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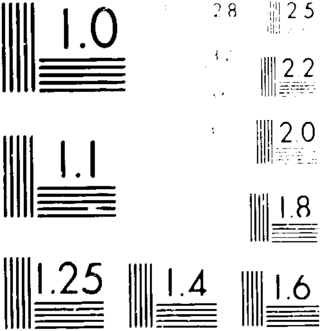
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ENERGY DEVELOPMENT AND INDUSTRIALIZATION *

Prepared by

the Special Advisory Group on Fnergy

in the Office of the Executive Director

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Note

This report on the interdependence between energy development and industrialization takes into account suggestions made at the Director's Meeting of 11 August 1982. After additional substantive revision, the report will be edited, translated and printed for general distribution.

PREFACE

It has become increasingly clear during recent years that social, economic and, particularly, industrial development are inextricably connected with energy development and utilization. Although other factors, such as technology, skilled human resources, finance and raw materials are also essential for the operation, establishment and/or expansion of industry in developed and developing countries, energy is, at present, one of the critical ones. It is also a decisive factor determining international trade and economic relations.

Industry is central to the development process and this applies also to the development of the energy sector. In this connexion it should be underlined that industry is the supplier of all the equipment needed by the latter. Besides being a large direct consumer of energy, industry, through production of energy-appropriate and energy-efficient capital and consumer goods, can also to a large extent determine the demand in other sectors of the economy.

It is, thus, essential that UNIDO devotes special attention to energy-related industrial development activities. In accordance with UNIDO's general mandate and with specific recommendations of the Industrial Development Board, a Task Force on Energy was appointed in 1977. Its Report was submitted to the Third UNIDO Conference on Industrialization (New Delhi, 21 January to 9 February 1980). In early 1980 a Special Advisory Group on Energy was established in my office, for co-ordination and promotion of energy-related activities in the context of UNIDO's Programme of Work. With the full co-operation of all relevant UNIDO units and officers this consolidated Report has been prepared. It should be considered as a comprehensive factual, conceptual and action-oriented framework on which to base further studies, promotion, technical assistance and other activities.

The magnitude and the complexity of the effort needed to enable developing countries to approach the Lima target demands great attention to their problems and opportunities in the harmonious development of the industry and energy sectors. The UNIDO Secretariat will continue to endeavour to increase its contribution towards awareness, studies, planning and action relating to industrial aspects of energy supply/demand. In its work the Secretariat will always look for opportunities of co-operation with other UN units, and with governmental, inter-governmental and non-governmental organizations.

The "blue-print" is available. We should now continue our work towards definition and implementation of a comprehensive, integrated and balanced energy-related programme.

Abd-El Rahman Khane
Executive Director

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I. INTRODUCTION

The objective of this report is to present the most relevant facts, concepts, goals, guidelines and proposals for action on energy-related industrial development activities as part of the work needed to define a comprehensive, integrated and balanced UNIDO energy programme. Starting from a factual-conceptual framework it attempts to identify activity areas requiring priority attention of UNIDO in terms of studies, technical assistance projects, promotional activities and co-operation with other UN bodies, G.O., I.G.O. and N.G.O.

The report is not a study and is not intended to present fully and/or in detail all aspects of the energy/industry interdependence. It is meant to be a "progress report" and a reference document to facilitate action by the appropriate and concerned UNIDO units.

The contents of the report (and attachments) reflect essential work carried out by UNIDO in the period mid-1980 to mid-1982, specially in connexion with the preparation for and participation in the UNCNRSE (and its follow-up). It reflects specific contributions made by various divisions and units of UNIDO. It also incorporates, in their essence, relevant parts of the previous UNIDO Energy Task Force Report and Proposed Action Programme (Doc. No. UNIDO/Ex.108 of 3 January 1980), as well as parts of a number of other documents prepared afterwards (v.g., UNIDO-OED 130 and 131, et allia).

The work carried out in the period mentioned and concisely presented (or mentioned) in this report was based upon and was a follow-up of the decisions and recommendations of UNIDO III and of the IDB.

II. THE BROAD PERSPECTIVE: THE SETTING

If one considers the broad perspective of world development since 1945 it is clear that five extraordinary scientific/technological/industrial efforts took and/or are taking place:

a) The atomic/nuclear effort which led to the availibility of a new kind of energy;

b) The semi-conductor research effort which led to the development of transistors and computers and to a continuing "electronic revolution";

c) The space exploration effort which led to service satellites for communications, earth resources exploration, etc.;

d) The "energy revolution": it is clear that we are now in the midst of a fourth vast international effort which will lead to a much needed readjustment in depth in the pattern of supply, processing, management and use of energy. Dispassionate and fair analysis shows that the "oil shock" of 1973 brought with it a worldwide awareness of the need for a readjustment of the world energy production-consumption pattern which will have profound and long lasting impact on the industrial structure and on industrial processes, products and services;

e) A fifth "revolution", whose impact will be even greater than that of the other four mentioned before, has already started. It is the "bio-technological revolution", including, very specially, molecular genetics (the new non-Mendelian genetics also called "genetic engineering" or "recombinant DNA").

It is clear that the five developments mentioned are closely related to the two critical inputs of modern industrial and economic developments: technology and energy (sometimes referred to, in another context, as the "technodollar" and the "energy-dollar", the latter being a broader concept than that of the "petrodollar")1/.

While considering the broad perspective, and without attempting to enumerate all the drastic changes that took place in the world, since 1945,

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1/ L.CdS. -

it is necessary, however, to recognize another fundamental "evolution" which took place in the seventies. In the 1970s developing countries, as a group, became fully aware of their extraordinary opportunities in economic and industrial development and took corresponding action. One may mention, as an example of this new awareness, the Lima Declaration and Plan of Action (Lima, 1975), in which, with the support of most developed countries, they set for themselves the target of producing 25 per cent of world industrial output by the year 2000. They have since decisively expanded their efforts towards this goal and are increasingly active in the analysis and decisions regarding options for economic, industrial, technological and scientific development, as well as in the implementation of the corresponding plans and action.

III. THE INTERDEPENDENCE AMONG DEVELOPMENT, INDUSTRIALIZATION AND ENERGY AVAILABILITY 1/

The strong linkage and interdependence among development (understood as economic and social development), industrialization, energy availability is demonstrated, recognized or supported by: (a) long term economic history; (b) recent events and trends of the world economy; (c) analysis of energy input/output and end-use in developed and developing economies: and, finally (d) by decisions taken and recommendations made by Governments and intergovernmental organizations. This linkage is concisely reviewed below.

a) The evidence found in long term economic history is clear. The "industrial revolution", which brought with it extraordinary economic and social progress, was essentially carried out in the XIXth and early XXth century and was based, on one hand, on the invention, development and extensive application of the steam engine (a technological development) and, on the other, on the availability of a cheap, abundant source of energy, namely coal. The availability of cheap and good quality coal mined mainly in the Rhine valley, in central England and Wales, in Pennsylvania and in the Don basin allowed and determined the pattern and extent of industrialization of Europe and North America. In this century, the increasing large scale availability of cheap petroleum obtained from local fields and/or through imports from foreign controlled fields in developing countries provided an additional thrust to the economies of the developed countries.

b) More recently, in the last two decades, the problems and opportunities related to the availability, control and/or access to cheap fossil or mineral fuels (mainly petroleum, natural gas, coal and uranium) have led, initially, to a high rate of expansion of economic activity, specially in the industrialized countries, involving a large degree of misuse and wastage of energy. This led, in the last few years, to a crisis situation or "energy emergency" caused by a recognition that the use of non-renewable resources, particularly petroleum, must be judiciously and rationally

1/ This concise review focuses on these variables for the sake of simplicity and relevance to the "energy issue". The strong linkage of the three variables mentioned with technology is also crucial but cannot be analyzed here, although it is implicit in the text.

managed to avoid an even worse crisis which would arise from their early exhaustion. The analysis of such events and trends leads, again, to the recognition of the close and essential linkage among development, industrial activity and energy availability and, insofar as planning is concerned, to the need to fit industrial and energy development plans within overall social and economic development planning. It also leads to the conclusion that energy development and management, including pla ing at national and international levels, down to plant level, is an imperative to ensure, on one hand, economic stability in developed countries and, on the other, economic and social development in the developing countries, based on a balanced, rational and accelerated industrialization effort.

c) **Broad economic and social development is practically synonimous with industrial development. It is for this reason that developed countries are also called "industrialized countries".[1/] Even the smallest among them may have such basic industries as: iron and steel, petrochemicals, heavy capital goods, etc.. Industrialization, in turn, depends on various factors but two of them stand out today as critical ones: technology and energy. These can be considered as the two "de facto" strong currencies now determining the state and course of the world economy (international trade, finance and monetary system).**

Structural analysis will also indicate that "industry is central to the energy problem" [2/] since about 35 per cent of total world energy supply is used directly in industry, and since the energy needed for the operation/ use of capital and consumer goods delivered by industry to other sectors of the economy amounts to another 50 per cent of total energy consumption. Thus, industrial activity is directly responsible for, or involved in, the use of some 85 per cent of the world energy consumption. It is industry, through R + D, through process and product engineering and through effective industrial operations that will have to develop and deliver more energy-efficient and energy-appropriate capital and consumer goods, with full use of innovation, substitution, miniaturization, conservation, etc. In particular, all the equipment needed for the energy sector[3/] is developed and produced by industrial enterprises. Accordingly, it has been stated that "there is no industry without energy and no energy without industry"

1/ It should also be remembered that the most advanced agriculture is found in industrialized countries.

2/ Address by Dr. A.R. Khane, Executive Director of UNIDO, to the Nairobi Conference (10-21 August 1981)

3/ Equipment needed to explore, exploit, extract, harness, convert, transport, transmit, process, distribute and use energy in all its forms.

d) The close and strong linkage among development, industrialization and energy has also been recognized specifically through various decisions, resolutions and recommendations by UN bodies. This is concisely reviewed in Section IV "Development, Industrialization and Energy: UN decisions and recommendations".

IV. DEVELOPMENT, INDUSTRIALIZATION AND ENERGY - UN DECISIONS AND RECOMMENDATIONS

As mentioned in the previous section, the linkage among development, industrialization and energy has been affirmed by various decisions and recommendations of the United Nations, many of which establish and/or clarify the UNIDO mandate or terms of reference. The main ones are mentioned below.

a) The need for a specialized Organization to promote and assist/ support the industrialization process in developing countries was recognized at an early stage, leading to the establishment of UNIDO 1/.

b) The acceleration of the industrialization process was recognized as essential to achieve rapid expansion, modernization and diversification of the economies of the developing countries 2/ 3/.

c) The industrialization target established in Lima was endorsed 4/ and was linked, in particular, to the "...development and expansion of all energy resources. 5/"; it was also linked to the "...strengthening of the scientific and technological capabilities of developing countries..." and to their "...economic and social objectives." 6/

d) Furthermore, energy problems and opportunities were the object of special attention in all their aspects, including the need to develop NRSE. 7/

1/ General Assembly Resolution 2152, XXI Session 1966, entitled United Nations Industrial Development Organization

2/ General Assembly Resolution 1710, XVI Session 1961, para 4(a) - from the UN Development Decade: A programme for international economic co-operation

3/ General Assembly Resolution 2626, XXV Session 1970, Section C, Ch.9, para (76),- from the International Development Strategy for the Second UN Development Decade

4/ General Assembly Resolution 3362, VII Special Session 1975, Ch.IV - from Development and International Economic Co-operation

5/ General Assembly Resolution 35/36, XXXV Session 1981, Ch.II, para 34- from the International Development Strategy for the Third UN Development Decade

6/ see Footnote 5/ Ch.II, paras 36 and 42

7/ see Footnote 5/ Ch.III, Section H

e) It was further recognized and reaffirmed that the international community should make all efforts "...to encourage the industrialization of developing countries..." and that it should also promote co-operation for "...research and development in exploration, exploitation...and utilization of...all sources of energy." 1/

f) The linkage between industrial development and energy availability, specially NRSE, has also been considered and recognized, in great detail, 2/ with specific recommendations for action to ensure that problems relating to the supply of energy needed for development can be solved on the basis of national efforts and international co-operation under various modalities. 3/

g) The interdependence and essential linkage of NRSE development, and application, on one hand. and industrial development on the other, was recognized and clearly indicated in the NPOA, which includes close to one hundred references to action needed and directly dependent on or related to industrial activities. 4/

1/ General Assembly Resolution 3202, VI Special Session 1974, Ch.III Introduction and Ch.IV (e) - from the Programme of Action on the Establishment of a New International Economic Order

2/ New Delhi Declaration and Plan of Action on Industrialization of Developing Countries and International Co-operation for their Industrial Development, PI/72, resulting from the Third General Conference of UNIDO, 21 January to 9 February 1980, Ch.II, para 103

3/ see 2/, Ch.IV, paras 200-223

4/ Nairobi Programme of Action for the Development and Utilization of New and Renewable Sources of Energy, A/CONF.100/11, resulting from the United Nations Conference on New and Renewable Sources of Energy, Nairobi, 10-21 August 1981

UNIDO'S ENERGY-RELATED ACTIVITIES - ORGANIZATIONAL ARRANGEMENTS

Since its inception, UNIDO carried out energy-related activities but the importance and urgency of such activities became particularly apparent after the "oil emergency" of 1973-1974.

