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17051

Distr.
LIMITED

IO.16 (SPEC)
12 April 1988

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ENGLISH

NEW AND RENEWABLE SOURCES OF ENERGY

AND

THE ACTIVITIES OF UNIDO IN THIS FIELD

Prepared by the

Department of Industrial Operations

for the

Inter-Agency Group on New and Renewable Sources of Energy,
seventh session, New York, 28 March 1988,

and the

Intergovernmental Committee on the Development and Utilization of
New and Renewable Sources of Energy, fourth session,
New York, 28 March to 8 April 1988

V.88-23785
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SUMMARY

This paper prepared by the Section for Integrated Industrial Projects, Department of Industrial Operations, highlights significant characteristics of the new and renewable sources of energy and gives special attention to the activities of UNIDO in the field of NRSE.

New and renewable sources of energy are specially important for developing countries, and although in most cases easily accessible, they are not fully exploited. The requests for UNIDO's technical assistance in the area of NRSE cover mainly the areas of biomass, hydropower, solar and wind. The promotion and information exchange of NRSE-related technologies are also clearly defined programme components of UNIDO.

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I. CHARACTERISTICS OF NEW AND RENEWABLE SOURCES OF ENERGY

Energy crises, generated among others through a heavy dependence on fossil fuel energy, albeit periodical, and the uneven distribution of effective conventional sources of energy, have been instrumental in fostering research and development in alternative sources of energy. New and renewable sources of energy (NRSE), although easily accessible in most cases, are not fully exploited usually owing to economic rather than technical constraints.

In principle, non-conventional and renewable sources of energy should be used or are already used complementary to conventional sources. In order for new and renewable sources of energy to be fully integrated into the economy, however, a number of obstacles must be overcome and certain conditions must be established.

Only infrequently can a solution to an energy source problem be found that would meet the following criteria:

Improving environmental quality
Conserving energy
Conserving conventional energy resources
Making obvious economic sense
Solving socio-economic problems

NRSE can meet these criteria under certain circumstances. In light of the mounting energy shortage, an increasing demand for environmental pollution control and quality as well as the need to prevent an increase of CO_2 in the atmosphere on a long-term basis, the so-called "clean" alternatives of wind, water, solar, tidal and geothermal energy have been given particular attention world-wide. The long-term future demand of energy supplies could be met by a combination of these sources.

Without intending to oversimplify a complex subject such as NRSE, the following issues constitute some of the broad characteristics of a NRSE:

(a) Deficiencies exist at the national and international level in the statistical assessment of the reserves and resource potential of NRSE, and it is still difficult to assess the role of various NRSE in national and international energy statistics;

(b) The major economic impediments to a more dynamic growth of NRSE are presently both external (world oil prices, budgetary policies) and internal (apparent high capital costs, lack of standardization/mass production, unsatisfactory producer/user dialogue);

(c) NRSE can play an important role in attenuating the effects of energy deficiencies, particularly in rural areas, remote areas, isolated systems etc. Therefore, NRSE are a valuable substitute for conventional energy sources, and their utilization prevents an uncontrolled use of fossil fuel energy;

(d) Hydropower (including small-scale), conventional geothermal energy, peat, some types of biomass, solar thermal energy for hot water production and wind systems are economic in many applications. Solar photovoltaic (PV) systems has proven competitive in isolated circumstances;

(e) Additional NRSE options are at various stages of R&D. A number of these technologies offer the promise of technical feasibility and economic viability under conditions of higher energy prices, environmental regulations, mass production, technical refinement and an innovative marketing effort and/or governmental support;

(f) The storage of energy (also in the case of NRSE), for later consumption is necessary for instance when there is an imbalance between consumption and demand at the regional or sectoral level. the availability of energy sources is irregular, or during long maintenance periods at the plant level etc.;

(g) By storing energy for later consumption, it is possible to use machines more effectively . In addition, if suitable energy storage systems could be made available for renewable energy sources, this would have a considerable beneficial effect on the development and use of these sources which would result in a far less detrimental environmental impact than the use of conventional sources. On a global scale, this has a two-fold effect on the environment: on the one hand, it will reduce the amount of emissions (CO_2, SO_2 and NO_2) associated with the burning of conventional fuels and, on the other hand, it will reduce the amount of energy produced from terrestrial sources;

(h) Most NRSE produce "clean" energy;

(i) NRSE need a wide range of equipment, special material, accurate assessment of siting and distribution. A large contribution from NRSE would entail economies of scale in the production of equipment and intermediate product and, subsequently, the rise of a new dynamic industrial branch;

(j) The increased utilization of NRSE on a long-term basis presupposes further efforts at cost reduction, energy storage, reduced energy and material intensity, and higher energy conversion efficiency;

(k) Attention has also to be paid to the price differential between conventional sources of energy (CSE), and NRSE; since most of the ongoing industrial activities depend on CSE, it is expected that an assessment of demand elasticities will reveal that the demand for NRSE is more elastic. Therefore, R&D costs could militate against NRSE unless government intervention in the form of incentives and disincentives could make NRSE development more attractive;

(l) The adaptation of mature technologies to varying user needs is of great importance compared with further technical refinement. The sharing of costs and risks through internal co-operative R&D has proven beneficial;

(m) The availability of comparative data on conventional energy sources and NRSE concerning investment cost as well as data about the amortisation time within the limits of a facility's serviceable life can help people to create important criteria for the economic viability of NRSE;

(n) There is a role of social responsibility in connection with NRSE for all segments of society in developing an effective power supply system; in this connection, Governments or authorities have an important role to play in creating the relevant infrastructure;

(o) A number of factors are instrumental in providing a development framework for NRSE. These include: the stability of monetary policies; continuity of R&D funding; neutral tax regimes; the simplification of building regulations; the harmonization of standards, test certifications and quality requirements; and the internalization of externalities in the prices of all fuels.

II. UTILIZATION OF NRSE IN THE DEVELOPING COUNTRIES AND THE ROLE OF UNIDO

The level of primary energy consumption in developing countries is low compared to world consumption or consumption in the industrialized countries. Primary energy consumption in the world, in the industrialized countries and in the developing countries is shown in figure I. Various scenarios for future primary energy consumption are illustrated in figure II. A breakdown of energy consumption by type of energy for the world during the period 1966-1986 is shown in figure III.

