ENHANCING SUPPLIES OF ENERGY AVAILABLE TO ENERGY NET-IMPORTING DEVELOPING COUNTRIES

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CONTENTS

1. This note sets out some of the principal factors relevant to increasing the supplies of energy available to the energy net-importing developing countries (OIDCs)(1). The note first provides information on some aspects of energy consumption in developing countries. Its second section is concerned with the energy resources potential of OIDCs. The third section briefly reviews the technological and financial requirements for increasing energy production in OIDCs and the extent of external assistance available to them; it also examines how energy production in these countries might be expanded through greater international cooperation, and stresses the importance to them of a global strategy for energy which would include arrangements for imports. Finally the note gives a few indications of the possibilities of conserving energy in OIDCs through improving the efficiency of its utilisation.

I. Some aspects of energy consumption in developing countries

2. In most developing countries, 'non-commercial' fuels (2) have been very important as sources of energy, but growth in their consumption has been much slower than in that of 'commercial' fuels, which increased swiftly during the 1950s and 1960s and was well maintained after the 1973-74 oil price rises (Table 1). Compared with the usually presented picture, therefore, developing countries' consumption of energy is greater in total (a broad estimate being of at least 1.5 billion tonnes, coal equivalent, in 1978 compared with 0.9 billion tonnes for 'commercial' fuels alone) and in per capita terms (at least 720 kg, coal equivalent, in 1978 compared with 450 kg for 'commercial' fuels) while their proportion of global consumption is higher (at least 16% in 1978 compared with 11% for 'commercial' fuels); their rate of increase in consumption however has been less fast (5% on average during 1974-78 compared with 6½% for 'commercial' fuels).

3. Per capita 'commercial' energy consumption in OIDCs varies greatly in quantity and in relative economic importance, depending on the availability of local energy resources, level of incomes, and structural composition of economies (Table 2). The energy/GDP ratio(3) has been higher on average in developing market economy countries than in developed market economy countries, and its size has tended to increase (averaging 1.2 during 1970-73 and 1.3 during 1974-78), suggesting that the economies of most developing countries are becoming more 'energy-intensive'. The ratio has varied substantially from one developing country to another and during 1960-76 there did not appear to be any marked positive correlation between its average size and the average rate of increase in GDP (Table 3). In general the ratio tended to be highest in the poorest developing countries and lower in the

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1. Because the imports of energy into the energy net-importing developing countries consist almost entirely of oil, these countries are referred to in this note as 'oil-importing developing countries', abbreviated to 'OIDCs'.

2. Fuelwood, animal and vegetable wastes.

3. The ratio of the percentage increase in 'commercial' energy consumed to that of GDP generated.

more prosperous ones, being less than unity for certain middle-income developing countries. One explanation for this is that it may be among the poorest countries that the substitution of 'commercial' for 'non-commercial' fuels in the incremental use of energy is most marked, and that coefficients of growth in total energy consumption to that of GDP would be quite different.

4. Developing countries have been more dependent on oil than on other sources of 'commercial' energy, a dependence which increased during the 1950s and 1960s before levelling-off after 1973; their dependence on oil has also been significantly greater than that of the developed market economy countries (Table 4). In only two developing market economy countries (India and Zimbabwe) has the consumption of coal been more important than that of oil, while in only two others (South Korea and Mozambique) has it been of significance. Many developing countries generate hydro-electricity - which is often the second most important source of 'commercial' energy - but upwards of two dozen of them are entirely dependent on oil.

5. There are no comprehensive data on the sectoral consumption of energy in developing countries; all estimates are therefore somewhat arbitrary and should be treated with caution. Compared with developed market economy countries, 'commercial' energy consumed by the residential, agricultural and transport sectors of developing countries appears to be of greater comparative importance and that by their commercial/public administration and industry sectors of lesser comparative importance. If account is taken of 'non-commercial' fuels, however, the transport sector is probably of less significance in developing than in developed countries. For consumption both of total energy and of 'commercial' energy the industry sector is the most important in developing countries, followed by the residential sector, the transport sector and, at much lower levels, the agricultural and commercial/public administration sectors (Table 5).

6. The use of energy in the residential sector of developing countries is dominated by heat for cooking, which in the rural areas is derived almost entirely from 'non-commercial' fuels. Almost all energy used in the commercial/public administration sector is electricity. The comparative importance among developing countries of these two sectors is fairly stable, but that of the transport sector varies considerably, usually being much higher in the oil exporting countries than oil importing countries, among which there are great variations in levels of per capita consumption of gasoline. The energy importance of the industry sector also varies greatly, being much higher in developing countries which are industrialising generally or where energy-intensive industries account for a significant proportion of GDP than in the least developed ones. In developing countries as a whole, the coefficients of the ratios of increase in commercial energy consumption to industrial and manufacturing production have tended to rise(1) as a result of the growing relative importance of energy-intensive basic industries, such as steel, chemicals, non-ferrous metals, oil refining and electricity generation.

