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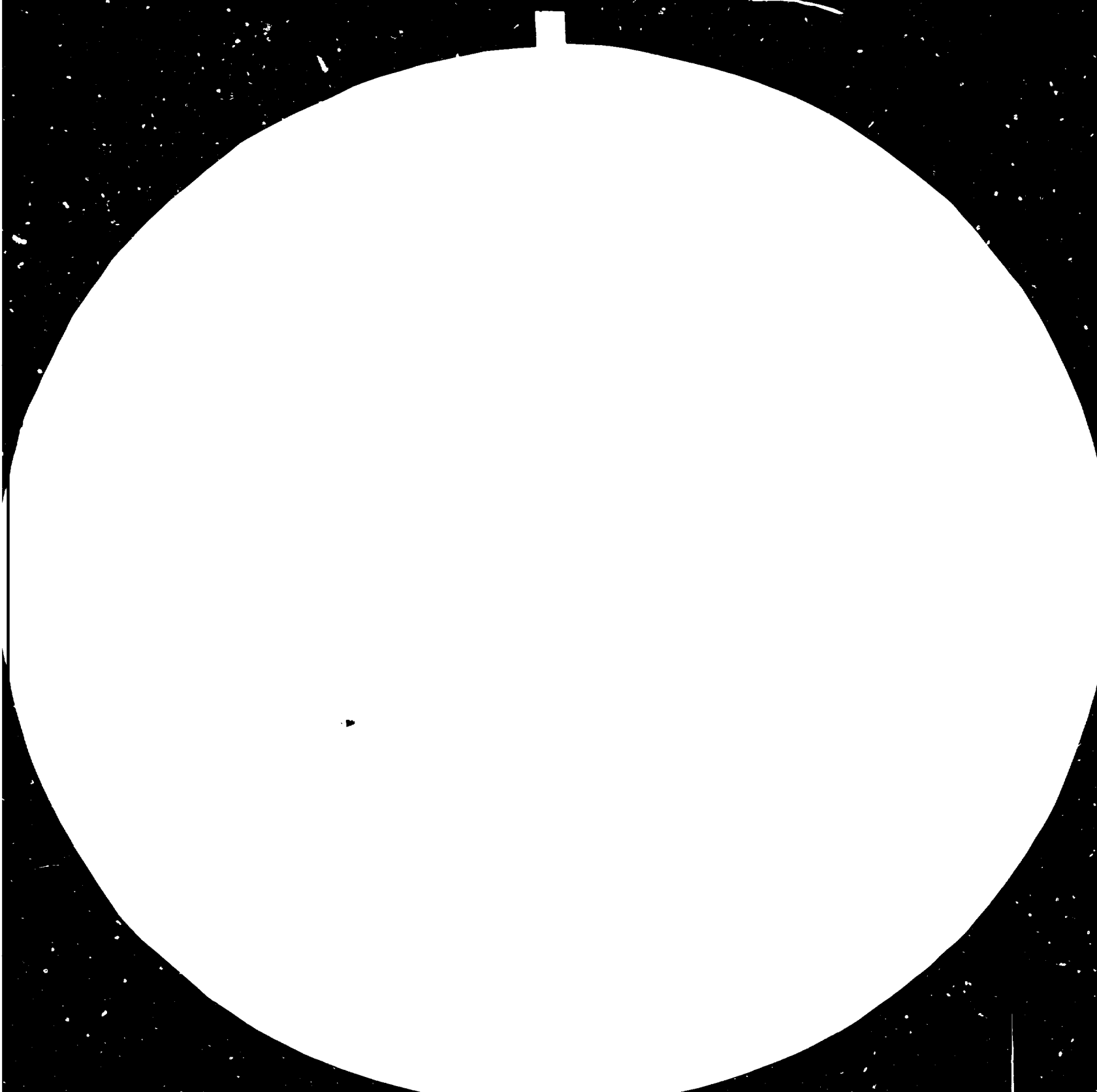

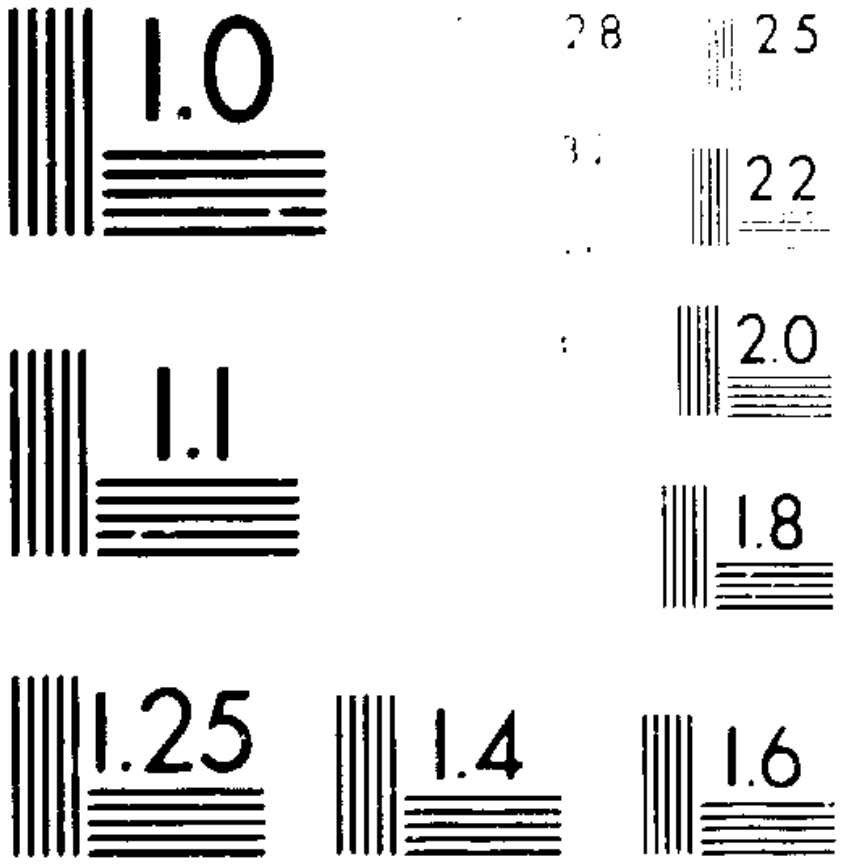

Item 5(d) of the provisional agenda

INTERNATIONAL CO-OPERATION, RELEVANT NATIONAL ACTIONS INCLUDING INDUSTRIAL POLICIES, AND UNIDO'S CONTRIBUTION IN CRITICAL AREAS OF INDUSTRIAL DEVELOPMENT 1985-2000:

