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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, the General Assembly requested the Secretary-General to continue to undertake appropriate studies and analyses of trends in energy exploration and development, taking into account the activities of relevant organizations of the United Nations system in that field, including the results of the Joint United Nations Development Programme/World Bank Energy Sector Assessment Programme and the suggestions resulting from the symposia held, and to report to the General Assembly at its forty-first session, through the Economic and Social Council and its second regular session of 1986.

2. In response to the resolution, the present report provides an analysis of recent trends and future prospects in energy exploration and development in developing countries, with special emphasis on the energy-deficient developing countries. 1/

3. Information was submitted by the Department of Technical Co-operation for Development, the United Nations Centre on Transnational Corporations, the Centre for Science and Technology for Development, all the regional commissions, the United Nations Conference on Trade and Development and the joint UNDP/World Bank Energy Sector Programmes.

4. The activities entailed the preparation of studies, reports, maps and meetings on:

(a) Energy planning, including the application of microcomputer technology;

(b) Petroleum exploration and development contracts between host Governments and transnational corporations;

(c) Investment trends in the exploration and development of energy resources;

(d) Developments in new and renewable sources of energy in general or in specific sources such as hydroelectric, biomass and photovoltaic systems, geothermal energy and solar energy;

(e) Methods of exploring and developing coal and natural gas resources;

(f) Prospects of nuclear energy in developing countries;

(g) Evaluation of the potential of energy resources;

(h) Evaluation of the technological capabilities of developing countries in energy and the examination of technology transfer issues.

A number of workshops and symposia were held, in particular by the regional commissions.

5. With regard to the joint UNDP/World Bank Energy Assessment Programme, which was initiated in October 1980, by the end of 1985 field work had been completed in 61 countries and final reports had been issued for 50 countries. By the end of 1986, field work should be completed in an additional nine countries and reports issued for all 70 countries targeted in the Programme. More detailed information on the Programme and on the relevant activities of the United Nations system can be found in the annex to this report.

6. This is an especially appropriate time to take a fresh look at energy exploration and development in developing countries, given the 50 per cent decline in oil prices since 1985. If maintained for an appreciable period, the decline could profoundly affect both the level and geographical distribution of energy exploration and development activity. Indeed, early effects, in the form of cuts in exploration budgets and the implications of such cuts for global patterns of energy production, are already being felt.

7. It is, however, by no means clear that the price of oil has stabilized at the level at which it will average over, say, the next five years. As noted in World Economic Survey, 1986, 2/ the recent volatility of oil prices has once again focused world attention on the inherent instability of oil markets. Any forecast of trends has to be qualified with a great degree of caution. The outcome depends to a large degree on decisions by sovereign States with regard to restraints on future oil output and export levels.

8. The volatility in oil prices actually experienced in recent years and the fact that there is reason to anticipate further fluctuations engender uncertainty about the economic rewards and risks associated with investment in oil and gas. That uncertainty is bound to produce a decrease in the total investment in the sector to below what it would be in a more predictable environment. In addition, it is likely to skew the geographical pattern of investment in the industry away from energy-deficient developing countries, unless vigorous policy measures are taken by national Governments and also by the international community.

9. This report is organized as follows: section II contains the core of the analysis, describing exploration and development trends in developing countries in recent years. Special attention is paid to activities in oil-importing developing countries, and emphasis is placed on trends in the oil and gas sectors, since they account for nearly 80 per cent of total commercial energy consumption in developing countries. Section III considers new constraints and opportunities which may be provided by lower oil prices. Section IV contains some conclusions, especially with regard to the need for stability in world energy markets, continued financing of exploration and development of energy resources in the energy-deficient developing countries and improvements in the collection of information and data on exploration and development trends on a global basis.

II. EXPLORATION AND DEVELOPMENT TRENDS

A. Oil and gas

10. The analysis which follows focuses on the number of oil and gas exploratory well completions, which is the most important single measure of exploration activity. Drilling in 28 oil-exporting and 50 oil-importing developing countries is covered (see table 1). Pre-drilling activities such as geological and geophysical surveys, petroleum legislation, the establishment and organization of appropriate institutions, including national geological services and oil companies, are also important but are not covered here due to the lack of up-to-date, comprehensive and compatible data.

1. Overall exploration trends

11. Oil and gas exploratory drilling in the market economies has been growing at an average annual rate of 4.4 per cent during the past 15 years. The number of exploratory wells completed averaged 19,405 per annum during the 1980-1984 period, or almost twice the level (10,457) of 1970-1973 (see table 2). Developed market economies, in general, and North America, in particular, account for the largest - and increasing - proportion of exploratory wells drilled in the world. Because of the nature of mineral rights in the United States of America, more drilling is carried out per specific area there than in practically any other country. The combined share of North America and Western Europe was 92.2 per cent in the first half of the 1980s, up from 89.3 per cent in the early 1970s. Exploratory drilling in regions mainly composed of developing countries has also increased, especially after the second (1979-1980) rise in crude oil prices. However, with the exception of Western Asia, the share of the developing countries in the world total during the current decade is even smaller than before 1974. That applies to the member countries of the Organization of Petroleum Exporting Countries (OPEC) as well.

12. However, those trends have been affected by more recent events. Between 1982 and 1984, when the world petroleum industry was already experiencing lower crude oil prices and mounting supply surpluses, exploration activity in most regions was correspondingly affected, but in an uneven manner. The group of "other" developed market economies (see table 3) was the only one experiencing consistent increases in the number of exploratory wells. In contrast, the number of exploratory wells in Western Europe and the developing countries decreased during those years in question. The decline in exploratory wells drilled in North America and the developed market economies as a whole between 1982 and 1984 was rather moderate: 4.3 per cent and 5.3 per cent, respectively.

13. Unfortunately, comprehensive information on exploratory drilling is not as yet available on a world basis for 1985. However, preliminary figures indicate a decrease of 8.8 per cent in the United States of America, where the number of wells was 13,743, which was below the 1983 trough. Since the drastic decline in oil prices which began in the last quarter of 1985, there has been a further sharp drop in exploration. For example, the number of active drilling rigs in the United States fell to only 809 at the beginning of May 1986, as compared to a high of 4,530 in December 1981.