The importance of energy and energy-related technologies to the industrial development of developing countries was recognized and implicit in the "Lima Declaration and Plan of Action" resulting from the Second General Conference of UNIDO, held in Lima, Peru, 12-26 March 1975 (document PI/38).

A UNIDO Energy Task Force was created by the Executive Director in 1977 and prepared a comprehensive Report (UNIDO/EX.108, 3 January 1980) which provided an overview of energy-related activities and programmes at that time.

The Third General Conference of UNIDO, held in New Delhi, 21 January to 9 February 1980, in its "New Delhi Declaration and Plan of Action" (document PI/72), specifically referred to the role of UNIDO in energy-related industrial development activities and made recommendations on action needed and priorities.

Accordingly, and as a further step towards designing and co-ordinating an integrated and comprehensive UNIDO energy-related programme, the Executive Director decided to create, in April 1980, a Special Advisory Group on Energy in his Office 1/ (reference UNIDO/EX/B.165 of 23 April 1980).

The decisions and recommendations relating to energy contained in the New Delhi Declaration and Plan of Action were subsequently discussed at the Industrial Development Board of UNIDO, at its 14th Session held in Vienna, 9-19 May 1980 and its Second Special Session, held 12-16 October 1980 (document ID/B/248 and GA Official Records of its 35th Session, Supplement No. 16 (A/35/16)), resulting in the establishment of energy-related industrial development activities as one of UNIDO's priorities. These priorities were endorsed by the General Assembly in its Resolution 35/66.

1/ Designated as OED/SAGE in this Report

As mentioned in the previous Section, the UN Conference on New and Renewable Sources of Energy (UNCNRSE) (Nairobi, 10-21 August 1981) considered specifically the role of NRSE in developing countries and action needed and directly related to industrial activities. The implementation of many of the recommendations made will involve UNIDO as either a leading or a co-operating agency.

PART B
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ANALYSIS. BASIC FACTS, CONCEPTS, GOALS
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I. SOME BASIC CONSIDERANDA

There are some general aspects and concepts which, for their practical relevance, should be kept in mind when analyzing or planning energy-related industrial activities. They are concisely reviewed below.

1) Lima target and implicit energy target

The Lima target already carried with it, implicitly, an "energy target". Programmes for expansion of the energy sector of developing countries and, particularly, of NRSE, should be consistent and commensurate with that target;

2) Macrosources vs. mini-sources

Careful examination of the problem indicates that the Lima energy gap will have to be bridged mainly by the macro-sources of energy; fossil hydrocarbons; coals (of all types); hydropower, biomass and nuclear electricity. The mini-sources (wind, geothermal, solar, etc.) are location- or purpose-specific and will, each of them, make only a minor albeit significant contribution to the overall energy balance of the developing countries in 2000;

3) The long-term and the short-term

One must be clearly aware of the fact that the broad energy problem of developing countries is long-term. It is necessary not to confuse it with the short term "energy emergency" or "transition", which has to do mainly with petroleum prices and balance of payments problems. It is necessary to plan imaginatively and for the long term, specially regarding biomass energy, an area which will see a drastic change from conventional to new technologies;

4) Local vs. imported energy

Another distinction which must be clearly made relates to the problems of physical availability of a resource (LSE potential and possibility for development)[1/] as against the problems arising from the absolute need to import large amounts of a certain fuel (or form of energy) with the consequent heavy burden to the balance of trade. The distinction here is between availability of physical as against financial resources;

1/ LSE = "local sources of energy"

5) Global vs. individual situations

In detailed analysis it is necessary to distinguish clearly the global industrial energy requirements of the developing countries as a whole from the individual situations of regions, countries or specific industrial sectors. The first approach is useful for broad evaluations and planning, leading to conclusions and recommendations which are valid for the group of developing countries as a whole or for those developing countries with a wide spectrum of options in energy and industry. The second approach (individual cases) is essential for identification of specific programmes and projects;

6) Goals of Dd.C. and of Dg.C.

It is essential, also, to keep in mind the distinction between needs, resources, capabilities and goals of developed countries, on one hand, and those of developing countries, on the other. Thus, as an example, energy is for developed countries, an essential input to maintain their very high standards of living and economic activity. On the other hand, for developing countries it corresponds to a crucial, generally insufficient input without which over half of humanity will continue to live in substandard conditions which are materially, socially and ethically unacceptable. Thus, while conservation may be the first priority in developed countries, in DgC,substitution is equally important and primary energy resource development should be of foremost concern, since a huge potential energy demand exists. In a variety of aspects, the optics of the problems and opportunities of energy development and use in developing countries is quite different from that of developed countries (see other Sections of this Report, for examples).

7) Interchangeability of energy forms

Another important point to be kept in mind is the question of interchangeability of energy forms. There are intrinsic technical limitations to substitution of one form of energy for another. Thus, while petroleum, natural gas, coal, nuclear energy and hydropower are interchangeable for the purpose of electricity generation, the same is not true when it comes to the substitution of petroleum derivatives for the operation of auto motive vehicles. In the latter case, the possible substitutes for gasolene and Diesel oil are at present limited to: LPG, fuel alcohols (ethanol or methanol) and certain vegetable oils.

II. THE MAGNITUDE OF THE TASK - TENTATIVE QUANTIFICATION

On the basis of the broad perspective and consideranda outlined before one can proceed to the presentation of more specific facts and goals which result from it . To put it informally, one can attempt to identify a "Lima train of thought and line of action in the energy area".

a) The Lima target

The Lima target already carried with it, implicitly, an "energy target", and programmes for expansion of the energy sector of developing countries 1/ and, particularly, of NRSE, should be consistent and commensurate with that target. Developing countries should produce 25 per cent of world industrial output in 2000. That is, their GDP should increase from 2,2 $T.US_{80}$ in 1980, to about 9,0 $T.US_{80}$ in 2000, assuming a growth rate of 7.3 per cent per year (optimistic, but not unfeasible); 1/

b) The "Lima energy implication" 1/ 2/

It follows that in terms of energy developing countries must increase their energy input from 1700 Mtoe/yr in 1980 to about 6500 Mtoe/yr in 2000. Or, in other words, from about 34 Mboe/d to about 130 Mboe/d;

c) The "Lima energy gap" 1/ 2/

It follows, then, that an "energy gap" of some 4800 Mtoe/yr (or some 96 Mboe/d) would exist between today and 2000. Accordingly, in order to reach the Lima industrial development target, this gap must be bridged and developing countries will have to secure an additional energy input of that magnitude, in that period.

d) The "Lima Nairobi energy target" 1/ 2/

Considering present patterns of energy use in developing countries, as well as their resources and prospects, it is reasonable to set as a target that about one half of the "Lima energy gap" (some 2400 Mtoe/yr) should come from NRSE (mainly hydropower and biomass). The other half: petroleum, natural gas and coal.

1/ All figures refer to a given scenario. Even if a less optimistic scenario is used, figures will still be very large. They include "non commercial energy" and energy demand in centrally planned Asian developing countries.

2/ Informal ad hoc designations.

The above figures, rough estimates as they are, and "optimistic" as they may be, are still of interest for purposes of broad, long term analyses. Real figures cannot turn out to be lower than 2/3 of the values suggested and, thus, the order of magnitude of the task ahead is still staggering.

Accordingly, to reach or approach the Lima target, a wide energy gap must be bridged. An unprecedented technological, industrial and financial effort will be required on the part of developing count which will need the full co-operation of developed countries. The resulting pattern of economic, social and industrial development will be diversified, new and characteristic, with a large degree of reliance on NRSE. Conversely, when developing countries approach the Lima target, the dimensions and diversity of their producing and consuming structure will surely make a decisive contribution to the economic stability and technological development of developed countries.

III. MAIN ISSUES, ASPECTS AND GOALS OF AN ENERGY PROGRAMME

The review of facts and the analysis of current trends leads directly to five basic questions or issues to be considered when tackling the problems/opportunities arising from the energy/industry interdependence:

a) Which energy sources have now or may have in the future a significant potential for use in industrial production? (Issue No. 1);

b) Which sectors, sub-sectors, branches or types of industries can be effectively developed on the basis of available energy resources? (Issue No. 2);

c) What types of capital goods and industrial engineering services will be required to meet the needs of the energy sector of developing countries? (Issue No. 3);

d) Which "energy processing" industries can and should be established to process primary fuels and special raw materials into higher grade or new fuels? (Issue No. 4);

e) What can be done, in terms of "energy management" to expand the application and to increase the efficiency and effectiveness of energy use in industrial systems, plants, processes and products? (Issue No. 5).

On the basis of UNIDO's experience and studies, it is by now clear that the attention of planners and managers, in Governments and in industry should be focused on certain main aspects and areas for action from which the main goals/objectives of programmes/projects arise logically. Accordingly, the five questions or issues raised above can be translated into the three main aspects and goals indicated below, which can be concisely identified as: "energy for industry", "industry for energy" and "industrial energy management".

IV. ENERGY FOR INDUSTRY

This aspect has to do with the fact that energy is a basic, critical input to the industrial sector. The diversity and amount of energy resources available determines, to a great extent, the expansion and structure of the industrial sector. There is a strong correlation between the pattern of energy availability (type, quantity, location, timing, cost, environmental impact) and the corresponding industrial pattern that can be established (sectors, size, processes, products, investments, production costs, location, export potential, environmental impact, etc.). In particular, for developing countries, the role of NRSE and their potential contribution to industrial operations and industrial development must be examined.

In this connexion, the effort will have to be directed at the development of: a) "energy-appropriate" and b) "energy-efficient" processes and products.

a) Industries, processes and products will have to be identified, selected and/or developed (after research and pilot plant work) to fit particular energy availability patterns characteristic of developing countries, especially those in which NRSE play an important role. This will require an unprecedented technological, industrial and financial effort by developing and developed countries.

b) Processes and products (capital and consumer goods) using energy more efficiently will have to be developed through adaptation or through entirely new solutions.

In particular, the development of consumer goods which are both "energy-appropriate" and "energy-efficient" is an imperative because of the technical and social implications of such development.

As an instance of adaptation of industrial production to energy constraints the case of the automotive industry is conspicuous: the industry responded effectively to the "energy emergency" (petroleum related) with more fuel efficient cars in developed countries, and with 100 per cent ethanol cars (fuel-appropriate) in certain developing countries (Brazil). In general, one may expect that the effort to adapt industrial-pattern to energy-pattern will necessarily include non-conventional processes and products. It may also lead to the full use of comparative advantages (for example, the utilization of abundant and cheap hydropower for production of aluminium for export).

The conclusion is, unavoidably, that the industrialization of developing countries will lead to a new or characteristic industrial pattern, which will be conditioned, in general, by a new or different pattern of social development, resources, needs, goals and capabilities, and also, in particular, by a different pattern of energy availability and use. In the paragraphs below, consideration is given to certain selected characteristics of this pattern.