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

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

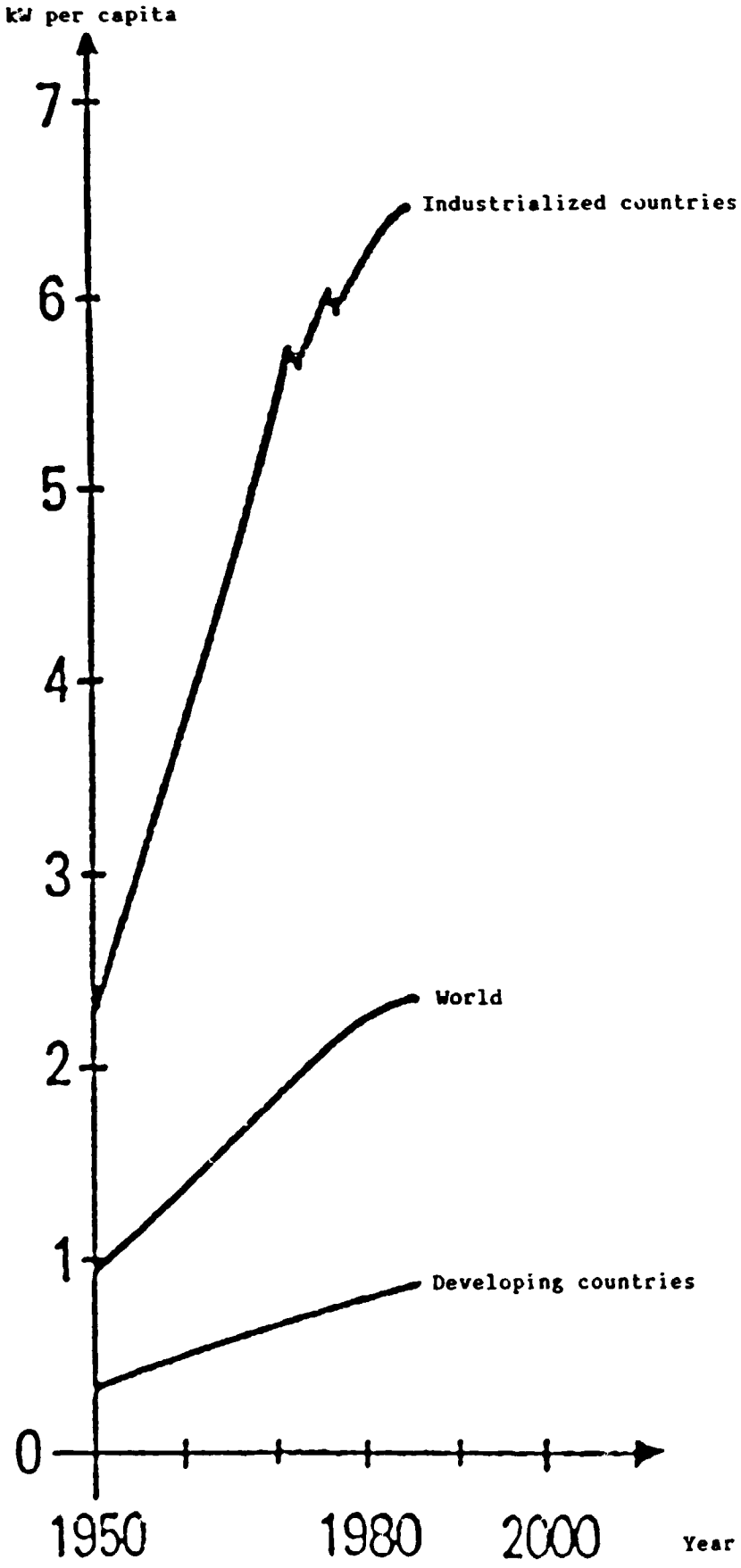
These constraints are interconnected. In spite of the great potential for satisfying their energy needs, several developing countries for instance countries of West Africa[1/], are not mastering technologies for renewable sources of energy owing to the above-mentioned constraints. Most of the potential resources either have not been developed at all or are being used in inefficient ways.

NRSE, are especially important for developing countries for at least two main reasons: (a) they constitute a respectable amount of total energy input of developing countries (see table 1) and (b) important NRSE, such as solar and water, are practically inexhaustible and they have the greatest potential for improvement, expansion and increased effectiveness, through new technologies. It is difficult to estimate the total energy produced from renewable sources in developing countries. Annual energy production in some countries are shown in table 2. The figures given are not comparable, because solar energy may include both heat and electricity generation. Minihydro and biogas energy in many countries and solar heat production in some countries are already in commercial use, as can be seen in table 2. A word of caution is necessary, however: 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 the developing countries into new forms of dependence, unless they take the appropriate institutional and technological action, to ensure that they can take decisions autonomously. The proportions of different types of energy sources harnessed in 47 developing countries are shown in table 3.

In dealing with industrial development, it is essential for UNIDO to consider further the role of NRSE: their potential contribution and the interdependence between the development of such sources of energy and industrialization. Attention should be focused on the industrial energy requirements of developing countries, since in these countries energy demand will expand at a faster rate and NRSE are likely to contribute most towards the overall and/or industrial energy supply. (Scenario A in Figure II represents an optimistic variant of this trend.)

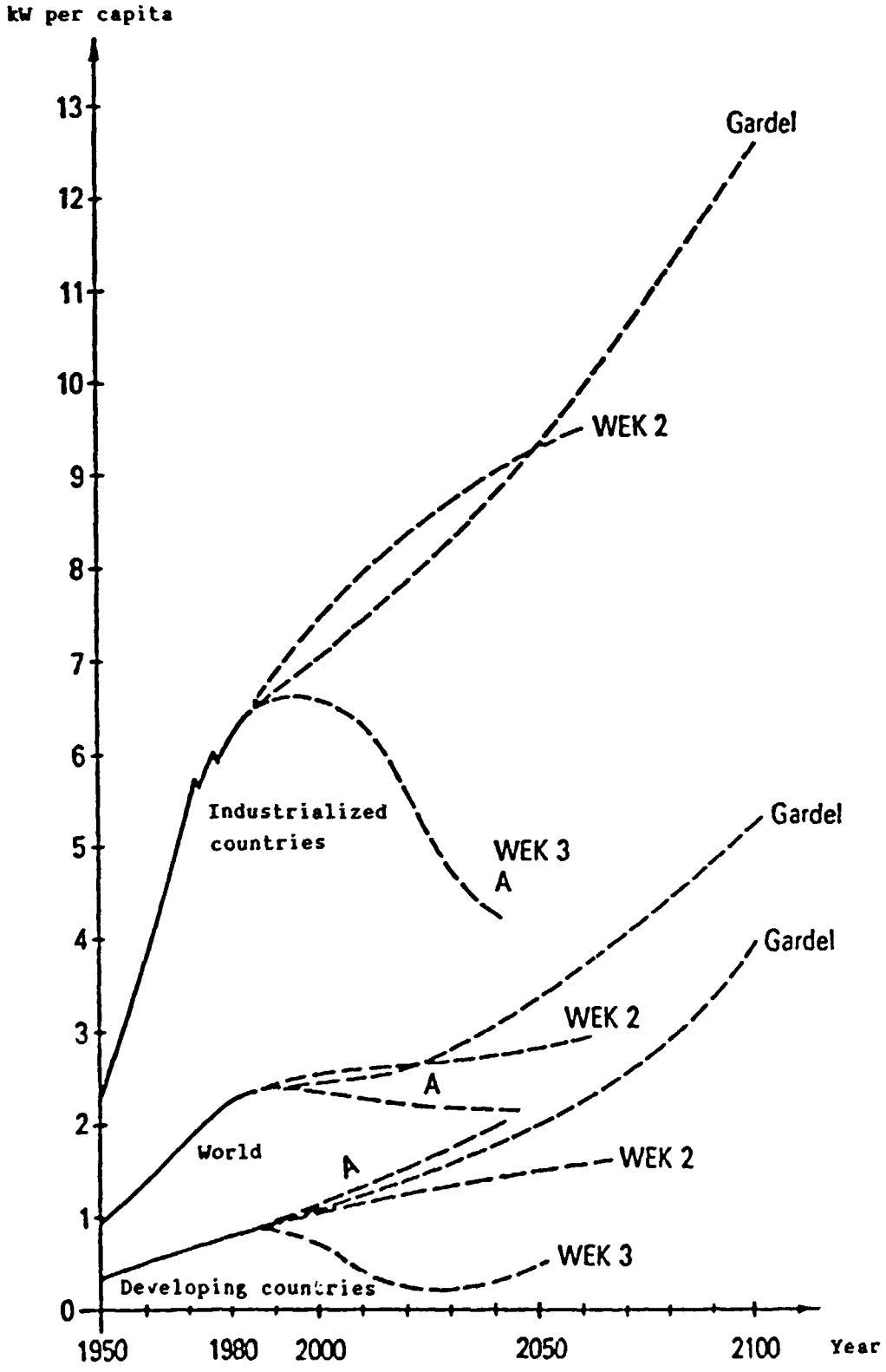
It is important to recognize that the pattern of energy availability and use in developing countries is changing especially with regard to NRSE. In fact, it is in the developing countries that some of the most original and significant departures from conventional energy use can be found at present. Necessity and ingenuity have led to non-conventional solutions (based on NRSE) that are 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.

Figure I. Per capita consumption of primary energy



Source: Technische Rundschau, March 1988.

