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DEVELOPMENT AND INTERNATIONAL ECONOMIC CO-OPERATION; DEVELOPMENT
OF THE ENERGY RESOURCES OF DEVELOPING COUNTRIES

Energy exploration and development trends in developing countries

Report of the Secretary-General

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I, INTRODUCTION

1. In paragraph 4 of its resolution 40/208 of 17 December 1965, the General Assembly requested the Secretary-General to continue to undertake appropriate studies and analyses of trends in energy exploration and development in developing countries, with particular reference to the energy-deficient developing countries.
2. In its decision 41/439 of 5 December 1986, the General Assembly took note of the report of the Secretary-General on energy exploration and development trends in developing countries (A/41/383-E/1986/101), which contained data up to and including 1984.
3. The present report focuses on exploration and development activities in developing countries, with particular reference to the energy-deficient developing countries, especially after 1984.
4. Since the previous report of the Secretary-General, the full dimensions of the oil price collapse in 1986 and its subsequent stabilisation in 1987 at roughly half the level that had prevailed previously have become more obvious, particularly with regard to exploration and development trends,
5. Investments by national oil companies in the developing world have suffered in oil-exporting countries because of the existence of massive production over-capacities in several of the member countries of the Organisation of Petroleum Exporting Countries (OPEC) and the great reduction in foreign exchange revenues from oil sales in both the OPEC and the non-OPEC oil-exporting developing countries. In oil-importing developing countries, the expectation that savings on oil imports could be channeled to exploration and development of indigenous energy resources has hardly materialised because of their deep indebtedness and sluggish growth in a great number of countries,
6. Corporate cash flows have also been reduced substantially with consequent severe cutbacks in investments, particularly in exploration and development, again because of the current oil glut and fears of yet another oil price collapse to the low levels of \$6-9 a barrel reached in mid-1986. Such investments were further reduced by the financial failure of hundreds of independent oil corporations that had grown and prospered during the 1970s and the first half of the 1980s in North America, the North Sea and elsewhere because of the high oil prices and profitability prevailing then. The reserves and other assets of such corporations were purchased by the major oil and other financially secure corporations, which, in turn, have been undergoing a series of mergers and consolidations as well as a general withdrawal from non-energy business and reduction in their activities aimed at the development of alternative energy sources such as coal, nuclear power and new and renewable sources of energy.
7. Long-term investments were further affected by the stock market crash of October 1987 and subsequent fears of financial instability and low economic growth prospects.

8. **Costs of exploration and development in the petroleum industry have been reduced substantially. The financial squeeze has led to redoubled efforts to cut costs through retrenchment and technological advances that are already bearing fruit in a variety of areas, including previously high-cost offshore oil and gas developments.**

9. **Lower oil prices, however, have once again led to growth in oil demand since 1986 despite the modest performance of the world economy***

10. **It is now widely believed that world oil prices will be maintained in real terms at their current levels in the medium term and that any upward trend is unlikely to surpass the \$25-30 a barrel level (in constant 1987 dollars) by the year 2000, if the oil-exporting developing countries are to recapture their previous share of the oil market.**

11. **Under such a scenario, energy-deficient developing countries need to increase their efforts to invest in exploration and development of their indigenous energy resources because of the availability of potential resources, the relatively low cost involved and expectations for higher domestic and foreign demand for discoveries. Because of their difficult economic and financial conditions, however, such an effort will require, in addition to investments from national sources and foreign oil companies, financial and technical assistance from multilateral and bilateral sources if energy-deficient developing countries are to avoid increasing import bills for their energy requirements.**

12. **The present report includes the following: section II focuses on a brief analysis of energy consumption trends, which bring out the reliance of the developing countries on petroleum (oil and gas) as their premier source of commercial primary energy, and forecasts that these trends are expected to continue to the year 2000. Section III provides more comprehensive data than previous reports on petroleum exploration and development trends, with particular reference to licensed areas, seismic surveys and exploration and development drilling in the developing countries during the period 1982-1986. Production trends in coal, petroleum, primary electricity and new and renewable sources of energy are then briefly reviewed and a forecast to the year 2000 is provided. Section IV concentrates on the impact of lower oil prices on investments in exploration and development of petroleum and analyses changes in the structure of the petroleum industry that may affect such activities in the future, particularly in the**

- **energy-deficient developing countries, and concludes with a review of measures,**
- **specially revisions in exploration and development contracts between host Governments and oil corporations, in order to attract additional investments.**

Section V describes some new methods of energy financing, and section VI summarises the major findings of the report and provides suggestions for further action.

II, TRENDS IN ENERGY CONSUMPTION

13. As indicated in table 1 of the present report, the contribution of petroleum in the commercial primary energy consumption of the developing countries was 75 per cent in 1986, as compared to 69 per cent in the developed market economies and 50 per cent in the centrally planned economies,

14. Since 1976, the share of petroleum has dropped by 5 percentage points in the developing countries and 7 percentage points in the developed market economies; in the centrally planned economies it increased by 4 percentage points.

15. This shift in relative shares was due to growth in the contribution of coal in both the developing and the developed market economies as well as hydropower in the former and nuclear power in the latter countries. In the centrally planned economies it was due to the drop in the share of coal,

16. The significance of petroleum in the energy consumption of the developing world can better be appreciated by an analysis on a country basis.

17. In 1966, in the 13 countries of OPEC (Algeria, Ecuador, Gabon, Indonesia, Iran (Islamic Republic of), Iraq, Kuwait, the Libyan Arab Jamahiriya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates and Venezuela), oil and gas contributed 97 per cent to total energy consumption. The role of coal and hydropower was insignificant.

18. In another 13 oil-exporting developing countries (Angola, Brunei Darussalam, Cameroon, Colombia, Congo, Egypt, Malaysia, Mexico, Oman, Peru, Trinidad and Tobago, Tunisia and Zaire), over 90 per cent of primary energy consumption was also based on petroleum. Coal was significant 1/ in Colombia and Zaire, and hydropower 1/ in Cameroon and Zaire.

19. In 85 oil-importing developing countries, however, petroleum accounted for 60 per cent of primary energy consumption, with the share of coal at 33 per cent and that of primary electricity (mainly hydropower) at 8 per cent. Nevertheless, even in this group of countries, coal was significant only in 11 countries (Afghanistan, Burma, Chile, India, Malawi, Morocco, Mozambique, the Republic of Korea, Turkey, Zambia and Zimbabwe), and hydropower in another 11 countries (Bhutan, Brazil, Costa Rica, Ghana, Malawi, Nepal, Sri Lanka, Rwanda, Uganda, Zambia and Zimbabwe). On the other hand, 24 of these countries depended on petroleum for 100 per cent and another 41 countries for more than 80 per cent of their commercial energy consumption.

