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REPORT AND PROPOSED ACTION PROGRAMME <sup>a/</sup>

prepared by the

UNIDO ENERGY TASK FORCE

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Introductory Note and Summary of Conclusions

The Task Force was guided by a series of general assumptions regarding energy demand and supply in the context of industrial development. \*/

- Energy supply represents an essential condition for development, whatever the model, scenario or strategy. This is especially evident for the industrial development of developing countries: industry is, and may be expected to remain, a major consumer of energy.
- Energy derived from fossil fuels, and in particular petroleum, will continue to play a pre-eminent role in the context of the Lima targets (accelerated industrialization of developing countries within a pattern of global and inter-dependent growth; year 2000 perspective) \*\*/
- Known petroleum resources exploitable with current technologies may be insufficient, at present consumption patterns and rates in all sectors (i.e. transport, agriculture, households, industry), to sustain industrial growth in the developed and developing countries within Lima parameters, especially if substantial growth rates are envisaged.
- Other fossil fuels -- primarily coal, natural gas, peat, heavy crude, oil shale and tar sands -- are certain to gain in importance in the next two decades. The main constraints, in the short and medium term, are inadequate exploration and high capital costs.
- A major increase of the use of coal in developing countries for power generation, synthetic fuel production and as a chemical feedstock requires determined exploration efforts (while the distribution is very uneven, some 50 developing countries are at present known to have coal resources: only 30 are currently exploiting them) \*\*\*/ as well as infrastructure development, and entails high capital expenditures: synthetic fuel production in particular involves sophisticated and capital-intensive technologies likely to become meaningful only in the second decade.

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\*/ Cf. in that connexion some recent UNIDO policy statements and papers with regard to energy, e.g. addresses of the Executive Director to the Conference of Non-Aligned States, Havana, Sept. 1979; Committee of the Whole, UN/GA, Sept. 1979; Royal Society, London, 20 June 1979; Kölner Rohstoffrunde, Cologne, 7 June 1978. Also UNIDO submission to ACAST, August 1979. See also Interim Report of UNIDO Energy Task Force, April 1978.

\*\*/ Lima Declaration and Plan of Action on Industrial Development and Co-operation / 2nd General Conference of UNIDO, 1975-7

\*\*\*/ Cf. Coal Development Potential and Prospects in the Developing Countries, IBRD, October 1979

(ii)

- Exploitation of natural gas resources in developing countries also requires further exploration and infrastructure development: early results could, however, be obtained by the fuller utilization of residual gases in connexion with petroleum extraction (e.g. flared gases).
- Renewable sources of energy (bio-mass, including agricultural wastes: solar, water, geothermal and aeolian energies) \*/ may have an important, but probably not decisive role within Lima parameters: in the next two decades, the direct use in industry of renewable energies other than hydro-power is, in fact, likely to be most significant in the agro- and certain manufacturing industries, especially at small-scale level and in decentralized patterns of industrial deployment: this may be expected to reinforce current development policies and to have major social and cultural implications.
- On the other hand, the indirect impact on industry of renewable and other non-critical \*\*/ sources of energy may be considerable if they can absorb competing energy demand in other sectors, especially household consumption (as well as transport and agriculture, in particular if storable and transportable synthetic fuels can be produced commercially).

It must be expected, if these assumptions are correct, that energy supply/utilization will be one of the most controversial political and policy issues of the next two decades, not only in terms of competition for scarce resources between the industrialized and developing world, or between particular countries, but also in terms of allocating these resources among the direct consumer sector, transport, agriculture and industry: problems will also arise with regard to the environment. It is thus evident that key dimensions of the energy problem, and many of the solutions which may be devised to overcome demand/supply imbalances and to reconcile competing interests, transcend the perspective of industrial development of developing countries and hence of the UNIDO Task Force. On the other hand, it is equally clear that the development objectives set for UNIDO are directly - and critically - affected by the energy problem, and that an organization such as UNIDO can make a major and concrete contribution through its technical assistance and promotional programmes to ensure the optimal utilization of conventional as well as of new and renewable energy resources. In fact, the Task Force believes that the following key questions are within UNIDO's specific area of competence:

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\*/ The Task Force did not consider the role of nuclear energy: however its further development as a source of power (power grid systems: possibly direct supply to industry) has been assumed.