Energy and industrialization, with special emphasis on development and application of energy resources and manufacture of equipment

Background paper prepared by the UNIDO secretariat

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CONTENTS

INTRODUCTION

1. It is recognized that energy is one of the key factors required for social, economic and particularly industrial development. For effective and sustained industrial development, energy production and utilization must be planned with other factors such as technology, human resources, raw materials and finance.

2. The interdependence of energy and the industrial sector is of major concern for Governments of developing countries in formulating both energy and industrial policies. Industry is a major market for energy, and developments in industry closely affect the energy sector, just as developments in the energy sector affect industry. The size and structure of the industrial sector determines the amount and type or form of energy needed. Similarly, the availability and cost of energy supplies has a major influence on industrial development.

3. Energy is needed for all sectors of the economy, and therefore an energy policy has to take into account the requirements of the household, transport, agricultural and other sectors, as well as the industrial sector. The amount and form of energy necessary for the industrial sector in each developing country varies greatly, depending on the level of industrialization and type of industry and natural resource endowments. On the industrial side, energy is a necessary input, but, except in the case of a few industries such as aluminium and petrochemicals, it is not the major factor in choosing a location for an industry or the technology that is used. In most cases in developing countries, industry uses the energy that is available locally, taking into account all the consumption sectors.

4. The importance of energy and energy-related technologies to the industrial development of developing countries clearly emerged in the context of the Lima Declaration and Plan of Action on Industrial Development and Co-operation (A/10112, chap.IV) resulting from the Second General Conference of the United Nations Industrial Development Organization (UNIDO). The Lima target, namely that developing countries should achieve a minimum of 25 per cent of world industrial output by the year 2000, requires for its achievement correspondingly massive inputs of energy.

5. The Third General Conference of UNIDO, held at New Delhi, referred specifically to energy in the process of industrialization. It stressed that the development of new and renewable sources was required in addition to the continued utilization of conventional sources of energy. Attention was also called to the need to rationalize the consumption of energy at the global level, particularly by developed countries. The New Delhi Declaration and Plan of Action on Industrialization of Developing Countries and International Co-operation for their Industrial Development (ID/CONF.4/22 and Corr.1, chap.VI) contains a number of recommendations specifically relating to energy.

6. The purpose of this paper is to outline the major elements of the energy-industrialization relationship in the developing countries and to examine the options available, the constraints and the actions needed. The subject of energy is very wide, and it has been necessary to focus on those aspects that are directly relevant to industrialization. The developing countries are not a homogenous group in terms of their energy supplies or in terms of their industrial structure and energy needs. This paper, therefore,

needs to deal with those issues that are common to the majority of developing countries; the implementation of policy measures, especially at the national level, will have to take account of the specific circumstances of the country or countries concerned.

I. ENERGY REQUIREMENTS FOR INDUSTRIALIZATION

7. Three essential aspects of the energy-industry interaction have been identified, 1/ namely "energy for industry", "industry for energy" and "industrial energy management".

8. "Energy for industry" refers to the development of industrialization patterns appropriate to and consistent with the local pattern of energy availability; it includes the development or adaptation of energy efficient or energy appropriate processes and products. There is a strong correlation between the pattern of energy availability, including the type, quality, location and cost, and the corresponding industrial pattern that can be established, such as the sector, size, location, export potential and processes.

9. Industry can also be a supplier of goods and services in developing the energy sector - an important industrial sector in its own right, covering a wide range of capital goods and engineering and design services. The timely development of an indigenous energy capital goods sector will enable developing countries to undertake the required energy exploration and production programmes without having to rely on imported technology and equipment. This is an important consideration in relation to the goal of energy self-sufficiency.

10. Industrial energy management is concerned with creating the capability to plan effectively energy production and utilization, both at the national and plant levels, in order to ensure maximum self-reliance and efficiency of local industry in using the energy input. Within this broad subject there are three subsets.

11. Firstly, there is energy planning at the national level and its incorporation into national economic and industrial planning. Energy is a means and not an end, and, therefore, new energy production facilities must be related to industrial and other uses.

12. Secondly, there is a need for energy management at the industrial or plant level. This involves considerations of energy conservation and fuel substitution, energy efficient processes and equipment optimization etc.

13. Thirdly, there are the essential supporting functions for energy management. These include scientific and technological development, education and training and a comprehensive system of information.

14. Industry is a major consumer of commercial energy in the developing countries. It has been estimated that the average for all developing countries is around 35 per cent, but there is, of course, wide variation between countries. The manufacturing sector is the major user of industrial energy, accounting for between 20 and 45 per cent of total energy consumption.

Changes in the sectoral composition of production from light to heavy industries, as well as the introduction of specific industries that are known to be energy-intensive, constitute the main factors determining future energy intensity and growth of energy requirements.

15. It is to be noted that the respective shares of developing countries are markedly lower in such energy intensive sectors as iron and steel and non-ferrous metals. The share of heavy industry has been generally rising, and this means that industrial energy demand is rising.