20. Average annual increases in oil consumption have been considerably higher in the developing countries than in the developed market economies because of the lack of alternative sources of energy, higher rates of growth in population, rapid urbanisation and, in some cases, comparatively rapid economic growth. Oil consumption increases were particularly high during the 1970s in OPEC member countries and other oil-exporting developing countries because of generally rapid development based on high oil exports and oil prices and low or subsidized prices of petroleum products for national consumption. Even in the oil-importing

developing countries, during the 1970s the average annual increase in demand was maintained at approximately 6 per cent, or more than four times the rate in the developed market economies.

21. In the first half of the 1980s, higher oil prices, as well as the impact of recession in many oil-importing developing countries, caused a drastic deceleration in the rate of increase of oil consumption to less than 1 per cent during the period 1981-1986. 2/

22. For the 10-year period prior to 1986 • x shown in table 2 below, the average annual growth rate in energy consumption in all the developing countries was 5.6 per cent, 7.3 per cent in member countries of OPEC, 5.8 per cent in other oil-exporting developing countries, and 4.9 per cent in oil-importing developing countries.

23. Incremental demand of about 36.9 million metric tons of oil equivalent during this 10-year period was met by: oil (176), coal (91), gas (77) and electricity (25) (see table 3 below).

24. Despite the higher rates of growth in coal and electricity consumption shown in table 3, it is still expected that the developing countries will remain dependent on petroleum as their premier source of commercial energy to the year 2000,

25. As pointed out in the Secretary-General's report to be submitted to the General Assembly at its forty-third session, entitled "Overall socio-economic perspective of the world economy to the year 2000", total energy consumption in the developing countries may be expected to increase by 4 per cent per year during the period 1966 to 2000. By the end of this period, the developing countries will be dependent on oil and gas for 50 per cent, coal 29 per cent, primary electricity (nuclear, hydro and geothermal) 13 per cent and other new and renewable sources of energy 7 per cent of their total energy requirements.

Table 1. Composition of commercial primary energy consumption
(Percentage)

		Coal	Oil	Gas	Electricity
Developed market • economies	1976	19.2	57.6	17.7	5.5
	1986	25.0	46.5	22.0	6.4
Centrally planned • economies	1976	52.3	29.3	16.0	2.3
	1986	48.0	23.3	26.4	2.3
Developing countries	1976	16.0	65.7	14.0	4.4
	1986	19.7	58.1	16.8	5.3
Member countries of OPEC	1976	1.2	65.3	32.1	1.5
	1986	1.5	64.1	32.7	1.7
Other oil-exporting countries	1976	6.8	70.7	18.3	4.2
	1986	5.3	73.0	17.7	4.0
Oil-importing countries	1976	24.5	64.2	5.8	5.5
	1986	33.3	50.0	9.1	7.6

Source: Department of International Economic and Social Affairs of the United Nations Secretariat, based on the Energy Statistics Yearbook, various issues.

Table 2. Growth of commercial primary energy consumption
in developing countries

(Millions of metric tone of oil equivalent)

	1976	1986	Annual increase per cent
All developing countries	505.9	674.4	5.6
Member countries of OPEC	110.0	223.1	7.3
Other oil-exporting countries	98.6	173.0	5.8
Oil-importing countries	297.2	478.3	4.9

Source: Department of International Economic and Social Affairs of the United Nations Secretariat, based on the Energy Statistics Yearbook, various issues.

Table 3. Growth of commercial primary energy consumption in developing countries a/ by source

(Millions of metric tons of oil ● quivalent)

	1976	1986	Annual increase (percentage)
<u>Coal</u>			
All developing countries	80.7	171.9	7.9
Member countries of OPEC	1.3	3.4	10.3
Other oil-exporting countries	6.7	9.2	3.2
Oil-importing countries	72.8	159.4	8.2
<u>Oil</u>			
All developing countries	332.4	508.5	4.3
Member countries of OPEC	71.9	143.1	7.1
Other oil-exporting countries	69.7	126.2	6.1
Oil-importing countries	190.8	239.2	2.3
<u>Gas</u>			
All developing countries	70.7	147.3	7.6
Member countries of OPEC	35.3	72.9	7.5
Other oil-exporting countries	18.1	30.7	5.4
Oil-importing countries	17.4	43.7	9.7
<u>Electricity</u>			
All developing countries	22.1	46.7	7.6
Member countries of OPEC	1.6	3.7	8.7
Other oil-exporting countries	4.2	6.9	5.1
Oil-importing countries	16.3	36.1	6.3

Source: Department of International Economic and Social Affairs of the United Nations Secretariat, based on the Energy Statistics Yearbook, various issues.

a/ Excluding China.

III. TRENDS IN ENERGY EXPLORATION, DEVELOPMENT AND PRODUCTION

A. Crude oil

26. Oil exploration and development trends during the first half of the 1980s were influenced by a variety of factors, including;

(a) Escalating prices during the 1970s from a low of \$1.30 a barrel at the beginning of the period to \$14.34 a barrel in January 1979 and \$36 a barrel by January 1981. Despite the drop to \$28 a barrel in 1985, most experts continued to forecast yet higher prices;

(b) Very sizeable economic rents in oil production because of the difference between costs and prices, which were appropriated either by host Governments in the form of special taxes and/or by the oil companies in high profits;

(c) Technological developments, including seismic survey techniques and computer application in seismic processing, secondary and enhanced oil recovery methods and techniques for additional production from existing fields and new technologies in offshore and frontier exploration and exploitation)

(d) Successful oil exploration efforts, some of which had been initiated during the low price period prior to the early 1970s in such areas as Alaska, Mexico, the North Sea and the Union of Soviet Socialist Republics;

(e) Increased cash flows and profitability for major oil companies and the entry of a great number of new corporations and capital from both the private and public sectors, especially from the developed market economies, but also by national oil companies in the developing world;

(f) Security of supply considerations including incentives from host Governments for exploration and development of indigenous resources;

(g) Policies of member countries of OPEC that apparently had accepted the role of swing oil producers, even in the context of decreasing world oil demand and a steadily decreasing market share, thus assuring males far discoveries in the rest of the world.

