be able to increase their domestic supplies of oil and gas by more than 50 percent of their potential domestic consumption by 1985.

Bangladesh

Petroleum

90. With no indigenous oil production to date, Bangladesh has been importing about 25,000 b/d at an estimated cost of more than US$125 million. The state oil company, Petrobangla, so far has been the sole prospector onshore. However, in 1976 the Government threw open the whole of Bangladesh's onshore fields to production-sharing contracts except in the areas reserved to Petrobangla, where joint-venture proposals were considered. The onshore areas are expected to be divided into six blocks. For its onshore work Bangladesh has recently signed agreements with West Germany for technical and exploration aid.

91. Bangladesh also has opened its offshore fields to international bids and in 1974, 5 permits were issued in the form of 21-year production-sharing agreements, to Arco, Ashland, Ina Naftaplin of Yugoslavia, Japan Petroleum Development and Union. So far, seismic surveys over about 25,000 square miles have been completed and a gas strike in the offshore by Union Oil was reported in 1977.

Natural Gas

92. The only available energy source in the country is natural gas. Excluding Union Oil's current discovery offshore, nine fields have been discovered onshore. Proven reserves of seven fields (two more are being delineated) are 235-265 billion cubic meters with probable reserves at some 480-560 billion cubic meters. These figures are comparable to those of Pakistan and Brunei, but utilization is very low. At first gas was only used in fertilizer production, but since 1968 the gas had also been applied to power generation in a comparatively small scale. Bangladesh's targeted power generating capacity by 1978 is 996 Mw, according to plans published by Petrobangla. If only a third of the proven natural gas reserves could be developed and utilized, there would be sufficient supplies to support 2,250 Mw of generating capacity for 30 years at an average of 50 percent load. The large gas fields could support a production of some eight billion cubic meters a year (eight times the actual rate and much more than the potential domestic requirement). Petrobangla officials have accordingly talked of an LNG export project with Japan. This could be considered a long-term possibility.

Burma

93. Until 1973, Burmese petroleum operations were under the control of the state oil company Myanma Oil Corporation (MOC). Since then, Burma has modified its petroleum policy so far as the offshore is concerned by awarding production-sharing contracts to AGIP,CFP, Cities Service, Dominex and a Japanese consortium. However, in 1976 MOC discovered the Letpando field onshore, about 350 miles north of Rangoon, and this is expected to yield from 10,000-20,000 b/d in addition to current production of about 18,000 b/d. The proven reserves being at 63 million barrels of oil, Burma can increase its production only marginally at about 25,000-30,000 b/d by 1985.

India

94. Indian policy up to late 1973 was to keep onshore drilling in the hands of the state-onwed Oil and Natural Gas Company (ONGC), ONGC having 50/50 parthership with Burma oil in the six existing onshore concessions. On the eve of oil crisis, India produced about 160,000 b/d of oil, while its total consumption amounted to about 440,000 b/d. The increase in oil prices in 1973-74 led to a sharp increase in the cost of petroleum imports, and India's petroleum policy was geared to meet the situation. The most important steps taken were toward intensifying domestic exploration and developing the offshore potential. Oil was struck in the Bombay High and North Bassein fields in 1973-74 and efforts were directed toward development of these fields through a program called "operation quick oil." In addition, the Government also opened up ten offshore areas to foreign exploration under production-sharing contracts. Three contracts, in which ONGC had participation, were signed with Asamera (Canada) Natomas (US) and Reading and Bates (US) to explore the basins of Kutch, the Bay of Bengal and the Cauvery, respectively. No commercial discovery has yet been made in these areas.

95. The discoveries of Bombay High and North Bassein have increased the proven reserves from about 900 million barrels to about 1,800 million barrels of oil and 30,000 million cubic feet of gas. ONGC's targeted total production is likely to reach about 400,000 b/d by 1980, of which 200,000 b/d will come from offshore, and about 500,000 b/d by 1985. The Bank has participated in the second stage of ONGC's development program by making a loan of US$150 million in July 1977.

Pakistan

Petroleum

96. Pakistan's oil production is less than 8,000 b/d and is confined to the existing Tut and Meyal fields. With the increases in oil prices, the cost of importing oil rose from US$63 million in 1973 to about US$400 million in 1976. To relieve the pressure of oil imports, Pakistan launched a three-pronged oil policy. First, it envisaged investments in secondary recoveries that would increase domestic production from the present 7,000 b/d

to 17,000 b/d by 1985. Second, it approved a higher budget for the State Oil and Gas Development Corporation (OGDC). Third, it opened up Pakistan's prospective areas to international companies both onshore and offshore.

97. Of the country's 310,800 square mile area, the Government has granted exploration concessions to western companies covering some 68,300 square miles. Another 120,000 square miles are open for exploration bids. Exploration currently involves 11 foreign companies. In early 1977 a petroleum commission was formed to supervise exploration activities of OGDC, foreign companies and also to oversee domestic marketing of oil products.

98. In early 1977, OGDC made the country's first significant oil find outside the Potwar Basin in the area called Dhodak, located in the Dera Ghazi Khan district south of Islamabad. So far, the estimated proven reserves stand at 200 million barrels of oil and 110-140 billion cubic meters of gas. Further development drilling is needed to determine the potential production level. However, based on available information, Pakistan can increase its production from less than 10,000 b/d at present to at least 30,000 b/d by 1980, and to about 45,000 b/d by 1985; thereby it can meet more than half its domestic requirements.