Table 1. Developing countries that produce oil and/or gas, by region, 1982-1984

Country or territory	Africa	Western Asia	South and East Asia	Latin America and the Caribbean	Other (Mediterranean)
Oil-exporting (28)	Algeria Egypt Libyan Arab Jamahiriya Tunisia Angola (and Cabinda) Cameroon Congo Gabon Nigeria Zaire	Bahrain Iran (Islamic Republic of) Iraq Kuwait Oman Qatar Saudi Arabia Syrian Arab Republic United Arab Emirates	Brunei China Indonesia Malaysia	Ecuador Mexico Peru Trinidad and Tobago Venezuela	
Oil-importing (102)					
Producing (26)	Morocco Ghana Ivory Coast Benin	Israel Jordan	Afghanistan Bangladesh Burma India Pakistan Philippines Taiwan, Province of China Thailand Viet Nam	Argentina Barbados Bolivia Brazil Chile Colombia Cuba Guatemala Suriname	Turkey Yugoslavia
Non-producing (76)					
Exploratory drilling in 1982-1984 (24)	Sudan Equatorial Guinea Guinea-Bissau Kenya Liberia Mali Niger Mauritania Senegal Sierra Leone Somalia Togo United Republic of Tanzania	Democratic Yemen Yemen	Fiji Republic of Korea Papua New Guinea	Belize Dominican Republic Guyana Jamaica Paraguay	Malta

Table 1 (continued)

Country or territory	Africa	Western Asia	South and East Asia	Latin America and the Caribbean	Other (Mediterranean)
No exploratory drilling recorded in 1982-1984 (52)	Botswana Burkina Faso Burundi Cape Verde Central African Republic Chad Comoros Djibouti Ethiopia Gambia Guinea Lesotho Madagascar Malawi Mauritius Mozambique Namibia Rwanda Seychelles Swaziland Uganda Western Sahara Zambia Zimbabwe		Bhutan Democratic Kampuchea Democratic People's Republic of Korea Kerguelen Is. Maldive Is. Nepal New Caledonia Palau Is. Solomon Is. Sri Lanka Tonga Vanuatu Western Samoa	Bahamas Costa Rica Dominica El Salvador French Guyana Grenada Haiti Honduras Netherlands Antilles Nicaragua Panama Puerto Rico Saint Lucia Uruguay	Cyprus

Source: Adapted, and updated, from John Foster, "Petroleum exploration and development trends in developing countries", paper presented to the United Nations Symposium on Financing of Petroleum Exploration and Development in Developing Countries, held at Athens, 22-27 April 1985 (IESA/P/SYMP/TP/8, 8 April 1985), tables 1 and 2.

Table 2. Oil and gas exploratory well completions in market economies, 1970-1984

Year	Total, market economies	North America	Western Europe a/	Latin America and the Caribbean b/	Africa	Western Asia c/	South and East Asia d/	Memo items	
								OPEC	North Sea
1970	10 544	9 230	159	574	263	72	246	350	66
1971	9 769	8 456	199	548	257	48	261	347	53
1972	10 540	9 172	210	542	223	81	312	379	51
1973	10 975	9 685	217	488	178	65	342	371	70
1974	11 699	10 354	243	503	191	70	338	398	92
1975	12 180	10 863	296	408	200	100	313	368	124
1976	12 959	11 715	272	441	162	120	249	320	109
1977	14 049	12 762	252	485	204	99	247	298	21
1978	15 248	13 821	297	412	201	122	395 e/	367	38
1979	14 315	13 409	325	..	204	..	377 d/	..	168
1980	16 965	15 773	..	494	207	88 f/	403	389	..
1981	20 191	18 242	507	1 033	284	..	125 f/	447 f/	135
1982	21 426	18 848	598	955	298	178 f/	549 e/	613 f/	201
1983	18 278	15 928	528	706	265	160 f/	691 e/	563 f/	220
1984	20 167	18 030	454	573	240	168 f/	702 e/	372 f/	125

Sources: American Petroleum Institute, Basic Petroleum Data Book, vol. VI, No. 1 (January 1986), table 13, sect. III; American Association of Petroleum Geologists, Bulletin (various issues).

Note: Two dots (..) indicate that the data are not available or are not separately reported.

a/ Includes Yugoslavia and some Mediterranean countries such as Malta.

b/ Excluding Cuba, owing to lack of detailed information.

c/ Includes all Middle East countries and Turkey.

d/ Excluding China and Viet Nam, owing to lack of detailed information.

e/ Includes Oceania.

f/ Complete data not available for all countries.

Table 3. Oil and gas exploratory drilling in market economies, 1982-1984

	1982			1983			1984		
	Number of wells	Average depth per hole (m)	Success a/ (Percentage)	Number of wells	Average depth per hole (m)	Success a/ percentage	Number of wells	Average depth per hole (m)	Success a/ percentage
Total, market economies	21 426	1 808	33.7	18 278	1 687	33.0	20 167	1 620	31.6
Developed market economies	19 589	1 757	33.8	16 630	1 606	32.8	18 755	1 556	31.5
North America	18 848	1 721	33.9	15 928	1 566	32.7	28 030	1 522	31.5
Western Europe	549	2 693	31.9	465	2 705	36.8	407	2 665	34.9
of which: North Sea	(201)	(3 029)	(36.3)	(220)	(3 133)	(39.5)	(125)	(3 361)	(38.4)
Others b/	192	2 565	26.7	237	2 112	28.1	318	2 038	24.2
Developing countries c/	1 837	2 482	32.7	1 648	2 526	35.1	1 412	2 470	33.8
Oil-exporting:	936	2 693	35.7	863	2 785	42.8	679	2 560	32.9
Africa	230	2 722	38.0	216	2 726	44.4	194	2 812	40.5
Western Asia d/	108	3 139	34.6	125	2 444	46.5	119	2 578	30.7
South and East Asia	238	2 051	33.5	290	2 093	43.4	246	1 905	25.0
Latin America and the Caribbean	360	3 725	35.4	232	3 853	35.9	120	3 756	32.5
Oil-importing:	901	2 313	30.4	785	2 248	27.0	733	2 393	34.4
Producing	848	2 276	31.0	752	2 245	25.9	707	2 388	35.5
Africa	26	2 716	30.4	12	2 084	0.0	14	2 703	42.9
Western Asia	17	2 718	11.8	12	2 398	16.7	11	1 480	9.1
South and East Asia d/	122	2 562	27.7	170	2 161	19.5	150	3 017	32.9
Latin America and the Caribbean	585	2 054	33.2	474	2 339	26.4	451	2 182	35.5
Others (Mediterranean)	98	2 194	23.4	84	1 887	33.3	81	2 412	42.0