16. This analysis, of course, only holds true in relation to what may be referred to as the classical process of industrialization through the establishment of centralized heavy industry. With a decentralized approach to industrialization and with the adoption of new and advanced energy efficient technologies, the increase in energy demand resulting from industrialization, or more general economic development, might not be so severe.

17. As an indication of the energy implications of industrialization in the near future, the estimates made by UNIDO 2/ of the energy needed to achieve the Lima target show that the energy requirements of the developing countries would have to increase from 1,600 million tonnes oil equivalent in 1975 to some 6,500 million tonnes oil equivalent by the year 2000. The energy reserves and resources necessary for this increase are available if all sources of energy, and not only oil, are considered. In fact, it was proposed at the United Nations Conference on New and Renewable Sources of Energy held at Nairobi that up to 50 per cent of the increased energy requirements of the developing countries be covered by new and renewable sources of energy. Achieving this calls for a major effort covering all forms of energy, conventional and otherwise new and renewable, and requires, in turn, support, both financial and technological, at all levels and co-operation in all forms, including trade.

II. THE ENERGY SCENE IN DEVELOPING COUNTRIES

18. For any analysis of the energy situation in developing countries to be meaningful, it is first necessary to look at the situation world-wide. Commercial energy production and consumption varies widely world-wide. In 1980 total commercial energy production in industrialized countries was some 77 million barrels of oil per day equivalent, while the corresponding production figure for all developing countries was 46 million barrels of oil per day equivalent. But in the same year, industrialized countries accounted for over 80 per cent of commercial energy consumption and developing countries for some 19 per cent. 3/ The factor behind this major difference in energy production and energy consumption levels is the dominance of oil in world energy and more particularly the key role in oil production and trade of a group of developing countries, namely the Organization of Petroleum Exporting Countries (OPEC). Of the 33 million barrels per day of oil that were exported in 1979, developing countries (largely OPEC members) accounted for 87 per cent.

19. Currently the developing countries have to import some 60 per cent of their commercial energy. This has an obvious and serious effect on their balance of payments.

20. Commercial energy consumption in the developing countries has been steadily increasing over the last two decades. The annual growth rate in energy consumption in the developing countries was 7.5 per cent in 1965-1973 and just under 6 per cent for the period 1973-1980. The growth in commercial energy consumption has been much higher in the developing countries than in the developed industrialized countries. An important feature is that the growth in energy consumption has continued in the developing countries even after the major oil price adujustments during the 1970s.

21. In considering energy demand in developing countries, a distinction should be made between the major oil exporting countries and those countries that are net oil importers. The former have many long-term development projects based on the availability of abundant energy and financial resources. With the cutback in their energy exports, they are currently scaling down such activities and have had problems of reduced production capacity, particularly in those industries where the feedstock is no longer available in the same quantities. On the other hand, some 75 other developing countries are energy importers, mainly of oil. Together they account for about one half of the world's population. As their energy needs continue to increase, they will face a steadily aggravating situation which will have an impact on their industrialization prospects. This is not restricted to the smaller countries or those at an early stage of industrial development. For example, Brazil, which is actively developing alternative sources, was still meeting 77 per cent of its total oil requirements in 1980 through oil imports.

22. With regard to energy consumption in the industrial sector, information in most developing countries suggests that the manufacturing sector accounts for between 20 and 45 per cent of total energy consumption. As examples, it ranged between 40-50 per cent in Brazil, Jamaica, Jordan, Mexico and Peru; between 30-40 per cent in Colombia, the Republic of Korea and Suriname; between 20-30 per cent in the Philippines, Turkey and Uruguay; 10-20 per cent in Costa Rica, Equador, Guatemala and Nicaragua. In India, all industry accounted for almost two thirds of electricity consumption.

23. Energy requirements vary considerably from one manufacturing branch to another. Energy input considerations influence industrial output mix, the location of production facilities and the technologies used for production, especially for the industrial branches having fuel costs as a substantial proportion of the total cost: cement (22 per cent), inorganic chemicals (19 per cent), iron and steel (17 per cent), textile finishing (13 per cent), building bricks (13 per cent), glass (12 per cent), paper and board (10 per cent), pottery (7 per cent) etc. 4/ On the other hand, branches such as textiles (spinning and weaving), food processing etc. are less energy intensive.

24. Within a manufacturing sector, the energy consumption per unit of product is appreciably higher in some developing countries than it is in industrialized countries. Crude steel production in China and India requires about twice as much energy per tonne of production as in Japan and one and a half times as much as in the United States of America.

25. The availability and cost of energy are decisive factors in the viability and effective operation of industrial plants and also play a vital role in the general economic well-being of countries. The developing countries are generally dependent on oil as an industrial fuel. Industrial

development and the economies of the developing countries seemed to withstand the recession of the mid-1970s with its adjustments in oil prices and dislocation of supply. One of the reasons why the economies of the developing countries were not so badly affected was the major increase in imports of the oil exporting countries. Most of the oil exporting countries are, apart from oil, resource poor, and their imports of raw materials from other developing countries grew rapidly. Also a number of the more industrialized developing countries were able to supply at competitive prices a growing number of manufactured products required for the industrialization process of the energy exporting nations. In addition, the energy importing developing countries were able to sustain their economies through substantial inflows of foreign capital; flows from the energy exporters were a major contributor, as were medium-term credits at modest or even negative real interest rates from the international banks. 5/

26. This situation is now reversed and industrial production has been declining over the last three years under the impact of the world recession, the decrease of world trade, particularly in exports of industrial goods from developing countries, and the sharp drop in commodity prices. Massive debts have been accumulated by the developing countries, resulting in unbearable debt service burdens and rapidly escalating balance-of-payment problems.

27. These changes came on top of other chronic problems that have plagued the energy sector in many developing countries and had an unfavourable impact, to varying degrees, on industrialization. These problems were due to inadequate or inappropriate repair, maintenance and operating practices in power generation and distribution, resulting in an intermittent or downgraded supply of energy to industry. An unreliable energy supply can result in very serious damage to plant and equipment and always leads to losses in production, the escalation of costs and the deterioration of product quality.