27. The above picture was radically changed with the oil price collapse of 1986, which was caused by the December 1985 agreement of the member countries of OPEC to seek an increasing share of the world oil market and their decision in December 1986 which restored price stability at \$18 a barrel.

1. Member countries of OPEC

28. In analysing exploration trends in the member countries of OPEC, it may be recalled that oil production in these countries, after reaching a high of 11.3 billion barrels in 1979 (47 per cent of world output), experienced a rapid decline beginning in 1980, which dropped to a low of 8.7 billion barrels

(27.5 per cent of world output) in 1965 and which could only be reversed somewhat in 1986 after the collapse of oil prices,

29. Lower world demand for OPEC oil during the period 1980 to 1985 led the member countries to resort to production cutbacks through the introduction of quotas in March 1963 that have since been revised repeatedly. 3/ As a result, most of the member countries of OPEC have been experiencing considerable over-production capacities, which, in total, have been estimated at about 6.6 billion barrels per annum (18 million barrels a day). 4/

30. While this picture of the situation in the OPEC member countries as a whole would indicate little need for additional exploration and development efforts, in fact national policies were, of course, determined by the particular situation of each of the countries involved. Factors influencing such activities have included expectations with regard to future national and export demand in relation to current and prospective reserves, availability of funds and technical capacities of national oil companies, and interest by foreign oil companies and strategies for negotiations in determining quotas within OPEC,

31. Despite the reduction in exploration and development efforts shown in table 4 below, the level of reserves in most of these countries has improved considerably in recent years, even with lower prices, because of either new discoveries or revision of previous estimates. As indicated in table 5, oil reserves of the member countries of OPEC increased by 36 per cent from 466.3 billion barrels in 1982 to 644.5 billion barrels in 1996. With the exception of Algeria, Indonesia and Nigeria, the other 10 countries registered an increase in their reserves during this period,

32. With increasing world oil demand since 1986, which is also expected to continue for the rest of the century, the strong position with regard to proved oil reserves of the member countries of OPEC, particularly in the Middle East, is even more significant in the context of production levels and expectation for additional discoveries in the rest of the world. With minor exceptions, all other countries have been producing at capacity and, in several cases, depleting their proved reserves. Furthermore, a recent study, after taking into consideration the totality of cumulative oil production, proved and inferred reserves and undiscovered resources, has projected declines beginning during the period 1987-1990 in Brazil, Colombia, Peru, the United Kingdom of Great Britain and Northern Ireland and the United States of America, during 1991-1995 in Argentina, Canada, Egypt and the Soviet Union, and during 1996-2000 in Australia, Brunei Darussalam and Malaysia. 5/

33. In such a scenario, unless unexpected surprises of giant oil discoveries materialize in the next few years, global oil demand will become increasingly dependent on supplies from the vast reserves of some of the member countries of

**Table 4 . Exploration and development indicators of
OPEC member countries a/
(1982-1986)**

Year	Licensed area (thousand sq km)	Seismic activity (line-km)	Exploratory drilling (number of wells)	Development drilling (number of wells)
1982	2 707	137 670	606 b/	2 705 b/
1983	2 565	128 554	474	2 032
1984	2 414	116 186	454	1 577
1985	2 178	101 923	358	1 224
1986	2 312	86 971	242	946

Source: World Petroleum Trends, 1987, Qetroconcultrnta (United Kingdom) Ltd.

a/ Accurate information and data on exploration and development in Iran (Islamic Republic of) and Iraq were not available for the period under review.

b/ Includes unusually high level of drilling in Venezuela owing mainly to the Orinoco tar belt for heavy oil,

**Table 5. OPEC oil reserves
(Millions of barrels)**

Country	1982	1983	1984	1985	1986	Per cent change 1982-1986
Algeria	9 440.0	9 220.0	9 000.0	8 820.0	8 800.0	-6.8
Ecuador	1 074.0	860.0	1 181.1	1 181.1	1 350.0	25.7
Gabon	481.8	547.3	518.1	677.5	733.0	52.1
Indonesia	9 550.0	9 100.0	8 650.0	8 500.0	9 000.0	-5.0
Iran (Islamic Republic of)	55 308.0	51 000.0	58 874.0	59 000.0	92 860.0	67.9
Iraq	59 000.0	65 000.0	65 000.0	65 000.0	72 000.0	22.0
Kuwait	67 150.0	67 100.0	92 710.0	92 464.0	94 522.1	40.8
Libyan Arab Jamahiriya	21 500.0	21 270.0	21 100.0	21 300.0	22 800.0	6.0
Nigeria	16 750.0	16 550.0	16 650.0	16 600.0	16 000.0	-4.5
Qatar	3 425.0	3 330.0	4 500.0	4 500.0	4 500.0	31.4
Saudi Arabia	165 320.0	168 847.5	171 710.0	171 490.0	169 179.9	2.3
United Arab Emirates	32 354.0	32 340.0	32 490.0	32 990.0	97 203.0	200.4
Venezuela	24 900.0	25 887.0	28 028.0	54 454.0	55 521.0	123.0
Total OPEC	466 252.8	471 051.8	510 411.2	536 976.6	644 469.0	38.2

Source: OPEC Annual Statistical Bulletin, 1986 .

2. Non-OPEC oil-exporting developing countries

34. While oil production in the member countries of OPEC had been declining during the period 1982-1986, as described above, because of their swing role in meeting world oil demand, production in other oil-exporting developing countries has been expanding; it increased from 2.7 billion barrels in 1982 to 3.3 billion barrels in 1986 (see table 6 below).

Table 6. Production of crude oil in developing countries
(Millions of barrels)

	1982	1983	1984	1985	1986	1987
All developing countries	10 075	9 648	9 832	9 679	10 460	10 408
Member countries OPEC	6 852	6 242	6 182	5 870	6 591	6 459
Other oil-exporting countries	2 747	2 854	3 031	3 149	3 195	3 292
Oil-importing countries	476	552	619	660	674	657

Source: Department of International Economic and Social Affairs of the United Nations Secretariat, based on Energy Statistics Yearbook for 1982-1986, and Oil and Gas Journal, 20 December 1987.

35. In a number of non-OPEC oil-exporting developing countries, exploration and development activities continued to expand, while the reverse was the case for the majority. Overall, licensed acreage, seismic surveys and exploration and development drilling declined during this period (see table 7 below).