Natural Gas

99. Production of natural gas from Pakistan's gas fields reached about 400 million cubic feet per day (mmcf/d) in 1976--equivalent to about 72,000 b/d of crude oil. The country has 11 gas fields, and 10 of these fields total 15.5 trillion cubic feet of combined recoverable reserves. Pakistan's first and biggest gas discovery was made in 1952 with the Sui field. Sui has produced about 1.6 trillion cubic feet of gas since 1955 when it went into production. The field still has nearly 7.5 trillion cubic feet of recoverable gas in place.

100. The second largest gas field in Pakistan, Mari, was found in 1957 about 40 miles southeast of the Sui field by Stanvac, a joint venture of units of companies now known as Exxon Corporation and Mobil Oil Corporation. It has reserves of 3.9 trillion cubic feet of high-quality gas. In addition to these two fields, which are currently in full production, eight new gas fields have been established which are considered to have reserves of about four trillion cubic feet. The total proven reserves of about 16 trillion cubic feet exclude the 1973 Kothar discovery. The country has plans to increase its natural gas production to 900 mncf/d by 1985. With the presently proven reserves of 16 trillion cubic feet, the targeted rate of production of 900 mncf/d gives a good reserve/production ratio beyond the year 2000.

Sri Lanka

101. Sri Lanka's efforts in oil exploration date back to the late 1960s when the French Petroleum Institute made exploration recommendations on data provided by a seismic survey carried out for the state company, Ceylon

Petroleum Corporation (CPC). CPC invited foreign companies to bid for permits in areas off the northwest coast. The Government reserved the offshore for CPC and depended mainly on Russia for technical assistance.

102. In 1974, Sri Lanka's first well was sunk in the Pesalai district. Good indications of oil and natural gas deposits were reported, but no commercial find was established. With the increases in oil prices, Sri Lanka's oil import bill for imports of about 30,000 b/d in 1975 reached more than US$130 million. The pressure to reduce the oil import bill led the Government to revise its oil policy which resulted in associating foreign companies for oil exploration and development.

103. The Government of Sri Lanka opened all of its continental shelf to international tenders for production-sharing contracts early in 1976. The first offshore well was spudded in the Palk Strait in July 1976 by Marathon Oil Company on a contract from Ceylon Petroleum. The production-sharing contracts specified that oil prospectors must bear all costs of exploration. In the event of commercial production, the oil operator could recover costs from the first 30 percent of output and split the remainder 80-20 in Sri Lanka's favor on the first 75,000 b/d of production. The split would rise to 92.5-7.5 for Sri Lanka on production over 300,000 b/d. The potential geological prospects appear bright. The goal of reaching self-sufficiency depends on the intensity of sustained exploratory efforts.

East Asia and Pacific

104. Intensified exploration in southeast and fareast Asia could possibly make some countries, with no apparent or neglible crude production at present, good prospects as potential suppliers. Malaysia is already a commercial oil producer and net oil exporter. The petroleum policies in other countries, notably the Philippines, South Korea, Thailand and Vietnam, have been intensified since the oil crisis to increase domestic production.

Brunei

105. Brunei's proven petroleum reserves as of January 1977 stood at 1,625 million barrels and its natural gas reserves amounted to 8,400 billion cubic feet. A Royal Dutch Shell group subsidiary is the sole operator, producing more than 200,000 b/d of oil from 4 offshore fields. More than 700 mncf/d of gas production supplies a LNG plant at Lumert, operated by Shell and Japan's Mitsubishi, from which exports are sent. The Government of Brunei has a 25 percent interest in Shell's total operations. Shell is maintaining an exploration and development program to raise output targeted to about 500,000 b/d. Brunei has very good prospects of raising its gas output based on proven reserves.

Vietnam

106. The most striking aspect of the Government's attitude is that within weeks of the end of the war, Vietnam was ready to contact the

international oil companies and in early 1976 the Government welcomed them to prospect for oil in Vietnam. By the end of 1976, the United Nations Economic and Social Commission for Asia and Pacific announced that a Norwegian rig would soon begin drilling offshore under a six-well offshore development program agreed with the Government of Vietnam. Other interested companies, hopeful of securing drilling rights, were Elf/Aquitaine (France) and Kaiyo Oil (Japan). In early 1977 Vietnam's petroleum policy took a step forward to attract foreign investment into the country. The investment code, issued in early 1977, would allow foreign companies to own up to 49 percent of a venture and repatriate most of their taxed profits. Negotiations are underway between Petrovietnam, the state oil company, and ENI (Italy), Elf/Aquitaine and West Germany's Dominex Company for the awards of exploration blocks offshore. During 1974-75 Mobil and Shell had already struck oil in the offshore and prospects for oil discoveries in Vietnam are considered favorable. Vietnam's potential production can reach about 20,000 b/d in 1980 and to about 55,000 b/d by 1985.

Thailand

107. More than ten companies or groups are operating in Thailand prospecting for oil and gas. Of these, Union Oil of California and a consortium headed by Texas Pacific have found commercial reserves of natural gas in the Gulf of Thailand. Unofficial estimates of natural gas reserves discovered by Union Oil Company alone are estimated at 28 billion cubic meters. In early 1977, the Government formed a state-owned natural gas organization and announced in April 1977 that it would invest US$100 million in the US$245 million pipeline project to transport offshore gas finds to Bangkok. The balance is expected to be financed from foreign financial institutions. The flow rate of gas production would be equivalent to the 23,000 b/d of fuel oil currently being used for Thailand's power generation.

108. On the west coast of Thailand, in the Andaman Sea, exploration tracts are held by Amoco International, Exxon Corporation, Oceanic Exploration Group and Weeks Natural Resources with North Petroleum. Exxon has already commenced offshore drilling in the Andaman Sea. Prospects of commercial discoveries to be made before 1982 are bright.