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1. Average 1970-73: Energy/industry ratio 1.00; energy/manufacturing ratio 0.93. Average 1974-77: Energy/industry ratio 1.56; energy/manufacturing ratio 1.18.

   (Note : energy consumption data are for all sectors)

7. Over 120 of the 150 or so developing countries and territories are net importers of 'commercial' energy. Their import dependence varies considerably, as can be seen from Table 6, which shows that of 67 OIDCs, two-thirds (accounting for nearly a quarter of aggregate population) had an energy import dependence in 1978 of more than 95% whereas under one-tenth had a dependence of less than 25%. Although per capita income rather than import dependence has been the main determinant of per capita levels of consumption, at any given level of income there was a tendency for consumption of energy to be higher, the lower the import dependence of the country concerned.

II. The energy resources potential of energy net-importing developing countries

8. The prospects of OIDCs for increasing energy production differ markedly, depending on their resources potential and on the availability of capital, trained manpower and suitable technologies. No comparable, comprehensive and up-to-date information on the energy resources of OIDCs is available, and earlier estimates which showed these countries' reserves as representing very small proportions of the world total were a reflection not of the size of their resources but of the very low levels of exploration which had been undertaken in the countries concerned.

9. Before the 1973-74 price rise, only 10 of the OIDCs produced oil in commercial quantities; subsequently a dozen or more entered into production while exploration was either started or intensified in over 50 others. The result was a steep rise in the proven oil reserves of OIDCs which by 1978 had reached 2 per cent of the world total (about the same as their proportion of world production). Yet much potential still exists, as these countries are estimated to account for at least 15 per cent of the world's ultimately recoverable reserves. Their problem has been inadequate geological exploration. In 1976 only 12 per cent of the world's petroleum exploration expenditures were in OIDCs (a mere 4 per cent in the non-oil producers), while during 1974-76 average annual expenditures on geophysical activities by the industry were considerably less in Africa, Latin America and south and south-east Asia together ($355 million) than in the United States ($508 million) where the prospects were far less promising. The distribution of expenditure on drilling activities was similarly skewed. The inadequacy of the effort in OIDCs was shown by a survey conducted in 1978 for the World Bank. This showed that of 67 OIDCs, 11 had potential petroleum resources which were categorised as 'very high' (over 1.5 billion barrels), 9 as 'high' (0.75-1.5 billion barrels), 15 as 'fair' (0.1-0.75 billion barrels) and 32 as 'low' (under 0.1 billion barrels - but still sufficient for the needs of some small least developed countries). But of these 67 OIDCs, exploration efforts in 37 were categorised as 'inadequate', in 20 as 'moderate' and in only 10 as 'adequate'. Moreover, of the 20 countries with 'high' or 'very high' prospective reserves, only seven had been explored 'adequately'.(1)

10. A similar picture exists for natural gas, much of which is associated with oil. Whilst increased exploration since 1975 has led to a marked expansion in the proven reserves of the OIDCs, the relatively much lower drilling activity in these countries than in, say, the United States (on a scale of 1:100 approximately) has meant that ultimately recoverable reserves are almost certainly many times larger, especially for non-associated deposits ('dry'gas).

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1. "A programme to accelerate petroleum production in the developing countries"; study prepared by IBRD for UN Committee on Natural Resources, May 1979.

11. The availability of cheap and abundant imported oil was a substantial discouragement to expenditure on coal exploration in OIDCs before 1974; in only two or three of them were domestic resources exploited on a significant scale and most had not been explored geologically for coal. More recently exploration has increased considerably, and over two dozen OIDCs are now known to have substantial deposits of coal. For these countries the need is to determine more reliably the extent and quality of the reserves, but for the majority of OIDCs additional exploration is needed simply to survey the countries concerned in the hope of discovering deposits and then delineating them in order to provide a meaningful evaluation of reserves.

12. The OIDCs are relatively well endowed with resources for producing nuclear electricity, the energy content of which is many times their present production of primary electricity.(1) For this fuel, therefore, the problem for these countries is not of inadequate resource exploration but of the vast amounts of capital and complex technologies which are needed to harness it.

13. Resources of fossil fuels and fissile materials are very unevenly distributed among the OIDCs and many have no significant reserves. Those of renewable forms of energy, on the other hand, are much more widely distributed. Apart from arid countries, most OIDCs have hydro resources, only 4 per cent of which have yet been exploited; as one example of the potential which exists, it may be noted that in Africa installable hydro capacity exceeds current consumption of all types of energy and yet hydro electricity provided only 3 per cent of the total in 1978. As most OIDCs have abundant sunshine the potential for solar energy production is obviously considerable when appropriate technologies have been developed. The geothermal potential is similarly good while biomass conversion systems are already making noticeable contributions in some countries.