\*\*/ The term "non-critical" is used here to denote generically those sources of energy that do not involve raw materials such as petroleum which, in the present state of technology, are in short supply.

(iii)

- How can energy resources be preserved by more rational use (including conservation measures) in industry, and by systematic industrial recycling of materials?
- How can the energy supply derived from new and renewable sources, as well as from such non-critical fossil resources as natural gas, peat, coal, oil shale and tar sands, be increased, especially for use in industry or by the industrial production of new fuels?
- How can industrial production of appropriate equipment and appliances for the generation and use of energy be optimized, with reference to all sectors (i.e. not only industry, but also agriculture, transport, household consumption), and how can the share of such equipment produced in developing countries be increased?

In this perspective, the Task Force has seen as its main function to ascertain what types of support are demanded by developing countries, and on that basis to formulate a modular but integrated action programme on the energy/industry interface addressing those issues on which the UN system, and in particular UNIDO, can hope to have an impact.

In summary, the Task Force proposes intensified efforts by UNIDO, jointly with other members of the United Nations family, to assist developing countries in attaining the following interrelated objectives:

- Efficient utilization of energy resources in industry: this should involve energy auditing and planning at national, sectoral and plant level; conservation measures; deliberate energy- and industrial development or deployment strategies ensuring the optimal use of locally available energy resources of energy, as well as the minimization of heat and distribution losses; non waste-technology industrial production processes (e.g. re-cycling of materials); etc. To that end, the Task Force proposes a combination of training activities; advisory services, including in particular advice on the industry dimension of national energy strategies and advice on energy auditing, planning and conservation at plant as well as at sectoral level; pilot and demonstration projects; dissemination of information on energy-saving practices, processes and technologies.
- Production of appropriate energy-related equipment and appliances. The Task Force urges that efforts be made at policy level (e.g. in the UNIDO system of consultations, and in the 1981 United Conference

on New and Renewable Sources of Energy) to ensure that a substantial share of such equipment and appliances be produced in developing countries. It further suggests an intensified effort to promote, by specific technical co-operation activities, the manufacture of capital goods and appliances for the generation, distribution and optimal use of energy from conventional as well as from renewable sources. This assistance will have to cover also the development, adaptation or acquisition of industrial technologies, repair and maintenance, product design, prototype development and testing, demonstration plants, investment promotion and wherever appropriate advice in the operation of industrial facilities: special efforts should be made to encourage economic and technical co-operation among developing countries by joint technology development, exchange of experts, training, standardization of equipment and multi-national production enterprises.

- Industrial production of fuels and related feedstocks derived from conventional petroleum resources, as well as from coal, natural gas and biomass. To that end, the Task Force proposes strengthening the UNIDO petrochemicals programme to attain increased efficiency in energy transformation (including for instance the utilization of flared gas). It also suggests new programmes to encourage the production in developing countries of fuels and feedstocks from fermentable crops (ethanol), agro-waste, low-grade coal and peat.

All these activities, which are essentially of an operational nature, would greatly benefit from any systematic technical-economic studies of energy perspectives and policies that may be conducted by the International Centre of Industrial studies with a sectoral, national or global focus, as well as from the services of the Industrial and Technological Information Bank.

While establishing long-term programme projections and priorities, the Task Force has encouraged a series of projects and studies of a preparatory or pilot nature. It has also considered with the secretariat units concerned their specific functions and resource requirements. In this, the Task Force assumed that there would be no major structural changes within UNIDO, and that no significant new staff resources could in the short and medium term be allocated to the energy programme. It has explored with other members of the United Nations family possible areas and modalities of co-operation in the context of the proposed energy programme: here again, the working hypothesis was that there would at this stage be no fundamental institutional changes within the system but that, if such changes were to occur, UNIDO would have a major say in them.