1) The potential contribution of various energy resources: the broad picture

In so far as energy sources are concerned, the following broad assumptions, relating to the use of energy for industrial development in the period 1980-2000, seem relevant.

a) Fossil hydrocarbons

Energy derived from fossil hydrocarbons, in particular petroleum, will continue to be an important factor in the development process. Given present consumption patterns, however, world demand might, in the next two to three decades, cause near exhaustion of known resources, necessitating the launching of large scale prospecting for, and exploitation of new petroleum and natural gas resources, especially in non-oil-exporting developing countries. Since the "petroleum crisis" of the early seventies, when the attention of developed and developing countries was drawn to the need for better management of production and use of exhaustible resources, great progress has been achieved in three areas: energy savings, ("conservation"), efficiency and substitution in developed countries; renewed and successful efforts in petroleum and natural gas exploration in developed and, developing countries; although investment for exploration and exploitation of new hydrocarbon resources in the latter still lag far behind that for developed countries; increased awareness and action, in developing countries, regarding their extraordinary potential in NRSE. It can be stated that, apart from financial problems relating strictly to the balance of trade and foreign debt of certain OIDC, the overall picture for petroleum availability and price is, today, much less gloomy than it was a few years ago. The hydrocarbon potential of developing countries as a group is extraordinary. Their present resources (some 500 G.boe) and installed production capacity (some 35-40 Mbo/d) far exceed their own needs. It is likely that many OIDC which are now largely dependent on imports will become only marginal importers in the nineties.1/ In the period 1979-81 no less than thirty developing countries produced more than 10,000 bo/d. Of these, some twenty produced more than 100,000 bo/d, of which twelve produced over 1 Mbo/d. It is likely that the position of OIDC (in terms of local petroleum availability and import load in real terms) will improve markedly in the medium term (5-10 years).

1/ As an example: In the last 10 years Mexico changed from an OIDC to one of the principal petroleum exporters.

b) Coal

The contribution of coal (all types of fossil carbonaceous fuels, from anthracite to peat) to the energy resource spectrum of developing countries is relatively secondary, in comparison with its role in developed countries. Nevertheless, developing countries do have significant coal resources and production and it is to be expected that, through additional exploration and expansion of mining operations (including beneficiation) the contribution of coal, as a substitute to petroleum and/or on its own, as an additional energy option, will increase in importance. Some thirty developing countries have coal reserves exceeding 100 Mt. Eleven developing countries have over 1 Gt of coal reserves.1/ Coal production exceeding 100,000 t/yr exists in twenty-five developing countries.2/ Reserves of lignite and brown coal are also important and are being used by a few developing countries. Peat will play a small role in industrial development but is an additional option for rural areas.

c) Nuclear energy

Nuclear energy is an important option to those developing countries which dispose of the necessary resources, infrastructure and technological capability. In spite of certain reservations raised against it, on the basis of human or ecological risk, it is very likely that the use of nuclear energy will continue to increase, in developed and in developing countries. With proper safeguards and under judicious control by Governments, nuclear energy is an important additional option. For developing countries it may mean: an additional physical energy input (which may be critical, if other options are lacking or insufficient); or, a new opportunity for export of the fuel (as "yellow cake" or other forms) which may improve their balance of trade. It should be noted that, more than for any other energy resource, the interdependence of industry and nuclear energy is very strong: nuclear energy conversion to electricity requires highly sophisticated capital goods and, at the same time, the large blocks of power which it must deliver to electrical grids presumes and/or enables a large industrial demand. It should be noted, as an example of the importance of uranium as a commercial fuel, that reserves of 200,000 t (in terms of "yellow cake") are equivalent to 2 Gtoe or some 15 Gtoe (in terms of effective electricity generated). This is equivalent to the use of 70 Mtoe/yr (1.4 Mboe/d) for thirty years. The export potential of this fuel is apparent.

1/ In the case of China it is exceptional: the reserves exceed 1000 Gt and constitute about 90 per cent of overall reserves of developing countries.

2/ All data here refer to 1980. (UN Statistical Year Book); China and India outdistance other developing countries with production of some 600 Mt and 100 Mt/yr.

d) Hydropower

Hydropower (hydroelectric power generation) constitues an extraordinary energy option for developing countries in view of the fact that their potential is of the order of 1,500 - 2,000 Mkw of installed capacity (all developing countries, including centrally planned Asia). This potential is widely distributed in developing countries and could generate up to 6,600 billion kWh/yr. This energy would be equivalent to 2,500 Mtoe/yr or to 50 Mboe/day, in terms of "effective energy".1/ Insofar as electricity generation is concerned, hydropower is as important as petroleum, for developing countries as a group. Petroleum continues to be essential for auto-motive vehicles where no general substitute for it exists at present. Risks in investment and operation are less than for any other form of energy and the energy output (electricity) is the "noblest" of all forms of energy. It is the one whose demand will always increase, in developed countries and in developing countries, for the medium as well as for the long term. Everything considered, true investment per unit of electric energy output (in the life of the installation, say 50 years) and cost of production are among the lowest of all energy forms, if not the lowest. Besides, it is a renewable, non-exhaustible energy source. The possibility of producing electricity at a fraction of the cost obtained in thermal power plants (on the basis of international prices for the k.cal or BTU in terms of petroleum or coal) makes development of hydropower extremely attractive to developing countries, which are already engaged in ambitious programmes for this purpose. The sub-options of macro, "midi", "mini" or micro-hydropower must all be considered in accordance with local conditions, needs, objectives and potential. There is no "a priori" reason to limit hydropower development planning in developing countries to mini or micro-hydro. Industrial development commensurate with the Lima target can only be attained through full use of hydropower, in all scales.

e) Biomass

Biomass, in all its forms, is one of the main energy resources used in developing countries today and will continue to be so. However, an extraordinary change in technologies used will occur in the next 2-3 decades. From conventional, traditional, often primitive technologies the sector will evolve towards increasing use of sophisticated,

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1/ At 4300 KWh/KW installed capacity, per year; and at 0,29 toe/1000 kWh; or, at 1,25 toe/KW I.C., per year.

revolutionary technologies (in terms of processes, equipment and efficiency)[1/]. According to available statistics (UN and WEC), the consumption of fuel wood in developing countries should be of the order of 300 Mtoe/yr today; waste, vegetable matter (straw , husks, bagasse, animal offal, etc.) might amount to another 200-250 Mtoe/yr. It is likely that these estimates do not cover the full spectrum of conventional biomass utilization in developing countries, but, even so, the order of magnitude of the energy involved (500/600 Mtoe/yr) is impressive and indicative of the importance of traditional biomass for developing countries.

f) Other sources

Various other energy resources will also play a role but will not, until 2000, individually have the impact of those mentioned above. Their contribution in terms of energy inputs to industrial installations will be minor (see further Sections of this Report). That is the case, for instance, of certain renewable resources, such as geothermal, wind and ocean energy, which will play on important, although quantitatively secondary role, as they are only suited to specific areas or applications. This applies also to solar energy which, although inexhaustible and available everywhere in very large amounts (some 200,000 kW/km^2) will, until 2000, only be utilized in special applications and/or locations. Solar energy offers, of course, extraordinary opportunities for application of innovative technologies (mainly in the areas of photovoltaic generation) but its prime contribution as an energy input will come after 2000. Shale and tar sands, of which very large reserves exist in certain locations will, until 2000, make a limited contribution as sources of energy in comparison with the five macro-sources mentioned in this Section, in view of the large economic and technological development problems involved. The contribution of some of these sources will be significant for rural or remote areas, or for agriculture and other special cases.

In conclusion: developing countries (as a group) are exceptionally rich in energy resources of various types which, in one form or another, are widely distributed. Quantitatively as well as qualitatively the energy potential needed for implementation of the Lima target is available. The problem, for the energy sector of developing countries, is, then, one of development and utilization of their energy resource potential. This

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1/ In subsequent Sections of this Report, this question will be further discussed.

can and must be effected in close linkage with the process of industrialization since energy development and industrial development are absolutely inseparable.1/

1/ Reference is made to other Sections of this Report in which this linkage is analyzed.

2) Potential contribution of NRSE for industrial development

New and renewable sources of energy (NRSE) are specially important for developing countries for two main reasons, at least: They still constitute roughly one half of total energy input of developing countries 1/; the most important NRSE are practically inexhaustible: they have the greatest potential for improvement, expansion and increased effectiveness, through new (and even "revolutionary") technologies. However, a word of caution seems needed here: it is important that developing countries take into consideration the fact that some of the new sources are highly dependent on "frontier technology" and might lead them into new forms of dependence, unless they take appropriate action, institutional and technological, to ensure their basic autonomy of decision.

Accordingly, in dealing with industrial development, it is essential to consider the role of NRSE: their potential contribution and the interdependence between NRSE development and industrialization. This is attempted here, in a concise and preliminary way. Attention will be focused on the industrial energy requirements of developing countries, since it is in these countries that energy demand will expand at the faster rate and where NRSE are likely to contribute most towards the overall and/or industrial energy supply.

a) NRSE utilization: the broad picture

Even in the most developed of developing countries the contribution of NRSE to the national energy balance is large and, in many cases predominant. (For example: 55 per cent of national energy input, in Brazil, and some 50-60 per cent in sub-Sahelian Africa. Fuel wood, charcoal and direct solar heat are used extensively for industrial production. These are complemented, increasingly, by hydropower, with special attention to mini-hydropower which can be used for small scale industries in rural or isolated areas. These "traditional" NRSF will contribute significantly or predominantly to the general operation of small and large scale industries in certain sectors. Their importance and their share are likely to increase as developing countries adapt their patterns of energy supply and use to an increased reliance on NRSF.

1/ All NRSE. All developing countries.

Additionally, other NRSE sources of energy such as: geothermal, wind (through improved wind mill systems), thermodynamic and electronic solar, new biomass utilization opportunities (such as biogas, fuel alcohol and vegetable oil), etc. will play an increasing role which, although highly location or purpose specific, and limited in their utilization for general industrial purposes, may be decisive for self-reliance and independent development in rural or remote areas. They may contribute to the diversification of the spectrum of options open to developed and developing countries in the establishment, operation and location of industries. Their overall contribution may be small, quantitatively, but their social impact may be, relatively, much greater. Notwithstanding the fact that conventional and/or non-renewable sources of energy will still play an important, if not the main, role in the industrial development of developing countries taken as a whole, it is apparent that the industrial pattern of developing countries, in 2000, will be markedly different from that found today in developed countries.

b) NRSE in developing countries: characteristic features, today

It is important to recognize, that the pattern of energy availability and use in developing countries is already new and/or characteristic, specially with regard to NRSE. In fact, it is in the developing countries that one can find, today, some of the most original and significant departures from conventional energy use. Necessity and ingenuity have led to non-conventional solutions (based on NRSE) remarkable for their pragmatism and, in certain cases, for their originality and sophistication, in terms of processes and fuels used, equipment produced and national planning involved. A few examples:

- Development and utilization of biogas. Some 7 million installations in China and some 80,000 in India, producing 1.2-1.5 m^3 gas/day. Increasing interest and use in other regions. Increasing improvements in technology and trend towards larger sizes.

- After 100 years of automotive industry development leading to vehicles 100 per cent dependent on petroleum derivatives for fuel, it is in a developing country (Brazil) that one can find today over 400,000 cars and light trucks which depend 100 per cent on ethanol obtained from sugar-cane. The development and implementation of such a programme required a great deal of technological and planning skills. The development was notable as a quick response to help cope with the "energy emergency" (petroleum prices and balance of trade problems).

- Large scale use of charcoal for production of pig iron and steel, in independent, small to medium size installations. Thus, 4.4 Mt of charcoal pig iron were produced in Brazil, in 1979. The "charcoal technology" allows viable installations from 10,000 to 500,000 tons/year for pig iron, and 50,000 to 1,000,000 t/yr for ingot steel. It must and is being complemented by intensive forestry management and reforestation programmes. This sector of the Brazilian iron and steel industry is characterized by its diversity in ownership (mainly private, many small companies), scale and location. Over 100 blast furnaces were in operation in 1979. The Government plans to help expand the sector.