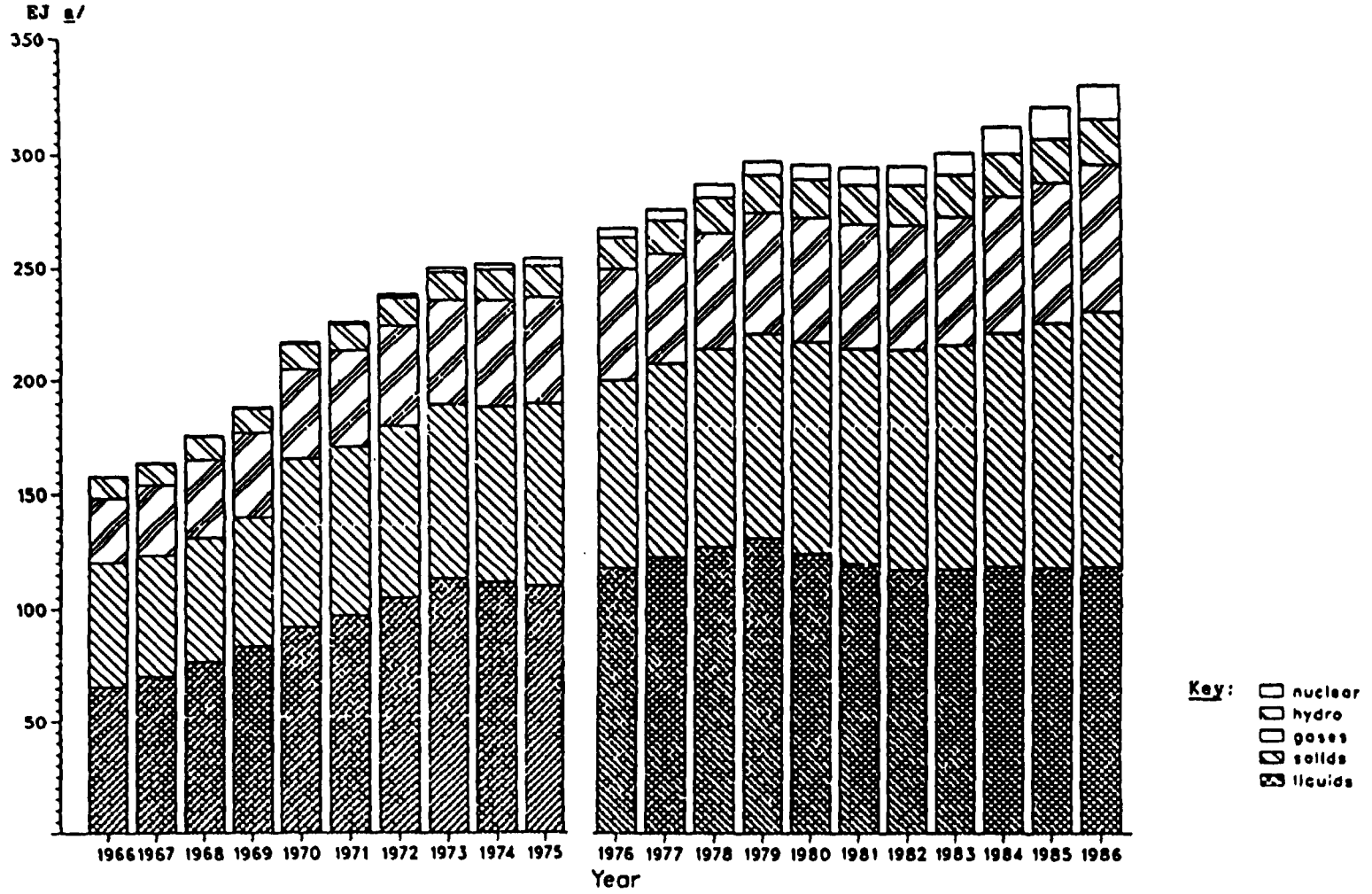
Figure II. Per capita consumption of primary energy to the year 2100, various scenarios



Source: Technische Rundschau, March 1988.

Note: An explanation of the various scenarios is contained in the source.

Figure III. Breakdown of total energy consumption for the world, 1966-1986



Source: International Atomic Energy Agency, Energy, Electricity and Nuclear Power Estimates for the Period up to 2000 (Vienna, 1987).

Note: Data for the period 1966-1969 do not include the contribution from fuel wood, which in 1970 contributed 7.4 per cent to the total energy consumption.

a/ 1 EJ = 104.17 TWh.
b/ All 1986 values excluding nuclear are extrapolations.

Table 1. Total world energy consumption a/ by type of fuel, 1986
(Percentage)

Region or group	Solids b/	Liquids	Gases	Hydro	Nuclear	Geotherm	Total
North America	25.21	38.41	23.81	6.86	5.55	0.16	100
Western Europe	23.36	42.19	16.10	7.78	10.53	0.05	100
Industrialized Pacific	22.42	50.50	12.58	6.17	8.18	0.16	100
Eastern Europe	32.97	29.29	31.96	3.31	2.43	0.04	100
Asia	66.11	22.77	5.34	4.61	1.05	0.13	100
Latin America	21.13	44.03	19.17	15.26	0.26	0.16	100
Africa and Middle East	43.07	42.37	11.55	2.59	0.39	0.03	100
World average	33.99	35.72	19.78	6.02	4.40	0.10	100
Developed countries	26.30	37.39	24.10	5.93	6.19	0.09	100
Developing countries:							
Centrally planned economies, Europe c/	52.65	23.34	20.06	1.70	2.24	0.00	100
Other developing countries	48.65	33.79	9.88	6.88	0.66	0.14	100
Total developing countries	49.18	32.41	11.23	6.20	0.87	0.12	100

Source: International Atomic Energy Agency, Energy, Electricity and Nuclear Power Estimates for the Period up to 2000 (Vienna, 1987).

a/ Total energy consumption = consumption of primary energy plus net imports (imports minus exports) of secondary energy.

b/ Solids include commercial wood.

c/ Albania, Bulgaria, Czechoslovakia, Hungary, Poland and Romania.

Table 2. Annual energy production from renewable energy sources in selected developing countries
(kWh/a x 10^3)

Country	Solar	Wind	Minihydro	Biomass	Biogas	Total
Pakistan	15 000 a/	--	484 x 10^6	--	1 800 a/	484 x 10^6
Panama	28 000	3 000	88 x 10^3	--	9 100	128.1 x 10^3
Philippines	480 000	--	1.5 x 10^6	--	180 000	2.16 x 10^6
Senegal	537 a/	14	--	--	204	755
Sri Lanka	4 000 a/	8 000	500 000	--	29 000	541 000

Source: Yehia El Maghary and Seppo Kaerkkaeinen, eds., Energy Storage Systems in Developing Countries (London, Cassell Tycooly, 1988).

a/ Electricity generation.

Table 3. Present and anticipated use of renewable energy sources in 47 developing countries
(Percentage of countries that have harnessed or plan to harness each energy source)

	Harnessed	Planned	Total
Solar	55	17	72
Wind	30	9	39
Minihydro	47	9	56
Biomass	28	13	41
Biogas	36	13	49
Tidal or wave	4	--	4
Other	9	--	9

Source: Yehia El Maghary and Seppo Kaerkkaeinen, eds., Energy Storage Systems in Developing Countries (London, Cassell Tycooly, 1988).

III. UNIDO ACTIVITIES IN THE AREA OF NRSE

The mandate of UNIDO in the energy-related aspects of industrialization, including especially new and renewable sources of energy, was established by the Second and Third General Conferences of UNIDO and was also reflected in the report of the Secretary-General to the General Assembly at its thirty-fifth session.

UNIDO, in its approach to the development of NRSE, is opting to support developing countries in the following areas:

Transfer and application of technology
Strengthening institutional infrastructure appropriate for the further development and infrastructure of NRSE
Identification of financial resources
Continuous training of technical and managerial personnel
Elaboration of relevant legislative and regulatory framework

An outline of the current and planned activities in connection with new and renewable sources of energy is contained in the annex.

UNIDO activities in the field of energy cover a wide range of energy issues, such as energy conservation, energy management as well as new and renewable sources of energy. Within this area, UNIDO functions in two ways, namely through: (a) technical assistance activities, which are a response to requests from Governments; and (b) promotion of industrial development.