III. ENERGY RESOURCE DEVELOPMENT AND APPLICATION - POTENTIAL AND OPTIONS

A. Increased energy self-sufficiency

28. At present some 96 per cent of total commercial energy in energy deficient developing countries is accounted for by hydrocarbon energy, i.e., conventional fossil fuels, and, as indicated earlier, the bulk of this is in the form of imported oil. The need to reduce this heavy dependence on oil imports, with the related balance-of-payments problems, has been recognized in the New Delhi Declaration and Plan of Action, which called for increased energy self-sufficiency for the energy deficient developing countries. There are many motivations for the desire for energy self-sufficiency, the two primary ones being savings to the economy and assured supply. It has been estimated that the oil import bill of the energy deficient developing countries was some $US 50 billion dollars in 1980 and could rise to over a $US 100 billion dollars in 1990. 6/ The goal of an assured energy supply is common to all countries. The history of dislocations in the world energy markets provides the incentive to develop indigenous energy resources and to avoid the serious consequences of interruptions in energy supply in the industrial sector.

B. Resource endowments

29. The first problem faced by developing countries is the lack of adequate knowledge of their energy resource endowments, not only of fossil fuels, but also of the potential new and renewable forms of energy such as solar, biomass and hydropower. Many global assessments have been made of the ultimate and recoverable reserves of oil, gas and coal. These show that fossil fuel resources are not evenly distributed. In the case of oil, the Arab oil producing countries, mainly Saudi Arabia, account for over 50 per cent of the proven oil reserves. The distribution of coal reserves is also very uneven; within the group of developing countries it is estimated that China and India account for 85 per cent of the total recoverable reserves of coal.

30. The uneven pattern of recoverable reserves of fossil fuels should not be a deterrent to the assessment of energy resources on a national and regional basis. One authoritative estimate 7/ shows that 44 per cent of the total area of sedimentary basins for oil and gas exploration is located in developing countries. Despite these encouraging circumstances and the strong economic incentives provided by higher oil prices, the number of wells drilled in oil importing developing countries has remained at only three per cent of the world total for the past decade. Even if the deposits of fossil fuels located in energy deficient countries are small in relation to those of the world's major producers and the cost per unit of output is higher, there still may be incentives, i.e., economic savings and security of supply to develop them.

31. The developing countries as a whole are well endowed with, and have the potential for developing new and renewable sources of energy, such as hydropower, biomass and solar. Most of these potential resources either have not been developed at all or are being used in inefficient ways.

32. The hydropower potential of the developing countries is vast; Africa alone is estimated to have some 30 per cent of the world's potential. The High-Level Expert Group Meeting Preparatory to the Fourth General Conference of UNIDO on Energy and Industrialization and the 1983 World Energy Conference concluded that hydropower was the major option for energy development in the developing countries. It was noted that currently only about 9 per cent of the hydroelectric power potential in the developing countries had been exploited. Electric power is a universal energy form and can be used to satisfy many industrial energy needs. Although the major part of electric power will be supplied from large-scale projects, there is an important role for small and mini-hydropower plants, especially in rural areas and for decentralized industrial application.

33. Biomass already provides between 6 and 13 per cent of total world energy needs. 8/ But such estimates can only be regarded as best guesses, because much of the biomass used for energy production is not recorded in any commercial energy statistics. It is clear, however, that biomass provides the major source of energy in many developing countries. This is mainly in the form of wood for fuel, and the unmanaged and unbalanced utilization of this resource has led to deforestation and a lack of wood for fuel in developing countries. The problem is not lack of biomass resources; it has been estimated that the biomass potential of the forests of the world alone has an energy content of nearly three times current world energy consumption. 9/

34. Biomass, and its conversion to a usable energy form, represents a major resource for the developing countries. It provides them with the possibility of obtaining large quantities of indigenously produced energy from a wide variety of feedstocks and processes and is a renewable energy form. It is, or can be, produced in a wide variety of forms to meet a range of needs. It is therefore possible with planning to provide the right quantity and type of energy or fuel for both the small- and large-scale industrial sectors. For full advantage to be gained from biomass energy, developing countries need to undertake and strengthen research and development on all aspects of the subject, from improved biomass resource management through new conversion technology to more efficient end-uses. At the same time, account must be taken of the fact that biomass resources have many competing uses. It is therefore necessary to adopt an integrated and balanced approach in line with the particular needs and resources of developing countries.

35. The developing countries, owing to their geographical location, have abundant solar radiation. This energy form has traditionally been used in the agricultural sector for cropdrying. There is a wider area of industrial application for solar energy in the form of low-temperature water (30° to 70°C) produced in simple thermosyphons with flat-plate collectors. Using concentrating collectors higher temperatures (up to 150°C) can be generated. This range of temperatures fits a variety of industrial uses such as bottle washing, sanitary uses, boiling etc.

36. Another solar energy route being developed is the direct production of electric power through photovoltaic cells. This is a new technology, and at present it is only economically viable for selective decentralized applications, particularly in areas that have few or no alternatives. In future, energy through photovoltaic systems could be an important renewable source of energy, particularly for developing countries. But the widespread application of solar photovoltaics will depend on major improvements in conversion efficiencies and large reduction in cost.

37. Where centralized electrical power systems have been installed or are planned, nuclear power is an option that provides a measure of energy independence for a country poor in energy resources. Several developing countries have nuclear power plants in operation, and by the year 2000 it is estimated that some 20 developing countries will have such plants. The introduction of nuclear power in developing countries entails specific problems and considerations. These include the technical complexity and unique safety requirements, as well as the economic consequences of unreliable operations. Nuclear fuel and nuclear fuel-cycle services have been and will continue to be subject to non-proliferation constraints, which have affected the assurance of fuel supply and the transfer of technology. But the question of fuel availability does not seem to be a major obstacle for the time being, and it is interesting to note that the export market price of uranium has fallen from $US 112 per kg in 1978 to less than $US 60 per kg in 1983.