Table 3 (continued)

	1982			1983			1984		
	Number of wells	Average depth per hole (m)	Success a/ (Percentage)	Number of wells	Average depth per hole (m)	Success a/ percentage	Number of wells	Average depth per hole (m)	Success a/ percentage
Non-producing	53	2 873	20.8	33	2 108	51.6	26	2 578	7.7
Africa	32	3 010	28.1	26	2 114	53.8	15	3 039	6.7
Western Asia d/	3	2 277	33.0	2	..	0.0	4	..	25.0
South and East Asia	7	2 136	0.0	5	2 074	40.0	5	2 032	0.0
Latin America and the Caribbean	10	2 920	10.0	--	--	--	2	1 407	0.0
Others (Mediterranean)	1	5 094	0.0	--	--	--	--	--	--

Source: American Association of Petroleum Geologists, Bulletin, vol. 69, No. 10 (October 1985); vol. 68, No. 10 (October 1984); vol. 67, No. 10 (October 1983); Oil and Gas Journal (various issues).

Note: Two dots (..) indicate that the data are not available. Two dashes (--) indicates that no activity has been reported.

a/ Ratio of producer (oil and/or gas) wells to exploratory wells drilled and completed in the year.

b/ Australia, Japan, New Zealand and South Africa.

c/ Comprising the 78 countries or territories classified and listed in table 1, except China, Cuba and Viet Nam.

d/ Complete data not available for most countries or territories. See also table 7.

2. Recent exploratory drilling activity in developing countries

14. After the 1979-1980 oil price increases, there were two to three years of renewed activity in oil and gas exploration in the developing world. Since 1982, however, exploratory drilling has subsided, with a drop of 23.1 per cent in the number of wells by 1984 (see table 3). The share of the developing countries in the world total thus fell from 8.6 per cent to 7.0 per cent between 1982 and 1984, or from 71.3 per cent to 66.1 per cent, if North America is excluded from that total. The decline occurred in spite of the higher exploration success ratio of the developing countries (see table 4).

Table 4. Oil and gas exploration effectiveness, 1975-1982

Region	Oil reserves per well (Millions of barrels)	Oil and gas reserves in oil equivalent per well (Millions of barrels)	Cost (1980 US dollars per barrel)
Developed market economies	0.24	0.61	4.95
Oil-importing developing countries	1.82	4.25	1.48
Oil-exporting developing countries	31.76	42.53	0.29

Source: C. R. Blitzer and others, "Oil exploration in the developing countries: poor geology or poor contracts?", Natural Resources Forum, vol. 9, No. 4 (November 1985).

15. During the 1970s and early 1980s State-owned corporations in developing countries had played a central role in the upsurge of exploratory drilling. About 50 per cent of the exploratory wells had been drilled by State-owned oil firms, 20 to 25 per cent by the major oil companies, 10 to 15 per cent by other large transnational oil corporations, 5 to 10 per cent each by independent oil companies and foreign State-owned corporations, and about 1 per cent by local private companies. 3/ The recent decline in exploratory wells appears to reflect not only falling oil prices but also the combined impact of adverse factors such as reduced investment capabilities of many State-owned oil corporations in developing countries because of overall fiscal and balance-of-payment constraints, a rise in costs resulting from operations in more difficult areas, higher capital costs and rates of interest, shortage of international private bank lending, stricter conditions for getting official bilateral and multilateral loans, and the preference of foreign investors for alternative uses of funds such as mergers, asset acquisitions etc.

16. A geographical breakdown of exploratory wells in the developing countries between 1982 and 1984 shows significant increases in the shares of South and East Asia (from 20 per cent to 28.3 per cent) and Western Asia (from 7 per cent to 9.5 per cent), as well as slight increases in the relative weights of African and Mediterranean countries. In contrast, the dominant share of Latin America and the Caribbean slipped considerably, from 51.9 per cent to 40.5 per cent.

17. The number of wells has decreased recently in both oil-exporting and oil-importing developing countries, but more so in the oil exporters whose share in total developing country exploratory wells fell between 1982 and 1984 from 51 per cent to 48.1 per cent. The corresponding share of oil and/or gas-producing oil importers increased from 46.1 per cent to 50.1 per cent. The small participation of non-producing oil importers was further reduced, from 2.5 per cent to 1.8 per cent.

18. Almost half of the developing oil-exporting countries are members of OPEC. As shown in table 2, there has been a decrease in OPEC's share in world exploratory wells from an average 3.5 per cent in 1970-1973 to an average 2.5 per cent in 1980-1984. However, that reflects, in part, problems of data availability on exploration activity in some of the countries belonging to OPEC. Those countries are singled out in table 5, with information on all kinds of wells (i.e., not only exploratory) completed during the present decade. As indicated, there is a lack of data for Iran and Iraq and declining trends in total wells drilled are shown in Algeria, Kuwait, Qatar and Saudi Arabia. OPEC's total wells completed actually increased in a sustained manner until 1983, because of good drilling performance in other member countries (e.g., Indonesia, United Arab Emirates, and including Venezuela, because development wells are also considered). A sharp fall of 35.5 per cent occurred in 1984, which contracted the share of OPEC in world total drilling from a 3.1 per cent average in 1980-1983 to 2.1 per cent in 1984.