A. Technical assistance

UNIDO delivers yearly some $US 100 million of technical assistance, of which ten percent is in energy in 1987. In the year 1980 it was only five per cent. The annual disbursements on energy for the years 1980-1987 are shown on figure IV. The increase in the technical assistance delivery on NRSE can be seen in figure V: in the year 1980, the share for NRSE amounted to 0.5 per cent of UNIDO technical assistance; by the end of 1987, an almost constant share of three per cent can be recorded. UNIDO technical assistance in NRSE compared to that for total energy for the period 1980-1987 is shown in figure VI.

Requests from developing countries for UNIDO technical assistance in the field of NRSE are mainly in the following areas: biomass; hydropower; solar; and wind (to a much smaller extent than the other areas). The trends in percentages of technical assistance requests with respect to these sources of energy are illustrated comparatively in figure VII.

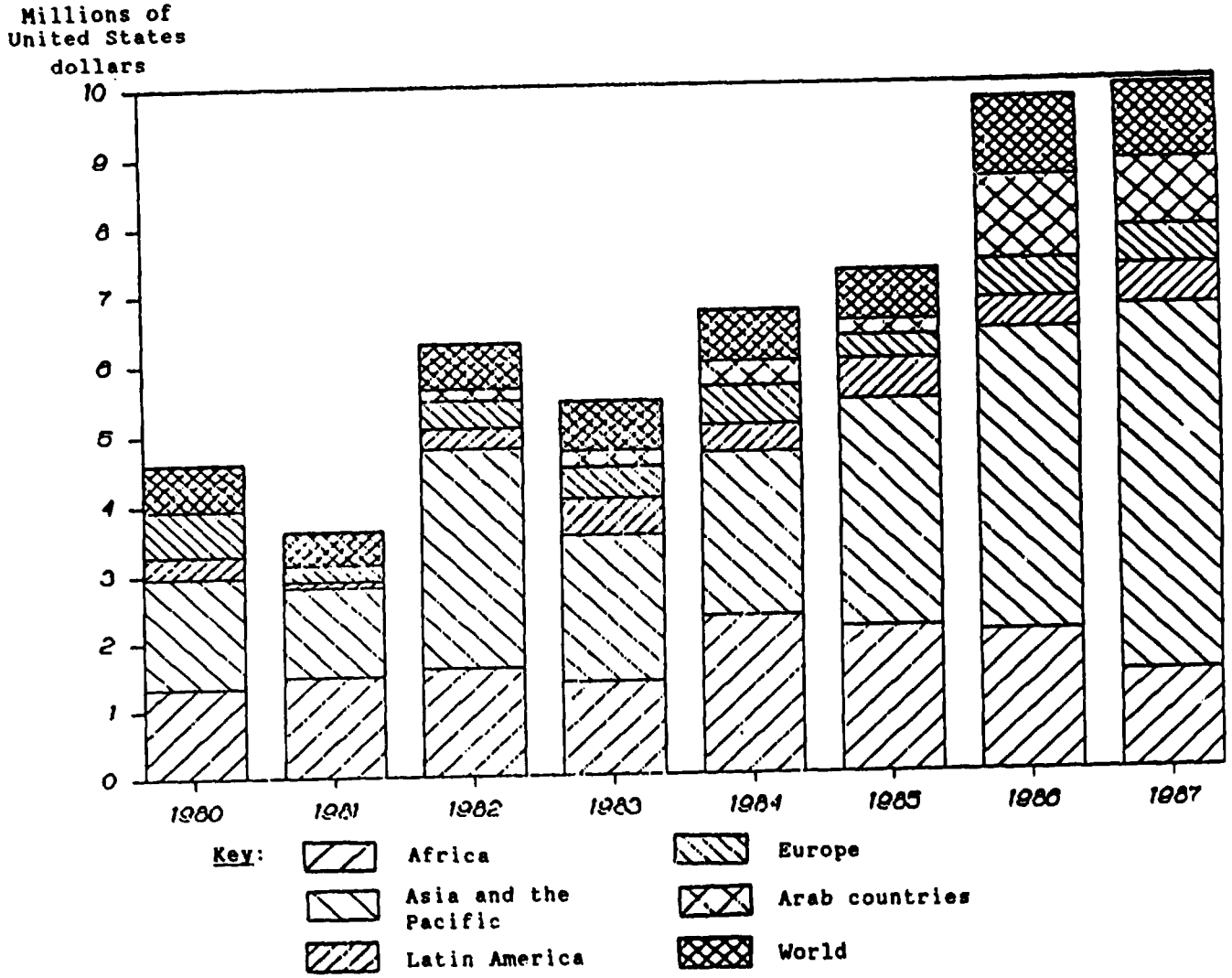
The assistance delivered in the various regions by type of energy is shown in figure VIII.

As mentioned in above, the developing countries as a whole are well endowed with, and have the potential for developing, new and renewable sources of energy, such as biomass, hydropower, solar and wind. These sources of energy and UNIDO activities relating to each of them are discussed below.

1. Biomass

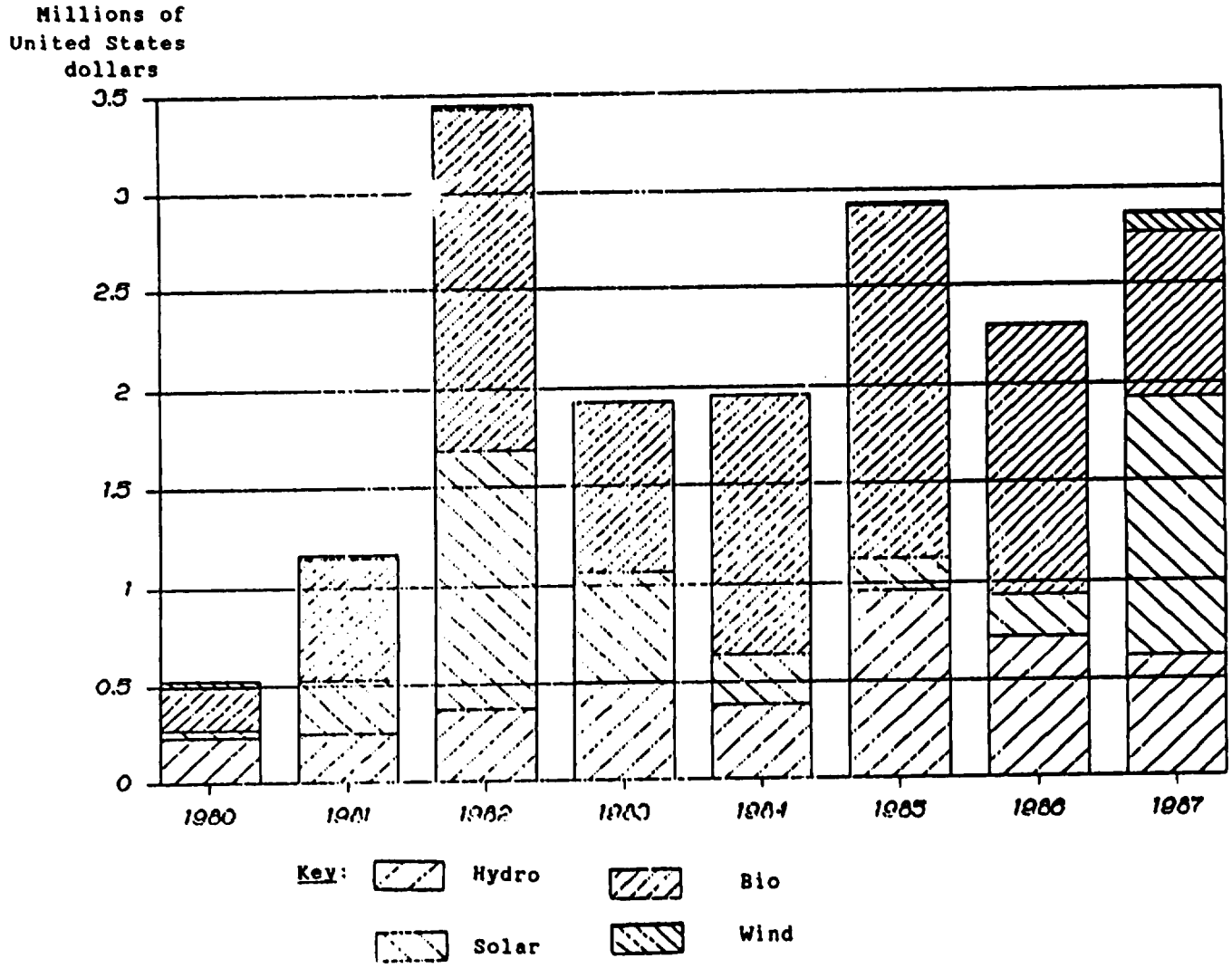
It has been estimated [2/] that biomass provides between 6 and 13 per cent of total world energy needs. But such estimates can only be regarded as best guesses, because much of the biomass used for energy production is not recorded in any commercial energy statistics. It is clear, however, that biomass provides the major source of energy in many developing countries. This is to a large extent in the form of wood for fuel. Typical biomass materials, conversion processes and biomass-derived fuels and energy products are shown in figure IX.