The Task Force has been aware that a United Nations Conference on New and Renewable Sources of Energy (UNCNRSE) is scheduled to take place in 1981. UNIDO, and other members of the UN family, are actively involved in its preparation. It might be asked, in that connexion, whether a large new programme on the energy/industry interface, as suggested in the present Report, should be launched or consolidated prior to UNCNRSE. The Task Force sees no contradiction between the two, but a great deal of complementarity. The UNIDO programme will, in fact, place major emphasis on the better use of conventional energy resources. To the extent that it relates also to the industry dimension of new and renewable energy resources (e.g. their significance as a source of energy to industry: the production of equipment and fuels by industry), the programme focuses primarily on a short- to medium-term perspective, i.e. on proven technologies and applications with regard to which there is no reason to wait for the outcome of UNCNRSE. Indeed, much of this work proposed as part of the UNIDO energy programme will feed into the 1981 conference, and in turn the conference may add to the UNIDO programme action on new and renewable sources of energy a long-term vision which the Task Force did not, at this point, consider practical or possible.

The proposed energy programme is ambitious both in its perspective and in terms of the technical assistance resources required to implement it. Quite apart from the fact that a more modest approach - e.g. action within limited time parameters, or focusing only on a small number of countries, sectors or types of technical assistance - might not do justice to the existing demand for supporting action and to the importance, complexity and interlinkages of the energy problem in the context of the industrial development of developing countries, the Task Force is confident that the various members of the United Nations system, and among them UNIDO, have the capacity to mobilize the requisite skills, manpower and financial resources. It is of course evident that a programme of the magnitude suggested cannot be started overnight: it will have to grow incrementally, and perhaps experimentally. This, however, simply confirms the need for comprehensive planning parameters and for an integrated pattern of programme development and management.



PROPOSED ACTION PROGRAMME ON ENERGY AND INDUSTRY

1. OVERALL PARAMETERS

- 1.1 The Task Force considers that a programme on the energy/industry interface in developing countries must give priority attention to:
- (i) the efficient utilization of energy in industry, including non-waste-technology production processes: <sup>1/</sup>
  - (ii) the production, repair and maintenance of energy-related equipment (both conventional and non-conventional, network and non-network);
  - (iii) the production of fuels and related feedstocks.
- 1.2 The proposed energy programme draws to the extent possible on on-going UNIDO activities. <sup>2/</sup> However, the Task Force has attempted to consider needs and opportunities for international action in wider time, conceptual and institutional parameters than would be customary for UN operational planning. The programme thus encompasses both technical assistance and non-technical assistance action in a long-term <sup>\*/</sup> perspective, on the assumption that many of the proposed activities would be carried out in collaboration with other members of the UN family, or in the broader context of UN-wide programmes. In adopting an integrated and conceptually comprehensive, but also modular approach (i.e. a programme organized around particular objectives and areas of action), the Task Force has taken into account UNIDO's overall co-ordinating role with regard to industrial development. It has thus suggested comprehensive parameters for consistent action to be developed within UNIDO and within the UN family, avoiding to the extent possible a duplication of efforts.

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<sup>1/</sup> "The practical application of knowledge, methods and means, so as to provide the most rational use of natural resources and energy". ECF Seminar on Non-Waste Technology and Production.

<sup>2/</sup> See also, in Annex B, a tabular presentation of the proposed energy programme components, with an indication of ongoing and pipeline projects, suggested responsibility for backstopping within UNIDO and possible involvement of other agencies. Project documents and other background documentation are available upon request.

<sup>\*/</sup> Ultimately the year 2000 (Lima target): the main operational focus however, is on the period 1980-1985 and 1980-1989.