III. Need for new and expanded mechanisms to facilitate increased supplies of energy available to energy net-importing developing countries

14. The OIDCs are deficient in the technologies, manpower skills and financial resources needed to raise their production of energy to levels commensurate with their consumption objectives, and they also lack long-term assurances of energy imports at adequate levels and reasonable prices. Mechanisms are needed to assist these countries improve their technological capacities and to help them fill the gap between the level of funds which under present conditions is likely to be forthcoming for their energy industries and that required to achieve their production targets. A mechanism is also needed to assure their imports of energy.

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1. OIDC resources of low cost uranium have an energy content of 60 times the 1978 output of primary electricity in these countries if used in slow thermal reactors and of 3,700 times if used in fast breeder reactors; in addition they possess low cost thorium resources whose energy content is 3,300 times their 1978 primary electricity production if used in breeder reactors.

i) Technology requirements and assistance

15. Energy systems technologies are usually large-scale and often complex, most markedly for oil, gas and nuclear fuels. The exploration, development and production stages of oil and gas are still largely dominated by a small number of independent contracting firms which provide specialised equipment and know-how and highly skilled manpower. Barriers to entry into these stages of the industry are usually high, particularly in the case of exploration where the risk element is often beyond the bearing capacity of local enterprises. Technological barriers are lower for standard oil refining operations, but the substantial economies of scale, high cost structures and specialised nature of certain of the more sophisticated refining processes constitute serious economic barriers to many OIDCs.

16. Technologies for the production of coal are much simpler than those for oil/gas and many have been developed by state-owned enterprises which are generally more flexible in their licencing policies than private corporations. Technologies for thermal and hydro electricity generating plant are also relatively simple in the case of small projects, although they become more complex with larger capacities; operating technologies are comparatively simple, and transmission and distribution technologies have become standardised. The key technological aspects lie in the manufacturing of heavy electricial equipment which is dominated by a relatively small number of transnationals; these operate a cartel in external markets and have faced charges of excessive pricing for contracts undertaken in OIDCs.

17. Specialised technologies are needed for generating electricity from non-conventional sources. Nuclear power technology provides a number of problems for OIDCs: uranium mining is highly concentrated, fuel supplies are complicated by institutional arrangements and the technology of all stages of the fuel and reactor cycles is complex, with substantial economies of scale and steep barriers to entry into the market, both for operating know-how and for equipment. The nuclear option is thus viable for relatively few OIDCs. Solar energy technology appears more promising for these countries, although as the area is still relatively new, firm conclusions are difficult to draw. The technologies range from the very simple to the highly complex, from very small operating and investment costs to quite large ones. It appears that for most OIDCs the greatest potential lies in solar thermal collectors for low-grade heat and electricity generation, particularly for small-scale operations in rural areas.

18. OIDCs face a number of vital constraints in attempting to meet the technological requirements of energy investments from their own capabilities.(1) Chief among these constraints is a deficiency in skilled manpower, particularly of engineering and managerial personnel. From that deficiency follow other constraints, e.g. inadequate information on technologies available and a lack of expertise in negotiating for them, an insufficient ability to absorb or adapt received technologies or to develop new ones, and an inadequate capacity to manufacture or in some cases even to service, energy plant and equipment. Technical assistance is required to help OIDCs overcome these constraints.

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1. See e.g. "Energy supplies for developing countries: issues in transfer and development of technology" (UNCTAD, October, 1978).

19. A significant amount of assistance is already available in the energy field. The UN Department of Technical Cooperation for Development, as executing agency for UNDP, has provided increasing assistance for energy exploration projects. The World Bank's expanded programme for fuel minerals (which commenced in July 1977) has a technical assistance component whose main purpose is to improve energy sector planning and development programmes. Technical assistance has also been forthcoming from other multilateral sources, e.g. from the EEC for solar energy in ACP countries and from OPEC for electric power development, as well as from various countries' bilateral programmes.

20. Yet there is abundant evidence of need for expanded technical assistance on energy technologies, and various proposals have been made for achieving it. In May 1977 the UN Secretary-General had proposed (to the fifth session of the UN Natural Resources Committee) the creation of a Consultative Group on Energy Resources Development, which would draw together the UNDP, World Bank and other substantive units of the UN system, along with other international organisations and interested governments, in order to channel technical assistance to developing countries for exploiting their energy resources.(1) In July 1978 a Group of Experts was commissioned to prepare a report, inter alia, on the availability of mechanisms for the transfer of technology to developing countries for exploration and exploitation of natural resources; among their recommendations was that the UN system should devise an appropriate framework to coordinate technical assistance activities. (2) In June 1979 the UN Secretary-General had proposed (to the sixth session of the Natural Resources Committee) an expanded UN programme for technical cooperation on energy. (3)

21. The content of these various proposals and recommendations varied in certain details but all emphasised the need for massive assistance to enable these countries to establish or strengthen their energy technology training facilities and R & D institutions, their energy strategies and policies (including resources evaluation and technology transfer), and their energy data base. Little if any action of significance seems to have been taken however, and the 1979 session of the Natural Resources Committee merely noted the latest of these proposals and remitted it to the Administrator of UNDP for consideration, with a request that a report be submitted to the Governing Council of UNDP and to the next session of the Committee in 1981. Further consideration of these issues by the Committee should also take into account the Brandt Commission's proposal for a global energy research centre to be set up under UN auspices.