Table 7. Exploration and development indicators in non-OPEC oil-exporting developing countries a/
(1982-1986)

Year	Licensed area (thousand sq km)	Seismic activity (line-km)	Exploratory drilling (number of wells)	Development drilling
1982	1 324	146 402	455	1 485
1983	1 222	121 461	369	1 310
1984	1 222	111 368	381	1 389
1985	1 106	127 528	406	1 128
1986	1 046	111 693	350	1 039

Source: World Petroleum Trends, 1987, Petroconsultants (United Kingdom) Ltd.

a/ Excluding China.

36. While exploratory drilling in Mexico remained unchanged, development drilling declined **considerably**.

37. Among the remaining countries, **significant** exploration and development continued in **Angola**, Colombia, Egypt, **Oman** and **Yemen**, which joined the rank of **exporters** at the end of 1987. In **China**, although **comprehensive** data are not available, **both exploratory** and development drilling have apparently **increased** and new acreage **awards** to **foreign oil companies** have included the first **onshore** permit.

38. Outside the member countries of OPEC, as reported in the previous report of the Secretary-General (see A/41/383-E/1986/101, table 4), exploration and development effectiveness was particularly high in the *non-OPEC* oil-exporting developing countries and there is no reason to believe that their situation has changed since then. However, some of these countries (for example, Egypt, Malaysia, Mexico and Oman) responded favourably in 1987 to the call of OPEC for oil production cutback, and during the first half of 1988 consultations took place with OPEC for co-ordinated reductions in output in order to stabilise oil prices. To what extent such plans may become effective in the future and their impact on future exploration and development investments, particularly by foreign oil corporations, remains to be seen.

3. Energy deficient developing countries

39. About 100 developing countries and territories are importers of oil, with 19 of them producing some of their requirements from indigenous resources and the remaining countries having no domestic oil production at all,

(a) Oil producing-importing countries

40. Oil production in these 19 countries (Argentina, Bangladesh, Barbados, Benin, Bolivia, Brazil, Burma, Chile, Côte d'Ivoire, Cuba, Ghana, Guatemala, India, Jordan, Morocco, Pakistan, the Philippines, Suriname and Thailand) increased from 476 to 674 million barrels between 1982 and 1986, but almost 90 per cent of that increase was due to only three of them, namely, Argentina, Brazil and India.

41. Overall exploration and development indicators in the oil producing-importing countries, as indicated in table 8 below, do not show any clear trend. Seismic activities, after a decrease in 1983 and 1984, have increased. Similarly, development drilling remained rather steady, but exploration drilling declined, especially in 1986.

Table 8. Exploration and development indicators in oil producing-importing developing countries
(1982-1986)

Year	Licensed area (thousand sq km)	Seismic activity (line-km)	Exploratory drilling (number of wells)	Development drilling (number of wells)
1982	3 397	196 873	705	1 748
1983	3 077	169 092	823	2 002
1984	3 869	168 786	699	2 115
1985	3 543	171 239	712	2 448
1986	3 578	194 552	570	2 270

Source: World Petroleum Trends, 1987, Petroconsultants (United Kingdom) Ltd.

42. In Argentina, Brazil and India, exploration, development and production of oil and gas have been historically under the exclusive control of their national oil companies, but in recent years, foreign oil companies have also become involved.

43. In Argentina, oil production declined from about 184,000 to 153,000 barrels per day during 1982-1986. Exploration and development drilling dropped in 1986. Argentina's national energy plan to the year 2000 aims at doubling the 1986 level of gas production and at a 30 per cent increase in oil production. The plan involves 3,000 exploratory wells, 18,000 development wells, and 800,000 kilometres of seismic liner, &/

44. In Brazil, oil production increased from 268,000 barrels per day in 1982 to 617,000 barrels per day in 1986. Exploration drilling dropped to 147 from 335 wells, but development drilling climbed to 992 from 371 wells between 1982 and 1986.

45. In India, exploration drilling more than doubled during the period, increasing from 68 wells in 1982 to 147 wells in 1986. Development drilling, however, dropped to 111 wells in 1986 from 120 wells in 1982 after reaching a high of 180 wells in 1983. Development drilling included a determined effort to increase oil output from existing fields through secondary and enhanced recovery techniques. Oil production increased from 144,000 barrels per day to 227,000 barrels per day during the period,

46. Because of growing oil demand at 7 to 8 per cent per year in recent years and expectations of continuing increases in the future, India's five-year plan for 1986-1990 provides for a tripling of exploration and development drilling by the end of the plan. Nevertheless, by the year 2000, India may have to rely on a much

higher level of oil imports of about 700,000 barrels per day, even though domestic production may increase to about 1 million barrels per day. g/

(b) Non-oil producing developing countries

47. In the group of 76 non-oil producing developing countries, 20 of them had some activity in petroleum exploration during the period 1982-1986, but it has been continually declining. This largely reflected a general slowing in the pace of acquisition of exploration acreage by international oil companies as well as the early relinquishments of acreage considered unprospective in view of the decline in oil prices (see table 9 below).

Table 9. Exploration and development indicators in non-oil producing developing countries
(1982-1986)

Year	Licensed area (thousand sq km)	Seismic activity (line-km)	Exploratory drilling (number of wells)	Development drilling (number of wells)
1982	2 278.0	41 239	44	0
1983	1 808.5	50 402	33	0
1984	2 057.0	33 095	23	4 a/
1985	1 985.5	24 784	34	13 b/
1986	1 842.4	30 148	18	24 b/

Source: World Petroleum Trends, 1987, Petroconsultants (United Kingdom) Ltd.

a/ Development well completed in the Sudan, however no production was scheduled.

b/ Development wells completed in Yemen, which became an oil field in 1987.

48. The sharpest decline in exploration activity took place in this group of countries. African countries with unproven petroleum potential were affected the most. In those African countries in which exploration activity took place in 1986, fewer wells were drilled and only five exploratory wells were completed in three countries, all of which proved to be dry, down from 16 exploratory wells drilled in seven countries in the previous year.