19. Oil exploration drilling activity was quite uneven in the non-OPEC group of oil-exporting developing countries during the period 1982-1984. The total number of exploratory wells fluctuated at around 300 during each of the three years, with increases in Brunei, the Congo, Oman, Peru, Syrian Arab Republic and Zaire and decreases in Angola, Cameroon, Egypt, Malaysia, Mexico, Trinidad and Tobago and Tunisia.

20. Twenty-six oil-importing developing countries are producers of oil or gas. Since the late 1970s exploration and development activities in oil and gas and other energy sources have been proceeding at above historical levels in many of those countries (especially in Argentina, Brazil, Colombia, Burma, India, Thailand, Turkey and Yugoslavia). More than 90 per cent of the exploratory drilling in the energy-deficient developing countries has been taking place in those with some production of oil and/or gas.

21. Exploratory wells in producing oil-importing countries climbed from a range of 300-430 in 1972-1973 to 848 in 1982; however, the number of wells completed fell by 16.6 per cent between 1982 and 1984 (tables 2 and 3). In relative terms the drop was less pronounced than simultaneous decreases experienced in the groups of developing oil exporters and non-producing oil importers.

Table 5. Oil and gas exploration and development wells completed in selected OPEC member countries, 1980-1984

		1980	1981	1982	1983	1984
Algeria	Wells	249	159	162	140	66
	Average depth (m)	2 482	2 462	2 462	2 477	2 510
	Percentage of producers	69.1	82.4	67.9	..	..
Iran (Islamic Republic of)	Wells	25	..	..	..	23
	Average depth (m)	..	..	..	..	2 325
	Percentage of producers	..	..	..	..	91.3
Iraq	Wells	67	39	..	..	..
	Average depth (m)	2 986	..	..	..	..
	Percentage of producers	59.7	..	..	..	..
Kuwait	Wells	36	44	12	34	11
	Average depth (m)	657	929	1 469	1 385	2 755
	Percentage of producers	83.3	..	41.7	52.9	54.5
Qatar	Wells	57	46	47	31	17
	Average depth (m)	2 285	2 219	2 112	2 397	2 188
	Percentage of producers	68.4	58.7	83.0	80.6	82.4
Saudi Arabia	Wells	223	229	185	184	92
	Average depth (m)	1 830	1 734	1 891	2 002	2 320
	Percentage of producers	53.4	38.9	40.0	66.3	76.1
Saudi Arabia Kuwait Divided Zone	Wells	4	5	9	7	1
	Average depth (m)	2 283	2 836	2 012	2 766	1 712
	Percentage of producers	75.0	80.0	77.8	100.0	--
Total, OPEC	Wells	2 521	2 731	2 927	3 128	2 018
	Average depth (m)	1 436	2 019	2 028	1 522	1 776
	Percentage of producers	71.6	65.5	68.9	55.8	70.9
Memo items: Total, world	Wells	85 291	98 712	99 873	87 630	95 575
	Average depth (m)	1 475	1 464	1 463	1 426	1 535
OPEC's share in world total	Percentage of wells	3.0	2.8	2.9	3.6	2.1
	Percentage of metric drilled	2.9	3.8	4.1	3.8	2.4

Sources: OPEC, Annual Statistical Bulletin, 1984 (table 37) and Annual Report, 1984 (table 1, p. 29); Comité professionnel du pétrole, Pétrole 84 (Paris) table E14; World Oil (various issues).

Note: Two dots (..) indicate that the data are not available. Two dashes (--) indicates that no activity has been reported.

22. The role of domestic State-owned oil firms in exploration in oil-importing producer countries was particularly strong, accounting for about 75 per cent of the wells drilled until the early 1980s. 3/ They have pursued in a determined manner the goal of energy self-sufficiency in the long term, keeping exploration at high levels during 1982-1984 despite discouraging signals from the world petroleum market. That has been a major factor in explaining why oil-importing producers were, as a group, less affected by the decline in exploratory drilling registered in recent years. Also, policies more conducive to attracting foreign capital have been implemented by several countries which in some cases (e.g., Colombia) have met with considerable success.

23. As shown in table 1, out of 102 countries and territories listed as energy deficient, only 26 have some oil and/or gas production. In the remaining 76, exploration drilling took place during 1982-1984 in 24 countries and territories, but the total number of wells remained very low and has declined to only 26 wells in 1984 as compared to 53 in 1982. No drilling at all was carried out in the remaining 52 countries and territories. Pre-drilling activities were conducted in 47 of the non-oil producing oil-importing developing countries.

3. Effectiveness of oil and gas exploration

24. In a recent study on oil and gas exploration in developed market economies and developing countries during 1975-1982, "exploration effectiveness" as measured by the parameters shown in table 4 was found to be very much greater in the developing countries. The sum of gross oil reserves and of oil and gas reserves, per exploratory well, was more than seven times greater in the energy-deficient developing countries than in the developed market economies. Consequently, the investment requirements per barrel of oil equivalent discovered in energy-deficient developing countries was about 30 per cent of the investment requirements in developed market economies, despite the generally higher costs per exploratory well in the former countries. As expected, exploration effectiveness was higher by several orders of magnitude in oil-exporting developing countries.

25. According to those data, the developed market economies are very high-cost areas for oil and gas exploration; $4.95 (1980 dollars) was required in investment per barrel in those countries, whereas only $1.48 was required in energy-deficient developing countries and a mere $0.29 in oil-exporting developing countries. In view of those indicators, in a perfectly competitive oil market, oil and gas exploration efforts would have been expected to be concentrated first in the oil-exporting developing countries and, secondly, in the energy-deficient developing countries. As described above, that has not been the case.

26. Many reasons can be identified for the geographical distribution of oil and gas exploration and the apparent misallocation of global investments. They include imperfections in the structure of the world oil market, oil production programming in the member countries of OPEC, taxation policies, security of supply considerations, and oil price developments, especially since the early 1970s. Until their recent drastic decline, oil prices had risen to levels which were considerably higher than exploration and development costs, even in difficult areas. In addition, taxation policies have generally resulted in higher profits per barrel in the developed market economies than in the developing countries.