C. Improvements in energy extraction and production

38. In addition to widening their resource base, developing countries can improve their energy self-sufficiency by increasing the output of existing energy deposits. This can be accomplished through improved techniques or the installation of new equipment.

39. In the coal sector, there are a number of steps that can be taken to increase the output from a given deposit. The traditional room-and-pillar system of underground mining results in about a two-thirds loss of potential coal reserves. The long-wall system of mining reduces the reserve loss to between 20 and 40 per cent, but, of course, requires more modern mining technology. In open-cast coal-mining operations, there are also a number of technical and operational changes that can be made to improve productivity.

40. Where developing countries already have oil and gas operations, it is possible to increase oil recovery from some 30 per cent of reserves to 40 per cent or even higher using secondary and tertiary oil recovery methods. This requires the introduction of new technology and thus capital expenditure. But the upgrading of existing oil and gas fields, especially for the smaller oil-producing countries, may be an attractive short-term option for increased energy production, even if this increase is at higher cost.

41. In the case of renewable forms of energy, better methods of energy conversion is the central issue. In the case of biomass energy, the resource base can be extended by the introduction of "energy farming", but the major advances are in technology for converting biomass resources into a usable energy form. Similarly, in the case of solar energy, where the actual amount of solar radiation is fixed, it is the amount of energy that can be harnessed that increases with improved technology. A distinction should be drawn between those gradual improvements in the conversion efficiency of renewable energy forms that are a result of better solar collectors or charcoal production techniques and those new developments that have a high potential impact, such as photovoltaic cells and the direct production of electricity from solar radiation and the production of liquid fuels from biomass. The first type of improvements can be made in a fairly short period of time and do not require major changes in the methods of production and patterns of use. The second type usually requires considerable development and takes time and finance, but the changes in the energy balance of the country could be quite dramatic.

42. The energy sector itself, which consists of the processing, conversion, transmission, distribution and storage of energy, is very energy-intensive and, therefore, presents considerable opportunities for improved fuel efficiencies. This can be achieved in a number of ways, including the substitution between hydro-based power and thermal power, the substitution of lower-cost thermal fuels (coal, lignite) for oil and the reduction of losses in the conversion process mainly in thermal plants and in electric power transmission and distribution. It is in the generation of electric power that some of the largest energy losses occur. Thermal power generation is thermo- dynamically inefficient, with energy losses of around 60 per cent. In the developing countries, these losses can be even higher owing to poor maintenance and operation. Co-generation of the combined production of heat and electricity from fossil fuel and nuclear plants feeding industrial processes could raise average efficiencies. Such co-generation, however, requires integrated urban planning and plant siting, which is not possible in the short term.

D. Improvements in energy efficiency in the industrial sector

43. Energy conservation through more efficient use is of major advantage and relevance to all countries. Studies covering developed market economies have demonstrated the many potential methods of increasing energy efficiency in all sectors. More recent studies of industrial energy consumption in developing countries have shown that there are equally large opportunities for energy savings in those countries. For example a study of Kenya concluded that 20-25 per cent energy consumed by Kenya's industrial sector at present could be conserved through economically attractive measures, thus saving around one million barrels of oil a year. 10/

44. In discussing improvements in energy efficiency in the industrial sector in developing countries, it is important to note that although the potential will vary from country to country depending on the specific industry and fuel mix utilized, the net result will be lower energy consumption per unit of output. A distinction has to be made between the centralized industrial sector and the decentralized small-scale sector. The centralized sector can save energy using improved technological production processes, and the energy-saving control measures developed in the industrialized countries can be of relevance. The decentralized industrial sector is large in most developing countries, and it is therefore essential that consideration be given to finding ways of improving energy efficiencies in this sector. In this case, however, the methods and practices used in the industries of the developed countries cannot be used as a model. Appropriate energy conservation measures for the small-scale decentralized industrial sector will have to be developed.

45. A major attraction of energy conservation is that it usually costs less than supplying an equivalent amount of additional energy. One study for the United States indicates that an average of 25 per cent of the energy used in the manufacturing sector could be saved by introducing measures where capital and related costs are less than the cost of generating equivalent amounts of energy. Another major advantage of energy conservation as a policy instrument is that substantial savings can be made in a relatively short time. It has been estimated that in the energy-intensive industries such as iron, steel and aluminium up to 10 per cent of total energy consumption can be saved through housekeeping improvements or other small changes requiring minimal investment. Much larger savings of up to 30 per cent can be achieved in a period of up to three years through retrofitting, the installation of controls and simple process changes. In the longer run greater savings can be achieved using entirely new technology and processes.

E. Integrated energy and industrial planning

46. Developing countries have another objective in addition to increasing their self-sufficiency in energy supplies and improving the efficiency of energy utilization. It is the integration of their energy policy and programmes into general industrial and economic planning. Energy planning aims at optimizing national energy supplies and consumption, according to natural resources, priorities assigned to different consuming sectors, financial considerations, the balance of payments and other factors. The central role of industry in the energy question means that national energy

planning is directly and inextricably connected with industrial planning. Sectoral energy planning is an essential part of national energy planning. New concepts and programmes are needed in connection with the development of new industrial structures, special attention being given to the selection of branches, the location, the size etc. and to energy availability. The maximum and effective use of indigenous energy sources is an obvious priority for the developing countries in evolving a national industrial development plan.

IV. MAJOR CONSTRAINTS ON ENERGY RESOURCE DEVELOPMENTS AND APPLICATIONS

47. The constraints encountered by developing countries in developing their energy resources to the optimum and improving the efficiency of their industrial energy consumption are numerous, but they can be grouped under five main headings:

Lack of finance;
Lack of know-how;
Lack of skilled human resources;
Lack of equipment;
Lack of plans and specific proposals.