Figure IV. Yearly regional disbursement on energy, 1980-1987



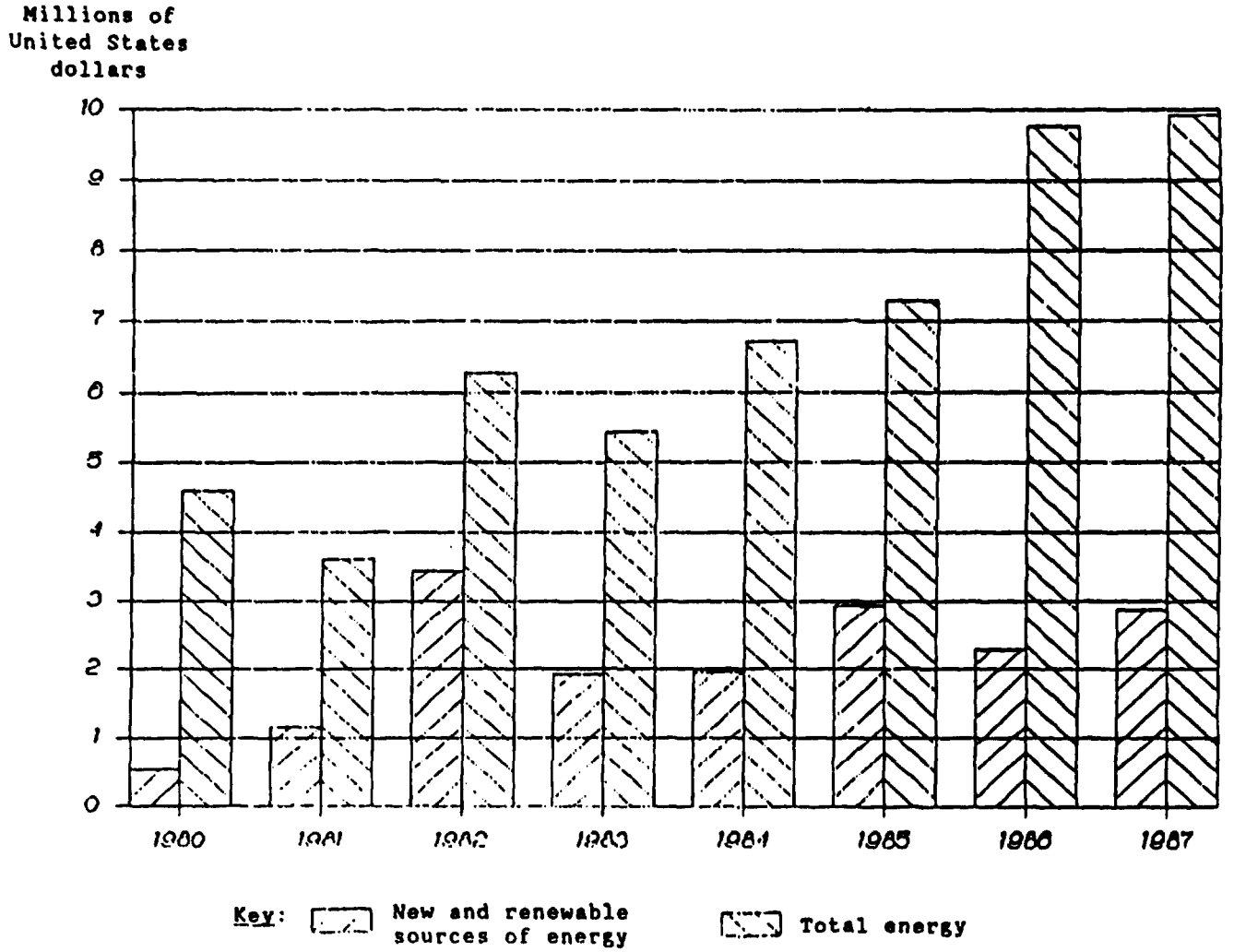
Source: IPCT/DTT/INF.

Figure V. UNIDO disbursements for new and renewable sources of energy by type of energy, 1980-1987



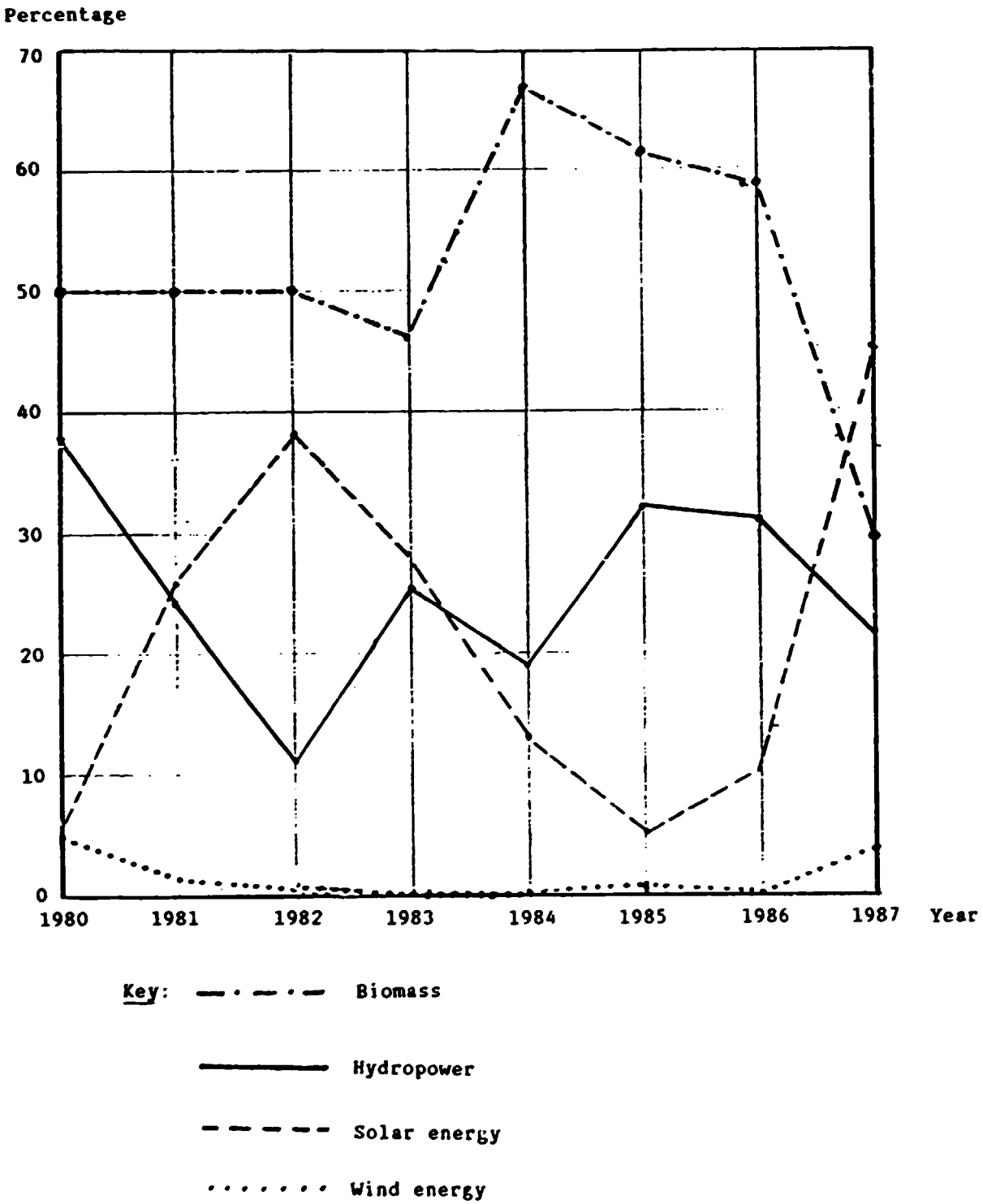
Source: IPCT/DTT/INF.