South Korea

109. South Korea's oil imports in 1977 are estimated at 350,000 b/d at a cost of US$1,660 million. None of the oil requirements come as yet from domestic sources. The Government's main hope of reducing the pressure of oil imports depends on generating domestic oil supplies. The success of South Korea's oil exploration efforts rests on resolving the deadlock governing offshore waters. The concessions that it has granted off its western shores in the Yellow Sea are disputed by China; a concession in the East China Sea is disputed by Taiwan; and the concessions it has granted below Cheju Island and westward of Japan have been disputed by the Japanese. South Korea has proposed that a part of the area in the Block VII be jointly explored with Japan. There is general expectation that this area contains

the most oil prospective areas of the two countries. United Nations Economic Commission for Asia and the Far East (ECAFE) chose it as a promising area in its Asian studies of 1968, and a survey by Nippon Oil Exploration detected sedimentary structures. Joint development for nine subzones has been agreed and in each of these subzones one or more companies have been authorized for exploration by each of the Governments.

Philippines

110. Located as it is along the Pacific's volcanic belt, the Philippines' most obvious source of energy is geothermal. There are also local reserves estimated at 438 million barrels of oil equivalent. Official policy is to find substitutes, whether from indigeneous oil or other local resources, for a current dependence of over 90 percent of imported oil for all energy needs. The Philippines imported about 200,000 b/d in 1976 at an estimated cost of more than US$850 million a year. A conservative program for the use of oil was launched in 1975.

111. Geothermal energy apart, domestic oil and gas discoveries remain the Philippines' best hope of reducing the imports bill for crude oil and petroleum products. The Government has mapped out an extensive oil exploration program aimed at spurring exploration. Philippine National Oil Company (PNOC), an arm of the country's petroleum board, will control all exploration activities onshore and offshore. Under a presidential decree issued in 1972, all concessions have been converted into contracts. This was done to spur exploration efforts as the service contracts require stipulated levels of investment, and drilling commitments in the specified period. The PNOC claims that prospective tertiary sediments exist in 11 basins of the archipelago. About a dozen foreign companies are involved with a large number of Philippine companies in production-sharing contracts. The Government holds about 27,000 square miles in reserve and about 25,000 square miles, mostly offshore in the Sulu Sea basin, still are open for exploration contracts. In 1977, 17 wildcats were scheduled, of which 11 were to be onshore. Successful strikes have been made in recent years to the south. Salen Energy has discovered hydrocarbons on the Reed Bank, off the west coast; but so far there has been no commercial discovery. In an effort to stimulate the interest of the foreign oil companies in exploration, the Government of Philippines has lately reorganized the concession terms offered. Drilling in the offshore Palaman in 1976 by Cities Service has resulted in interesting oil and gas shows. Cities Service proposed that the Government should put up Cities Service's 45 percent share for extra wildcatting beyond that agreed by Cities Service, with a provision that it would remain operator and receive suitable compensation in the event of a strike. But the Government's difficulty is to commit the already meager available resources for investment in exploration programs.

Malaysia

Crude Oil

112. As of 1977, the effective production rate of crude oil in Malaysia stood at 195,000 b/d. More than 60 percent of this comes from the 4 offshore fields of Sarawak (Bakau, Baram, Baronia and West Lutong) operated by a subsidiary of Royal Dutch Shell. The remaining 40 percent of present production capacity comes from offshore Sabah fields: Samarang and Tembungo, the former under operation by Shell and the latter by Exxon.

113. Among the concession-holding companies in Malaysia, Continental Oil Company (CONOCO), Exxon and Shell have made a number of commercial discoveries. Exxon's major development program included a new 24-slot producing platform to be installed on the Tambungo structure and targeted to produce 100,000 b/d by 1980. Exxon also aimed to put Pulai field into production off Western Malaysia. In late 1975, two 24-slot drilling and production platforms were to be delivered for production of 50,000 b/d.

114. Shell's plan for developing Erb West and Samarang fields included building a new export terminal on the Labuan Island to link with 30 miles off Samarang field. Sarawak Shell expects to develop these three fields producing a total of 70,000 b/d by 1978. In December 1976, Petronas Malaysia, the state oil company, reached production-sharing agreements with Shell and Exxon, allowing the companies to deduct up to 20 percent of costs including exploration, development and production expenses and 10 percent for royalties. The remaining 70 percent will be divided between Petronas and Shell, with the state company taking 70 percent and the companies taking 30 percent. In addition, the oil companies will pay income tax at the rate of 45 percent. This arrangement amounts to, after tax, 83.5 percent for Government and 16.5 percent for Shell and Exxon. The production-sharing agreement will last for 20 years with the option of a 4-year extension. The contract for gas is for 20 years with a 14-year extension.

115. Petronas has assumed ownership of Malaysia's oil resources, however, its skilled personnel and resource constraints are too severe to undertake exploration on its own, and it is moving forward to associate other foreign oil companies for oil prospecting. By June 1977 more than 40 companies had approached Malaysia seeking exploration and development deals. Petronas seems to have categorized international oil companies into four groups: (i) present producers: Exxon and Shell; (ii) the continental oil group that had a 1974 oil discovery off the country's east coast and with which Petronas is discussing a joint-venture deal; (iii) companies that have explored offshore: Aquitaine, Sabah, Teiseki and the oceanic exploration-forest oil consortium. All newcomers are being placed in a fourth group. Areas that are not picked up by the first three groups will be made available to the fourth group. In addition, new onshore and offshore acreage will be offered to interested companies.