49. Exploration acreage under licence in those African countries continued to decline, with the total area down by about 10 per cent in 1986 from 1985, continuing a downward trend in which overall licensed acreage has declined by about 23 per cent between 1982 and 1986. However, licensing activity continued to take place in 1986 in several of those countries with awards announced or acreage opened for bids. Now acreage was awarded for the first time in Zambia, while in Ethiopia and Seychelles • offered failed to attract any bids. Additional permits were granted in Kenya and Somalia and significant right-holding changes also took place in the United Republic of Tanzania. Acquisition of exploration acreage in those countries reflects continued interest in the entire East Africa rift area, where an increase in exploration drilling is expected, especially in those countries that had extensive seismic data acquisition programmes. However, substantial decreases in exploratory right-holdings were reported from Mali, Sierra Leone, Liberia, Togo and Madagascar, while Senegal reported increases in exploration acreage over the previous year.

50. In Asia, exploration licensing activity in Papua New Guinea increased significantly, with 14 new exploration permits being awarded since January 1986. The discovery of oil in 1986, with recoverable reserves estimated at 400 to 600 million barrels, indicated that Papua New Guinea could become an exporter in the 1990s. In Nepal, of 10 exploration blocks offered in 1985, only 1 block was taken and the first seismic survey was conducted in late 1986. Exploration drilling has never been attempted in Nepal but the operator of the block was committed to drill a well by mid-1990. Further seismic surveys in Nepal were to be carried out by Petro-Canada under a three-year seismic exploration programme.

51. A number of Latin American countries of the group, Belize, Guyana and Honduras, opened up exploration acreage to international oil companies in 1986. Belize called for bidding in early 1986, for 11 onshore and offshore blocks. Licensed acreage in Belize increased in 1986 with 10 companies or groups holding 13 licences totalling about 24,300 sq km in 1985. However, there was no exploration activity carried out in 1986.

52. In Guyana, negotiations were being conducted on an application for an exploration permit in the continental shelf area. In Honduras, it was reported that three onshore leases were being held by three companies and reconnaissance surveys were conducted.

B. Natural gas

53. Natural gas has often been the by-product of petroleum exploration and development. Indeed, much of the natural gas produced in the developed countries is associated with oil.

54. Nevertheless, natural gas reserves and potential resources contain as much energy as oil in the developing world. However, known gas prone areas and countries have often been avoided by explorationists, since markets were difficult to develop because of high investment requirements in transportation and distribution systems.

55. The development of liquefied natural gas (LNG) technologies in the past 20 years and their use for exports of Algerian and Libyan gas to Western Europe and gas from Brunei and Indonesia to Japan have given rise to a number of planned projects. While export demand appears saturated at present, especially in Western Europe because of gas discoveries in the North Sea and a significant expansion of Soviet exports, much will depend in the future on the viability of coal-fired and nuclear power plants and choices made for both economic and environmental considerations, as well as a general economic development in other sectors.

56. As already indicated (see table 1 above), gas consumption has increased considerably in the developing countries; similarly with gas production, as shown in table 10 below,

Table 10. Production of natural gas in developing countries

(Million cubic metres)

	1982	1986
All developing countries	174 409	234 076
Member countries of OPEC	74 291	120 927
Non-OPEC oil-exporting countries	67 346	66 284
Oil-importing countries	32 772	47 665

Source: Department of International Economic and Social Affairs of the United Nations Secretariat, based on the *Energy Statistics Yearbook*, various issues.

57. Investment constraints in gas development and utilisation in recent years have eased somewhat, because of the willingness of transnational oil corporations to participate in exchange for competitive pricing and liberalisation of exchange controls in developing countries (for example, Egypt and Pakistan). Multilateral financial agencies have also been playing an increasing role in this sector,

C. Coal

58. Coal production in the developing countries increased from 761 to 991 million tons between 1982 and 1986 (see table 11 below).

Table 11, Production of solid fuels in developing countries
(Millions of metric ton of coal ● equivalent)

	1982	1986
All developing countries	761	991
Member countries of OPEC	1	3
Other oil-exporting countries	619	809
Oil-importing countries	141	179

Source: Department of International Economic and Social Affairs of the United Nations Secretariat, based on the Q ,

59. China is by far the most important coal producer in the developing world with its output of 613 million tons in 1986, accounting for 62 per cent of the total.

60. Among the oil-exporting developing countries, in addition to China, only Colombia expanded its coal output during the period from about 5 million to 10 million tons.

61. In the group of oil-importing developing countries, India increased coal production from 109 million tons in 1982 to 140 million tons in 1986. Other important producers include Brazil, the Republic of Korea and Zimbabwe.

62. The future of coal production in China and India appears promising because of the magnitude of their indigenous reserves and resources. In a number of other developing countries, considerable effort is also made to develop even relatively small reserves for domestic demand and exports. In recent years, in addition to Colombia, Indonesia and Venezuela have also entered the export market. However, the prevalent optimism expressed during the period of high energy prices that imported coal could be used widely, especially in oil-importing developing countries for electricity generation and other uses (for ● example, cement plants), has not materialized because of a variety of factors, including economic recession in many developing countries, costs of infrastructure, upfront heavy capital investment requirements, and, perhaps most important, declining oil prices. In this context it may be noted that contrary to the ● experience of the developed market economies, where residual fuel oil consumption decreased from 8 to 4 million barrels per day between 1970 and 1986, in the developing countries it increased from 1.3 to 2.8 million barrels per day during the same period, 10/

D. Primary electricity

63. Among sources of primary electricity in the developing world hydropower is by far the most important,

64. Since 1970 world production of hydroelectricity has almost doubled from 1,160 billion kilowatt hours (kWh) to 2,014 billion kWh in 1986. Out of this increase of 846 billion kWh, 397 billion kWh was added in the developing countries, 299 billion kWh in the developed market • $\text{M}\square\text{E}\square\text{O}\text{K}\square$ and 138 billion kWh in the centrally planned economies.

65. Since 1982, developing countries have added 114 billion kWh, as indicated in the following table.

Table 12, Production of hydroelectricity
(Billion kilowatt hours)

	1982	1986
All developing countries	470	584
OPEC member countries	28	43
Other oil-exporting countries	144	180
Oil-importing countries	298	361

Source: Department of International Economic and Social Affairs of the United Nations Secretariat, based on the Energy Statistics Yearbook, various issues.

66. Several developing countries participated in this increase in hydropower.

67. In the member countries of OPEC, Venezuela was by far the most important, but significant expansions also took place in Ecuador and Indonesia.

68. In the non-OPEC oil-exporting developing countries, China accounted for more than half of the output, but other important producers included Colombia, Egypt, Mexico, Peru and Zaire.