Figure VI. UNIDO disbursement in new and renewable sources of energy compared with total energy, 1980-1987



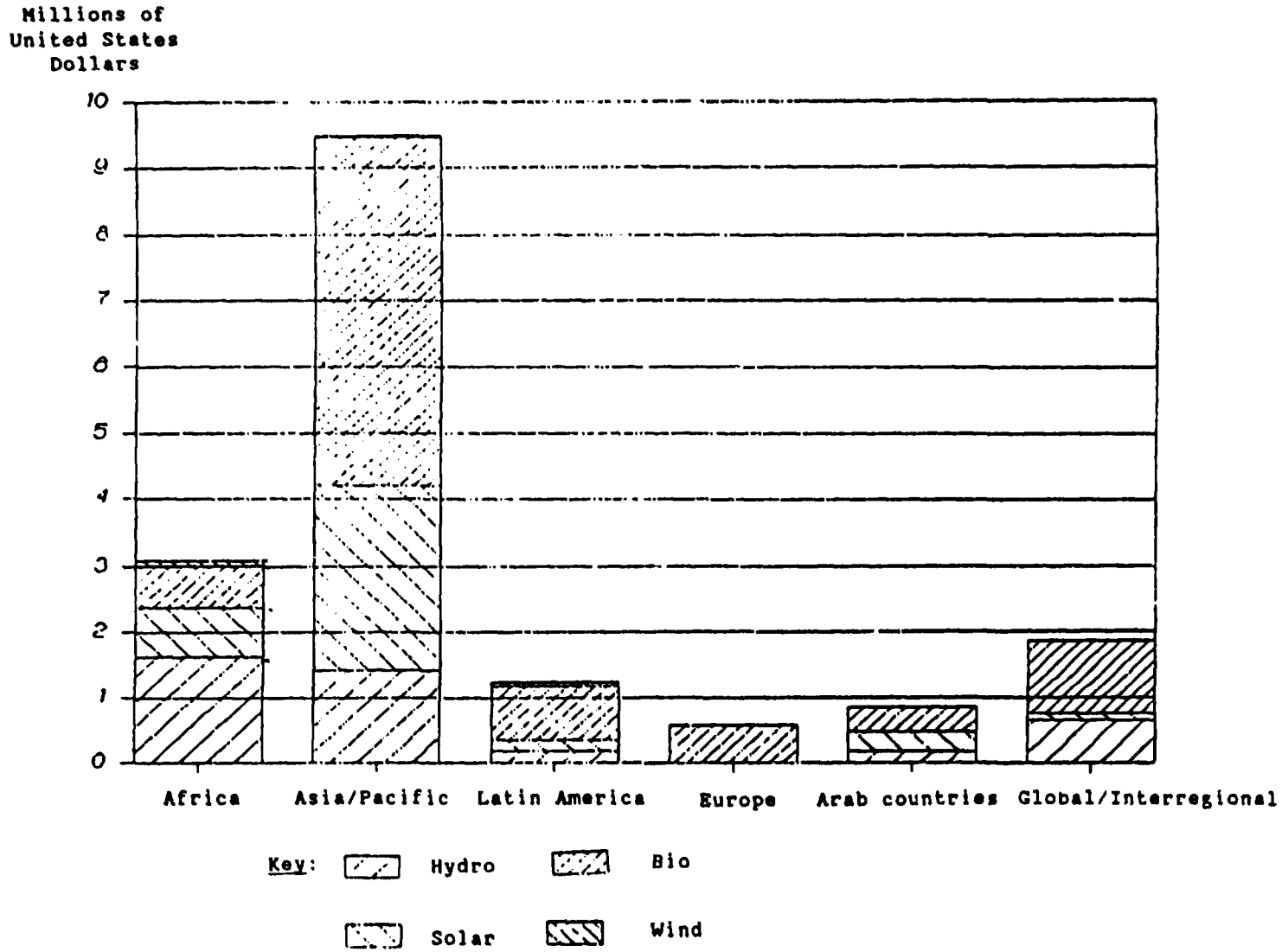
Source: IPCT/DTT/INF.

Figure VII. Requests for technical assistance, by type of energy, 1980-1987



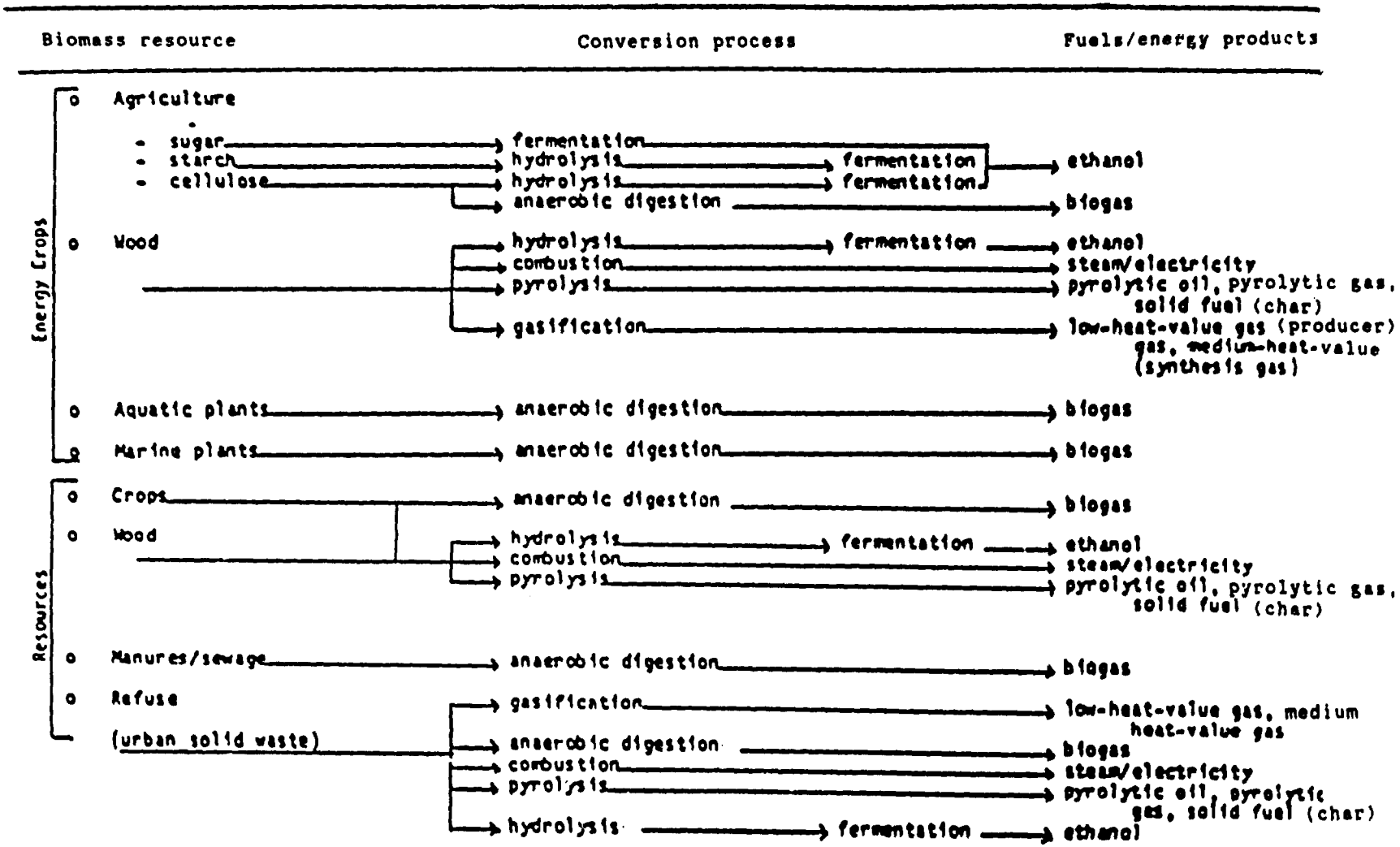
Source: IPCT/DTT/INF.