116. Petronas estimates Malaysia's recoverable reserves as of June 1977, at about 900 million barrels of crude oil and 17 billion cubic feet of natural gas. At the present production rate, between 180,000 to 200,000 b/d, the nation's reserves will not last more than 13 years. If new discoveries are not made and domestic consumption increases, Malaysia could turn out to be a net importer of oil by 1985. With presently proven reserves, it is possible to maintain production to about 200,000 b/d through 1985.

Natural Gas

117. The major gas find so far in Malaysian waters is Shell's Bintulu discovery off the west coast of Sarawak. Reserves are estimated at six trillion cubic feet. A LNG plant is planned for construction to process about 750 million cubic feet per day of gas for liquefaction mainly for LNG export to Japan under 20-year contracts agreed in May 1977. Mitsubishi, Petronas, Shell, Tokyo Electric and Tokyo Gas have agreed to form a marketing company in Japan to market LNG exported from Malaysia. Petronas' share is expected to be 65 percent in the marketing company which would be its first important overseas venture. Mitsubishi and Shell equally hold the remaining shares. The time scale of the contract is set for 20 years' exports beginning in 1983.

118. Malaysian International Shipping Corporation is to manage the task of shipping the LNG. It appears to have signed a US$700 million contract with France for 5 LNG tankers deliverable by 1981-82. Construction of liquefaction facilities is expected to begin in 1978 with shipments to Japan scheduled to start in early 1983. The net contribution to balance of payments from LNG exports depends on various factors: viz., the contract price for LNG exports, the unit cost structure of LNG to be delivered, the volume of exports and allowance for lags in the delivery of LNG tankers accompanied with allowances to be made for unavoidable delays in the lead time for implementation of LNG export project.

119. The unit cost of LNG delivered is comprised of the wellhead price for gas, cost of delivery to the liquefaction plant, cost of liquefaction and the cost of marine freight at the receiving terminal. The non-marine costs (wellhead to export point) can range from US$0.30 to US$1.00 per million Btu. Freight costs vary from as little as US$0.15 on shorthaul projects to over US$1.50 in the longest trades per million Btu.

120. The export price for LNG related to its crude oil equivalent price reflects a base f.o.b. price of US$1.35 per million Btu for LNG contracts negotiated at present for 20 years starting from 1980 adjustable upwards for inflation and other variables that cause changes in the energy market. Accordingly, a projected CIF price of US$2.00 per million Btu for Malaysia's LNG exports to Japanese ports by 1983 can be assumed. Freight costs are estimated at about US$0.45; thus the projected price for LNG, f.o.b. Sarawak, will be about US$1.55 per million Btu. The contributions to Malaysia from its LNG exports appear to commence only by 1984. If provision is made for accompanying uncertainties, the LNG export can have its impact felt on balance of payments only by 1985.

Southern Europe

Turkey

121. Turkey has proven reserves of oil at 390 million barrels, gas reserves of about 540 billion cubic feet and produces about 60,000 b/d, which meets 20 percent of its total consumption as of January 1977. The state-owned Turkish Petroleum Corporation (TPAO) produces about 20,000 b/d and has been moderately successful in its oil exploration efforts; Mobil and Shell produce the remaining 40,000 b/d of oil. Several foreign companies have been exploring for oil and the first half of 1977 a few oil finds were reported near Adiyaman and Diyarbakier regions in southern Turkey. Exploration bids have been invited in three northern areas of the Aegean Sea and drilling will start as soon as bids have been evaluated. At the present production level of about 60,000 b/d, Turkey's proven reserves have a life of about 15-17 years.

Yugoslavia

122. Yugoslavia has proven reserves of about 350 million barrels of oil and 1,500 billion cubic feet of natural gas, however, its oil fields are relatively small and a continued addition to reserves is necessary to avoid depletion. Yugoslavia's state-run organization, Naftaplin, has been in charge of exploration and drilling activity, not only within Yugoslavia, but also in overseas exploration projects attempting to secure access to larger reserves. Naftaplin has joint-venture agreements in exploration/drilling projects in Bangladesh, Guinea and Jordan.

123. Yugoslavia's own offshore territory is also viewed as a possible source of hydrocarbons. In its eagerness to develop its oil resources, Yugoslavia has ventured into partnership with Buttes Gas and Oil (US), to drill for oil off Montenegro. More recently, Naftaplin started drilling off the Dalmatian coast where surveys have indicated the presence of sedimentary rocks.

124. Despite the fact that the presently producing fields are small, Yugoslavia has been able to increase its output from these fields by further development drilling. Oil production has reached a peak of about 79,000 b/d; only a small increase is expected in 1977. The 1976-80 plan envisages an annual increase in output of nearly 5 percent to reach an output of about 95,000 b/d in 1980. In the absence of additions to reserves from new discoveries in the offshore, it may be difficult to reach that target. On the basis of the current rate of production of about 80,000 b/d, presently proven reserves of 350 million barrels will last for about 10 years.

COUNTRIES INCLUDED IN THE ANALYSIS

Countries are classified into operational regional groups and include six geographic categories and five per capita income classes. The following short table explains country group by income:

Income Classes by GNP Per Capita
(in US$ by 1976 prices)

Country Group	GNP Per Capita
Low Income	280 or less
Lower Middle Income	281 - 550
Intermediate Middle Income	551 - 1,135
Upper Middle Income	1,136 - 2,500
High Income	2,501 or more

The income classification is based on World Bank Atlas estimates of GNP per capita for 1976. The global analysis in oil and gas to 1982 for non-OPEC developing countries according to the status of their oil and gas prospects are classified into five groups, A, B, C, D and E, as follows:

A - current producers of oil and/or gas, including 14 net oil importers, etc.