- 1.3 In line with UNIDO's mandate, the proposed energy/industry programme focuses on problems of the developing countries, even though its main postulates - especially the call for a more rational use of energy - concern with even greater force the industrialized countries which at present consume a major share of the world's energy supply. Since the latter possess much more substantial scientific and financial means to develop better energy technologies and to tap new energy resources, it may be expected that their experience and knowledge will benefit also developing countries, to the extent that this experience and knowledge can be adapted to their needs and conditions (e.g. locally available resources; scale of industrial operations; socio-economic conditions). Beyond this, however, efforts must be made in the developing countries themselves to develop strategies, processes and technologies that address their own particular problems: hence the emphasis in the support action suggested by the Task Force on country-specific energy planning and energy-appropriate industrial strategies.
- 1.4 The Task Force believes that, in time, the proposed programme on the energy/industry interface would involve a considerable volume of technical assistance. <sup>3/</sup> This presupposes access to a variety of sources of funding - including the UN Development Programme (country, regional and global IPFs: SIS), the UN Industrial Development Fund (both general and special purpose contributions), the new Science and Technology Fund, the Capital Development Fund, Regular Budget, as well as national, bilateral and regional resources. Opportunities for establishing a special energy development fund within UNDP, within a new UN Science and Technology programme or within UNIDF might be explored. However, the Task Force believes that this would pose both conceptual and management problems. <sup>4/</sup> System-wide consolidation of objectives and action seems, at this point, more important (and also more feasible) than the consolidation of resources.
- 
- <sup>3/</sup> The Task Force has been hesitant to suggest concrete figures, although an ultimate target figure of \$20 - 30 million per year, based on current programme costs, may be advanced as an educated guess.
- <sup>4/</sup> There is also some danger that by establishing a new, programme-specific fund, support from other sources (especially UNDP/IPF) might decline.

- 1.5 Institutional and manpower implications of the energy programme within UNIDO are discussed in Chapter 5 of this report. In general terms the Task Force does not believe that the action it proposes would, at this stage, call for major structural changes or resource growth within the UNIDO Secretariat. This presupposes, however, that co-ordination and live linkages between secretariat units can be maintained at policy level by a continuing, inter-divisional mechanism to ensure integrated programme development and management, without thereby inhibiting the responsibility and efficiency of the units charged with specific operational tasks. It also calls for close contacts with, and rapid access to expertise outside UNIDO.
- 1.6 Lastly, the Task Force would stress again, and will point out wherever appropriate with reference to specific activities discussed in this report, that international action on the energy/industry interface can only be effective if it represents a system-wide effort of the United Nations as a whole, involving also regional UN bodies and non-UN organizations concerned with energy and development.<sup>5/</sup>

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<sup>5/</sup> Including whenever appropriate access of other agencies or organizations to resources which may become available for the energy programme (e.g. through UNIDF).

## 2. UTILIZATION OF ENERGY IN INDUSTRY

The Task Force believes that in the short and medium term, while reliable and economically attractive technologies are being developed with regard to new sources of energy, systematic efforts to encourage more efficient energy utilization in industry should be given top priority. <sup>6/</sup>

Action to this end will have to involve:

- energy auditing and conservation measures, particularly in plants and distribution systems;
- energy-appropriate industrial development strategies, plans, processes, technologies, equipment and management practices;
- the optimal utilization in industry of renewable and other locally available sources of energy, including agricultural wastes and by-products, usually in combination with each other or with conventional energy sources;
- adoption of non waste-technology production processes, including the industrial re-cycling of materials with a high energy content.