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1. "Strengthening international cooperation in energy : possible approaches" (UN, April 1977).

2. "Report of the group of experts on mineral and energy exploration in developing countries", reproduced in "Development and International Cooperation - multilateral development assistance for exploration of natural resources" (UN, October 1978).

3. "Some energy problems and issues in developing countries" (UN, April 1979).

ii) Financial requirements and assistance

22. Because of the large-scale of production necessary and complex nature of the technologies involved, the level of funds needed to meet the financial requirements of energy systems is very high. In the case of fossil fuels they are highest for oil, in whose production the OIDCs are most deficient, and on which almost all of them depend the most. The investments needed for geological/geophysical surveys, for example, range from $0.5 to $5.0 million per project, whilst those for exploratory drilling range from $10 to $50 million per 10,000 sq. km. The main financial constraint exists at this latter stage because of the high risks involved and the inadequacies of domestic risk capital, aggravated in many OIDCs by the absence of expertise in negotiating mentioned earlier. Revised estimates by the World Bank(1) suggest that over the ten years 1976-1985 the OIDCs could raise their oil consumption by 5% annually whilst only increasing their imports by 3% per annum if they could expand their oil production by 9% a year, which would require annually investment funds of $3.4 billion (1977 dollars).(2) The IBRD also calculated that an increase of 10% per annum in the natural gas production of these countries would require an annual investment of $0.6 billion (1977 dollars). (2)

23. Capital investment requirements for coal development vary widely, but by comparison with oil they are fairly modest, especially if the costly infrastructural facilities needed are excluded. A recent estimate by the World Bank (3) suggests that developing countries would need some $20 billion (1978 dollars) between 1978 and 1990 for coal mining and transport facilities if they are to raise their coal production from the 1977 level of 176 million tonnes to 440 million tonnes by 1990. This implies an average annual investment of around $1.5 billion (1978 dollars). Electric power generation is the largest energy industry in the OIDCs and a 1975 World Bank projection put their annual requirement for capital investment during the period 1974-80 at $3.8 billion (1973 dollars). It would be much higher now and if a World Bank projection of a near trebling in the OIDCs' production of primary electricity from 1976 to 1985 is to be met, very substantial investments would be needed, possibly of the order of $6 to $7 billion annually. Most of this would be for hydro stations, much of the remainder for thermal plant and an increasing amount for nuclear reactors; in addition large amounts of capital would be needed for electricity transmission and distribution, especially in rural areas. Given adequate technological progress, capital would also be needed later in the decade for small-scale solar generation plant, wind generators and possibly geothermal plant.

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1. "A programme to accelerate petroleum production in the developing countries", study prepared by World Bank for UN Natural Resources Committee, May 1979.

2. Covers investment in upstream activities only, i.e. oil and gas exploration (25%-30%), development and production (including crude oil pipelines). These activities account for about half the total investment required; the remainder (downstream activities) consists of refining, transport and distribution.

3. "Coal development potential and prospects in the developing countries", World Bank, October 1979.

24. The amount of financial assistance available to help OlDCs to expand their energy production has increased significantly during recent years, but not by as much as would be required if these countries are to meet their energy objectives. The size of the financing gap has been variously estimated, but the Group of Experts commissioned by the UN Secretary-General in 1978 to prepare a report,(1) inter alia, on financial requirements over the following 10-15 years for the exploration and location of natural resources in developing countries and on the availability of multilateral mechanisms for the provision of adequate finance for the exploration of natural resources, concluded that for petroleum exploration alone, a gap of $1-$2 billion (1976 dollars) per annum existed in the OlDCs for the period from 1978 to 1990. They emphasised, moreover, that the size of the gap would be much higher if more consideration were given to realising the petroleum potential of these countries or their reaching self-sufficiency. Regarding the availability of multilateral financing mechanisms, the Group concluded that (i) no new institutions were required for petroleum exploration financing; (ii) consideration should be given to the World Bank providing funds (including equity) on appropriate terms to OlDCs for petroleum exploration; (iii) consideration should be given to the creation of a mechanism to tap private capital markets under a guarantee mechanism supported by interested countries; (iv) multinational finance agencies should consider a 'commitment' procedure to create a partnership at the prospecting phase without necessarily participating in direct exploration funding; and (v) the UN Revolving Fund for Natural Resources Exploration should be expanded to include geothermal projects.

25. Since that report was presented, the World Bank has further extended its lending activities in the energy field to include oil and gas exploration, coal and other sources of energy from January 1979(oil and gas development had been added to the traditional Bank role in the electric power section in July 1977). During the Bank's present energy programme (fiscal years 1979-83) its lending is expected to increase substantially, and by the end of the period should have reached annual rates of $1.2 billion for oil and gas exploration, development and production, and $100-200 million for coal; in addition it expects to lend $1.5 billion annually for electric power development (all data in current dollars).