Figure VIII. UNIDO disbursement on new and renewable sources of energy, by region and type of energy, 1980-1987



Source: IPCT/DTT/INF.

Figure IX. Biomass conversion processes and fuels/energy products



Source: Handbook of Biomass Conversion Technologies for Developing Countries (UNIDO/IO.580).

Biomass, and its conversion to a usable energy form, represents a major resource for the developing countries. It provides them with the possibility of obtaining large quantities of indigenously produced energy from a wide variety of feedstocks and processes and is a renewable energy form. It is, or can be, produced in a wide variety of form to meet a range of needs, as can be seen in figure IX. It is therefore possible with planning to provide the right quantity and type of energy or fuel.

In keeping with its mandate of promoting industrialization, the UNIDO biomass energy programme targets primarily the agro- and forest-industry subsectors. Food processing industries, including breweries, distilleries, dairies and abattoirs, are usual counterparts for annerobic digestion (biogas) projects. In charcoal production and thermochemical gasification, UNIDO provides technical assistance to agricultural and logging/sawmilling organizations with activities such as charcoal production from sawmill waste and crop residues and the gasification of waste for shaft power generation. Priority is given to processes and techniques for which equipment can be locally fabricated.

UNIDO continues to support the fermentation alcohol industry with projects that address a wide range of problems, from improved process engineering-immobilized yeast cell processes to the use of surfactants with diesel fuel/ethanol blends for the production of stable emulsions of up to 25 per cent alcohol requiring no engine modifications.

For full advantage to be gained from biomass energy, developing countries need to undertake and strengthen R&D on all aspects of the subject, from improved biomass resource management through conversion technology to more efficient end-uses. At the same time account must be taken of the fact that biomass resources have many competing uses. It is therefore necessary to adopt an integrated and balanced approach in line with the particular needs and resources of developing countries. The conversion of biomass has to be carefully assessed in order not to disturb natural balances and to fully assess environmental impacts.

2. Hydropower

The hydropower potential of the developing countries is vast; Africa alone is estimated to have some 30 per cent of the world's potential. It was noted that currently only about 9 per cent of the hp potential in the developing countries had been exploited. Electric power is a universal energy form and can be used to satisfy many industrial energy needs. Although the major part of electric power will be supplied from large -scale projects, there is an important role for small and mini-hydropower plants, especially in rural areas and in decentralized industrial applications.

The estimated world's potential hp capacity is about 2.2 x 10**6 MW. Approximately 60 per cent of this potential exists in the less developed countries of Latin America, Africa and Asia and the Pacific. Compared with the requirements and potential resources, however, the utilization of hp, especially the portion below 5 MW capacity, is largely underdeveloped. Only about 16 per cent of the total technically usable hydropotential in Asia and about 13 per cent of the corresponding rate of utilization in South America have so far been harnessed. For Africa, the corresponding proportion is only 4 per cent compared to 94 per cent in Europe. Mini-hydro projects (under 1 MW) might comprise 5 - 10 per cent of the world's total hydro-resources. Small-scale hydro power plants are gaining growing importance and are being widely used in the range from 10 kW to approximately 5,000 kW at heads from 2 m to 500 m.

UNIDO has paid special attention to this area and particularly to small-scale hydropower and has established a strong reputation in the field of NRSE. In that connection, attention is drawn to the most recent UNIDO Workshop on Mini Hydropower Development, held in Vienna in June 1987.

3. Solar energy

The developing countries, owing to their geographical locations, have abundant solar radiation. There is a wide area of industrial application for solar energy in the form of low-temperature water (30-70° C) produced in simple thermosyphons with flat-plate collectors. Using concentrating collectors, high temperatures (up to 150° C) can be generated. This range of temperatures fits a variety of industrial uses such as bottle washing, sanitary uses or boiling.

Another solar energy route being developed is the direct production of electric power through photovoltaic cells. This is a new technology. In the future, energy through PV systems could be an important renewable source of energy, particularly for developing countries.

In general, UNIDO has already accumulated some valuable experience in the introduction and application of PV systems in developing countries and quite good connections have been established with a number of R&D institutions and firms in industrialized countries dealing with promising solar energy projects and related technologies including PV.

UNIDO technical assistance activities are mainly concentrated, where possible, on the establishment of facilities for detailed design, system engineering, prototype development, testing and pilot plant production of complete PV systems or components tailored to the needs of developing countries.

4. Wind energy

With regard to wind power. UNIDO has realized wind pump pilot schemes and technical assistance activities in African and Latin American countries aimed at establishing local capabilities for the production and installation of wind mill systems on the medium or long term for water-pumping and/or electricity generation.

B. Promotion of technology and information exchange

The promotion of energy and NRSE technologies is a clearly defined programme component of UNIDO. Solar energy, particularly is considered by UNIDO to be one of the promising sectors deserving promotion through international co-operation It is infinitely renewable, abundant and widely available in both developed and developing countries.

In connection with the establishment of a Consultative Group on Solar Energy, Research and Application (COSERA)[3/] the following activities have been undertaken by UNIDO:

(a) Background reports and publications related to solar energy research and application;

(b) A workshop on COSERA, 8 - 14 December 1986:

(c) Donor agencies, international organizations and research institutions were canvassed for their view of and support for COSERA, the result being generally strong favourable reaction;

(d) Consultant's reports on solar energy research institutions in Latin America and Asia; a third consultancy covering North African countries will be undertaken this April;

(e) Preparation of a portfolio of solar R&D projects from various sources to be reviewed and considered for implementation by COSERA.

UNIDO acts as a clearing house for appropriate technologies and also promotes information transfer.

Information is one of the three factors constituting the physical plane of the production function, as detailed in figure X . The appropriate information results in energy conservation or/and optimal energy generation or utilization.

UNIDO has a strong mandate in the field of industrial information and has, for over 20 years, been active in providing computerized information packages and in establishing information networks on specific topics, including NRSE.

The exchange of technological information plays a growing role and UNIDO is aware of the necessity to contribute in closing the technology gaps between countries and to assist in avoiding duplication of responsibilities and efforts. Therefore, the UNIDO Energy Information System (EIS) has been created in order to provide support for the Organization's energy programme and to record its energy activities.

The System's key components are described below.

PRAD DATA BASE

The necessity for reporting on UNIDO activities in the energy sector led to the creation of a computerized information system covering project and other energy-related activities, which has been expanded over the years and has gained in complexity and coverage. Almost 500 energy projects have been under implementation since 1980 and form a part of the PRAD computer programme (one component of EIS). This data base provides information on project activities, giving standard data on project number, title, financial aspects, counterpart agencies as well as an abstract on each project's scope and coverage.