These constraints are, of course, not confined to the energy sector but are common problems faced by developing countries in the process of industrialization. Another important point is that the constraints are interconnected, for example the lack of finance hampers research and development of technology, which is also restricted by lack of trained labour.

A. Finance

48. As with all major investment programmes and in today's economic climate, the financing of large-scale capital intensive projects - and most energy development projects are of this type - is extremely difficult. Most oil-importing developing countries already have large debt burdens, owing in large measure to the need to import high priced oil and to high rates of interest. In this situation, they are not in a favourable position to obtain finance for energy projects from normal commercial banks. This lack of finance affects all sectors of energy development, from assessment and exploration to exploitation and conversion to industrial end-use.

49. It is important to note that the World Bank has estimated 11/ that the developing countries will need to spend an average of $US 130 billion a year on investments in energy between now and 1995. If the World Bank were to devote 25 per cent of its lending to energy investment, this would only amount to $US 4 billion a year. This energy investment gap must be filled if the energy necessary for the developing countries' industrialization programmes is to be forthcoming. Many developed and developing countries have supported the proposal for international action on the provision of finance for energy development, including the establishment of a World Bank Energy Affiliate, but up to now no agreement or action has been taken, and developing countries will have to generate as much as possible of the capital internally.

B. Technology

50. The development and utilization of most energy resources in developing countries, whether of conventional or new and renewable forms, requires the development or transfer of the necessary technology. Such activity cannot be considered in isolation but will have to be part of a more general policy on strengthening the technological capabilities of developing countries.

51. The technological constraints on the energy sector in developing countries can be divided into three broad categories: those associated with the transfer and acquisition of existing technologies from industrialized countries; those associated with the need to carry out research and development on new energy technologies; and those associated with improving or adapting existing technologies.

52. The developing countries, with a few notable exceptions such as Brazil and India, have generally relied heavily on the supply of energy technology from the developed countries. Consequently the technology for the development of oil, gas, coal and nuclear power is largely controlled by a small number of international companies. In recognition of this situation, there have been a number of calls for the developed countries to improve the transfer of appropriate technology in the energy sector to the developing countries, but only little progress has so far been made in this regard.

53. There are a number of new energy technologies that show promise and have major potential for the developing countries, at least in the long term. These, as noted above, include biomass and solar energy. The problem is that much of the early research and development has been carried out by the developed countries, but, with the recent decline in oil prices, the incentive for them to continue this work seems to have declined. The developing countries will have to strengthen their own research and development capacities in the field of new and renewable sources of energy and bring them to commercialization. Unless this is done, the developing countries will lose a major opportunity to improve their energy self-sufficiency through the use of new and renewable sources of energy.

54. In exploiting energy resources and using industrial energy efficiently, the developing countries face a number of problems in improving or adapting imported technology. The question of scale is an important example. The technologies used for developing major oil and gas deposits are often too costly and not suitable for small deposits which developing countries may wish to exploit for their domestic needs. Similarly, the technological advances taking place in electric power generation are usually limited to large generating plants, and, therefore, the developing countries with small power stations cannot benefit from these improvements. For developing countries to gain from technological advances, they would have to use the same type of industrial process.

C. Human resources

55. There is great potential in the developing countries for increasing the efficiency and reliability of equipment used in the energy sector. The realization of this potential depends heavily on the availability of people

with scientific and technological skills. This is true for all stages of energy development, including the construction, operation and maintenance of plant and equipment. Skilled individuals are a very scarce resource in developing countries, and the energy sector has to compete with all other sectors. It is essential that scientific and educational training in the developing countries takes into account the future skills and technical knowledge required for the development of energy resources. This is a long-term programme, however, and in the short term other solutions must be developed. Expatriate staff may be used to build, operate and maintain energy installations and run industrial energy plants, but this not only continues the period of technological dependence but also is costlier. Certain new technologies, such as maintenance-free equipment and micro-processor controls, can help, but these are often too costly for developing countries or do not fit into the existing energy plants.

D. Capital goods for the energy sector

56. In addition to the lack of technology or know-how, most developing countries depend on imported capital goods for the energy sector. This leads not only to high foreign-exchange costs but often to the introduction of capital equipment that is not suitable to the conditions in developing countries. The market in capital goods and services for the generation of energy is very large and varied and represents an important industrial sector for the developing countries.

57. The energy sector needs a wide range of equipment and special materials for, inter alia, petroleum exploration, coal mining, hydropower stations, biomass conversion, transmission lines and pipelines. Much of the equipment needed is within the capabilities of the developing countries and could be manufactured locally. There would be no real benefit in replacing imported oil with energy forms that require substantial imports of capital goods.

58. There is a natural progression that countries can follow to establish an energy capital goods industry. The first is the development of repair and maintenance capability for energy equipment. This would improve the utilization of existing equipment, prolong the life of capital equipment and lower capital investment per unit of output.

59. The next stage would be the development of manufacturing capability for energy capital equipment. This could be achieved through a joint activity (license, joint venture etc.) with a manufacturer in a developed country. However, local manufacture of equipment is often hindered by the small size of the local market. It is therefore important that developing countries consider a regional approach with co-ordination in the manufacture of equipment for a larger market.

E. Plans and specific proposals

60. The energy situation of the developing countries is now in a stage of transition. The aim is to move away from dependence on imported energy and its financial burden and to increase the use of indigenous energy sources and improve energy management. This transition requires the careful examination

of the complex policy options and associated issues and the formulation of clear and purposeful plans and proposals. This difficult task of identifying options, establishing priorities and translating policies into concrete action is often a major constraint to development.