26. Reference to the figures given in paragraphs 22 and 23 make it apparent that if OIDCs are to continue to expand their consumption of 'commercial' energy at a fast pace and simultaneously begin to reduce their dependence on external sources, very substantial financial resources will be needed. No authoritative estimates of the overall requirements are available, but if the OIDCs were to increase their 'commercial' energy consumption from 1976 to 1985 at an annual average rate of, say, 6% and restain the growth in their net imports of energy to half that rate, it would appear that the additional annual capital for the necessary energy exploration/development/production/refining/distribution activities would be of the order of at least $16 billion (1977 dollars). Around four-ninths of that investment would be for the oil and gas sector, a similar proportion for electricity (primary and secondary) and the remaining one-ninth for coal. Rolling this estimate forward and making an allowance for inflation, it would seem that during the 1980s OIDCs might need annual capital

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1. "Report of the group of experts", op. cit. (UN, October 1978).

of the order of at least $20-$25 billion (1980 dollars) if their energy systems are to meet desired objectives. The bulk of this investment would have to be raised from domestic sources and from the private international capital market, but there would seem to be need for official multilateral loans of at least $4-$6 billion a year. (1)

27. Part of this official multilateral loan requirement will be met by the World Bank, whose energy loan programme should be assisted by the doubling of the Bank's capital base, but it is clear that new initiatives are called for by the UN system and other organisations. One initiative would be a change in the World Bank's gearing ratio from 1:1 to 2:1, as recommended by the Brandt Commission. Another would be an expansion in the energy assistance of the UNDP, and an extension of the UN Revolving Fund to cover the energy sector, but this would appear to depend on the provision of substantially larger resources being made available under official development assistance programmes to multilateral agencies.

28. There is also need for much greater direct investment in the energy sector of OIDCs. One possibility of raising the necessary funds might be through a levy by OPEC of, say, 50 US cents per barrel on its oil exports to OECD member countries. This would account for only some 2% of OPEC revenues from the export of oil but would produce around $4.5 billion annually and thus make a substantial contribution to the energy investment requirements of OIDCs. There is also need to tap more equity funds from the private capital markets by means of modifying and otherwise improving the usual contractual arrangements in order to provide a more stable environment and thus to lessen the element of risk. Various possibilities deserve further attention, including an extension of developed countries' investment guarantee schemes into the exploration phase of the energy sector, an involvement of multilateral financial agencies in partnership at the exploration stage, a more favourable developed country tax policy toward overseas energy exploration ventures, and a separation of licencing for exploration from that for production.

iii) Import assurances

29. The long leads and large investments needed to plan and implement energy production systems mean that even for countries which can eventually achieve self-sufficiency there is need for transitional arrangements to facilitate energy imports at adequate levels and reasonable prices; for those which do not possess sufficient energy resources, satisfactory import arrangements are needed on a permanent basis. There have been several recent pronouncements on the need to ensure adequate quantities of oil for OIDCs, and at the Third General Conference of UNIDO in February 1980, an OPEC official warned that in future the Organisation might have to curtail supplies to industrialised nations to meet domestic and developing nations' demands. In that connection it may be recalled that the Energy Commission of CIEC had recommended that, in periods of reduced oil supplies, the most vulnerable developing countries should be given priority to allow them to meet essential requirements. Similar proposals have been made elsewhere and it would seem desirable for OPEC or any global negotiation on energy to consider drawing up contingency plans to protect these countries in the event of scarcity. (IEA arrangements already exist to allocate oil supplies within member countries.)

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1. See also Brandt Commission Report, page 231, which gives an estimate of at least $4 billion annually, excluding electricity.

iv) Conclusion

30. Finally, it should be added that a lasting solution to the energy problems of the OIDCs will be found only in the context of a global accommodation between OPEC and oil-importing countries (including the OIDCs)and the general acceptance of a multi-faceted international strategy for energy. This is now seen as a major element of a renewed North-South dialogue, and will be on the agenda of the UN General Assembly Special Session in August-September 1980, which is to launch a round of 'global and sustained negotiations on international economic cooperation for development'. Elements of such an international strategy for energy should include the following: assurances of production levels by oil-exporting countries; special arrangements to ensure that poorer developing countries receive the amounts of oil needed; acceptance and implementation of ambitious conservation targets by major energy consuming countries; determination of oil prices at levels giving incentives for greater production and encouraging more conservation, and without sudden major increases; major investment in energy production within OIDCs; and greater R & D into alternative sources of energy.