Considerable experience with improved energy utilization in industry has developed under the pressure of rising fuel- and feedstock costs, and can be brought to bear on the proposed programme. This concerns practices at plant level, as well as deliberate efforts to deploy and equip industry in such a way as to minimize distribution losses, re-cycle and recuperate waste heat, re-cycle materials and generally to rely on the most appropriate resources in industrial processes (e.g. direct reduction in metallurgy). One should be under no

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<sup>6/</sup> It is recalled that industry consumes from 30 to over 50% of the total energy supply. Energy consumption, potential energy rationalization/conservation coefficients, as well as growth/energy elasticities, are quite different from sector to sector, and are conditioned by a whole range of dependent and independent variables. The Task Force notes in this connexion that most energy supply/demand projections or scenarios are technology-flat, or use very arbitrary coefficients for future technological innovations and potential rationalization, especially as they relate to utilization (demand). In time, the proposed energy programme may generate more accurate data and targets.

illusion, however, that optimal energy utilization in industry can be achieved rapidly and cheaply. Even such basic and theoretically attractive postulates as co-generation, for instance, imply major decisions on investment, plant location and the development of products and markets, and have to face constraints which are not (or not only) technological. Also, current experience and new approaches to better energy utilization refer in general to large-scale, traditionally energy-intensive and therefore energy-conscious industries such as iron and steel, aluminum, or petro-chemicals. The problem, for the UNIDO programme, is to relate them to conditions prevailing in developing countries, including smaller-scale industrial production, industrial sectors which may not be traditionally energy-intensive, and locally available energy resources. It is of course evident that not all energy-saving processes and technologies applied in large-scale, energy-intensive industries can be transposed to such conditions. This calls for new approaches (e.g. the combined use of conventional and renewable energies, or of solar energy and biomass) specific to developing countries.

Particular importance should be attached to the utilization in industry of new and renewable sources of energy. These are discussed in further detail in the following chapter (production of energy-related equipment). At present, however, and for the short and medium term, it must be expected that new and renewable sources of energy will be relevant primarily in relatively small-scale, decentralized industrial units, and that with the possible exception of hydropower and certain biomass-derived energies they will supplement rather than substitute conventional sources of energy. Examples are the direct utilization of solar heat for crop drying; use of agro-wastes; small-scale hydro power generation. It is of course evident that any decision to rely on new and renewable sources of energy requires a rigorous and country-specific technological and economic analysis of all available alternatives, as discussed in paragraph 2.2.1 below with regard to industrial energy strategies and energy planning.

In principle, the Task Force has considered the following operational tools for the proposed energy utilization programme:

- training in energy conservation and auditing at plant level:
- advice on energy strategies, planning and conservation in industry at national or sectoral level; mobile demonstration units or teams to provide on-the-spot advice on energy auditing and conservation at plant level:
- in-depth analysis of energy balances and optimal energy utilization in particular branches of industry:
- considering energy aspects also in non energy-specific UNIDO technical assistance projects, especially feasibility studies, industrial planning and training projects:
- dissemination of information: INTIB; monographs; manuals.

#### 2.1 Training in Energy Conservation and Auditing

At this stage, the purpose of training in energy conservation must be seen both as promotional - in the sense of enhancing the awareness of needs and opportunities for energy conservation - and operational, by allowing qualified participants to identify and observe improved energy utilization practices in industry, and relate them to conditions in their own countries and plants. The term "training" may be somewhat inaccurate: programmes should involve a maximum of joint, problem-oriented thinking and discussion among participants from developed as well as from developing countries. This puts a premium on the quality of the participants, and calls for interlinkages with other energy programme components (e.g. advisory services, in-depth studies of particular industrial sectors, etc.), as well as with major UNIDO technical assistance projects.

### 2.1.1 Special Training Courses on Energy Conservation

A pilot course on energy conservation has been conducted, in collaboration with the ILO/Turin Training Centre, for three English-speaking countries. There appears to be a demand for additional training activities of this type: one is currently being considered with the Latin American Energy Organization (OALDE). The Task Force believes that with present staff resources two training courses per year could be backstopped. However, before adopting a definitive pattern for training on energy conservation, it appears necessary to assess the results of the pilot project. One of the key issues to be examined concerns the level of participants: the pilot project was designed for plant engineers, but includes in its final phase also a colloquium with managers. Another issue is whether the curriculum should focus on selected industries, or on particular processes relevant to several industrial sectors. Thirdly, it will be important to optimize the impact in the participating countries, e.g. by shifting the venue of future training courses at least in part to a developing country, by local follow-up training that may involve the original participants as resource persons, and by the wider dissemination of training materials and manuals developed in the training courses.