B - non-OPEC developing countries which are currently non-producers of oil and/or gas but have proven reserves and announced commercial discoveries to be exploited as of November 1977.

C - non-OPEC developing countries, currenly carrying on intensive exploratory activity and have favorable geological prospects for potential oil/gas discoveries.

D - non-OPEC developing countries, whose geological prospects for oil and/or gas at the present state of technical knowledge are not very favorable. However, in some of these countries, viz. Kenya, some exploratory activity is still being carried on.

E - includes 13 oil exporting developing countries which are members of OPEC, and 5 non-OPEC net oil exporting developing countries which are high/upper middle income countries.

DEVELOPING COUNTRIES: By Income and Status of Oil and Gas

	Group A	Group B	Group C	Group D	Group E
South Asia					
Low Income	Bangladesh Burma India Pakistan		Sri Lanka	Nepal	
East Asia & Pacific					
High Income				Singapore	Brunei
Upper Middle				Hong Kong	
Intermediate Middle	Malaysia		Korea		
Lower Middle		Papua New Guinea Philippines Thailand		Western Samoa	
Low Income			Vietnam	Laos	Indonesia
EMENA					
High Income					Libya, Qatar Saudi Arabia UAR, Kuwait
Upper Middle	Yugoslavia				Bahrain Iran Iraq Oman
Intermediate Middle	Syria Tunisia Turkey				Algeria
Lower Middle	Congo Egypt Morocco		Jordan		
Low Income	Afghanistan		Yemen AR Yemen PDR		
East Africa					
High Income					
Upper Middle Income					
Intermediate Middle				Zambia Mauritus	
Lower Middle Income			Mozambique	Botswana	
Low Income	Zaire	Burundi Rwanda Tanzania	Ethiopia Madagascar Somalia	Comoros Islands Kenya Lesotho Malawi Uganda	
West Africa					
High Income					
Upper Middle				Gabon	
Intermediate Middle			Sao Tome and Principe Centa and Melilla		
Lower Middle		Cameroon Ivory Coast	Equatorial Guinea Ghana Guinea Bissau Togo Senegal	Nigeria	
Low Income		Chad	Benin Central Africa Empire Gambia Guinea Mali Niger Sierra Leone	Upper Volta	
Latin America and Caribbean					
High Income					
Upper Middle	Argentina Brazil Barbados		Surinam Uruguay Jamaica		Venezuela Mexico Trinidad and Tobago
Intermediate Middle	Colombia Chile Peru	Guatemala	Guyana Paraguay Dominican Republic Nicaragua Costa Rica		Ecuador
Lower Middle	Bolivia		Panama El Salvador Honduras		
Low Income			Haiti		
Total Number of Countries	21	10	36	14	16

Table 1 EAST AFRICA

REGIONAL SUMMARY

	GROUP A				GROUP B				GROUP C				GROUP D				REGIONAL TOTAL				GRAND TOTAL[f/]
FY :	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	1977-85
Country Data - Oil																					
URR (mn barrels)[e/]	1,000	1,000	1,000	1,000	370	370	370	370	1,980	1,980	1,980	1,980	-	-	-	-	3,350	3,350	3,350	3,350	3,350
Proven reserves (mn barrels)	500	500	600	700	-	-	-	100	-	-	300	600	-	-	-	-	500	500	900	1,400	1,400
Production (mn barrels)	10	12	20	35	-	-	-	-	-	-	5	10	-	-	-	-	10	12	25	45	200
Consumption (mn barrels)	7	8	10	13	5	6	8	10[b/]	20	21	29	35[b/]	28	30	40	50[b,r/]	60	65	87	108[b/]	1,310
Investments (mn $)[d/]	-	-	500[a/]	500[b/]	-	-	200[a/]	200[b/]	-	-	400[a/]	400[b/]	-	-	300[a,r/]	200[b,r/]	-	-	1,400[a/]	1,300[b/]	2,700
Country Data - Gas																					
URR (10^9 cft)[e/]	105	105	105	105	n.a.	n.a.	n.a.	n.a.	2,330	2,330	2,330	2,330	-	-	-	-	2,435	2,435	2,435	2,435	2,435[q/]
Proven (10^9 cft)	50	50	60	70	872[p/]	872[p/]	1,000[p/]	1,200[p/]	-	-	230	800	-	-	-	-	922	922	1,290	2,070	2,070
Production (10^9 cft)	-	-	2	5	-	-	11	15	-	-	10	20	-	-	-	-	-	-	23	40	110
Consumption (10^9 cft)	-	-	2	5	-	-	11	15	-	-	10	20	-	-	-	-	-	-	23	40	110
Investment ($ million)[c/]	-	-	-	-	-	-	250[a/]	100[b/]	-	-	-	-	-	-	-	-	-	-	250[a/]	100[b/]	350