B. Coal

27. World coal reserves are highly concentrated, with the United States holding 25.4 per cent of proved recoverable reserves of bituminous coal, the Soviet Union 22.1 per cent, and China 20.0 per cent. Deposits of coal and lignite, which may be of considerable local significance, are widely distributed throughout the world, however, so that developmental trends relative to that fuel are of general importance. 4/

28. A number of individual coal-mining projects or coal infrastructure developments of significance have been launched in recent years. In Canada, for example, there have been important developments in transportation infrastructure in the Pacific coast ports of Roberts Bank and Prince Rupert, where considerable coal-handling capacity is under construction. In addition, a restructuring of the western rail system in that country is under way, following the passage of major new legislation in the autumn of 1983. That should add to the efficiency with which coal is delivered to west coast ports for export. Among the centrally planned economies, a great deal will depend on the exploitation of the very large solid fuel resources of the Soviet Union, especially the Kansk-Achinsk lignite deposits in the Kazakhstan region and the huge deposits of solid fuels known to exist in Siberia. Development of the latter received considerable impetus in 1984 from completion of the Baikal-Amur railway from east Siberia to the Pacific Ocean; Coal exports from east Siberia began in 1986, and coal-handling facilities in the Pacific Ocean ports of the Soviet Union are being expanded to handle the exports. 5/

29. The traditional coal-producing developing countries have registered a steady increase in their production in recent years. In those developing countries with lower production levels, most have sustained their output rates, with marginal increases in some countries and declines in others. The largest such producer, China, is upgrading several major coal ports, and in 1984 signed an agreement with a large natural resource company to construct what will be the largest open-cast coal mine in the world. Earlier, Botswana and Colombia had entered into arrangements with foreign mining and oil companies for coal exploration or mine construction. In Colombia, the major coal development project is in the El Cerrojón area, and port facilities on the Caribbean coast nearby are simultaneously being developed for an export trade. Progress has been achieved in the production of coal in India, which almost doubled its annual production rate during the period 1973-1984, with a gain in production from 77.9 million tons in 1973 to about 144.8 million tons in 1984. Elsewhere in Asia increasing emphasis has been placed on the development of indigenous coal reserves in Indonesia, Pakistan, the Philippines and Thailand. In Africa, significant coal reserves have been identified mostly in the central and southern part of the continent (Botswana, Mozambique, Swaziland, United Republic of Tanzania, Zaire and Zimbabwe, with smaller reserves occurring in Malawi and Zambia). 5/

30. Viewed on a broad statistical basis, the rise in coal production over the past decade has been quite impressive. For the whole period 1973-1984 coal production rose over 30 per cent in the market economies. 5/ Nevertheless, there has been a widespread sense of disappointment with the pace of development of coal resources and the rate of growth in coal production in the market economy group.

Expectations formed in the mid-1970s to the effect that coal exploration and development would boom virtually everywhere over the next two decades have not thus far been borne out by events. Development has been spotty and, broadly speaking, really large increases in output have been restricted to areas where the lack of alternatives is acute. For instance, coal production rose about 41 per cent over the period in North America but nearly 78 per cent in Latin America. 6/

31. The basic problem inhibiting the exploitation of coal deposits has simply been a lack of market demand. Over the past few years, sluggish economic growth has retarded coal development on a wide geographical basis. The chief use for coal is for heat, either industrial boiler-firing or secondary electricity generation, followed by its use in steel-making. All of those applications are very sensitive to the level of aggregate economic activity, so that during periods of generally slow economic growth, expansion of coal production falters as well. Over a longer period, say from 1973-1974 onwards, conservation activities have dampened final energy use in the form of heat relatively more than in the forms of electricity or liquid fuels, thereby impinging upon coal use to a relatively high degree.

32. Also, in a longer perspective, in those areas with practical alternatives to coal, such as oil and natural gas, hydropower, and electricity grids large enough to support nuclear power stations, substitution of coal for those alternatives has simply not occurred at the pace anticipated several years ago. Here the softness of real oil prices following the price rises of 1973-1974 and the recurrence of the same phenomena since the price increases on 1979-1980 are important explanatory factors. Coal has long enjoyed a marked price advantage vis-à-vis oil in several important markets. The expectation of a decade ago, however, was that the advantage would widen rapidly over the 1980s and spur demand for coal, but the anticipated rapid increase in crude oil prices has not occurred.

33. Finally, demand for coal has been hurt by the fuel's role in air pollution and in the "acid rain" problem in North America and Europe. Although the particulate emission associated with coal use can be largely alleviated by smokestack scrubbers, the installation of such equipment adds very significantly to the investment costs of coal-burning facilities.

34. In addition to a lacklustre growth in demand, coal development has been slowed by the very large infrastructure requirements, especially for transportation, associated with the development of coal deposits. In some cases, investment in the coal mine proper represents only about one third of the total investment cost of a coal development project; infrastructure requirements form the bulk of project costs.

35. The slow rate of growth in demand for coal in the market economies has led to a situation in which known coal reserves in those countries will last at least another 200 years at recent rates of consumption. There is little incentive for the industry, as a whole, to invest in additional exploration for and development of coal deposits.

C. New and renewable sources of energy

36. Globally, the production of new and renewable sources of energy (NRSE) expanded at an average rate of about 1.6 per cent per year from 1981, the year of the United Nations Conference on New and Renewable Sources of Energy, to 1984. Table 6 shows the role such sources play in the world energy picture and how that role changed over the 1981-1984 period.

Table 6. World energy production, 1981 and 1984

(Millions of metric tons of oil equivalent)

	1981	1984
Petroleum	2 923	2 860
Natural gas	1 276	1 368
Coal	1 812	1 942
Nuclear energy	226	331
Renewable sources	916	1 005
Total	7 153	7 506

Source: "Monitoring the implementation of the Nairobi Programme of Action for the Development and Utilization of New and Renewable Sources of Energy: report of the Secretary-General" (A/AC.218/9, 6 March 1986).