#### 2.1.5.1 Power Plant Operation

It is also proposed to organize on a regional basis a series of training courses focussing on the efficient operation of electrical power plants; particular attention should be paid to equipment maintenance, replacement and the availability of spare parts.

### 2.2 Advice on Energy Utilization and Resource Management

The need for advice on strategies, planning and specific measures to ensure the better exploitation and use of energy resources in industry is expected to grow sharply in coming years; concretely, this means linking industrial development strategies and appropriate energy strategies. Whatever the level at which such advice may be requested - national, sectoral or plant - it calls for a comprehensive

technological and economic matrix to determine not only the most efficient methods of utilizing energy in industry, but also to provide guidance in the choice of energy sources or "energy mix", keeping in mind available energy resources and their alternative uses. In that sense, energy utilization and energy resource management or planning are closely interrelated.

It should be noted that throughout this programme component - especially advice on energy utilization/planning at national and sectoral level -- direct benefit could be derived from systematic studies that might be undertaken by ICIS on energy demand, energy supply and energy coefficients in particular branches of industry, as well as for particular countries.

2.2.1 At National Level: Industrial Energy Strategies; Energy Planning

Among the pilot projects initiated by the Task Force, a preliminary survey was carried out in Kenya to examine the possibilities of using locally available agro-wastes and primary agro-products for the supply of energy to new industries, especially in the decentralized agro-industrial sectors. Follow-up action will include the formulation of terms of reference for pre-investment feasibility studies. Other similar requests are under consideration. The Task Force urges that they be given priority attention in the energy programme. To that end it proposes to develop, with the assistance of national institutions such as the Academy of Sciences of the USSR, a comprehensive techno-economic matrix to guide the formulation of industrial energy strategies and resource management at national level. Reference to such comprehensive parameters seems in fact essential for any major policy or investment decision in industry - including in particular those concerning the production of fuels and feedstocks, the development of alternative sources of energy, as well as the manufacture of energy-related capital goods and appliances (see Chapter 3 and 4, below).

While UNIDO should be prepared to meet requests for advice on energy strategies and planning as they relate to industry, the Task Force believes that a consortial approach including also other members of the UN family - especially the UN Center for Natural Resources, Energy and Transport (CNRET), FAO, IAEA and



and perhaps IBRD - would be desirable. It is in fact evident that industrial energy strategies and planning must take account of energy demand in other sectors (e.g. transport and agriculture) and of power generation and grid systems which may be expected to draw also on nuclear energy. It is thus proposed that when requests for advice on energy strategies and planning are submitted to UNIDO, CNRET should be consulted and, if appropriate, involved in connexion with overall energy policy aspects. Conversely, UNIDO should be prepared to handle the industry dimension of general energy planning projects entrusted to CNRET. This collaboration should extend to FAO where energy generation from biomass (e.g. agro-wastes and agricultural commodities) is envisaged, and to IAEA whenever nuclear power generation may be involved. The Task Force notes that IAEA is already providing to its members advisory services on electric power system planning (WASP), and that IBRD has also utilized them. The possibility of collaborating with this service, or perhaps to develop it as a joint IAEA/UNIDO/CNRET activity, should be explored.

#### 2.2.2 At Sectoral Level: Advisory Projects: In-depth Surveys

The Task Force has encouraged several advisory projects on energy conservation and better use of locally available energy resources in particular industrial sectors. In Turkey, for instance, an expert team has provided advice on energy conservation in selected industries, including cement, glass and textile industries. Energy utilization and auditing in the sugar industry, with particular reference to the use of bagasse, has been the subject of an advisory survey in Cuba: a regional colloquium on that subject is presently under consideration, and may be replicated in other regions (see 2.2.2.1 below).