a/ Refer to totals including FY77-82

b/ Refer to totals including FY83-85

c/ Investment in non-associated gas only, excludes LNG cost

d/ Includes investment in associated gas development

e/ Excludes deep offshore and any undiscovered giant fields

f/ Refer to totals including FY77-85

p/ Preliminary estimates

r/ Exploration expenditures only

q/ Excludes URR of Group B countries

Table 2 : WEST AFRICA

REGIONAL SUMMARY

	GROUP A				GROUP B				GROUP C				GROUP D				REGIONAL TOTAL				GRAND TOTAL
FY :	76/77	78	82	85 :	76/77	78	82	85 :	76/77	78	82	85 :	76/77	78	82	85 :	76/77	78	82	85	1977-85
Country Data - Oil																					
URR (mn barrels) e/	5,390	5,390	5,390	5,390	4,470	4,470	4,470	4,470	6,250	6,250	6,250	6,250	-	-	-	-	16,110	16,110	16,110	16,110	16,110
Proven reserves (mn barrels)	285	285	350	500	570	570	1,120	1,750	-	-	600	1,000	-	-	-	-	855	855	2,070	3,250	3,250
Production (mn barrels)	15	17	15	6	-	-	14	25	-	-	15	25	-	-	-	-	15	17	44	56	265
Consumption (mn barrels)	1.3	1.4	2	3	13	15	22	29	25	27	37	50	0.7	0.8	1.0	1.5	40	44	62	84	560
Investments (1977 $ million)	-	-	200a/	100b/	-	-	600a/	350b/	-	-	500a/	200b/	-		-		-	-	1,300a/	650b	1,950
Country Data - Gas																					
URR (10^9 cft) e/	1,200	1,200	1,200	1,200	4,460	4,460	4,460	4,460	6,250	6,250	6,250	6,250	-		-		6,250	6,250	6,250	6,250	6,250
Proven (10^9 cft)	7	10	100	200	20	50	200	320	-	-	600	1,000	-		-		27	60	900	1,520	1,520
Production (10^9 cft)	-	-	5	10	-	0.2	6	12	-	-	5	5	-		-		-	0.2	16	27	75
Consumption (10^9 cft)	-	-	5	10	-	0.2	6	12	-	-	5	5	-		-		-	0.2	16	27	75
Investment ($ million) d/	-	-	-	-	-	-	-	-	-	-	-	-	-		-		-	-	-	-	-

a/ Refer to totals including FY77-82

b/ Refer to totals including FY83-85

c/ Includes associated natural gas development

d/ Assumed as associated gas development and therefore included in (c)

e/ Excludes deep offshore and undiscovered giant fields

November 1977

Table 3 EAST ASIA AND PACIFIC

REGIONAL SUMMARY

	GROUP A				GROUP B				GROUP C				GROUP D				REGIONAL TOTAL				GRAND TOTAL f/
FY :	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	1977-85
Country Date - Oil																					
URR (mn barrels) g/	2,500	2,500	2,500	2,500	3,745	3,745	3,745	3,745	2,745	2,745	2,745	2,745	n.a.	n.a.	n.a.	n.a.	8,990	8,990	8,990	8,990	8,990
Proven reserves (mn barrels)	900	900	1,200	1,500	10	10	250	600	-	-	250	550	-	-	-	-	910	910	1,700	2,650	2,650
Production (mn barrels)	65	70	85	110	-	-	17	30	-	-	5	25	-	-	-	-	65	70	112	155	820
Consumption (mn barrels)	27	28	33	36	126	132	155	182	115	121	170	220	50	53	64	72	318	334	422	510	3,350
Investments (1977 $ million)	-	-	200a/	200b/	-	-	600a/	400b/	-	-	1,000a/	600b/	-	-	-	-	-	-	1,800a/	1,200b/	3,000
Country Date - Gas																					
URR (10^9 cft) g/	n.a.	n.a.	n.a.	n.a.	29,855	29,855	29,855	29,855	22,000	22,000	22,000	22,000	10,820	10,820	10,820	10,820	62,675	62,675	62,675	62,675	62,675
Proven (10^9 cft)	17,000	17,000	17,000	17,000	1,000	1,000	1,660	2,300	-	-	1,000	2,160	-	-	-	2,000	18,000	18,000	19,660	21,460	21,460
Production (10^9 cft)	-	-	30	35	-	-	60	100	-	-	50	115	-	-	-	-	-	-	140	250	670
Consumption (10^9 cft)	-	-	-	-	-	-	60	100	-	-	50	115	-	-	-	-	-	-	110	215	545
Investment (1977 $ million) c/	-	-	1,000c/	-	-	-	500a/	250b/	-	-	e/	e/	-	-	-	-	-	-	1,500a/	250b/	1,750

a/ Refer to totals including FY78-82

b/ Refer to totals including FY83-85

c/ Includes LNG project cost in Malaysia LNG to be exported to Japan starting 1983

d/ Includes engineering loan of $5 million to Thailand gas development project

e/ Assumed to be associated gas development

f/ Refer to totals including FY77-85

g/ Excludes deep offshore and undiscovered fields

October, 1977

Table 4 S O U T H A S I A

REGIONAL SUMMARY

	Group A				Group B			Group C				Group D			Regional Total				Total 1977-1985[d]
	1976/77	1978	1982	1985	1976/77	'78/'82	1985	1976/77	1978	1982	1985	1976/77	'78/'82	1985	1976/77	1978	1982	1985	
Country Data - Oil																			
URR (Mn barrels)[e]	7,500	7,500	7,500	7,500	-	-	-	365	365	365	365	-	-	-	7,865	7,865	7,865	7,865	7,865
Proven Reserves (Mn barrels)	2,138	2,138	2,960	3,780	-	-	-	-	-	50	100	-	-	-	2,138	2,138	3,010	3,880	3,880
Production (Mn barrels)	78	90	133	217	-	-	-	-	-	13	15	-	-	-	78	90	146	232	1,388
Consumption(Mn barrels)	230	249	334	422	-	-	-	10	10.5	13	15	-	-	-	240	260	347[a]	437[b]	2,890
Investment ($ Million)	-	-	3,000[a]	1,300[b]	-	-	-	-	-	250[a]	100[b]	-	-	-	-	-	3,250[a]	1,400[b]	4,650
Country Data - Gas																			
URR (10^9 cft)[e]	57,965	57,965	57,965	57,965	-	-	-	2,895	2,895	2,895	2,895	-	-	-		59,950	59,950	59,950	59,950
Proven (10^9 cft)	27,520	27,520	29,720	29,720	-	-	-	-	-	290	580	-	-	-		27,810	30,300	30,300	30,300
Production (10^9 cft)	255	278	1,400	1,665	-	-	-	-	-	73		-	-	-	255	278	1,473	1,810	9,212
Consumption (10^9 cft)	255	278	1,200[a]	1,465[b]	-	-	-	-	-	73[a]		-	-	-	255	278	1,273[a]	1,610[b]	8,076
Investment ($ Million)[c]	-	-	300[a]	250[b]	-	-	-	-	-	120[a]	130[b]	-	-	-	-	-	420[a]	380[b]	800