61. When faced with an extremely complex situation, as in the case of energy and industrial policy, it often happens that no firm policy action is taken and events are left to take their own course. Each country needs to formulate a strategy, with priorities identified and short- and long-term actions clearly defined. Clear and workable proposals need to be developed and implemented in the field of energy and industry. Such a set of proposals will not only enable developing countries to plan at the national level but will also enable them to co-ordinate activities at the regional or global level. Comprehensive and detailed proposals on energy projects are also necessary to obtain financing from international financial institutions.

V. SPECIFIC ACTIONS AND PROGRAMME INITIATIVES

62. The future energy needs of the developing countries in relation to their industrial development has received widespread international attention. Since its inception, UNIDO has carried out energy-related activities; the importance and urgency of such activities became particularly apparent after 1973-1974. At the Second General Conference of UNIDO, held at Lima in 1975, the importance of energy and energy-related technologies was recognized and was implicit in the Lima Declaration and Plan of Action. The Third General Conference of UNIDO, held at New Delhi 1980, specifically referred to the role of UNIDO in energy-related industrial activities and made recommendations on action needed and priorities. The Industrial Development Board of UNIDO has established energy-related activities as one of the priorities of UNIDO, and this has been endorsed by the General Assembly.

63. The High-Level Expert Group Meeting Preparatory to the Fourth General Conference of UNIDO on Energy and Industrialization, 1/ held at Oslo, had before it a report on the UNIDO energy development and industrialization programme (ID/WG.402/5). The Oslo Meeting took into account the reports and recommendations on energy and industrialization from other international meetings and organizations (see the annex).

64. The aims and objectives of developing countries in the field of energy and industrialization could be:

(a) To undertake integrated energy and industrial planning;

(b) To increase their energy self-sufficiency and develop and widen their energy resource base;

(c) To enhance capital goods manufacture in support of the energy sector;

(d) To increase industrial energy efficiency.

These topics provide a set of priorities for new initiatives on energy for developing countries.

65. The Oslo Meeting on Energy and Industrialization made some general recommendations for action by the developing countries with the active assistance of UNIDO. Within the area of energy development it was recommended that:

(a) Developing countries should initiate more active programmes for oil exploration and development;

(b) Those developing countries with potential coal resources should formulate coal development strategies covering a co-ordinated programme of investment in resource extraction, transport and coal-fired plants or industrial equipment;

(c) International assistance should be given to developing countries to enhance the exploitation of natural gas for industry;

(d) Hydropower assessments should be carried out on a national and regional basis, and the valuable work of UNIDO in this area should be expanded;

(e) Biomass energy conversion technologies should be monitored and assessed by UNIDO for the benefit of developing countries. UNIDO should play a major role in strengthening local design and construction capacity in biomass energy conversion in developing countries through workshops and the provision of manuals;

(f) UNIDO should develop a network of researchers, especially those in developing countries, working in the field of biomass energy;

(g) Assistance should be given by UNIDO and other appropriate bodies to developing countries in evaluating the potential for solar industrial process heat;

(h) Encouragement and support should be given by UNIDO to research on techniques to manufacture solar photovoltaic materials in developing countries.

66. In relation to capital goods for the energy sector, it was recommended that UNIDO should:

(a) Assist developing countries in identifying and contracting with partners in developed countries for the local manufacture of energy equipment;

(b) Assist developing countries in designing and negotiating regional manufacturing agreements in energy equipment;

(c) Review and strengthen information networks on energy and industry technologies, including costs, performance, applications and manufacture, in co-operation with relevant international organizations;

(d) Establish repair and maintenance capacity for energy equipment in developing countries. In this connection, the Oslo Meeting endorsed the suggestion of the High-Level Expert Group Meeting on Accelerated Development of Human Resources for Industrial Development 12/ that a programme be established to develop local capabilities in industrial maintenance, perhaps through multi-purpose industrial maintenance institutes.

67. In the area of industrial energy management, it was recommended that:

(a) Developing countries should adopt appropriate industrial energy pricing policies in line with long-term costs of additional energy supply;

(b) UNIDO should undertake a comparative study on the subject of incentives for energy conservation and raise the level of interest in the subject in developing countries through meetings, publications etc.;

(c) UNIDO should assist countries in the establishment of regulatory frameworks for industrial energy consumption;

(d) Research and development should be undertaken on the specific problems of energy conservation for decentralized industries. UNIDO should promote such a programme at the national level;

(e) Energy audits should be undertaken at the national, industrial sector and plant levels to estimate the energy savings potential and to identify conservation measures and their costs;

(f) UNIDO should design and undertake training programmes for industrial energy co-ordination or energy management teams in the field of energy audits and industrial energy management practices;

(g) UNIDO should organize necessary meetings at the regional and subregional level for the establishment of centres of excellence within developing countries for energy planning, energy development and energy management;

(h) The UNIDO Industrial and Technological Information Bank (INTIB) should play an important role in the collection and dissemination of information in the field of energy development and industrial energy management.

68. Within these general recommendations on energy and industrialization for developing countries, the Oslo Meeting proposed specific programmes for UNIDO in areas of highest priority. The Meeting recommended that UNIDO should:

(a) Develop mechanisms such as workshops and seminars to allow developing countries to share experience in the integration of development, industrial and energy policies;

(b) Extend its project feasibility service to assist developing countries in formulating energy and industry projects in line with the criteria used by international financial institutions;

(c) Carry out activities to support the local manufacture of energy equipment in developing countries, including guidance in establishing a manufacturing plant, facilitating the transfer of the necessary technology and encouraging joint-venture relationships through the UNIDO investment promotion service;

(d) Initiate a mini-hydropower development programme in Africa similar to the successful programme it promoted in Asia;

(e) Selectively conduct demonstration projects on technologies for the extraction of useful energy from biomass in the form of agricultural waste so as to provide the necessary information on the design of an industrial scale operation. One particular area would be the design of gasifiers for use with various agricultural waste feedstocks;

(f) Assist developing countries in launching a comprehensive integrated result-oriented programme of industrial energy conservation. This would include education and training and preparation of manuals, methodologies for energy audits and assessment. The first phase of this programme would be aimed at energy savings with little or no capital investment coupled with a system to measure progress.