69. In the oil-importing countries, Brazil dominated the picture with half of the output; other important producers included Argentina, Chile, India, Pakistan, Turkey and Zambia.

70. In 1986, the developing world produced 29 per cent of the world's hydroelectricity. Unlike the developed market economies, however, only a small part of their hydropower potential has been exploited, mainly because of lack of markets near the sites and a variety of other factors, including the lack of capital and of regional co-operation.

71. Recent advances in superconductivity with their promise of eliminating transmission losses, once out of the laboratories and into practical applications, may offer new opportunities for intensified utilization of this energy potential of the developing countries, especially at the subregional and regional levels.

72. Nuclear power has been a disappointment in the developing countries since its early hopes that it would "provide electricity too cheap to meter".

73. By 1985, out of a total of 350 nuclear power plants in operation in the world only 19 were in the developing countries, namely, Argentina (2), Brazil (1), India (5), Republic of Korea (4), Pakistan (1), and Taiwan (Province of China) (6).

74. In addition, 19 plants were under construction in: Argentina (1), Brazil (2), China (1), Cuba (2), India (6), Iran (Islamic Republic of) (2), and Republic of Korea (5), out of a total of 175 in the world. At the same time, orders were being considered for 12 new plants in: Brazil (2), China (4), Egypt (2), India (2), the Philippines (1) and Turkey (1). 11/

75. In the aftermath of the accident at Chernobyl in the Soviet Union, in April 1986, several of the plants under consideration for new orders have been postponed or cancelled.

76. For economic and safety considerations, the future of this source of electricity in the developing countries remains problematic and all alternatives may be expected to receive very careful evaluation in the future on the basis of realistic price projections of conventional fuels and costs of nuclear power, including decommissioning and disposal of radioactive wastes. 12/

E. New and renewable sources of energy

77. As stressed in the Secretary-General's report to the Committee on the Development and Utilization of New and Renewable Sources of Energy at its fourth session (A/AC.218/15), the current abundant energy supplies pertain to the commercial sector of the global energy economy. The rural sector in developing countries, which relies heavily on traditional sources of energy, continues to be largely disconnected from international energy markets and does, therefore, not benefit from current relatively easy supply conditions of commercial sources of **energy**. Instead, traditional sources of energy, especially those based on biomass, are seriously depleted. This demonstrates the importance of new and renewable sources of energy in developing countries.

78. The share of new and renewable sources of energy consumption in developing countries remained largely unchanged during the period 1981-1985, but they

contributed about 30 per cent of total energy consumption, 57 per cent in Africa, 38 per cent in Latin America and 20 per cent in Asia and the Pacific. Hydropower contributed 55 per cent and fuel wood (including charcoal) 38 per cent of all new and renewable sources of energy (see table 13 below).

Table 13, Energy consumption in developing regions, 1981 and 1985

(Millions of metric tons of oil equivalent)

	<u>Africa</u>		<u>Latin America and the Caribbean</u>		<u>Asia and the Pacific</u>		<u>Total</u>	
	1981	1985	1981	1985	1981	1985	1981	1985
Petroleum	51	61	205	197	290	348	546	606
Natural gas	14	16	57	65	49	74	120	155
Coal	5	5	16	20	434	595	455	620
Nuclear energy	0	0	1	2	4	14	5	18
Renewable energy	93	109	143	176	226	266	442	551
Total	163	191	422	460	1 003	1 297	1 588	1 948

source : "Implementation of the Nairobi Programme of Action for the Development and Utilisation of New and Renewable Sources of Energy": report of the Secretary-General (A/AC.218/15), 25 January 1988.

79. The report of the Committee on the Development and Utilisation of New and Renewable Sources of Energy, which will be submitted to the General Assembly at its forty-third session, contains a full evaluation of progress made in this field. 13/

F. Forecast to the year 2000

80. As indicated in table 14 below, production of energy in the developing countries in 1986 was in aggregate equal to production in the developed market economies. However, by the year 2000, energy production in the developing countries is expected to increase at a much faster rate than either in the developed market and in the centrally planned economies. A little less than half of this additional production is expected to derive from additional supplies of oil and gas, particularly from available over-production capacities in the member countries of OPEC.

Table 1 4 . World primary energy production in the year 2000

(Millions of barrels of oil equivalent per day)

	1 9 8 6	2 0 0 0
Developed market economies		
Coal	20.0	21.0
Oil	14.3	11.0
Natural gas	12.1	12.0
Nuclear power	5.1	10.0
Renewable energy ^{a/}	5.6	10.0
Total primary energy	57.1	64.0
Centrally planned economies		
Coal	16.0	19.0
Oil	12.7	13.0
Natural gas	11.5	14.0
Nuclear power	2.4	7.0
Renewable energy ^{a/}	1.8	4.0
Total primary energy	44.4	57.0
Developing countries		
Coal	15.1	23.0
Oil	29.1	50.0
Natural gas	4.2	13.0
Nuclear power	0.4	1.0
Renewable energy ^{a/}	9.6	16.0
Total primary energy	56.4	103.0

Source: Department of International Economic and Social Affairs of the United Nations Secretariat, based on the report of the Secretary-General to be submitted to the General Assembly at its forty-third session entitled "Overall socio-economic perspectives of the world economy to the year 2000".

^{a/} Modern renewable sources only (e.g. hydropower, geothermal, etc.).

IV. INVESTMENTS AND CHANGES IN PETROLEUM INDUSTRY STRUCTURES

81. Comprehensive data on capital investments in petroleum in the developing countries are not available. Some indication of investment trends, however, is provided by actual expenditure of national oil companies and investments by transnational oil corporations.

82. With regard to transnational oil corporations, lower oil prices since the early 1980s have led to a downward trend in investments in petroleum exploration and production. The impact was particularly severe in 1986 because of the oil price collapse of that year. Despite the relative stability of 1987, uncertainties and fears of yet another oil price collapse, coupled with the world financial instability and its effects on oil corporations, have worked against a definite resumption of petroleum investments world wide. As indicated in the World Economic Survey 1988, 14/ oil exploration expenditures by the seven major oil companies from the United States and Western Europe (British Petroleum, Exxon, Gulf Oil, 15/ Mobil, Royal Dutch/Shell, Chevron, Texaco) decreased to \$4.9 billion in 1986 from \$9.2 billion in 1982; investment in production fell from \$19.6 billion to \$11.3 billion during the same period.