- A large degree of reliance on electricity from hydropower, reaching close to 100 per cent in certain large developing countries. A vast programme of hydropower development is under way, involving numerous developing countries, in all regions, to tap the huge available potential (1500 -2000 M.kw) now only fractionally utilized. It should be noted that the world's largest (Itaipú, between Paraguay and Brazil) and second largest dams (Guri, Venezuela) are being built in developing countries, relying mainly on their own engineering and managerial skills. The extraordinary development of mini-hydro in China should also be noted as a striking example of on-going action based mainly on local skills and equipment. Some 90,000 installations are in operation, with a joint installed capacity of about 6.8 M.kw I.C. The vast hydropower potential of developing countries can and must be harnessed; with careful planning and management one can produce electricity at a fraction (one-fifth to one-half) of the cost of that obtained from thermal power stations based on fossil fuels at international prices.

In conclusion: in questions relating to selection, development and application of practical, appropriate energy-related technologies for their needs, conditions and objectives developing countries have fully demonstrated their capability to plan, implement and get results. Thus, when considering the transfer of technology (from developed countries) it should not be assumed that the developing countries are totally dependent on the developed countries. What is urgently needed is an all out effort to strengthen local technological capability to create and/or apply other novel solutions independently.

c) NRSE for industry, in the period 1980-2000: some possible developments

Some of the features of NRSE use for industry, or for utilization of industrial products, in the period 1980 - 2000 are suggested below.1/

- NRSE will continue to play a major role in the energy balances of developing countries contributing with close to 50 per cent of total energy. The share of industry in the utilization of NRSE (hydropower, biomass, etc.) is likely to increase.

- It is to be expected that developing countries, more than developed countries, will develop and rely upon a diversified, pluralistic pattern of energy resources not only for general use but, also, for use in industry, specially in the case of agro-industries, rural industries and industries located in remote areas. Apart from a variety of fossil and mineral fuels, and from hydropower, the spectrum of options will include: fuelwood; charcoal; agricultural wastes (e.g.: bagasse, saw mill dust, husks, straws, etc.); biogas; geothermal energy; solar energy; wind energy; hydrocarbons from shale and tar sands; etc.

- A "revised model" will be developed for urban transportation systems, with increased use of: electricity from hydropower or other; vehicles moved by engines using non-conventional fuels (NRSE). With increasing emphasis on economy, small size, life of items, ease of maintenance, fuel flexibility and computerized mass transportation systems. In general, one may expect the development (or improvement) and production of automobiles, trucks, tractors, locomotives and small boats and ships using Diesel and Otto engines (or other new engine types) operating with: fuel-alcohol (from sugar-cane, wood, etc.); vegetable oils; charcoal and wood-chip gas-generators; etc.

1/ Additional developments will take place, of course. The enumeration presented here cannot but be a tentative one.

- Increased use of biomass "feed stock" for the organic chemicals industry (as alternative to petrochemicals) can also be expected.

- One can also expect an increased share (possibly a major share) of developing countries in certain energy intensive industries, taking advantage of low cost electricity from large hydro-power projects or from thermal generation with use of cheap local fossil or mineral fuels such as flared gas, natural gas, uranium, etc. Thus, for example, the aluminium industry, which requires some 16,000 kWh/t of metal is already being shifted to favourable locations in developing countries, a world wide restructuring of this industry has already started.

- An extraordinary and diversified technological development will take place relating to the development and use of NRSE in developing countries. Technologies will evolve drastically from "traditional-primitive" to "modern-sophisticated". New and/or non-conventional processes and products will be developed, based on NRSE and particularly adapted to developing countries'conditions, needs and goals. The "technical revolution" will have a special impact on biomass energy development, where bio-technology and molecular genetics are creating opportunities almost unthinkable twenty years ago. In general, novel energy-efficient and energy-appropriate processes, equipment, energy systems and consumer products will be developed and used in developing countries.

d) NRSE for industry in period 1980-2000: Tentative projections, quantification, examples

In Section II the energy implications of the Lima target were tentatively outlined. In view of the importance of NRSE for developing countries it is necessary to consider the question of which of NRSE can make significant contributions to the overall demand indicated and to the industrial sector, in particular. As mentioned before, it is apparent that hydropower and biomass (including fuelwood and charcoal) are the ones likely to make the most significant contributions both in quantitative and in qualitative terms. Other NRSE are highly "location"- or "purpose specific", and their contributions to the overall industrial energy supply of developing countries, in terms of quantity, will be minor, per source, although important in their qualitative impact.

Table I contains very tentative estimates of various data and projections for 2000, on the basis of a scenario consistent with the Lima target, on one hand, and with the need to maximize utilization of the full potential of NRSE for industrialization of developing countries on the other. The figures are, in many cases, very rough estimates and are meant as indicative of the magnitude of the problems and opportunities ahead.

On the basis of the scenario previously used, the total energy requirements for the industrial sector of developing countries would rise from circa 440 Mtoe/yr in 1980 (assuming a 26 per cent share in the total energy balance) to circa 2300 Mtoe/yr in 2000 (assuming a 35 per cent share of total energy demand). The contribution of NRSE would rise from an estimated 220 Mtoe/yr in 1980 to circa 1050 Mtoe/yr in 2000.

Table II presents a possible scenario, consistent with the Lima target, of the relative contributions of NRSE for industry, in 2000. Estimates and rates of growth have been assumed so as to have a coherent and, although optimistic, also feasible picture of the development effort required. Thus, for instance, rates of growth of hydropower capacity of close to 12 per cent have been sustained for long periods in certain developing countries. With full technological and financial support of the developed countries, the sub-targets or figures for 2000 could be attained.

Table III presents some selected typical examples of the use of NRSE in industry. The Table includes selected examples of industrial manufacturing sectors (Column I) which may appropriately use some of the NRSE (Column II) through either standard or special processes (Column III) leading to the manufacture of products, conventional or new (Column IV).

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TABLE I: ESTIMATE OF NRSE UTILIZATION - 1980/2000 1/

$G.US_{80}$ 2/ and Mtoe 3/	1960	Factors	2000
- Dg.Countries			
- GDP ($G.US_{80}$)	2200	7.3% (4.1x)	9200
- Industry ($G.US_{80}$)	440	8.6% (5.2x)	2300
- Share Ind/GDP	20.1%		25.4%
- Share Dg.C.ind/Wld.ind.	13.5%		26.0%
- Tot. Energy consumption Dg.C. (Mtoe)	1700	7.0% (3.8x)	6500
- Share of world consumption	25%		46% (?)
- Energy for industry (Mtoe)	440	7.0% (3.8x)	2300
- Share of industry	26.0%		35.0%
- Total NRSE energy Mtoe.	800	6.8% (3.7x)	3000
- Share of NRSE/tot.	47.0%		46.0%
- NRSE for industry	225?		1050
- Share of ind. in NRSE	30.0%		35.0%
- Share of various NRSE (in total energy balance) (Mtoe)			
- Biomass (with fuelwood and charcoal)	680	3.0% (1.8x)	1200
- Hydropower	120	12.0% (9.6x)	1200
- Other	20	18.5% (30x)	600
- NRSE use in industry (Mtoe)			
- Biomass (with fuelwood and charcoal)	80?		350?
- Hydropower	60?		600?
- Other	5?		100?
- Dd. Countries			
- GDP ($G.US_{80}$)	9200	3.6%	19.600
- Industry ($G.US_{80}$)	2800	3.8%	6.450?
- Dd.C.energy consumpt. (Mtoe	5000	2.0% ?	7.500?
- World energy cons. (Mtoe)	6.700	3.8% ?	14.000?

1/ Figures are rough estimates and should all be rounded. The figures proposed correspond to certain scenarios and assumptions. They are consistent with the Lima target and with current models being used in UNIDO. Other scenarios and assumptions could be considered.

2/ $G.US_{80}$ = billions of dollars of 1980.

3/ To convert the figures in Mtoe into the equivalent installed hydropower capacity, divide by 1.25 (since 1 M.kW I.C. year = approx. 1.25 Mtoe)

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TABLE II - EVALUATION OF RELATIVE SIGNIFICANCE OF NRSE FOR INDUSTRY IN 2000 1/

NRSE AND ORDER OF MAGNITUDE OF POTENTIAL 5/	POSSIBLE INDUSTRIAL USES	APPROX COST US$ / kWh ELECTR.OR MECH. PURPOSES 3/	HEATING PURPOSES 2/
1. Large hydro (440-520 M.kW I.C.) (550-650 Mtoe/yr)	General urban and rural industries. Large energy-based industrial estates. Aluminium smelters. Urban transportation Railroad electrification.	0.020-0.030	same 4/
2. Mini-hydro (50 M.kW I.C. (63 Mtoe/yr)	mall and/or rural industrial estates. Isolated medium and large scale industries.	0.050-0.150	same
3. Biomass (incl.fuel wood, saw mill dust, charcoal, agro-wastes, alcohol (280 to 320 M. kW.I.C.) (350-400 M.toe/yr)	Already used widely for small and medium scale ind. as fuelwood. Charcoal based iron and steel industries. Fuel-alcohol automobiles. Rural industries. (Great potential for further development and application, in volume and diversity).		
4. Oilshale and tar sands (1,2Mtoe/day by 2000?) (about 50 M.kW. I.C. or 60 Mtoe/yr).	Great potential but highly dependent on technological development. In principle, could be used competitively with petroleum but particularly important for: transportation (as fuel); resource based industrial estates;feedstocks f.petrochemicals industry.	0.070-0.100 (about same as petroleum based)	0.03 - 0.050
5. Geothermal (20 to 30 M.kw I.C.) (or 25 to 40 Mtoe/yr)	Small to medium-sized industrial zones. Isolated industrial plants	0.030-0.100	0.020-0.050
6. Wind (5M. kW. I.C.) (or 6 Mtoe)	Very small scale or "cottage" industries. Small agro-industries	0.030-0.100	---
7. Other NRSE (15 M.kW I.C.) (or 20 Mtoe)	Very small scale industries, small agro-industrial installations. Special uses. Feeding of main grids.		

1/ Reference is made to Table 19, page 43 of Wld.Bk.Report "Energy in Developing Countries" - August 1980
2/ Effective energy delivered to mechanical or electrical systems or for heating purposes. At 30% and 60% conversion efficiencies, respectively for fuel to effective energy.
3/ US dollars of 1980.
4/ Efficiency of conversion kWh to heat assumed at 100%.
5/ Estimated (rough) contribution in terms of power (kW) for actual use in industry (2000). (The unit used is the equivalent installed hydropower capacity, in M.kW I.C. together with M.toe/yr).

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TABLE III - SELECTED TYPICAL EXAMPLES OF NRSE USE IN INDUSTRY

Sector/Factor Prod. System Service	NRSE	Process	Product
- Iron and steel production	Forests, wood-charcoal	Charcoal pig-iron 1/	St. 2/
- Aluminium smelting	Hydro (large/macro)	St. 2/	St.
- Organic chemicals and fuels	Biomass:Sugar-cane	Direct or indirect (via molasses) alcohol production	St. (alcohol) and bagasse
- Alcohol cars	Biomass: sugar-cane	St.	100% fuel alcohol cars
- En. based industrial zones	Hydro (large scale to small scale)	St. (agro ind. small scale ind. manufact. ind. centre or complex	St.
- Ceramic inds.: brick, tile crockery, porcelain, etc.	Wood (fuel)	St.	St.
- Agro and food inds.: product drying	Solar (direct, thermal)	Special ovens, kilns, installations	Dried grains, meat, fish
- Salt industry	"	Evaporating basins/ponds	St.
- Heating and refrigeration equipment, household appliances, etc.	Solar (thermodynamic)	Various technologies	Hot water, space heaters
- Manufact. industr. (light/ medium), special locations	Geothermal	St.	St.

1/ NB: It is the process which is different. Pig-iron produced is about same as from coke.