Notes

1/ Report of the High-Level Expert Group Meetings Preparatory to the Fourth General Conference of UNIDO: Energy and Industrialization, Oslo, Norway, 29 August - 2 September 1983 (ID/WG.402/12).

2/ Energy and Industrialization of Developing Countries: Some Overall and Sectoral Considerations (UNIDO/IS.393), p.11.

3/ South-South and North-South Co-operation on Energy for Industrialization of the South (UNIDO/IS.369).

4/ Industrial energy requirements and some policy implications for developing countries (ID/WG.402/6), p.1.

5/ World Economic Survey 1983, United Nations, New York 1983.

6/ According to a report of the Economic and Social Council (E/1983/91).

7/ Michael Halbouty, "World petroleum reserves and resources", Petroleum Exploration Strategies in Developing Countries (London, Graham Trotman, Ltd., in co-operation with the United Nations, 1982).

8/ World Bank, Energy in the Developing Countries (Washington, D.C., 1980).

9/ Report of Technical Panel on Biomass Energy A/Conf.100/PC/28 United Nations Conference on New and Renewable Sources of Energy (Nairobi, 1981).

10/ The Economies of and Potential for Energy Conservation and Substitution (ID/WG.402/7).

11/ World Bank, The Energy Transition in Developing Countries (Washington, D.C., 1983).

12/ Report of the High-Level Expert Group Meetings Preparatory to the Fourth General Conference of UNIDO: Accelerated Development of Human Resources for Industrial Development, Yaoundé, United Republic of Cameroon, 30 May - 3 June 1983 (ID/WG.394/8).

Annex

RECOMMENDATIONS ON ENERGY AND INDUSTRIALIZATION FROM RECENT INTERNATIONAL MEETINGS

1. Within the Programme for the Industrial Development Decade for Africa, a/ the following energy-related activities have been proposed:

(a) The implementation of comprehensive energy programmes at the national, subregional and regional levels to support the entire industrialization process in Africa;

(b) The intensification of research and development activities related to developing alternative new and renewable sources of energy at the national, subregional and regional levels;

(c) An analysis of current uses of sources of energy with a view to ascertaining the efficiency of energy uses as well as the potential and possibilities for conservation;

(d) An assessment of energy, machinery and equipment needed for energy generation, transmission etc., within the industrialization framework of the Lagos Plan of Action, taking into account existing and future requirements;

(e) An assessment of the cost-effectiveness of the various available types of energy sources, end-uses of energy and energy conversion systems, with a view to selecting the most effective energy sources and systems for particular end-uses;

(f) The preparation of labour profiles for the energy sector;

(g) Intergovernmental consultations on policies for energy development, within the industrialization framework of the Lagos Plan of Action.

2. In addition, the following institutional framework was proposed at the national and international level:

(a) Energy study groups to advise Governments on national energy needs, supply policies, conservation measures and energy research and development efforts required to ensure the development and application of technology in the energy sector;

(b) Enterprises for the development, production and marketing of energy resources;

(c) Research, development and training centres, with emphasis on non-conventional energy;

(d) Enterprises for the manufacture and marketing of energy conversion, generation, storage, transport, transmission and utilization equipment and devices;

(e) Subregional and regional energy boards, comprised of the national energy boards, to foster the integration and interconnection of energy networks as well as the standardization of energy equipment.

3. The Group of 77 Meeting on Energy Development, Supplies and Rationalization of Energy Consumption held at Bangkok in August 1983 b/ drew up a series of recommendations for co-operation among developing countries in the energy field that included the:

(a) Identification of requirements, by preparing an inventory on a country or regional basis as necessary of potential energy resources in relation to present and future energy needs;

(b) Identification of existing capabilities in developing countries in the various energy-related activities such as planning, research and development, training, capital equipment manufacturing, consultancy services and others;

(c) Establishment of close working relationships between national consultancy and operating organizations in the coal and solid fuel sector on a bilateral, regional, subregional and interregional basis, in all phases of exploration and development;

(d) Identification and enlistment of the services of established coal research and development laboratories and institutes in those few developing countries with long-established coal industries as regional and subregional training centres or centres of excellence in coal research and development;

(e) Co-operation in the area of capital equipment supply for coal production and utilization among developing countries;

(f) Mobilization of financial resources for energy exploration and development through existing international, regional and other financial institutions, whose facilities should be fully utilized;

(g) Further study of the feasibility of a third world petroleum international consortium of state petroleum enterprises of developing countries for co-operation in petroleum exploration and the development of hydrocarbon resources;

(h) Identification of existing training institutes in the developing countries and promotion of national training and research centres of multinational scope;

(i) Preparation of study of areas of co-operation in downstream oil activities;

(j) Encouragement of co-operation among developing countries in the conservation of energy resources, regulations and environmental protection;

(k) Promotion of information exchange by setting up an energy information system. Information may also be exchanged through direct contacts, meetings of experts and other channels;

(l) Identification of areas of needs and available human resources on a national basis, to be distributed to all developing countries so that they can select personnel for training or study in the most appropriate sector;

(m) Promotion of direct contact between existing subregional and regional organizations or arrangements concerned with petroleum co-operation.

4. The Group of 77 Meeting also proposed the establishment of an action committee to ensure further progress in co-operation among developing countries in the field of fossil fuels.

Notes

a/ A Programme for the Industrial Development Decade for Africa. Prepared jointly by the Economic Commission for Africa, the Organization of African Unity and the United Nations Development Organization (ID/287).

b/ Report of the Meeting on Energy Development, Supplies and Rationalization of Energy Consumption, Bangkok, Thailand, August 1983, G77/ECDC/E-2/Rpt.1. Held in connection with the Caracas Programme of Action on Economic Co-operation among Developing Countries.