IV. Energy conservation in energy net-importing developing countries

31. It would appear at first that the possibilities of conserving energy consumption in OIDCs are rather narrow, since the bulk of consumption in most of these countries is for 'essential' purposes, e.g. kerosene for domestic lighting and cooking, diesel for irrigation pumps and road freight services, and fuel oil for thermal electricity generation and for industrial process heating. Moreover most OIDCs are in the process of attempting to transform their economies from an agrarian subsistence basis to an industrial commercial basis, and as is well known, the energy-intensiveness of basic industrial activities is much greater than that of subsistence agriculture. Yet if the prospects of energy conservation through the elimination of wasteful usage and a lessening of the 'energy-structure' of the economy are in general relatively poor, those which can be achieved through technical improvement would seem very much brighter. The following paragraphs briefly review some of the sectoral prospects for energy conservation by OIDCs.

32. In the residential sector of these countries considerable economies in the consumption of kerosene and LPG can be achieved by the use of more efficient stoves and burners, and several countries (including India) have better designed appliances under development and trial. Similar economies are possible for wood-burning domestic stoves, while some countries have found the use of closed hearth fireplaces has reduced consumption of firewood.

33. The relative importance of the transport sector in OIDCs varies enormously, but in some of the middle-income countries there is considerable scope for the conservation of gasoline in private motoring. Such economies can be achieved in a variety of ways: some OIDCs have undertaken the mandatory closing of gasoline stations at weekends (e.g. South Korea); some have converted vehicle engines from running entirely on gasoline (mainly imported) to using a fuel which includes power alcohol from domestic agricultural materials (e.g. from sugar-cane for Volkswagon cars in Brazil); others have used fiscal measures to conserve consumption of gasoline (e.g. India), while quite a few of these countries, particularly in the Western Hemisphere, appear to have considerable potential for energy conservation through greater use of the pricing mechanism to foster the substitution of small

for large vehicles. Better vehicle maintenance would also save fuel. As regards rail transport, several OIDCs have saved energy through substituting diesel or electric traction for coal-fired locomotives; the problem in certain countries (including India) is that the coal was from domestic sources whereas most of the oil has to be imported.

34. For most OIDCs the commercial sector is not of great importance as a consumer of energy, but in some countries devices which save energy in that sector are nevertheless worth pursuing. They are particularly important for the more advanced OIDCs, some of which have taken measures to cut down the use of excessive lighting (e.g. South Korea) or to reduce the use of air-conditioning (e.g. Sri Lanka).

35. At present use of commercial energy in the agricultural sector of OIDCs is comparatively small, most being consumed in water pumping machinery. The importance of raising the efficiency of agricultural pumps has been recognised by many OIDCs and several are in the process of substituting electrical sets for less efficient diesel ones. Other countries are undertaking research into raising the efficiency of tractor engines or of using alternative and renewable sources of energy, e.g. solar-heated crop driers or rice husks in rice mills.

36. In the industry sector substantial economies are possible in the energy-intensive sectors such as steel (e.g. through raising the ratio of pellets to sinter in the blast furnace charge, raising the temperature of the blast furnace, reusing waste heat, etc.),cement (e.g. converting from the wet to the dry process), fertilizers (e.g. use of the Haber process for ammonia production), aluminium (e.g. use of the Alcoa process), etc. Several OIDCs are taking measures in this area (e.g. India in the conservation of coking coal in the coke ovens and blast furnaces). Finally, substantial economies are possible within the energy industry itself. Thermal generation of electricity, for example, becomes more efficient with larger sets, and the bigger OIDCs, such as India, are taking advantage of these scale economies. Many OIDCs are making efforts to reduce electricity transmission and distribution losses, which are particularly important if long distances are involved; others are also involved in raising the efficiency with which imported oil-based town gas is used (e.g. Singapore).

37. For OIDCs to make optimum use of the energy-conserving technologies already available or under development, increased technical cooperation is needed among these countries, as well as of assistance from the industrialised countries. Appropriate fiscal and financial policies are also needed internally, as well as suitable institutional and legislative arrangements. The energy conservation scope in these countries is considerable, and the potential benefit to their balance of payments is immense. For this to be realised will require the necessary commitment of resources and implementation of policies.

Table 1

Increases in developing countries' consumption of 'commercial' energy

(% annual averages)

	1951-60	1961-70	1971-73	1974-78	1974	1975	1976	1977	1978
Total	7.5	7.3	5.5	6.6	6.1	5.0	8.7	8.2	5.2
OIDCs	7.0	7.2	4.7	5.0	3.8	3.8	6.3	6.9	4.1
OEDCs	8.7	7.5	7.2	9.6	10.3	7.1	12.8	10.5	7.0

Source : UN World Energy Supplies.