2/ St: Standard/conventional process or product

(CONT..).../2

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Sector/Factor Prod. System Service	NRSF	Process	Product
- Organic chemistry, Methanol	Wood	Fermentation, hydrolisis, etc.	St. (methanol)
- Hydrocarbon production	Shale + tar sands	a) Special distillation b) Special extraction	St.
- Small scale, agro-inds. or rural inds.	Wind (electromechanical generation)	St.	St.
- " " " "	Peat: processed, dried	Special peat burning equipment	St.
- Very small scale inds. (special cases)	Solar (photovoltaic)	Photovoltaic generation	St.
- Glass (special), silica and high temp. ceramics	Solar (thermal-optical, reflectors, etc.)	Specially designed process and equipment	St.
- Wood industry, cellulose production, etc.	Forest wastes, sawmill dust	General heating/or electric generation	St.

V. INDUSTRY FOR ENERGY

In this case one has to deal with industry as a supplier of inputs or services to the energy sector. The contribution of industry includes two main types of activity outlined below.

1) Production of equipment

Production of equipment and special materials for the energy sector (for petroleum exploration, coal mining, hydropwer stations, transmission lines, pipelines, etc.) is an important industrial activity. Energy resource development and utilization (exploration, exploitation, conversion, distribution, etc.) depends directly and critically on the development of the capital goods industry and of the appropriate industrial engineering services. It will require the development of a full technological and industrial capability, in developing countries, to carry out research, design, process and product engineering, as well as to produce and service a varied spectrum of equipment needed by the energy sector, specially in the case of NRSE.

2) Industrial processing of fuels

The other critical contribution of industry to energy development and supply lies in the industrial processing of primary fuels or of special raw materials for production of secondary, higher quality or special fuels (Examples: production of petroleum derivatives and petrochemicals; production of coke or charcoal; production of fuel alcohol; "coal gasification"; coal "liquefaction"; fuel beneficiation and agglomeration (from wastes, v.g. , etc.). It is important to note, in this connexion, that there is a definite trend towards an increasing reliance on "industrialized fuels", of increasing sophistication and diversity, the development and processing of which will depend specially on a dynamic and modern industrial sector (in terms of technology, processes, equipment, etc.). This is especially true for the chemical industry sub-sector. The development of such an "energy-processing industry", in developing countries, is an imperative to enable full use of local raw materials and market opportunities.

3) Main types of equipment to be delivered to the energy sector

The concise list below is meant only as an illustration and reminder of the variety (in type, size, etc.) of the equipment to be produced for the energy sector of developing countries, mainly by their own industry.

a) Petroleum and natural gas exploration, transportation, refining and distribution equipment. From offshore platforms, tankers and pipelines to refineries, service station equipment, etc.;

b) Mining and processing equipment for fossil and mineral fuels such as: coal, peat, uranium, shale, etc.;

c) Conventional electricity generation and distribution equipment such as: large boilers, steam and gas turbines; hydraulic turbines (including mini-hydro); generators, transformers, transmission towers, switching and control equipment; urban and rural distribution equipment; etc.;

d) Special equipment for the nuclear energy sector, including reactors and related accessories and systems;

e) Agricultural machinery for "energy-crops" (sugar-cane, sorghum, etc.); sugar-cane processing industry, including distilleries for fuel alcohol; alcohol transporting systems (tanktrucks, pipelines, etc.);

f) Forestry equipment, including planters; fertilizer and pesticide distributing mobile units; saws and logging equipment; wood chipping machinery, etc.;

g) Charcoal and special fuel wood processing and transporting equipment;

h) Biogas generators and ancillary equipment;

i) Geothermal exploration equipment; heat and/or steam extraction equipment; special geothermal power generating equipment (for cleaning of natural steam and water, v.g.), etc.;

j) Windmills and ancillary equipment;

k) Shale and tar sand processing equipment, including drilling equipment; large scale open-pit mining equipment; distilleries and refineries, etc.;

l) Solar energy (electronic and thermal) equipment for a variety of solar energy capture and application technologies (from semi-conductor devices to crop drying equipment).

VI. "INDUSTRIAL ENERGY MANAGEMENT" 1/

Good energy management has always been a primary concern in industrial operations. Well managed medium or large scale industrial plants have, for decades, included an energy management unit of some sort and/or appropriate energy control programmes. The problem has, however, become acute in recent years, with the scope and urgency of such programmes being increased to the point when energy management is receiving the closest attention from both industry and Governments; at national, sector and plant levels.

As shown in previous sections of this report, the energy resources of developing countries are vast and diversified and they are by far more than adequate to ensure the energy inputs required for implementation of the Lima target.

The good "management" (in the broadest sense of the word) required to ensure the transformation of "potential" into "reality" is, probably, the critical factor which will determine the degree of success in the endeavour.

In this connexion, however, it is essential that the demand side should receive priority attention. Planning overall development and industrial development to use the energy provided is an imperative. The end-use approach is a practical and necessary one.

1/ Industrial energy management relates directly to "Issue No. 5" proposed in an earlier Section of this Report.

1) The three main areas of industrial energy management

The pre-occupation with "industrial energy management" now includes, inter alia, the aspects mentioned below.

a) National industrial energy planning

Most developing countries are already engaged in energy planning aiming at optimization of national energy supplies and consumption according to: natural resources; priorities assigned to different consuming sectors (urban, industrial rural, commercial, etc.): problems relating to national finance, to the balance of payments and to foreign debt. In view of the central role of industry in the energy problem, national energy planning is directly and inextricably connected with industrial planning. In particular, sectoral energy planning (for steel, non-ferrous, chemical, electro-mechanical, automotive and other sectors) is an essential part of national energy planning. New concepts and programmes are needed in connexion with the development of new industrial structures, with special attention to: selection of branches; location; sizes; conditions, restrictions, incentives, etc. as a function of various factors but, in particular, of energy availability.

For developing countries, industrial energy planning must take into consideration the need to utilize effectively [1/] and to the maximum extent possible the locally available energy resources, and this leads in many cases to the intensive use of NRSE. The associated problems and opportunities have been mentioned previously, in this Report. It is also clear that, for developing countries, national industrial energy planning is an issue which arises directly from the Lima target. Resources mobilized, goals and actual implementation must be commensurate with and effectively contribute to the Lima target, within the national frame of reference.

1/ "Efficiency" is measured in terms of "output" compared to "input". "Effectiveness", in terms of "actual results" or "effect" in relation to an action taken.

b) Energy planning at plant level

At another level, it is also necessary to consider and manage the optimization, improvement and control of plant energy balances with special attention to: energy substitution, for lower costs and/or to save foreign exchange; "conservation" or savings through increasing energy-efficiency of processes and equipment, with close energy-monitoring and auditing (energy "accounting"); preventive maintenance for energy equipment and accessories; recovery of waste heat; diversification of sources (to ensure supply); optimization of operating schedules (to take maximum advantage of "peak and trough" in supply, demand and costs); etc..

This area of activity comprises a great diversity of problems (and opportunities), a great variety of specialized industrial activities and technologies. Hardware and software solutions are involved. Increasing use of electronic systems, sophisticated equipment and management systems is required.

A word of caution seems needed, in connexion with "conservation" (in the sense of energy-savings programmes or increased efficiency in the use of energy). This activity, one among many needed, is particularly relevant and very important to those countries, developed or developing, in which large amounts of energy are already in use and where the infrastructure (managerial and technological) exists which can establish and implement energy savings programmes. These may lead, as demonstrated in developed countries in recent years, to extraordinary energy savings, without a decrease in output. Important as energy savings are, however, the solution of the "energy problem" of developing countries in general but specially in the least developed, really implies: a) the use of large new energy inputs (to enable industrialization and development to proceed) and b) energy substitution 1/ (to avoid unnecessary and/or costly imports). Concisely: although conservation is important wherever energy is used, for most developing countries local energy resource development and utilization as well as energy substitution are the main preoccupations.

1/ Substitution may, in many cases, actually lead to the use of more energy (in k.cal) for the same output.

c) Energy management: the "MEANS"

Industrial energy management must consider, analyse, plan and programme action relating to the "MEANS" required, in developing countries, to enable the successful, expeditious and effective implementation of the concurrent goals of energy development and utilization and industrialization. I.e., it is necessary to plan and implement action to ensure the "human-ware" and "soft-ware" resources needed to develop and utilize the energy inputs needed for industry and, on the other hand, to deliver the appropriate industrial outputs to the energy sector.

These MEANS include:

i) scientific and technological development to secure the basis of knowledge and know-how essential for energy-related activities

ii) education and training (including "recycling") to ensure the availability of proficient energy-engineers, energy-economists, energy-technicians and skilled workers needed for the operation of the energy, industry and other sectors;

iii) adequate financial machinery to promote and sustain the energy/industry development effort;

iv) legislative, fiscal and promotional framework to originate and provide incentives for expansion or improvement of patterns of energy production and consumption.

2) Considerations relating to the "means"

Since the instruments, tools or means to achieve the goals are so important for developing countries, a brief review of the main ones is attempted below.

a) Scientific and technological development

It will be practically impossible to handle successfully the expansion and use of energy options, to the extent commensurate with the Lima target, specially those related to NRSE, without the creation or strengthening of scientific and technological institutions, enterprises and teams proficient and active in the handling of energy-related problems. These problems are functions of a large number of variables and the corresponding scientific and technological areas, activities and services are also extremely diversified.

Energy-related science and technology will have to be expanded or strengthened in developing countries through specially tailored institutions and programmes, taking into account local resources, needs, goals and capabilities. Local science and technology must ensure:

- The capability to handle the special problems and opportunities relating to local energy resources, their development and utilization. This is true for all energy types and to the various stages of extraction, conversion, distribution and final use. Scientific and technological research and development must be strengthened, for energy-related areas;

- The capability to develop new industrial processes and products appropriate for new and/or characteristic energy availability patterns, as well as to local conditions and needs. Industrial technology, with emphasis on energy aspects of process and product engineering must be strongly supported;

- The availability of industrial engineering services relating to the design, construction and operation of energy-related installations, including energy distribution to and inside industrial plants. Such engineering services would include such novel areas as: fuel alcohol distilleries and ancillary systems (bagasse use as fuel or for other purposes); conversion of industrial installations for substitution of energy types; installation of energy saving equipment; etc.;

- The availability of specialized scientific, technological and industrial information, properly selected, coded, easily retrievable and accessible to all institutions, teams and individuals engaged in activities common to the areas of energy and industry development.

b) Education and training (human resources)

One of the significant aspects of the energy problems now facing all countries (and industry in general) is the relative lack of familiarity of planners, managers and operating personnel at all levels with the peculiarities and intricacies of energy processing and utilization, specially regarding NRSE.

The problem arises from three circumstances:

i) The fact that until very recently energy was, so to speak, "taken for granted", as a generally available and low cost "utility" which only merited special attention in certain highly energy-intensive sectors;

ii) The fact that energy is a phenomenon and an input which is difficult to handle from any point of view: in science,[1/] in technology, in industry, in economics and in national planning. The multiplicy of forms in which it appears (photons, electrons, mass, molecular vibrations; light,electricity, heat, mechanical power, chemical energy; etc.) together with the diversity of sources, processes and products needed for extraction, conversion, transmission, distribution and utilization make energy science, technology and economics one of the most complex areas of human activity;

1/ The scientific basis of energy involves sophisticated physics (photon and electron behaviour; solid state physics; nuclear reactions; electro-magnetic phenomena; etc.); physical-chemistry (solutions; thermodynamics; etc.) and chemistry (photosynthesis; bio-chemistry; etc.)

iii) The goods and services production system of developed countries has been essentially based, specially in the recent past, on energy from conventional non-renewable resources. Familiarity with the potential and peculiarities of NRSE is practically non-existent. This is most conspicuously noticeable in the extent and nature of the treatment or attention devoted to NRSE in the technical and industrial literature, where even basic and essential facts are ignored.

Accordingly, one of the concrete problems now faced by developed countries and developing countries is the lack of "energy proficient" personnel, in terms of numbers and level of qualification. This lacuna is specially noticeable in the following activities and is particularly acute in the area of NRSE: i) Energy planning and management at national level; ii) Ditto, at plant level; iii) R + D and technology of NRSE-related processes and products; iv) Energy "processing" engineering (extraction, conversion, transmission and distribution); v) Energy economics (financing, investment, operating costs, etc.); vi) Industrial equipment operation, control and maintenance for optimum energy performance.