It may be expected that a considerable number of similar requests will have to be handled by UNIDO in coming years. While the Task Force foresees no difficulties with backstopping, it suggests that FAO should be consulted whenever agro-wastes or agricultural products are involved as sources of energy.

Beyond specific advisory projects, the Task Force believes that UNIDO should include in the energy programme a series of in-depth analyses

of the energy balance - present and potential - in those branches of industry in which requests for advice on energy utilization/conservation as well as other technical assistance activities and investment opportunities are likely to develop - e.g. food processing and building materials, as well as traditionally energy-intensive industries, such as iron and steel, aluminium and petrochemicals. These analyses, which should take into account also opportunities for adopting non waste-technology production processes (see 2.3 below), may be expected to involve or lead to technical meetings, publications, pre-investment feasibility studies and pilot or demonstration action, and should thus be designed, funded and implemented as technical assistance.

#### 2.2.2.1 Energy utilization in the sugar industry

The choice of the sugar industry for a first in-depth assessment of sectoral energy balances was dictated both by the fact that there exist real opportunities for rationalization, and that sugar production concerns most, if not all developing countries, including LDCs. A pilot project is currently being considered with OLADE for the Latin American region. It is intended to explore the potential uses of sugar cane and its by-products, in particular the use of bagasse as a source of energy within and outside plants (i.e. by feeding into electrical power grid systems), and the production of ethanol by fermentation processes. To that end, a comprehensive economic matrix, considering also alternative land-, product- and manpower uses, markets and ecological implications will be developed in consultation with FAO. The project would analyse technological aspects, including problems relating to equipment, size and location of production units and management at plant and sectoral level: although most of the processes and technologies are mature, this would provide an opportunity to up-date knowledge, illustrate success-stories and develop models or blueprints suitable for conditions in particular developing countries. Similar regional projects might be considered in future in the Asia/Pacific area and Africa. Although conditions - especially those relating to economic variables - might be different from country to country and region to

region, it should be possible to utilize the results of the Latin American workshop in these successive projects.

2.2.3 At Plant Level: Mobile Diagnostic Units

Among the various methods to provide advice on energy auditing and conservation at plant level, the Task Force considers the concept of mobile diagnostic units as particularly attractive. Such mobile units have been operating for some years in Canada and in the CSSR (with particular emphasis in the building materials industry). The Task Force has explored with Czech authorities the possibility of utilizing their mobile unit in connexion with the UNIDO energy programme. It is also considering with OLADE a joint project to equip and operate a similar mobile diagnostic unit in the Latin America region starting in 1981.

2.3 Non Waste-Technology Production Processes

Non waste-technology production processes, including the recycling of materials with a high energy content (ranging from metals to glass, paper, plastics, etc.) should, in the opinion of the Task Force, be given major attention in the proposed energy programme, both from the specific perspective of energy conservation and, more generally, in the context of overall resource management in industry. This could involve a series of studies, symposia and technical publications, as well as advisory, demonstration and training projects.

2.4 General Technical Assistance Activities

The Task Force believes that a systematic effort should be made to consider energy utilization and conservation issues also in UNIDO projects which may not be energy-specific. This concerns especially feasibility studies, industrial surveys and planning, pilot plants and factory management: the inclusion of energy in training and in-plant training programmes has already been referred to above.

2.5

Information Systems and Dissemination

Programme action relating to energy utilization in industry requires deliberate efforts to gather and disseminate adequate, i.e. precise and timely information within UNIDO - primarily in support of programme- and project-development - and outside UNIDO. The Task has thus considered the following information activities:

2.5.1 INTIB (Industrial and Technological Information Bank)

One of its functions, stressed in a recent Plan of Action elaborated by a Senior expert <sup>7/</sup>, is to gather information available within UNIDO and make it available throughout the Secretariat. To the extent that INTIB can tap sources of information (including data systems) existing outside UNIDO on specific experience and technologies relating to energy utilization in industry, such external information should also be disseminated to the secretariat units responsible for formulating and implementing operational action under the energy programme. In fact, the Task Force staff have benefited substantially from bibliographies and abstracts obtained through INTIB on some alternative sources of energy.