/ Refer to totals including FY77 to FY82
/ Refer to totals including FY83-FY85
/ Refers to investment in non-associated gas in Bangladesh and Pakistan, the gas utilization is for local consumption and therefore excludes any investment in development and production for exports.
/ Refer to totals including 1977 to 1985
/ Excludes deep offshore and undiscovered giant fields

Table 5 EUROPE, MIDDLE EAST AND NORTH AFRICA

REGIONAL SUMMARY

	GROUP A				GROUP B				GROUP C				GROUP D				REGIONAL SUMMARY				GRAND TOTAL
FY :	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	1977-85
Key Data - Oil																					
URR (mn barrels) e/	16,700c/	16,700c/	16,700c/	16,700c/					1,500	1,500	1,500	1,500	-	-			18,200	18,200	18,200	18,200	18,200
Proven Reserves (mn barrels)	9,725	9,725	11,500	13,250					-	-	150	150	-	-			9,725	9,725	11,650	13,400	13,400
Production (mn barrels)	247	280	530	645					-	-	-	-	-	-			247	280	527	637	4,315
Consumption (mn barrels)	315	338	470	570					25	26	38	45	-	-			340	364	508	615	4,300
Investments (1977 $ million)	-	-	8,750	5,000					-	-	200a,f/	200b,f/	-	-			-	-	8,950	5,200	14,150
Key Data - Gas																					
URR (10^9 cft) e/	20,015c/	20,015c/	20,015c/	20,015c/					900	900	900	900	-	-			20,915	20,915	20,915	20,915	20,915
Proven reserves (10^9 cft)	16,730	16,730	17,860	20,300					-	-	90	90	-	-			15,730	15,730	17,440	18,690	18,690
Production (10^9 cft)	189	212	422	595					-	-	-	-	-	-			189	202	422	595	3,160
Consumption (10^9 cft)	79	92	366	381					-	-	-	-	-	-			79	92	366	381	2,457
Investment ($ million)	-	-	525a/	220b/					-	-	-	-	-	-			-	-	525a/	220b/	745

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a/ Refer to totals including FY77-82

b/ Refer to totals including FY83-85

c/ Includes URR for Tunisia and Yugoslavia

d/ Non-associated gas projects only. Investment in associated gas is included in investment for oil development.

e/ Includes deep offshore and undiscovered giant fields.

f/ Exploration expenditures only.

Table 6 LATIN AMERICA AND CARIBBEAN

REGIONAL SUMMARY

	GROUP A				GROUP B				GROUP C				GROUP D				REGIONAL TOTAL				GRAND TOTAL[f]
FY :	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	76/77	78	82	85	1977-85
Country Data - Oil																					
URR (mn barrels)[e]	19,695	19,695	19,695	19,695	700	700	700	700	4,800	4,800	4,800	4,800	-	-	-	-	25,195	25,195	25,195	25,195	25,195
Proven reserves (mn barrels)	5,200	5,400	6,680	10,025	20	20	20	20	-	-	1,000	1,600	-	-	-	-	5,220	5,420	7,700	11,645	11,645
Production (mn barrels)	317	339	467	657	-	-	5	9	-	-	-	100	-	-	-	-	317	339	472	676	3,990
Consumption (mn barrels)	667	702	845[a]	980[b]	7	8	11[a]	15[b]	90	95	115	135[b]	-	-	-	-	765	805	971[a]	1,130[b]	8,495
Investments (1977 $ million)[c]	-	-	10,100[a]	9,650[b]	-	-	100[a]	100[b]	-	-	1,000[a,r]	1,000[b]	-	-	-	-	-	-	11,200[a]	10,750[b]	21,950
Country Data - Gas																					
URR (10^9 cft)[e]	50,015	50,015	50,015	50,015	2,075	2,075	2,075	2,075	14,450	14,450	14,450	14,450	-	-	-	-	66,540	66,540	66,540	66,540	66,540
Proven (10^9 cft)	22,150	22,400	26,450	31,230	-	-	200	200	-	-	2,000	3,500	-	-	-	-	22,150	22,400	28,650	34,930	34,930
Production (10^9 cft)	617	711	1,071	1,265	-	-	-	-	-	-	-	15	-	-	-	-	617	711	1,071	1,280	8,550
Consumption (10^9 cft)	600	706	930	1,075[b]	-	-	-	-	-	-	-	15	-	-	-	-	600	706	930[a]	1,080[b]	7,770
Investment ($ million)[d]	-	-	1,500[a]	950[b]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,500[a]	950[b]	2,450

a/ Refer to totals including FY77-82

b/ Refer to totals including FY83-85

c/ Includes associated gas development

d/ Non-associated gas projects only. Excludes LNG investment projects

e/ Excludes deep offshore and undiscovered giant fields

f/ Refer to totals including FY77-85

r/ Exploration expenditures only

METHODOLOGY OF THE ANALYSIS OF PETROLEUM RESOURCE BASE

1. To determine long-range supply prospects, it is necessary to have accurate estimates of the total amount of recoverable oil in a given country. Given the high degree of unpredictability of the actual location of petroleum deposits and technological limitations in the search techniques, it is not possible to locate all the remaining deposits.