Consequently, it seems essential and urgent that educational and training programmes and activities to cover the "demand" outlined above are immediately initiated and/or intensified. Manpower needs should be covered, inter alia, by: 1/

i) Energy engineers - there is urgent need for establishment of this specialized profession and for the corresponding University curriculae;

ii) Energy technicians - ditto, with establishment of the appropriate curriculae, in technical and professional schools of intermediate level, for a diversity of specialized tasks;

iii) Skilled operators and workers to produce, handle and operate specialized equipment (for example: a charcoal kiln; a biogas unit;

1/ The listing is illustrative and is certainly not complete. V.g.: "energy scientists" are essential, but it is assumed that this is one case in which, fortunately, highly skilled physicists are already available even in developing countries. What is necessary is to involve them in the practical problems of their countries.

maintenance of alcohol driven motors; etc.);

iv) Energy economists - specializing in the economics of energy trade, pricing, costing, etc.;

v) Energy planners and managers - specializing in broad energy planning, programming and management.

The above needs can and must be met through regular courses, specialized training and "re-cycling programmes". It is not easy to quantify such needs globally or by specialties. This will demand detailed and specific surveys and studies. It can be roughly estimated, however, that total immediate yearly demand would be no less than 10-20 specialists per 1 million of population, in developing countries.[1/]

To reach the Lima target it will be an imperative to train or recycle planners, managers and operators at all levels, in the intricacies of energy selection for and application in industry. Computerized, automatic and special monitoring and control systems will become current and will require, inter alia, the development of new specializations and new services.

c) Financial requirements

The enormous development effort implied by the Lima target cannot be implemented without the appropriate (in terms of facilities, "mechanisms") and commensurate (in terms of magnitudes involved) financial input.

The broad, overall financing of industrial development will require extraordinary resources, coming from various origins and facilities, in a variety of modalities (including, of course, a large degree of self-financing, in local currency, through national savings).

The share of finance required for energy-related development, although only a part of overall development financing, will still be a huge one. Reference is made to Section II: ("The Magnitude of the Task - Tentative Quantification") and to Table I of Section IV: ("Estimate of NRSE Utilization - 1980/2000"). On the basis of the rough estimates presented

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1/ A low estimate, surely.

(according to a scenario consistent with the Lima target) a preliminary estimate of finance required can be made and is presented in Table IV.

According to Table IV, then, it can be roughly estimated that all the additional investment (including equipment) for harnessing and distribution of energy, including up-stream and down-stream installations (from primary site to plant gate, consumer door and service station) in developing countries, in the period 1980-2000, will amount to no less than 4800 $G.US_{80}$. Even if lower estimates are considered, it is still clear that energy development will require an extraordinary effort, by developing countries. This effort will include the establishment or expansion of their capital goods industry to enable delivery of, at least, a major part of the 2400 $G.US_{80}$ of equipment required.

Further analysis of the financial implications outlined above, with consideration of the more detailed pattern of industrial investment in the developing countries (locations, timing, sectors, etc.) will be required and could be one area for special studies.

TABLE IV

Estimate of financing required for the energy sector of developing countries [1/]

- Total energy input for developing countries (Mtoe) 1980	1700
- (Ditto, only NRSE, 1980)	(800)
- Ditto, 2000 (Mtoe) (all sources)	6500
- (Ditto, only NRSE, 2000)	(3000)
- Additional input to be developed and used in period 1980-2000 (Mtoe)	+4800
- (Ditto, only NRSE)	(+2200)
- Approx. total investment required [2/] $G.US_{80}$ [3/]	4800
- Ditto, for NRSE	(2200)
- Share of industrial equipment and services (about 50%), $G.US_{80}$	2400
- GDP, 1980, $G.US_{80}$	2200
- Ditto, 2000, $G.US_{80}$	9200
- Accumulated GDP, period 1980-2000, $G.US_{80}$, approx.	90,000
- Share of accumulated GDP (1980-2000) to be invested in the energy sector, approx.	5%

1/ All developing countries; all forms of energy.

2/ Total value of installed capacity for energy supply, all types, assuming about 1250 US_{80} per equivalent hydropower kW I.C. or 1000 US_{80} per toe/yr. In this connexion the following conversion equivalences can be used: 1 kWh = 0,29 koe; 1 koe = 3,45 kWh; 1 kW I.C.yr = 1,25 toe/yr = 4300 kWh/yr.

3/ 1G.US_{80} = 1 gigadollar of 1980 = 1 billion dollars of 1980.

d) Legislative, fiscal and promotional framework

Economic development, in general, recognizedly requires a favourable framework of legal, fiscal (taxes, tarifs, etc.), financial and other incentives. This is especially true for basic/heavy industries and for the transportation and energy infrastructural sectors. Investments are frequently very heavy and risks (technical and/or economic) may be high.

The energy/industry interdependence requires that a suitable, favourable framework for state or private enterprises be organized and operated on a sound economic, technical and commercial basis, according to the best interests of the country or community (at macro or micro-economic level). This must be kept in mind when planning and programming energy/industry development.[1/]

1/ This Report cannot attempt even a concise review of the complex and varied aspects of such framework.

VII. SUMMARY AND CONCLUSIONS
(For PARTS I AND II)

- The triple interdependence among economic and social development, industrialization and energy development is strong and inextricable.

- The Lima target carries with it specific and imperative energy implications; it implies an "energy target" and an "energy gap".

- Developing countries have extraordinary energy resources (in amount and diversity) which are by far, more than sufficient to reach the Lima target. Their problem, which is also an opportunity, is one of energy resource development and utilization.

- An unprecedented effort will be required, on the part of developing and developed countries, in close international co-operation, to cope with the diversified and huge additional energy input needed for industrialization.

- Since industry is central to the energy problem, the energy-related activities of UNIDO have to be adapted and/or expanded so as to result in a comprehensive, integrated and balanced programme, commensurate with the Lima target and appropriate to the needs, conditions, objectives and capabilities of developing countries.

- A wide diversity of facts, concepts, goals and guidelines must be carefully taken into account in order to elaborate and implement such a programme. This is essential in view of the complexity of the scientific, technological, industrial, economic and social factors involved.

PART C

PROGRAMME ASPECTS [1]

[1] A very concise review is presented here. The diversity in scope and nature of the activities considered (on-going; planned;or projected pending availability of additional resources) can only be fully ascertained through reference to documents listed in Annex I. However,not all of these are available for general distribution at this time because of the need for up-dating,editing,etc;others are internal working documents.

I. OVERVIEW OF PROGRAMMING ASPECTS

1) Goals of an energy related programme of industrial development assistance

The goals of a UNIDO energy related programme to assist developing countries in the establishment and operation of technically and economically sound industries which may contribute effectively to their economic and social development are implicit in the various relevant decisions and resolutions. The analyses carried out in Parts A and B establish a factual, conceptual framework for action at the programming and implementation levels.

i) The Lima target carries with it an implicit energy target. Industrial and energy development must be planned and carried out together since they are inextricably linked. The magnitude and variety of the tasks ahead for developing countries requires the greatest attention in planning and implementation at all levels.

ii) The main issues to be tackled have been examined in Part B/Section III of this report. The main goals of a UNIDO energy related programme can be grouped under three principal headings: "Energy for Industry", "Industry for Energy" and "Industrial Energy Management". These have been explained in Part B, Sections IV,V and VI of the report. The means or tools for achieving the energy/industry goals have also been reviewed under the heading "Industrial Energy Management" (Part B, Section VI).

2) Guidelines for definition and implementation Ref. 2+4

i) The main guidelines for definition and implementation of programmes and projects arise directly from the analyses carried out in Parts A and B. In this connexion, special attention should be given to Part B/I "Some Basic Consideranda" and to various specific considerations contained in Part B,IV, V and VI.

ii) In connection with the definitions of a "UNIDO energy programme", it seems useful to distinguish between technical assistance stricto sensu and other essential activities. Concisely one could consider the ad hoc equation: DA = PA + TA where:

DA = development assistance

PA = policy, planning, promotional, programming and project design assistance including: studies; technological and investment promotion; consultations and negotiations; meetings; visits and missions; publications and public information; etc.

TA = technical assistance (expertise, equipment, etc.) provided at Governments' request

Both types of activities will have to be covered by an integrated, comprehensive and balanced UNIDO energy-related programme. It must be stressed that PA type activities are no less important than TA type activities insofar as industry/energy development is concerned. Thus, within UNIDO, the Division for Industrial Studies (global, regional and sectoral studies; technology programme; industrial information); the Division of Policy Co-ordination (consultations and negotiations; promotion of activities and projects for LDCs; promotion of economic co-operation among Developing Countries; contacts and co-operation with other UN Bodies and non-Governmental organizations; interaction with field activities and definition and promotion of new TA projects, etc.); the Division of Industrial Operations (investment promotion, industrial planning; development of infrastructure; plant construction and management; training; sectoral programmes); and, finally, the Division of Conference Services (publications; public information; contacts with Governments and inter-Governmental Organizations) all have a very important contribution to make through PA activities.

3) Structure and resources required. Constraints

The present organizational structure of UNIDO seems quite adequate to tackle energy related activities in connection with industrial development assistance. Minor adaptation might be nee[illegible] for the future depending on experience gained in handling energy-related activities. The main constraints lie in the area of financial resources available to cover adequately the additional development activities connected with the energy input to industry. Additional resources would be clearly needed to expand all such activities but they would be specially critical for additional energy-related activities. Minor constraints seem to exist also in the availability of staff expertise in certain specialized areas of the energy-industry inter-action, which has increased in importance in recent years and has introduced additional technical variables to be considered in programme and project design.

II. RECENT AND ON-GOING ACTIVITIES

1) Background

Ref 1+2

UNIDO has always been active in energy-related development activities. However, their volume and diversity have been increasing and should expand in coming years for the reasons mentioned in Parts A and B. Diversity and scope of recent and on-going energy-related activities in the past, when put together, are quite impressive. Reference should be made to the reports of the Executive Director to the IDB and to the report on "Energy-related Industrial Development Activities" (Document No. UNIDO/OID.130), as well as to other sections of this Report. Additionally, reference can also be made to other documents listed in Annex I, specially to those mentioned under 2) below. Ref.13

2) Concise review of standard UNIDO activities (studies, technical assistance, promotion, meetings, publications)

Informal lists of energy-related activities, (studies, technical assistance projects, publications, meetings, etc.) are available or are under preparation and can be consulted for details on recent and on-going UNIDO action in the energy area. A full review of such activities would be too long to be included here. However, it should be noted that: Refs. 17,18, 19+20

i) by mid-1982 the list of energy-related activities, included 154 items (Technical Assistance projects, studies etc) including activities completed since 1 January 1981, on-going and pipeline activities;

ii) the total value of the activities mentioned above exceeded $32 million. The distribution of the main items was:

* DIO (mainly on-going TA projects) - ca. $10.3 mill.
* DPC (mainly pipeline TA projects) - ca. $18.8 mill.
* Technology Group - ca. $ 2.4 mill.

All the above figures are approximate. They cover the total worth of the activities, many of which do not focus on energy alone; on the other hand, for many of the activities carried out by UNIDO there were no figures readily available;

iii) in the period 1979-1982 UNIDO organized 26 meetings in which energy was the main subject or an important aspect discussed;

iv) in the period 1979-1981 UNIDO attended 36 out of a total of 38 meetings related to the UN Conference on NRSE. Furthermore, in 1981 alone UNIDO participated in another 33 meetings held by other organizations.

v) in the period 1979-1982 UNIDO issued or prepared 249 publications and studies specifically covering energy or devoting substantial attention to energy-related aspects of industrialization.