83. Similarly, capital expenditures of United States companies abroad have also been reduced substantially since 1982, as indicated below in table 15.

Table 15. Capital expenditures on petroleum by majority-owned foreign affiliates of United States companies, 1982-1988

(Millions of dollars)

	Actual expenditure					Latest plans	
	1982	1983	1984	1985	1986	1987	1988
Developed market economies	11 437	8 939	8 926	8 733	6 055	6 039	6 261
Australia	678	538	435	327	534	536	505
Canada	3 380	2 375	2 547	2 665	1 488	1 650	1 922
Western Europe	7 252	7 670	5 822	5 626	3 829	3 661	3 654
Developing countries	8 270	6 466	4 928	4 620	3 297	3 252	3 547
Latin America	1 915	996	822	950	720	619	628
Africa	2 350	1 778	1 368	1 421	925	918	965
Middle East	638	661	571	437	297	236	234
Asia and the Pacific	3 368	3 032	2 166	1 813	1 354	1 479	1 720
Total	20 760	15 915	14 124	13 673	9 606	9 482	10 010

Source: Department of International Economic and Social Affairs of the United Nations Secretariat, based on the report by Ellen M. Herr entitled "Capital expenditures by majority-owned foreign affiliates of U.S. Companies, 1906 and 1917", Survey of Current Business (Washington, D.C., United States Department of Commerce, October 1986 and September 1987), and loc. cit., 1987 and 1988.

84. Investments in the developing countries fell from \$8.3 billion in 1982 to only \$3.3 billion in 1986. Among the developing **countries**, the main recipients were exporting countries such as Colombia, Ecuador, Egypt, Indonesia, Malaysia, Nigeria, Peru, Trinidad and Tobago and the United Arab Emirates.

85. The stabilization of oil prices in 1987 and expectations that any declines would be of short duration have led to some increases in investment plans, but their levels remain considerably lower than pre-1986 efforts.

86. In the energy deficient developing countries, investment plans by national oil companies have remained relatively strong, perhaps because of their severe oil import bills during the 1974-1985 high oil price period, their expectation of high rates of growth of petroleum demand in their economies in the future, the lack of alternative energy sources, and expectations of higher prices once the current oil glut on the world markets may reach scarcity levels once again.

87. In Argentina, the national energy plan calls for investments of \$25 billion by the year 2000. 16/

88. In Brazil, Petrobras was planning to increase its annual exploration and production budget from \$2.31 billion in 1986 to \$3.3 billion by 1989. 17/

89. Similarly, India's 1986-1990 plan provides for investments of \$12.6 billion, of which \$10.6 billion would be devoted to exploration and development. 18/

90. The implementation of these plans, in addition to the mobilization of domestic financial resources will require access to the international capital markets and further financing from multilateral and bilateral sources.

91. A brief analysis in the World Economic Survey 1988 focuses on recent and prospective changes in the structure of the world petroleum industry that require monitoring and evaluation with respect to their eventual impact on supplies and prices. 19/ Similarly, lower oil prices and the instability of the financial markets have already led to a considerable number of oil company mergers and consolidations and this trend is expected to continue. This may have a considerable impact on exploration and development in the developing countries, particularly because of the financial shake-up of so many independent oil companies. Such companies had met with success, especially in North America and the North Sea during the high oil price period, and had begun an expansion in several developing countries in competition for new acreage with major oil companies. Their reduced number and financial capacity as well as their contribution to competition is bound to influence conditions in host countries.

92. Changes in policies of member countries of OPEC, which, since 1986, have aimed at increasing their share of the oil market, may also attract additional interest by the oil companies because of their demonstrated exploration effectiveness, possibilities of additional export volume in a growing market and well established relationships in existing exploration and development agreements. Such a possibility may be further extended to those member countries of OPEC which had nationalized operations in the past because of new relationships exemplified by

joint ventures in downstream investments (refining and marketing) between oil companies and member countries of OPEC,

93. In view of the lower corporate cash flows and the lower level of oil prices **as** well as changes in the structure of the petroleum industry already mentioned, non-OPEC oil exporting and energy deficient developing countries have generally been revising the conditions of long-term exploration and **development agreements** with oil companies in order to attract investments.

94. Incentives, which have been incorporated in such revisions, have focused on:

(a) Acceleration of cost recovery:

(b) Increase in the share of oil output to the oil company after recovery of costs:

(c) Lower participation rights of host Governments after discoveries are made:

(d) Lower tax rates, including royalties:

(e) Reduction or removal of oil price **controls**, especially for oil sold in the domestic market of the host Government;

(f) Foreign exchange liberalization;

(g) Reduction in training requirements for local personnel;

(h) **Commercialization** of gas discoveries through competitive pricing;

(i) Reductions in drilling obligations where exploration does not appear promising.

95. Several developing countries have instituted a variety of these revisions including Angola, Argentina, Brazil, Egypt, India, Indonesia, Liberia, Malaysia, Morocco, Nepal, Nigeria, Peru, the Philippines, Seychelles, Sri Lanka, Trinidad and Tobago and Tunisia. Other developing countries enacted new legislation which in effect revised previous conditions. **20/**

V. **NEW METHODS AND SOURCES OF ENERGY FINANCING**

96. In the energy sector, traditional sources and methods of financing in the developing countries have varied according to special considerations for each source, including its capital intensity, ownership and marketability of output in either domestic or foreign markets.

97. In the primary electricity sector and new and renewable sources of energy, financing has mostly been through the investment of public funds through government agencies that, in addition to their own resources, have borrowed from the international capital markets as well as bilateral and multilateral financial

institutions, including credits from equipment manufacturers quite often with assistance from export credit guarantee organizations of the developed market

• 1990-1991 •

98. Because of the recession in so many of the developing countries and their deep indebtedness in the past few years, such financing has become more problematic and some new methods have been under consideration.