IDA DATA BASE

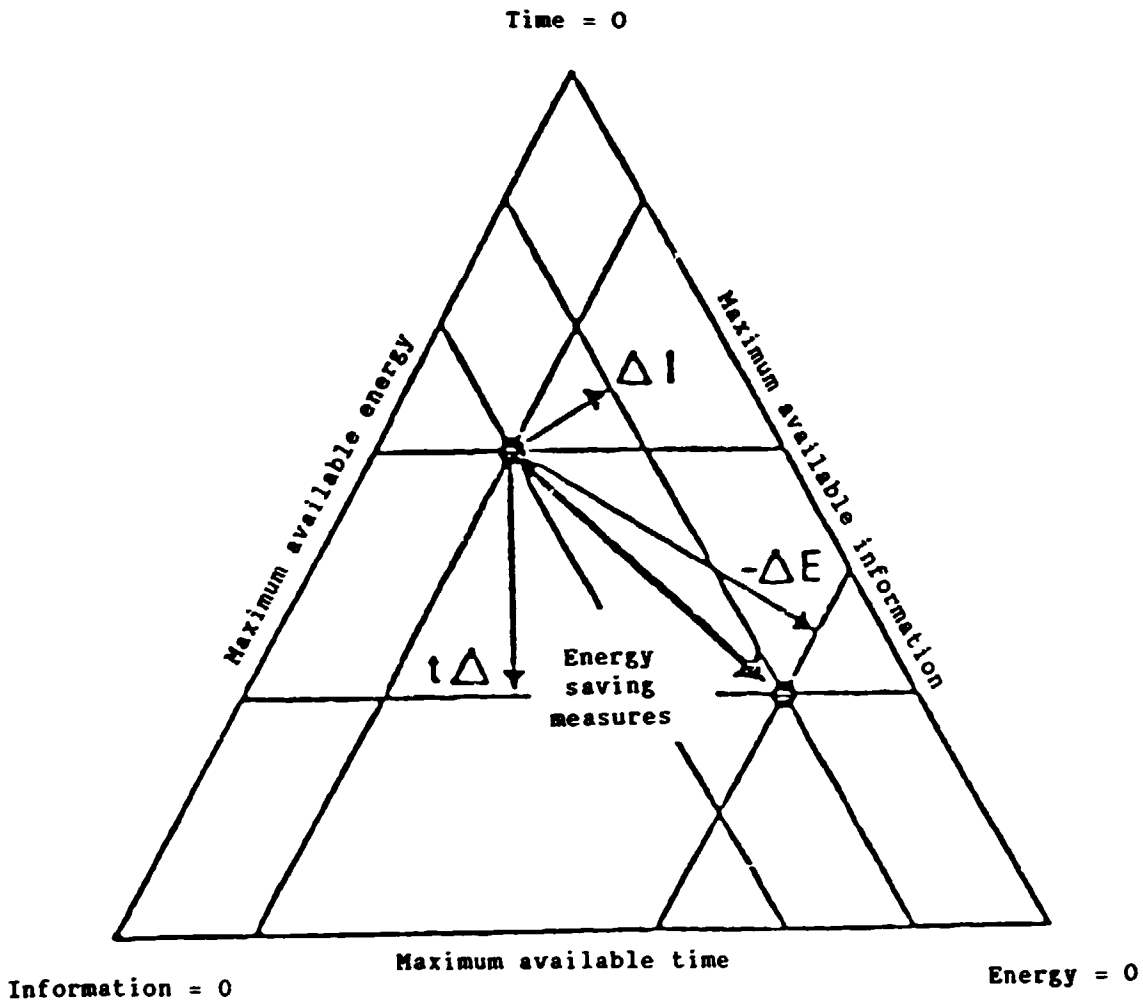
The Industrial Development Abstracts data base records, inter alia, technical and final reports that stem from projects, thereby providing a complementary source of information on energy project activities. This data base is also utilized for providing information on what UNIDO has been doing in the energy sector.

ENER DATA BASE

The ENER data base system primarily provides support for the Industrial Energy Conservation Abstracts, which cover information on several activities related to energy conservation in industry, namely:

Abstracts of technical papers
Energy efficient technologies/equipment
Training opportunities
Research and development
Planned meetings
Consultants/experts

Figure X. Time/information/energy triangle



P = f (T, I, E)

Conventional economic point of view:

P = f (work, capital, country)

Where: P = production
T = time
I = information
E = energy

Source: D. T. Spreng, Substitution von Energie durch Information, NFP 44 (Swiss National Fond for the Promotion of Scientific Research).

The data base will also be available in micro form by mid-1988.

The sectoral focal points of the Industrial Energy Conservation Abstracts are:

Energy auditing
Iron and steel
Chemicals
Building materials
Food processing
Waste heat recovery
Energy conservation policy.

The Industrial Energy Conservation Abstracts data base is the core of an initiative for creating an information network on industrial energy conservation.

Resulting from a supported project by the United Nations Development Programme (UNDP) in the European region, the network concept has found an echo in other regions, initially the Association of South-East Asian Nations (ASEAN) and the Caribbean, and with other organizations. Activities will include the utilization of electronic mail for information exchange and the initiation of information exchange modalities between interested parties/nodes within each region and between regions. The envisaged output of the Industrial Energy Conservation Abstracts network information structure are:

(a) Manuals/guides on energy technologies and activities related to them - e.g. solar energy and energy conservation in specific sectors;
(b) Information on UNIDO energy activities;
(c) An Industrial Energy Conservation Abstracts newsletter;;
(d) Information packages on selected aspects of energy/industry.

Notes

1/ "Involvement of NGOs in the development of renewable sources of energy in Africa" (ID/WG.444/4).

2/ "Energy and industrialization", background paper presented to the Fourth General Conference of the United Nations Industrial Development Organization, Vienna, August 1984.

3/ "Workshop on the establishment of COSERA: Report" (ID/WG.464/4).

Annex

CURRENT AND PLANNED ACTIVITIES OF UNIDO IN CONNECTION WITH NEW AND RENEWABLE SOURCES OF ENERGY

The mandate of UNIDO in the NRSE-related aspects of industrialization finds response in the following:

(a) Implementation of comprehensive NRSE programmes at the national, subregional and regional levels to support the industrialization process;

(b) Intensification of research and development activities at the national, subregional and regional levels;

(c) Analysis of current uses of NRSE with a view to ascertaining the efficiency of their uses as well as the potential and possibilities for conservation;

(d) Assessment of energy, machinery and equipment needed for the generation, transmission etc. of NRSE, taking into account existing and future requirements;

(e) Assessment of the cost-effectiveness of the various available types of NRSE and end-uses of energy generated with a view to selecting the most effective renewable source of energy and systems for particular end-uses;

(f) Preparation of various profiles for the NRSE Sector;

(g) Intergovernmental consultations on policies for the development of NRSE within the overall industrialization framework;

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

(i) Enterprises for the development, reliability, production and marketing of new and renewable energy resources;

(j) Research, development and training centers, with emphasis on non-conventional energy;

(k) Enterprises for the manufacture and marketing of equipment and devices for the generation, storage, transport, transmission and utilization of NRSE;

(l) Subregional and regional energy boards, consisting of the national energy boards, to foster the integration and interconnection of energy networks as well as the standardization of energy equipment with respect to NRSE;

(m) Identification of resource requirements for the development of potential new and renewable resources in relation to present and future energy needs (preparation of inventories on a country and/or regional basis);

(n) Identification of existing capabilities in developing countries in the various activities related to NRSE such as planning, R&D, training, capital equipment manufacturing, consultancy services;

(o) Establishment of close working relationships between national institutions and regional/national, and international organizations, in all phases of exploration and development of NRSE;

(p) Co-operation in the area of capital equipment supply for the production and utilization of NRSE;

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

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

(s) Encouragement of co-operation between countries in the conservation of energy resources, the utilization of NRSE, storage of energy, regulations and environmental protection;

(t) Promotion of information exchange by strengthening or setting up energy information systems and liaising with on-going activities. Co-operation for the development of a world-wide network with other international, national and regional organizations. Information may also be exchanged through direct contracts, meetings of experts and other channels;

(u) Support or establishment of repair and maintenance capacities for existing NRSE facilities;

(v) Assistance to countries to enhance their activities in the NRSE area;

(w) Assistance to developing countries to evaluate their NRSE potential;

(x) Monitoring and assessing NRSE technologies for the benefit of developing countries.

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