Table 2

Some aspects of 'commercial' energy consumption in selected developing countries

(kg,coal equivalent)

	Per dollar of GDP		Per capita		Per dollar of GDP		Per capita
	1960	1976	1978		1960	1976	1978
South Korea	1.2	1.7	1,359	Somalia	0.2	0.4	99
India	1.3	1.6	178	Burma	0.5	0.4	64
Jamaica	0.2	1.5	1,823	Malawi	n.a.	0.4	52
Zambia	n.a.	1.3	474	Afghanistan	0.2	0.4	47
Pakistan	1.3	1.2	172	Tanzania	0.3	0.4	65
Colombia	1.3	1.2	700	Guinea	0.3	0.4	105
Chile	1.2	1.2	997	Mauritania	0.1	0.4	203
Liberia	0.2	1.0	395	Senegal	0.3	0.4	181
Jordan	0.7	1.0	535	Ivory Coast	0.2	0.4	357
Argentina	0.9	1.0	1,873	Guatemala	0.4	0.4	260
Dominican Rep.	0.3	0.9	464	Bangladesh	n.a.	0.3	43
Singapore	0.4	0.9	2,461	Ethiopia	0.1	0.3	20
Thailand	0.3	0.8	327	Mali	0.2	0.3	30
Philippines	0.6	0.8	339	Benin	0.2	0.3	56
Panama	0.7	0.8	991	Malagasy Rep.	0.2	0.3	n.a.
Uruguay	0.7	0.8	1,054	Togo	0.1	0.3	96
Honduras Republic	0.5	0.7	284	Cameroon	0.2	0.3	119
Hong Kong	0.7	0.7	1,657	Ghana	0.2	0.3	165
Israel	0.7	0.7	2,362	Congo	0.3	0.3	175
Kenya	0.8	0.6	139	Paraguay	0.2	0.3	200
Sudan	0.2	0.6	172	Chad	0.1	0.2	22
Papua New Guinea	0.2	0.6	292	Rwanda	n.a.	0.2	17
El Salvador	0.4	0.6	265	Upper Volta	0.1	0.2	25
Morocco	0.4	0.6	285	Niger	-	0.2	38
Nicaragua	0.4	0.6	517	Cent. African Rep.	0.1	0.2	44
Brazil	0.6	0.6	794	Uganda	0.1	0.2	48
Mozambique	0.4	0.5	151	Nigeria	0.1	0.2	106
Sierra Leone	0.3	0.5	100	Nepal	-	0.1	11
Sri Lanka	0.7	0.5	109	Burundi	n.a.	0.1	12
Costa Rica	0.4	0.5	564	Haiti	0.2	0.1	57

Source: IBRD World Development Reports and UN World Energy Supplies.

Table 3

Energy/GDP ratios for selected developing countries*

	1960-73	1974-76	1960-76		1960-73	1974-76	1960-76
Central African Rep.	n.a	2.4	6.7	Paraguay	1.9	1.2	1.6
Niger	n.a	n.a	5.8	El Salvador	1.4	2.4	1.5
Somalia	n.a	n.a	5.6	Bolivia	1.2	2.3	1.5
Sierra Leone	3.0[a]	11.7	5.1	Jordan	n.a	n.a	1.5
Malagasy Rep.	n.a	n.a	4.3	Panama	1.4	n.a	1.5
Nepal	7.2[b]	0.4	4.1	Saudi Arabia	n.a	n.a	1.5
Chad	n.a	1.4	4.1	South Korea	1.5	0.6	1.4
Jamaica	n.a	-1.1	3.3	Nicaragua	1.6	1.4	1.4
Liberia	5.5[b]	2.8	3.2	Tunisia	1.7	0.6	1.4
Ethiopia	3.3[a]	-2.3	3.0	Malaysia	1.9	n.a	1.4
Afghanistan	n.a	n.a	2.9	Costa Rica	n.a	1.8	1.4
Upper Volta	n.a	n.a	2.9	Iran	1.4	1.4	1.4
Algeria	n.a	n.a	2.7	Sri Lanka	1.3[b]	-0.5	1.3
Sudan	n.a	n.a	2.6	Indonesia	1.1	3.8	1.3
Ghana	2.5	n.a	2.5	Argentina	1.3	-0.7	1.3
Benin	n.a	n.a	2.3	Pakistan	1.2	0.3	1.2
Uganda	2.2	4.6	2.3	Ecuador	1.3[b]	2.4	1.2
Cuba	n.a	n.a	2.3	Libya	n.a	n.a	1.2
Mozambique	n.a	n.a	2.2	Burma	1.4[a]	0.2	1.1
Tanzania	2.1[b]	2.4	2.2	Cameroon	n.a	2.0	1.1
Mauritania	n.a	n.a	2.2	Colombia	1.1	n.a	1.1
Nigeria	n.a	n.a	2.2	Guatemala	1.1	1.7	1.1
Dominican Rep.	2.5	0.4	2.1	Peru	1.3[a]	1.9	1.1
Thailand	2.1	0.7	2.1	Taiwan	n.a	n.a	1.1
Senegal	n.a	n.a	2.1	Venezuela	1.2	0.5	1.1
Chile	n.a	n.a	2.0	Israel	1.1	-0.6	1.1
Haiti	2.2	1.1	1.9	Egypt	n.a	n.a	1.0
Honduras Rep.	n.a	n.a	1.9	Mexico	1.1	0.5	1.0
Ivory Coast	n.a	n.a	1.9	Brazil	0.9[b]	1.0	0.9
Trinidad &Tobago	1.4[c]	2.1	1.9	Uruguay	2.8	0.7	0.9
Mali	n.a	n.a	1.8	Guinea	n.a	n.a	0.8
Angola	n.a	n.a	1.8	Iraq	1.3[b]	0.4	0.8
Togo	n.a	n.a	1.8	Zaire	n.a	n.a	0.7
Philippines	1.9	1.1	1.8	Kenya	0.6[b]	0.4	0.7
Morocco	1.7	2.6	1.7	Congo	n.a	n.a	0.7
Syria	1.5	1.7	1.7	Hong Kong	0.8[a]	0.6	0.7
Singapore	2.0	0.7	1.7	Lebanon	n.a	n.a	0.2
India	n.a	n.a	1.6				