37. New and renewable sources of energy are especially important in developing countries, where they account for about 30 per cent of total energy consumed. In sub-Saharan Africa, over 90 per cent of the energy used is from such sources, and in several countries in Asia, over 80 per cent. In such areas, traditional biomass fuels (firewood and charcoal, mainly) and draught animal power provide the bulk of the energy available. Table 7 shows how energy consumption in developing countries was satisfied by the various broad categories of energy sources in 1981 and 1984. Use of new and renewable sources of energy rose by 4.0 per cent per year, on the average, while total energy consumption grew by 4.9 per cent over the period. Investment in new and renewable sources of energy along with that in coal and other alternatives to oil, was affected by the decline in oil prices. Similarly, future developmental prospects for all energy sources - including new and renewable sources of energy - will be strongly conditioned by trends in the oil market.

Table 7. Energy consumption in developing regions, 1981 and 1984

(Millions of metric tons of oil equivalent)

	Africa		Latin America and the Caribbean		Asia and the Pacific		Total	
	1981	1984	1981	1984	1981	1984	1981	1984
Petroleum	51	74	205	196	290	332	546	602
Natural gas	14	16	57	63	49	61	120	141
Coal	5	5	16	18	434	536	455	559
Nuclear energy	0	0	1	1	4	11	5	12
Renewable sources	93	98	143	174	226	248	462	519
Total	163	193	422	452	1 003	1 188	1 588	1 833

Source: "Monitoring the implementation of the Nairobi Programme of Action for the Development and Utilization of New and Renewable Sources of Energy: report of the Secretary-General" (A/AC.218/9, 6 March 1986).

Note: The data are for the developing countries in the regions mentioned.

III. NEW CONSTRAINTS AND OPPORTUNITIES

38. Until it dropped abruptly during the first quarter of 1986, the price of oil had been in the range of $25-30 per barrel during the period 1982-1985, which allowed for exploration and development of new oil resources, even in difficult areas. That price range led to a significant expansion of oil production in the developed market economies and developing countries, both oil-exporting and oil-importing, at the expense of production in the member countries of OPEC. Oil production in OPEC countries, however, had dropped to about 50 per cent of capacity by 1985, while practically all other countries were producing at their maximum rates.

39. Oil production in developed market economies, particularly in the United States of America, had been kept at a high level through sizeable investments in exploration and development, including the application of secondary and other enhanced oil-recovery methods in order to arrest the depletion rates of existing oil fields. Since 1973 about $400 billion has been spent in the United States of America alone in oil and gas exploration and development. That effort was based on expectations of steadily increasing oil prices, an assumption which has been shaken by the recent events in the world oil market.

40. Many oil companies have already announced deep cuts in their planned exploration and development investment for 1986. With regard to subsequent years much will depend on the level of oil prices for the rest of 1986 and expectations for the future.

41. Lower oil prices may therefore be expected to have a negative effect on oil and gas exploration and development in the energy-deficient developing countries where the role of transnational oil corporations has been important. As indicated in the report of the Secretary-General submitted to the General Assembly at its thirty-ninth session (A/39/420 and Corr.1), the role of those corporations was considered particularly crucial, especially in those developing countries that had been unable to develop effective local institutions such as national oil companies with financing for the exploration of indigenous resources.

42. Oil exploration and development may, however, remain attractive as compared to other investments in the developing world. Lower profits per barrel may still yield relatively favourable rates of return. For new investment, profitability will be determined by the level of oil prices in the next 5-10 years because of the necessary time lag for each project, and investment decisions will thus be determined on the basis of expectations for the 1990s.

43. Uncertainty with regard to the future level of oil prices will mitigate against new investments. That uncertainty is further compounded by the existence of sizeable over-capacity in several of the OPEC member countries which, as recent events have indicated, may be used in order to supply a bigger share of the market at even lower prices.

44. In the absence of an international agreement on the level of oil prices, many experts believe that at current or lower prices, the dependence of the oil market on supplies from OPEC member countries will increase during the next decade, which may then result again in abrupt changes in prices. If such a point of view were to become prevalent among policy makers, the recent events in the oil market may not have very negative effects on the oil exploration and development effort in the energy-deficient developing countries. Much, of course, will depend on the financial capacity of the various relevant institutions - namely, the Governments of energy-deficient developing countries and their national oil companies, transnational oil corporations, and bilateral and multilateral programmes.

45. Lower oil-import bills in the energy-deficient developing countries could actually provide additional finance for oil and gas exploration and development, although several of those countries continue to be deeply in debt and much of their savings on oil imports will be needed for servicing their foreign debts and for other development purposes.

46. Borrowing on the international capital markets is also expected to remain problematic because of the adverse financial position of many developing countries and uncertainty as to the future level of oil prices as perceived by the commercial banks.

47. As noted in the report of the Secretary-General on the development of energy resources of developing countries (A/40/637, paras. 47-55), some bilateral programmes of assistance (e.g., Canada, Japan, Norway) had been expanding their activities in oil and gas exploration in developing countries. Their future course will be determined by the respective Governments, but in the case of Japan it has been reported that "... The Ministry of International Trade and Industry (MITI) intends to take advantage of this [i.e., savings in oil imports] to expand foreign

exploration by Japanese companies. MITI assumes leases to promising areas will be at bargain prices and the foreign oil majors have slashed their budgets and will not be competing. Usually only 10 per cent of applications for financial help are approved each year but MITI now intends to permit 15-20 projects - a 4-5 fold increase - and the goal is to have 30 per cent of imported crude from Japanese projects, nearly three times the present share". 7/

48. Much of the assistance of the World Bank, including international development assistance (IDA) in energy has been directed towards the preparation of surveys and legislation necessary in order to attract private capital. The future of such assistance will be influenced, inter alia, by the policies of the oil companies in oil exploration in developing countries. Loans and credits for the development of proved reserves may be expected to continue on the basis of project evaluations.

49. Complex considerations are expected to influence the policies of transnational oil corporations. After the loss of their equity oil in several of the OPEC member countries during the 1970s, their determined effort led to a world-wide upsurge in oil and gas exploration and development in the developed market economies and many of the developing countries in expectation of increasing oil prices in the future. Despite their apparent success, the oil reserves position of the various groups of countries has not changed significantly and, as stated previously, there may be increasing dependence on oil imports from OPEC member countries in view of the recent developments in the oil market.