2. Therefore, to appraise the long-range supply of oil and gas requires more than projections from present trends. The first step in analyzing long-range prospects of supply is to estimate the magnitude of the resource base, irrespective of economics of its exploitation and uncertainty of discovery. The second step is to categorize the resource base, subjecting it to various intervals of unit costs, in increasing order from present levels. This is necessary as technological developments and changing market conditions would allow the exploitation of certain resource categories which currently seem uneconomical. The third step is to divide the resource base according to certainty of occurrence. Improving exploration techniques and increasing knowledge of actual geologic conditions would allow incorporating into available supply some resources whose existence now is considered uncertain.

Model for Estimating Resource Base

3. The tools of mathematical statistics are employed to define more rigorously the problem of appraisal of petroleum resources. The magnitude of recoverable oil and gas of a given part of a region can only be given in probabilistic terms. It is *a priori* a probability density function of the recoverable amount of petroleum for an undrilled area. Such probability density functions are not known for areas such as Argentina's continental shelf and they can only be surmised.

4. Conceptionally, at a given time one can classify the remaining resources (R) as to the probability of being found with continued exploration. This probability, say p, is the product of the probability of existence of a field and of the probability of actually locating the undiscovered field. The undiscovered resources are classified as incremental quantities, d, corresponding to ranges of the probability p. Starting from resources that have a probability of eventually being found equal or greater than 80 percent but smaller than 100 percent (certainty), down to some low value of the probability, say 5 to 10 percent, the resource base say (U), could be defined as the expected value of the resources, that is, the integration of the incremental resource amounts multiplied by the probabilty of finding them:

$$U = \int pd\,R.$$

5. After this initial classification, the next step is to determine actual recoverable resources. Only a fraction of the segment of resources within a certain probability range, say between 60 to 100 percent, can be

considered to be economically recoverable depending on the conditions at the time of the assessment. However, the largest expected contribution to (U), the ultimate recoverable reserves, should come from resources with low probabilities of eventually being found. Nevertheless, gradual improvement of the picture can be attempted considering the past record of discovery as a basis for estimating parameters of theoretical statistical models.

6. To appraise the petroleum resource potential of new tracts of territory, the basic scheme involves various steps. After the sedimentary basins have been identified, a pre-drilling potential estimate is made, based on the following factors.

Pre-drilling Information

Area of basins
Maximum thickness of sediments
Existence of structural traps
Existence of stratigraphic traps
Reconstruction of geologic history
Oil or gas seeps
Adjoining petroleum provinces
Pre-drilling potential

The second phase starts with an exploratory drilling campaign and a post-drilling estimate of petroleum potential. The third phase resumes further geological and geophysical work and further drilling to determine development of oil potential.

Petroleum Potential of the Non-OPEC Developing Countries

7. Estimates for the major regions of the world, including continental shelves to a depth of 600 feet, having sedimentary areas with petroleum potential, are as follows:

World Prospecting Areas

Countries	Square Miles
Developed Economies	7,916,000
Latin America	4,890,000
Africa and Madagascar	4,722,000
South and Southeast Asia	2,993,000
Middle East	1,200,000
USSR	3,480,000
People's Republic of China	900,000
Total	26,101,000

Source: Geological Survey Bulletin 1411, p. 26.

8. The prospective petroleum areas in the non-OPEC developing countries account for more than 40 percent of the total prospective areas in the world; yet it currently produces only about 6 percent of the total world production. Because of the high degree of uncertainty involved in arriving at the probable magnitude of ultimate recoverable reserves, estimates of potentially available reserves vary widely. Mr. King Hubbert, of the US Geological Survey, recently reviewed the world's oil and natural gas resources for the US Congressional Research Service Study and selected a mean of eight recent projections of ultimate petroleum/gas reserves, including the studies by the oil industry, the National Academy of Sciences and the US Geological Survey 1975. Based on these studies, Hubbert estimated the mean of ultimate recoverable reserves of petroleum at 1,925 billion barrels. Of this, about 339 billion barrels have already been produced and another 567 billion barrels exist in the form of proven oil reserves. Hence, 906 billion barrels out of a total estimated resource base of about 2,000 billion barrels have already been discovered. The world, therefore, appears to be approximately halfway in its ultimate petroleum recovery.

9. According to Hubbert, ultimate recoverable reserves of natural gas are estimated at about 10,000 trillion cubic feet. Cumulative world production has been 1,507 trillion cubic feet and proven reserves are estimated at 2,174 trillion cubic feet. This leaves more than 6,000 trillion cubic feet of natural gas in the category of undiscovered recoverable resources of natural gas. While most petroleum geologists appear to agree with Hubbert's thesis on reserves, there are some who disagree. Notably, among them is Dr. Bernardo Grossling, a senior geologist at the US Geological Survey, whose figures for petroleum/natural gas are more than double those of the Hubbert figures. Nevertheless, it can be said that Hubbert's analysis of the resource base forms the lower bound for policy purposes as it is less speculative than other optimistic estimates. The interesting fact for non-OPEC developing countries is that, even if we base our supply prospects on the Hubbert analysis of the resource base, nearly 75 percent of potential petroleum resources in Latin America, 82 percent in Africa and 85 percent in Asia and the Far East remain to be discovered and developed.

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