99. In the electricity sector, for example, it has been reported that Turkey has decided to go ahead with three coal-fired power plants of an aggregate capacity of 2,460 MW to be constructed under Build-Own-Transfer (B.O.T.) agreements. Under this formula, foreign contractors raise the funds for a particular project, build it, and operate it for a specific period - probably 10 or 15 years - until investments are recovered. Afterwards, ownership is transferred to the host country. The Government of Turkey has also considered the construction of 50 hydroelectric projects and a nuclear power plant under similar arrangements. 21/

100. In view of severe power shortages and expectations of high rates of growth of electricity demand, such new arrangements may be expected to expand in the future, because of the difficult financial situation of public utilities in many developing countries. Foreign private sector participation, particularly in electricity supply based on new and renewable sources of energy, particularly for decentralised systems, has also been suggested as another possibility, which might also include debt swaps in view of the relatively large local currency reparation involved. 22/

101. Coal development has received investments of public funds as the electricity sector in some countries (for example, India), but in others transnational corporations have been active in a few cases (for example, Colombia and Indonesia).

102. In petroleum, as indicated previously, the main sources of financing continue to be national oil companies and transnational oil corporations with additional funds coming from some bilateral and multilateral sources. As far as the latter are concerned, the contribution of the World Bank, including the International Development Association and the International Finance Corporation, remains crucial in a number of countries.

103. A few developing countries have also adopted novel measures with the objective of increasing their own funds to be devoted to exploration and development. In the past, Mexico had a special gasoline tax that was used for this purpose and, more recently, the Republic of Korea established a Petroleum Business Fund that has been financed with surcharges, particularly on crude oil imports. Financial arrangements from this Fund have been used in order to encourage firms of the Republic of Korea to participate in foreign oil development ventures. 23/

VI. CONCLUSIONS AND SUGGESTIONS FOR FURTHER ACTION

104. The energy crises of the 1970s have been followed by the abundance and even surplus capacities in energy supplies of the 1980s. Yet, the current state of affairs has been reached in an antagonistic manner through massive investments in high-cost energy sources and by conservation and more efficient energy utilisation. The global energy situation at present is characterised by the unused oil and gas production capacities, especially of the member countries of OPEC, while higher cost energy sources are developed and used in the developed market and the centrally planned economies. Furthermore, some of these energy sources are more deleterious to the global environment.

105. The energy deficient developing countries, however, have not been able to adjust to the changes in the global energy situation, mainly because of their lack of financial resources and technologies. Their energy import bill, although much lower at present than in the 1980-1985 period, still weighs heavily on their total foreign exchange. With increased mobilisation of their limited capital and increased assistance from both bilateral and multilateral sources, they have been able to expand their exploration and development efforts for indigenous energy sources but only a few of them have been successful enough to decrease their import dependence despite their sluggish economic expansion, which resulted in unusually low growth rates of their energy demand.

106. Higher oil prices had attracted investments from the transnational oil corporations as well as a growing number of independent oil corporations and national oil companies from the developed world. Lower oil prices, however, have already resulted in an investment slump and a reduction in the number of possible investors for the future.

107. A few developing countries, more fortunate in their economic development performance in recent years, have been able to maintain and even plan for increases in their energy development efforts. Others have been revising the conditions for investments in all energy sectors with the hope of increased financial flows in their direction.

108. With a resumption of economic growth in the developing countries, their energy demand is expected to grow at a higher rate than in the developed countries and the import dependence of oil-importing developing countries will become even more pronounced. This is likely to happen during the next decade when it is expected that world energy demand, especially for oil, will once again increase the role of oil-exporting countries with possible pressures for higher prices in the absence of international co-operation between producers and consumers. In this connection, there is a continuing need for international co-operation in order to ensure stability in energy investments, production and consumption patterns, and the role of the United Nations in promoting such co-operation deserves serious consideration.

109. In view of the current situation and energy prospects to the year 2000, the need for special measures to assist energy deficient developing countries in their energy exploration and development efforts remains important. A possible avenue for international co-operation in this crucial field can start at the forty-third

session of the General Assembly, which may wish to recommend the formulation of a comprehensive programme of action for the energy deficient developing countries in order to accelerate their exploration and development of indigenous energy resources. Such a programme might be initiated with the co-operation of interested Governments, through a country-by-country survey of available energy projections and plans to the year 2000. The results of such a survey, and their implications for increased energy self-reliance, could then be submitted to the General Assembly at its forty-fifth session for further consideration.

Notes

- 1/ Above 10 per cent of national commercial primary energy consumption.
- 2/ World Economic Survey 1988 (United Nations publication, Sales No. E.88.II.C.1), table V.3, p. 85.
- 3/ World Economic Survey 1988 (United Nations publication, Sales No. E.88.II.C.1), table A.III.14, p. 171.
- 4/ Fadhil G. Al-Chalabi, "The causes and the implications for OPEC of the oil price decline of 1986", OPEC Review, spring 1988, p. 2.
- 5/ Joseph P. Riva, Jr., "Oil distribution and production potential", Oil and Gas Journal, 18 January 1988, p. 58.
- 6/ World Economic Survey 1987 (United Nations publication, Sales No. E.87.II.C.1), p. 106.
- 7/ World Economic Survey 1988 (United Nations publication, Sales No. E.88.II.C.1), p. 87.
- 8/ Financial Times, 5 August 1986, p. 3.
- 9/ Oil and Gas Journal, 15 February 1988, p. 24.
- 10/ World Economic Survey 1988 (United Nations publication, Sales No. E.88.II.C.1), table V, 4, p. 86.
- 11/ International Nuclear Reactor Hazard Study, report prepared by Greenpeace (Hanover, Gruppe Ökologie, September 1986), p. 51.
- 12/ United Nations, "The development of nuclear power in developing countries" (A/CONF.108/PC/22), report submitted to the Preparatory Committee for the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy, at its sixth session, Vienna, 1985.
- 13/ Official Records of the General Assembly, Forty-third Session, Supplement No. 36 (A/43/36).

Notes (continued)

14/ United Nations publication, Sales No. E.88.II.C.1, tables A.III.16 and A.III.17, p. 173,

15/ Gulf Oil merged with Chrvron in 1984.

16/ Financial Times, 5 August 1986, p. 3.

17/ Petroleum Economist, December 1986, p. 467.

18/ Oil and Gas Journal, 30 December 1985, p. 52.

19/ United Nations publication, Sales No. E.88.II.C.1, p. 88.

20/ World Petroleum Arrangements, 1987, The Barrows Company, Inc., United States of America,

21/ me. Wall Street Journal, 26 May 1987, p. 41, and Financial Times, 18 September 1985, 6.

22/ Philip C. Crurer, "An opportunity for OPEC in the alternative energy industry", OPEC Bulletin, May 1988.

23/ The Petroleum Industry in Korea, 1987, prepared by the Korea Petroleum Association, p. 17,