3) Special inputs prepared for UN Bodies, Conferences and inter-agency exercises 1/

In connexion with the increased interest and priorities assigned to energy-related activities by the UN system, UNIDO participated in a number of inter-agency exercises, specially in the period 1980-1982, in connexion with the UNCNRSE or with other UN activities. The preparation of special inputs (documents, papers, operational data, etc.) involved the participation of many UNIDO units and were quite effective in increasing in-house awareness and co-operation in the energy-related area. Special mention should be made of the following inputs provided by UNIDO. Refs. 3,6,7 8,19

i) Statement by Dr. Abd-El Rahman Khane, Executive Director of UNIDO at the United Nations Conference on New and Renewable Sources of Energy (UNCNRSE), Nairobi, Kenya, 10-21 August 1981; Ref.4

ii) Various papers and comments submitted to the ACC Task Force on Long-Term Development Objectives; Ref.21

iii) Information on activities through a "Compendium" and comments on the text of the draft of the ACC Report on current and planned activities of the UN system to implement the Nairobi Programme of Action (subsequently Document No. A/AC.215/2); Ref.9

iv) Participation in various inter-agency meetings; leading agency of the Task Force of the ACC Ad Hoc Working Group on Inter-agency Follow-up to the NPA charged with the preparation of Chapter IV ("Energy and Industrialization") for the ACC Report on proposals for action-oriented plans and programmes for carrying out the Nairobi Programme of Action (subsequently Document No. A/AC.215/5). UNIDO also provided inputs to the other Task Forces handling other chapters of that document; Ref. 7 Ref. 10

v) Detailed comments and suggestions provided for the preparation of Chapter 11 of the draft UN Medium-Term Plan 1984-1989 on Energy, (subsequently Document No. A/37/6). Ref. 15

1/ It would be difficult to quantify the staff time, travel expenditures and other resources allocated to the work reviewed here, but they were substantial.

III. FUTURE ACTIVITIES

1) Background

The analysis carried out in Part B indicates the magnitude and diversity of the effort required to ensure the harmonious development of the energy and industrial sectors of developing countries. It is clear that a substantial expansion of development activities (PA + TA) will be required in the coming years.

2) Planned activities (1982/83 and MTP)

The energy-related activities of UNIDO in the biennium 1982/83 and planned for the medium term are mentioned in the following documents:

- The Proposed Programme Budget for the Biennium 1982/83; Volume II Section 17 (Doc. No. A/36/6) Ref.12
- The Medium Term Plan for 1984-1989 (IDB/B/C.3/107) of which energy relevant extracts have been prepared by OID/SACE Ref.14

They are also reflected in control lists and computer print-outs kept by various UNIDO units for operational purposes.

3) Additional priority activities needed

Since the planned activities mentioned in the previous item are determined in their scope by programming, budget and staff constraints and since an expansion of energy-related activities is essential, a number of additional programmes, proposals and project concepts have been elaborated with a view, inter alia, to justifying such expansion and obtaining additional resources. In this connexion the following documents are relevant:

i) IDB - ID/B/C.3/107/Add 1 (submitted to the Permanent Committee November 1981); Ref.14

ii) ACC report on "Proposals for action-oriented plans and programmes for carrying out the Nairobi Programme of Action" - A/AC.215/5. (Document submitted to the Interim Committee on NRSE for the follow-up of the Nairobi Programme of Action: Rome, June 1982). Ref.10 Ref.11

iii) Informal project proposals prepared by various UNIDO units in connexion with UNCNRSE follow-up. Ref.7

iv) Table V of this report, "Priority Activity Areas relating to Energy and Industrialization" is an attempt to illustrate the scope and diversity of a comprehensive industry/energy programme. This table shows additional activities which can and should be programmed, pending availability of resources, to cover adequately the industrial development assistance needed by developing countries in the coming years. It includes use of all sources of energy (not only NRSE).

IV. CO-OPERATION WITH OTHER UN BODIES

1) Background

Ref.22

The activities of the UNIDO in the energy related area has led to an increased co-operation with other UN Bodies; G.O., I.G.O. and N.G.O. In fact, the preoccupation with energy problems is widespread and surely provides an opportunity for new and expanded co-operation. The presentation below is very concise and should be expanded and complemented with lists of co-operative projects and activities (on-going or planned) relating to the various organizations mentioned.

2) Other UN Units

As mentioned previously in this report, the interaction of UNIDO with other agencies and units of the UN system has increased sharply since 1980 in connection with energy activities. The spirit of co-operation is very strong and there is an awareness that a pluralistic effort is required, involving directly a large number of the UN system bodies. Energy can constitute a new "cement" among the system units. The inter-agency activities carried out in connection with the follow up of the UNCNRSE have proven that large scope and readiness for co-operation exists. In this connection the various informal inputs exchanged among the agencies Ref.16

TABLE V: PRIORITY ACTIVITY AREAS RELATING TO ENERGY AND INDUSTRIALIZATION

SOURCES	ENERGY - INDUSTRY	INDUSTRY - ENERGY	INDUSTRIAL ENERGY MANAGEMENT	REMARKS
I. ENERGY SOURCES: MAJOR, NON-RENEWABLE				
- Petroleum (local)	- Planning, design, construction and operation of: petrochemical plants (monomers; polymers; lubricants, etc.); mechanical industries producing equipment for plastic articles manufacture - Development and production of capital and consumer goods making more efficient use of petroleum; industries using flared gas;......	- Energy processing industry: design, construction and operation of petroleum refineries - Production of capital goods for exploration refining, distribution: inland drilling rigs and accessories; off-shore platforms, tankers, pipelines and ancillary heavy equipment; refinery equipment; household gas bottles for LPG; service station equipment; etc.	- Petroleum derivatives substitution (through locally available fuels or electric energy) in industry - Conservation programmes for petroleum dependent operations/utilization in industry - Optimization programmes for most effective and essential allocation of petroleum use - Development of a local scientific and technological capability to ensure the sound and expeditious development of the local petroleum industry: establishment or strengthening of specialised institutions - Special training programmes relating to substitution and conservation of petroleum derivatives	- Co-op: DTCD, OPEC Fund,.... - Co-op: WEC, OPEC Fund,....
- Petroleum (imported)	- (Same as above)	- Energy processing industry: design, construction and operation of petroleum refineries - Production of capital goods for refining and distribution only	- All above - "Industry for export": develop viable industries producing manufactures for export to be able to pay for imported petroleum	- Co-op: UNCTAD, ...

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SOURCES	ENERGY - INDUSTRY	INDUSTRY - ENERGY	INDUSTRIAL ENERGY MANAGEMENT	REMARKS
- Natural Gas (local)	- Industries using natural gas as fuel (total or part of fuel input): a variety of industries can be developed or adapted for the use of natural gas - Production of capital and consumer goods for use of natural gas: furnaces, stoves, space heating systems, ... - Industries using natural gas as feedstock or reductant: production of petrochemicals; sponge iron production;........	- Production of capital goods for exploration, beneficiation and distribution of natural gas (up to plant gate, household door, etc.)	- Special programmes to use locally available natural gas as substitute fuel to petroleum in industry	- Co-op:DTCD,...
- Coal (various types of locally available coal)	- Planning, design, construction and operation of industries based on local coal as a fuel - Chemical and metallurgical industries using coal as a "feed stock" or reductant: specially important in the case of the iron and steel industry	- Energy processing industry. design, construction and operation of coal processing installations for production of: briquettes, coking coal, gases of various types ("coal gasefication"), synthetic fuels, etc. - Production of capital goods for mining, beneficiation and industrial processing of coals of various types	- Special programmes for substitution of petroleum with coal derived fuels (pulverized coal, producer gas, etc.)	- Co-op: DTCD,..

SOURCES	ENERGY - INDUSTRY	INDUSTRY - ENERGY	INDUSTRIAL ENERGY MANAGEMENT	REMARKS
- Nuclear Energy	- Planning, construction and operation of industries to be based on electricity generated, partly or totally, by nuclear power - Production of special equipment items for non-power applications of nuclear energy (medical application equipment, isotope storage and transportation, etc.)	- Production of capital goods needed for the nuclear energy sector: nuclear reactor components and ancillary equipment of various types; electricity distribution equipment;	- Ensuring the appropriate scientific and technological basis for the design and production of nuclear related equipment	- Co-op: IAEA

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SOURCES	ENERGY - INDUSTRY	INDUSTRY - ENERGY	INDUSTRIAL ENERGY MANAGEMENT	REMARKS
II. ENERGY SOURCES: NEW AND RENEWABLE				
- Hydropower	- Planning, construction and operation of industries which make use of substantial amounts of electricity generated from hydropower. With special attention to certain metallurgical and chemical industries which are heavy consumers of electricity such as aluminium, electrolytic refining, soda, carbon graphite products, refractories, basic abrasives, ferro-alloys, iron and steel, etc. - Production of a diversified spectrum of capital and consumer goods which depend on electricity for operation, (from motors, electric furnaces....to household appliances, lightbulbs, etc.......)	- Production of hydropower turbines, generators, transformers, transmission towers and posts; copper and aluminium cable and wire; control panels, switches, insulators, etc.; with special attention, on one hand to heavy equipment for large scale hydro and on the other, for mini and macro hydro equipment - Production of reinforcing bars, cement , other materials needed for dam construction	- National or regional planning of joint and balanced development of the hydropower sector and the corresponding industries to ensure optimum economic and social results from investments - Planning of industries (sectors or individual plants) consuming large blocks of electricity - Planning integrated mini and macro hydropower and small scale industries' development - Training of engineers and managers for electricity utilization in industry (plant network design, equipment design and production, etc.)	- Co-op: DTCD,..
- Fuelwood	- Development or, specially, improvement of fuelwood consuming industries such as: brick, tile, and simple consumer ceramics; food processing and agro-industry - Industries based on processing of wood by-products and wastes	- Production of forestry-related equipment; seeding, planting, cutting, off road transportation, fertilizer and pesticide distribution; sawing and logging equipment; wood chipping; etc.	- Development of improved technologies for industrial fuelwood processing and utilization	- Co-op: FAO,...

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SOURCES	ENERGY - INDUSTRY	INDUSTRY - ENERGY	INDUSTRIAL ENERGY MANAGEMENT	REMARKS
- Charcoal	- Development of industries based on charcoal as a fuel and/or reductant. With special attention to charcoal-based pig iron and steel industries - Production of special equipment using charcoal as a fuel (gas generators of various types, furnaces, stoves, heaters, etc.) - Industries based on by-products and wastes arising from charcoal making through wood pyrolysis	- Production of charcoal in industrial installations with recovery of by-products (v.g. for use in the iron and steel industry and chemical industries - Production of equipment for the charcoal industry; kilns, stoves, transportation equipment, distillation equipment, briquetting machinery, burners for pulverized charcoal, etc.	- Development and improvement of technologies for charcoal making and utilization with particular attention to improving yield	- Co-op: FAO,..
- Biomass: "energy crops"	- Production of automotive vehicles, including tractors using ethanol, methanol and other fuels obtained through "energy crops" - Production of agricultural machinery and equipment using ethanol, methanol, etc. as fuels	- Production of bio-chemical processing equipment (hydrolisis fermentation, etc.) for production of ethanol, methanol, refined vegetable oils, briquetting of residues, etc. - Industrial processing of cellulosic material, starch and sugar into high grade fuels such as ethanol, methanol, methane rich gases, vegetable oils, briquettes, lignine coke, etc.	- Scientific and technological programmes needed to identify and develop new processes, equipment and applications. Great potential for innovation through biotechnology	- Co-op: FAO, UNESCO, UNITAR

SOURCES	ENERGY - INDUSTRY	INDUSTRY - ENERGY	INDUSTRIAL ENERGY MANAGEMENT	REMARKS
- Biomass: Wastes as fuels	- Industries using own waste as fuel: wood industry, using saw mill dust as a fuel for heat or steam generation; sugar and alcohol industries using bagasse as a fuel for heat and electricity;......... - Production of small scale simple equipment using rice husks, straw, etc. for heating, cooking, etc.	- Production of a variety of equipment, generally small scale for converting agro-wastes into useful energy (heat, electricity generation, producer gas,....); special burning and gasefication equipment	- Scientific and technological programmes needed to identify and develop new processes, equipment and applications. Great potential for innovation through biotechnology	- Co-op: FAO, UNITAR, UNESCO,.
- Biomass: fermentation of wastes to biogas	- Small scale industries, mainly rural, using biogas as fuel	- Equipment for production and distribution of "biogas" (methane)	- Ditto	- Co-op: FAO, UNITAR, UNESCO,.