50. Some experts believe that netback or realization contracts, in which the f.o.b. price of oil is directly related to the selling prices of products refined from it after deductions for costs of shipment, insurance and refining, now prevailing in the international trade of crude oil may be a step towards new arrangements between oil companies and oil-exporting countries which may affect supply conditions and prices. Others believe that lower oil prices and the slowdown of exploration activities in the developed market economies may lead to expanded exploration in energy-deficient developing countries because of the latter's exploration effectiveness and the desire of the former for geographical diversification of supplies. In addition, several of the energy-deficient developing countries have shown a willingness to revise the terms and conditions of exploration and development contracts in order to take into account the new realities of the oil market and to attract more private capital.

IV. CONCLUSIONS

51. Energy exploration and development in the developing countries have declined because of various factors, including the continued concentration of effort in the developed market economies, the slowdown in the growth of energy demand, lower energy prices and financial constraints affecting the developing countries, transnational oil corporations and multilateral and bilateral programmes of assistance. Yet several of the energy-deficient developing countries have been successful in the exploration and development of indigenous energy resources.

52. Available evidence indicates that oil and gas exploration effectiveness has been particularly favourable in the developing countries. In view of the decline

in exploration activities, oil prices may be expected to strengthen considerably in the years ahead. Current savings on oil-import bills could provide some of the resources for increased exploration and development activities in energy-deficient developing countries. Additional financing will be required from multilateral and bilateral assistance programmes and transnational oil corporations in order to meet higher energy demand for economic growth.

53. There is considerable room for improvement in the collection of up-to-date information and data on the exploration and development of energy resources. If a more complete monitoring of energy exploration and development trends by the international community is to be undertaken, the co-operation of governments will be required in the collection of comprehensive and reliable information. The issue is becoming even more pressing because of the great uncertainty with regard to future energy exploration and development trends as a result of the recent decline in oil prices and the instability of the world energy markets.

54. In the long run, the most important challenge to the international community is to seek to reduce this uncertainty and enhance the stability of world energy markets. The formidable difficulties of that task must not obscure the considerable mutual benefits to all parties of greater predictability of energy prices, permitting a more orderly process of exploration and development of new and old sources of energy as well as of investments in energy use.

Notes

1/ The present report responds to the latest in a series of General Assembly resolutions (37/251, 38/151, 39/176) that reflect its concern with the development of the energy resources of developing countries. The immediately preceding report, submitted to the Assembly at its fortieth session (A/40/511 and Corr.1), summarized three earlier reports and provided estimates of potential energy resources in developing countries (hydrocarbons, coal, uranium and new and renewable sources of energy); the probable energy picture in developing countries by the year 2000; and investment requirements for the developing countries if they were to realize the projected production increases in the various energy sources up to the year 2000.

2/ United Nations publication, Sales No. E.86.II.C.1.

3/ John Foster, "Petroleum exploration and development trends in developing countries" (paper presented to the United Nations Symposium on Financing of Petroleum Exploration and Development in Developing Countries, held at Athens, 22-26 April 1985) (IESA/P/SYMP/TP/8, 8 April 1985), p. 15.

4/ World Energy Conference, Survey of Energy Resources, 1983 (London, 1983), table 2.1.

5/ Petroleum Economist (July 1984), p. 267.

6/ International Energy Agency, Coal Information, 1984 (Paris, Organisation for Economic Co-operation and Development).

7/ "Investing the windfall profits", Petroleum Economist (May 1986), p. 185.

ANNEX

Recent research activities

The following activities in the study of the development of the energy resources of developing countries, taken in connection with General Assembly resolution 40/208, have been reported:

1. Department of Technical Co-operation for Development

(a) A study on current issues in the economics of off-shore petroleum arrangements (TCD/DNRE/E.2);

(b) An analytical review of the financial requirements for petroleum exploration in developing countries (TCD/DNRE/E.1);

(c) A study on issues in energy demand management (TCD/DNRE/E.3);

(d) A study on choices of energy sources for electricity generation in developing countries;

(e) Proceedings of the Workshop on Microcomputer Software Applications for Energy Planning in Developing Countries; United Nations Headquarters, 9-13 September 1985;

(f) An appraisal of small-scale hydropower in selected developing countries (November 1984);

(g) A study on the approach to geothermal development and utilization in developing countries (November 1984).

2. United Nations Centre on Transnational Corporations

(a) Paper on natural gas clauses in petroleum contracts (not published);

(b) Paper on economic and fiscal aspects of petroleum development (to be published in 1986);

(c) Paper on contract arrangements between host Governments and transnational corporations affecting exploration and development issues in petroleum projects (to be published in 1986);

(d) During 1985 the Centre started work on a project to design a computer-based subject index to the large quantity of contract material relating to petroleum which is held by the Centre. As a first step in the design of the computer-based index, it has been necessary to carry out an analytical review of the subject of petroleum agreements and break it down into some 90 main categories in the light of experience in the negotiation of petroleum agreements. The next

stage involves the subdivision of those main categories into a large number of subcategories corresponding to the wide variety of alternative forms currently in use in the industry to regulate specific aspects of petroleum development;

(e) In its periodic surveys of transnational corporations in world development, the Centre reviewed the latest developments in the energy sector. Thus, in Transnational Corporations in World Development: Third Survey (United Nations publication, Sales No. E.83.II.A.14), investment trends in the exploration and development of fossil and non-fossil fuels were examined with a particular focus on the role of transnational corporations. In 1985, investment trends and prospects in petroleum were analysed in the context of the changes which occurred in the world market (see Trends and Issues in Foreign Direct Investment and Related Flow[illegible] United Nations publication, Sales No. E.85.II.A.15).

3. Centre for Science and Technology for Development

Workshop: Integrated Application of Emerging and Traditional Technology for Development of New Energy Technology (Tokyo, April 1984) at which were discussed specific proposals in new energy, including micro hydroelectric generation, biomass energy and photovoltaic systems.