* Average percentage change in commercial energy consumption divided by average percentage change in GDP during different periods.

a Growth in GDP: 1963-73

b Growth in GDP: 1965-73

c Growth in GDP: 1966-73

Source: Computed from data in IBRD World Development Reports and UN Yearbook of National Accounts Statistics.

Table 4

Changes in the pattern of 'commercial' energy consumption (%)

	Solid fuels			Liquid fuels		
	1950	1973	1978	1950	1973	1978
DMECs	56.9	22.4	22.5	28.9	52.4	51.7
LDCs	38.9	15.9	15.0	55.4	67.2	66.8
World	61.5	31.7	32.0	27.0	46.3	45.2

	Natural gas			Primary electricity		
	1950	1973	1978	1950	1973	1978
DMECs	12.1	22.4	22.2	2.1	2.8	3.6
LDCs	4.3	13.4	14.1	1.4	3.5	4.2
World	9.8	19.6	19.8	1.7	2.4	2.9

Note: DMECs = Developed Market Economy Countries.
LDCs = Less Developed Countries.
World = includes Centrally Planned Economy Countries.

Source: UN World Energy Supplies.

Table 5

Estimated consumption of primary energy by sector in 1976 (%)

	'Commercial' energy			Total energy		
	DMECs	LDCs	World	DMECs	LDCs	World
Residential	16	24	18	18	34	20
Commercial, etc.	8	2	6	8	2	6
Agricultural	1	4	2	1	4	2
Industrial of which:	55	47	59	53	42	57
manufacturing	(23)	(21)	(30)	(22)	(19)	(29)
energy*	(28)	(20)	(25)	(27)	(18)	(24)
other**	(4)	(6)	(4)	(4)	(5)	(4)
Transport	20	23	15	20	18	15
Total	100	100	100	100	100	100

Note: DMECs = Developed Market Economy Countries.
LDCs = Less Developed Countries.
World = includes Centrally Planned Economy Countries.

* Consumption of primary energy in production of thermal electricity, manufactured gas, petroleum products, coal products, etc.

** Mining, building and construction.

Source: Commonwealth Secretariat estimates.

Table 6

Commercial energy - import dependence and consumption of selected developing countries

	Countries	Population	GNP per capita*	Energy consumption per capita*	Energy consumption	Net imports of energy	Net imports as proportion of consumption
	(no.)	mid-1977 (millions)	1977 ($)	1978 (kg)	1978 (mtce)	1978 (mtce)	1978 (%)
Net importing countries							
> 75% import dependence							
p.c. consumption							
< 200 kg	28	201.5	201	66	13.5	13.2	98.1
200-1000 kg	15	147.7	529	349	49.7	48.1	96.7
>1000 kg	8	51.5	1,162	1,425	72.7	64.3	88.5
25-75% import dependence							
p.c. consumption							
< 200 kg	3	156.2	138	105	16.9	7.4	51.6
200-1000 kg	5	198.3	1,194	815	157.5	105.7	67.1
>1000 kg	1	21.7	1,960	2,035	44.6	18.4	41.4
< 25% import dependence							
p.c. consumption							
< 200 kg**	6(5)	736.5(104.8)	154(179)	169(112)	125.3(11.7)	24.0(0.8)	19.2(6.8)
200-1000 kg	0	-	-	-	-	-	-
>1000 kg	1	26.0	1,730	1,873	49.4	8.2	16.6
Net exporting countries							
p.c. consumption							
< 200 kg	5	123.2	341	94	9.8	-129.4	-
200-1000 kg	9	247.9	522	435	106.5	-386.0	-
>1000 kg	12	126.6	2,214	1,873	239.9	-1,631.4	-
TOTAL	93	2,037.1	433	440	885.8	-1,127.7	-
of which:							
Net energy importing developing countries	67	1,539.4	414	347	387.0	289.2	74.7

* Weighted average. ** Figures in brackets denote totals excluding India.

Source: UN World Energy Supplies, IBRD World Development Report, UN Statistical Yearbook.