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SOURCES	ENERGY - INDUSTRY	INDUSTRY - ENERGY	INDUSTRIAL ENERGY MANAGEMENT	REMARKS
- Geothermal Energy (for electricity or heat)	- Establishment of special industries located near geothermal sources to make use of the heat/electricity available and to recover useful by-products, if any	- Production of equipment and accessories for geothermal energy	- Scientific and technological development relating to geothermal energy utilization (with special attention to corrosion problems of metals and alloys used in equipment making)	- Co-op: DTCD
- Solar Energy	- Limited to small and very small scale. Utilization may increase for heating, drying and other industrial applications, specially in rural areas	- Production of solar equipment of a diversified nature: solar panels (thermal, photovoltaic); related electricity, heat, and other conversion equipment; kilns, ovens, and drying systems etc.	- Technological development, programmes to ensure maximum utilization of solar energy within technically and economically acceptable parameters. Promotion and information after judicious evaluation	- Co-op: UNESCO UNITAR,........ - Obsv: Solar energy include a variety of technologies, some of which are of great potential for the future but requiring extremely careful evaluation for correct application in Dg.Cs.
- Wind Power	- Limited to very small scale industry and industrial service activities, specially in rural or remote areas: accessories for wind mill power utilization (pumps, irrigation equipment, etc.)	- Production of wind mill related equipment: wind mills, generators, energy storage and control systems, etc.		- Obsv: Small contribution to industry

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SOURCES	ENERGY - INDUSTRY	INDUSTRY - ENERGY	INDUSTRIAL ENERGY MANAGEMENT	REMARKS
- Oil Shale	-	- Production of mining and distillation equipment for recovery/production of hydrocarbons from oil shale	**- Development of the technology for hydrocarbon recovery/ production from oil shale. Breakthroughs are needed**	- Co-op: DTCD, UNITAR,.......
- Peat	- Development of small scale, rural industries based on the use of peat as a fuel	- Production of equipment for mining, drying, burning of peat	**- Development of the technology for peat beneficiation and utilization as a fuel in industry, with by-products**	- Co-op: DTCD, UNITAR,.......

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should be referred to. Specific meetings and agreements in bilateral co-operation have also taken place routinely between UNIDO and various agencies, with inclusion of energy items.

3) Governmental Organizations (G.Os.) Ref.22

Certain G.Os. are interested and active in providing technical assistance relating to energy. This assistance, generally bilateral, can contribute substantially to the definition or solution of specific energy problems in developing countries. UNIDO has been requested to assist in the definition and implementation of a number of such programmes and projects. This activity could be expanded in the coming years since a number of Governmental organizations have accumulated a rich experience in certain specific energy-related areas (v.g., mini hydropower, biogas, peat technology, large scale hydro, oil exploration, conservation, etc.), provided additional resources become available to the Secretariat.

4) Intergovernmental Organizations (I.G.Os.) Ref.22

UNIDO has been co-operating with "IGOs", in various areas and, specifically, in the area of energy. Co-operation has taken or is taking place and is planned with a number of IGOs (v.g., OLADE, OPEC, OAPEC, Council of Europe, ECOWAS, OAU, etc.).
Undoubtedly, there is great scope for co-operation with IGOs in: technical assistance, meetings, special publications, etc. The action needed here is mainly dependent on the careful definition of areas for co-operation and specific projects. On the basis of the analysis and information contained in this report and reference documents, there should be no difficulty in proceeding with work in this direction, always taking into account the priorities and interests of developing countries.

5) Non-Governmental Organizations (N.G.Os.) Ref.22

The co-operation of UNIDO with selected N.G.Os. (v.g., World Energy Conference) could and should be greatly expanded taking into account existing arrangements and contacts as well as the goals and guidelines suggested in this report.

V. PARTICIPATION IN SPECIAL PROGRAMMES AND CONFERENCES

1) Background

UNIDO is engaged in work related to special programmes and conferences. A very concise review is presented below since it is not possible here to cover adequately the involvement of UNIDO in the important events and programmes mentioned.

2) UNCNRSE

Since 1979 UNIDO participated actively in the preparatory work and in the follow-up of the UN Conference on New and Renewable Sources of Energy. The workload connected with this participation was quite heavy in 1981 and early 1982. Reference is made to the Executive Director's reports for 1980 and 1981. A great deal of work was involved, with participation of most units of UNIDO. It included: preparation of special documents; participation in meetings; contribution of comments and detailed information as inputs to UN documents; co-ordination of parts of UN system documents. This is mentioned in previous sections of this report and in reference documents. Ref.19 Ref.13 Ref.3 Ref.10

In this connexion it should be noted that the Nairobi Programme of Action contains some 100 references to industry-related activities or aspects. These are indicated in one of the reference documents for this report. The proposed follow-up to the Conference in terms of additional programmes, projects and resources, after having been considered by the Interim Committee in Rome (7-18 June 1982), will be submitted to the 37th Session of the General Assembly. It contains specific proposals relating to the "Energy and Industrialization" priority area. Ref.5 Refs. 9,10,11

3) UNIDO IV Ref.22

In the consideration of the UNIDO IV scope and agenda, the energy related problems and opportunities have been the object of attention as a suitable matter for discussion, given the importance and urgency of action in this respect. The tentative draft provisional agenda for the conference, recommended by the IDB to the General Assembly (ID/B.289 Page 36, para. 167) contains a specific agenda item (Item 5(d)) "Energy and Industrialization with special emphasis on development and application of energy resources and manufacture of equipment". As part of the preparations for UNIDO IV, 5 high-level meetings will be held early in 1983: one of these being on Energy in view of the importance of this area for UNIDO's future work.

4) Industrial Development Decade for Africa (IDDA) Ref.22

The energy/industry potential and needs of Africa are enormous. The availability of petroleum, hydropower, coal, peat, uranium, biomas is extraordinary and ensures the energy basis needed for the full industrialization of Africa. There is great scope for UNIDO in the design of programmes and projects in which, more than in any other region, the joint, balanced and simultaneous development of energy and industry are mandatory. In this connection, inter alia, numerous references to the problems and opportunities of energy/industry development in Africa are found in document E/ECA/CM.8/2 plus proposals for the formulation and implementation of a programme for the Industrial Development Decade for Africa: ECA/IDD.1/INR/WP/1; ECA/CMI.6/INR./WP/1, all of which were submitted to the 16th Session of the IDB, for consideration.

5) Least Developed Countries (LDC) Ref.22

The energy problems of LDCs have been recognized as particularly important and meriting full attention and consideration by the international community. In this connection, inter alia, special references were made in document ID/B/C.3/107/Add.1, Chapter I. The design of energy related programmes and projects for these countries require special attention to their main goals and priorities. The factual and conceptual framework presented in Parts A and B of this report must be taken into account. There is a tendency to consider that in view of the very small, sometimes negligible industrial sector in these countries, solutions, projects and planning should be accordingly "miniaturized". Nevertheless, one must keep in mind that in a number of them there are local conditions and rescurces requiring and justifying the planning of industrial development in the medium or large scale. Accordingly, energy development should not be confined to the micro and/or primitive resources but should definitely consider the energy capability of the country fully.

6) Economic Co-operation among Developing Countries (ECDC) and Technical Co-operation among Developing Countries (TCDC) Ref.22

The potential for ECDC and TCDC in energy/industry programmes and projects is very great. The linkage of inter-regional, regional, multilateral and bilateral interests among developing countries exists and many initiatives, Governmental and private, are increasingly being taken in connexion with various problems and opportunities. Joint work relating to energy/industry co-operation can and must be greatly expanded with UNIDO's assistance, inter alia, through consultations, technology and investment promotion.

7) Other special programmes and conferences

UNIDO will be increasingly involved as an essential partner or participant in a number of other special programmes and conferences. The increasing contacts and requests received by UNIDO so indicate. UNIDO will participate, inter alia, in the following:

- 12th Congress of the World Energy Conference being organized for 1983
- United Nations Conference for the Promotion of International Co-operation in the Peaceful uses of Nuclear Energy, being planned for August - September, 1983

VI. FOLLOW UP ACTION NEEDED

The record indicates, as this report and related reference documents substantiate, that the volume and diversity of energy related activities are increasing considerably. UNIDO is being looked at more and more as one of the key organizations for the identification and implementation of energy related activities. A number of Governmental, intergovernmental and non-Governmental organizations, as well as other UN units, have contacted UNIDO in connexion with participation/co-operation in important programmes, projects, studies and meetings. Taking into account this fact and other numerous commitments (actual or potential) arising from UNIDO's activities and described or mentioned in this report, the following follow-up action seems needed.

1) **Determined in-house effor aiming at: increasing awareness of the energy/industry interdependen improving co-ordination of energy-related activities; careful examination of substance and priorities of on-going and planned energy-related activities in accordance with the policy and guidelines established by the IDB and by the Executive Director; continuation of the effort to design a comprehensive, integrated, and balanced "UNIDO Energy Programme"; special attention to possibilities of increasing resources available for expansion of the energy-related activities of UNIDO.**

2) **Increasing efforts to strengthen the co-operation with other UN, G.O., I.G.O. and N.G.O. organizations and using, as far as possible, existing structures, procedures and operating practices while taking into full account the policies and guidelines established by the IDB and by the Executive Director.**

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ANNEX I

Selected reference documents 1/

	Title	Date	Doc. No.
1.	- Report and Proposed Action Programme	3.1.80	UNIDO/EX.108 2/
2.	- Report on Energy-related Industrial Development Activities	11.2.81	UNIDO/OED.130
3.	- Draft Background Paper for UNCNRSE	3.3.81	UNIDO/OED.131 2/
4.	- Statement by Dr. Khane at the UNCNRSE	Aug.81	(No number)
5.	- Quotations from the UNCNRSE of relevance to industrial development	July 82	OED/SAGE 5
6.	- List of model proposals for NRSE-related industrial development (titles only)	Aug.82	OED/SAGE 7
7.	- Model proposals for NRSE-related industrial development		OED/SAGE 9 4/
	- Concise preliminary proposals to the ACC Ad Hoc Working Group on Inter-agency Follow-up to the NPA ("Geneva I")	25.3.82	
	- Final proposals to ACC ditto ("Geneva II")	8.4.82	
	- Specific proposals prepared by UNIDO units in connexion with the preparatory work for ACC ditto	25.3.82	
8.	- Draft study "Energy and Industrialization" by the Sectoral Studies Branch	19.3.82	(No number) 4/
9.	- ACC: Report on current and planned activities of the UN system to implement the Nairobi Programme of Action	21.4.82	A/AC.215/2
10.	- ACC: Proposals for action-oriented plans and Programmes for carrying out the Nairobi Programme of Action	11.5.82	A/AC.215/5
11.	- Report of the Interim Committee on New and Renewable Sources of Energy (Rome, June 1982)	July 82	A/37/47
12.	- Programme Budget for the Biennium 1982-83 (selected energy-related extracts from A/36/6)	Aug.82	OED/SAGE 11
13.	- Reports of the Executive Director 1980 + 1981	March 81 March 82	ID/B/260 ID/B/280
14.	- UNIDO's Medium-term Plan 1984-1989 (doc. ID/B/C.3/107) and addendum (doc. ID/B/C.3/107/Add.1) - energy-related extracts	Jan. 82	OED/SAGE 6

15.	- Chapter 11 of the UN Medium-term Plan 1984-1989 (on energy)	Jan.82	A.37/6
16.	- Bodies of the UN system involved in energy matters: functions, recent activities and documents	July 82	OED/SAGE 8 3/
17.	- List of energy-related activities of UNIDO	July 82	OED/SAGE 1
18.	- List of energy-related meetings organized by UNIDO	July 82	OED/SAGE 3
19.	- List of energy-related meetings 1981-1982, with UNIDO attendance	July 82	OED/SAGE 4 4/
20.	- List of UNIDO publications and studies on energy	July 82	OED/SAGE 2
21.	- UNIDO-UN preliminary proposals (to ACC Task Force on LTDO, Technical Energy Group)	28.4.81	OED/SAGE 10 4/
22.	- Selected texts + policy statements on UNIDO, UN system, NGO + IGO energy activities		3/ 4/

1/ Not all the documents are available for general distribution at this time because of the need for up-dating, editing, etc; others are internal working documents.

2/ By now, essentially superseded.

3/ Under preparation or revision

4/ Internal working document: not for general distribution