4. Economic Commission for Europe

Studies under preparation:

(a) Exploration by geophysical methods, extraction and transport of hard rock intrusions during overburden removal in open-cast coal mines;

(b) Coal exploration and mine design, with a view to an efficient exploitation of coal and other associated materials by the open-cast method, particularly in difficult mining and geological conditions,

(c) Geological and geophysical methods of prospecting for natural gas;

(d) Exploitation of natural gas, stimulation and enhanced recovery techniques;

(e) Assessment of natural gas resources;

(f) Map of natural gas fields of Europe;

(g) Off-shore exploration and production of gas;

(h) Evaluation of Europe's hydroelectric potential;

(i) Utilization of geothermal energy for electric power production and space heating.

5. Economic and Social Commission for Asia and the Pacific

(a) Oil and natural gas map of Asia (third edition);

(b) Atlas of Stratigraphy IV, vol. X, China (ST/ESCAP/330);

(c) Atlas of Stratigraphy V, vol. XI, Republic of Korea (ST/ESCAP/383);

(d) Staff backstopping of joint governmental geophysical off-shore exploration;

(e) Identification of OTEC sites and studies of wave energy sources;

(f) Assistance to joint governmental activities in preparation and publication of thematic maps and reports; collection and analysis of data on off-shore basins; studies of heat flow and geothermal gradients both on shore and off shore; investigations of the petroleum potential of pre-tertiary rocks; assessment of petroleum potential of carbonate formations; aeromagnetic surveys of off-shore basins; three-dimensional seismic and stable platform gravimetry; and compilation of on-shore and off-shore stratigraphic, structural, geochemical, geophysical and tectonic data.

6. Economic Commission for Latin America and the Caribbean

(a) Review of prospects for the development of nuclear energy in 11 countries;

(b) Consultations with donors on opportunities for projects in new and renewable sources of energy in Latin America;

(c) Study of the viability of solar energy in the region (planned);

(d) Study of forecasting methods for energy planning and policy (planned);

(e) Study on contract arrangements for oil exploration and development in selected countries of the region (planned).

7. Economic Commission for Africa

(a) Regional Workshop on Energy Supply and Demand Projections Through 1985-1990 in Africa (Addis Ababa, 25-29 November 1985), (E/ECA/NRD/ESDP/8, 9 December 1985);

(b) Regional Workshop on Energy Planning in Africa (Addis Ababa, 3-7 December 1984);

(c) Report of the meeting of experts from the African region held in preparation for the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy (Addis Ababa, 1-4 July 1985), (E/ECA/CM.12/22, 12 July 1985);

(d) Inventory and assessment of hydrocarbon potential for some member States of the east and southern African subregion and central African subregion (E/ECA/NRD/ERU/OIL/2/85, 26 December 1985);

(e) Energy review in Africa (E/ECA/NRD/ERU/3/85, 30 December 1985);

(f) Inventory and assessment of African coal resources, production and trade in the context of regional African development (E/ECA/NRD/ESD/7 and E/ECA/NRD/ERU/COAL/280/2/85, 15 November 1985).

8. Economic and Social Commission for Western Asia

Recent energy exploration activities in the ESCWA region (1985).

9. United Nations Conference on Trade and Development

(a) Development of the technological capability of the petroleum industry in Peru (TD/B/C.6/103);

(b) Power alcohol in Kenya and Zimbabwe - a case study in the transfer of a renewable energy technology (TD/B/C.6/104);

(c) Technological impact of the public procurement policy: the experience of the power plant sector in the Republic of Korea (TD/B/C.6/105);

(d) Small-scale hydropower projects in Nepal (TD/B/C.6/116);

(e) Comparative analysis of the methods used to promote oil exploration in three West African countries: Cameroon, Ivory Coast and Guinea-Bissau (TD/B/C.6/117);

(f) UNCTAD will convene, in close co-operation with UNIDO, FAO and other relevant United Nations bodies, a meeting of an intergovernmental group of experts on the transfer, application and development of technology in the energy sector, paying particular attention to new and renewable sources of energy, 15-24 September 1986. (Trade and Development Board resolution 326 (XXXI), adopted on 27 September 1985);

(g) In preparation for the United Nations Conference for the Promotion of International Co-operation in the Peaceful Uses of Nuclear Energy, UNCTAD has prepared a paper entitled "Nuclear energy and the development process in developing countries" for submission to its Preparatory Committee.

10. Joint UNDP/World Bank Energy Sector Programmes

The joint UNDP/World Bank Energy Assessment Programme, which was initiated in October 1980, was designed to offer policy makers in developing countries a cohesive view of the energy sector, a sharp focus on the key policy and investment decisions required for the sector, and a systematic and well argued ranking of priorities for action. The intention was not to duplicate resource inventory work already being carried out by other agencies or to offer master plan solutions. Instead, the assessments were designed to be policy-oriented studies, with an emphasis on energy supply and demand options, pricing, investment priorities and institutional efficiency, out of which would flow a recommended list of specific actions.

Generally, the assessment surveys evaluate and make recommendations on:

(a) The evolution of energy demand for commercial and non-commercial energy;

(b) The present and potential supply of commercial and non-commercial energy;

(c) The present and forecasted energy balance;

(d) Energy prices, taxes and subsidies;

(e) Energy sector organization and institutions;

(f) Energy conservation and demand management;

(g) The investment and technical assistance requirements of the energy sector.

By the end of 1985 field work had been completed in 61 countries and final reports had been issued for 50 countries. By the end of 1986, field work should be completed in an additional nine countries and reports issued for all 70 countries targeted in the Programme.

The joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) commenced in April 1983 as the operational follow-up to the Assessment Programme in order to assist Governments in the implementation of key recommendations of the assessment reports. Since its inception, ESMAP has been active in a total of 41 countries, and its activities have led to the identification of some $250 million in investment possibilities. ESMAP has prepared a number of pre-investment projects involving the exploration and development of indigenous energy resources, such as hydropower, geothermal sources and the utilization of biomass, as well as providing technical assistance.