It is evident that, if INTIB coverage of in-house and external information on energy utilization in industry can be built up, its services should also be made available, on request, to outside users. This will depend primarily on the ability to link up with comprehensive energy data systems at national level - including especially information on industrial practices and programmes.

2.5.2 Training Materials and Manuals

It has been noted earlier that such materials would be produced in connexion with special energy conservation training and in-plant training courses. In addition to their immediate didactic value, they should wherever appropriate be translated and disseminated in the participating countries as part of local follow-up activities.

7/

Plan of Action for Implementation of Recommendations Concerning the Information and Documentation System of UNIDO, Seifol-Molukov, August 1979.

2.5.3 Monographs on Energy Utilization

In addition to training manuals, the energy programme may be expected to produce materials on energy utilization and conservation suitable for publication, possibly as part of the Technology Series. Topics which might be given priority attention are co-generation; heat pumping; energy utilization in the sugar industry; re-cycling of particular materials (e.g. glass: plastics). It is particularly hoped that UNIDO's operational experience, as well as the programme of studies of ICIS, would be utilized for or at least be reflected in these publications.

3.

ENERGY-RELATED EQUIPMENT

A second priority area for UNIDO action is the industrial production, repair, maintenance and operation of equipment related to energy, whether in industry, agriculture, transport or households. This would have to include equipment for the recovery, production, conversion, distribution and use of energy, as well as appliances and equipment components. The term "industrial production" is used in a comprehensive sense, covering the development of industrial technologies, design, testing, demonstration, manufacturing, marketing, as well as repair and maintenance of equipment and appliances.

A policy question arises at this point as to the extent to which an organization such as UNIDO should be directly involved in scientific research, especially with regard to new and renewable sources of energy. There is no doubt that technologies and product development in that area are contingent upon the results of ongoing research and experimentation, which should therefore be closely monitored by the units concerned with the energy programme. The Task Force nevertheless believes that, given its present resources and mandate, UNIDO should concentrate on the practical application of the results of scientific research which as a rule will be carried out elsewhere, at national or international level. There is, however, a grey area concerning the building and testing of prototypes, demonstration projects, adaptation to local conditions and appropriate product development, and generally the development of industrial technologies. This grey area lies specifically within UNIDO's field of interest and competence, and is thus included in the proposed programme.

UNIDO's present programme already includes a wide variety of projects on the production of energy-related equipment. The Task Force believes, however, that there is need for a more selective and yet conceptually comprehensive approach. There is some danger - especially when new and renewable sources of energy are concerned - that one or the other of the possible alternatives (whether solar, bio-gas, fermentation alcohol or wood) be held out as a panacea for all energy problems.

Care must also be taken not to rely on un-tried experimental technologies, and especially not to promote the production of equipment likely to become obsolete in the near future. Lastly, it has already been pointed out (paragraph 2.5.1 above) how important it is with regard to new and renewable sources of energy to relate technology and product choices to country-specific economic, social and environmental parameters. In fact, most developing countries will have to rely on an energy "mix" involving a number of conventional and non-conventional energy sources, and likely to vary considerably in time as well as in space.

The proposed energy programme encompasses both conventional energy-generation and distribution equipment, and equipment and appliances for the use of renewable sources of energy. Among the latter, the Task Force has focussed primarily on three areas in which a substantive volume of work (including some recent preparatory or pilot action) is already underway:

- (i) biomass
- (ii) solar energy
- (iii) hydro-power generation

In future, however, UNIDO must be prepared to deal also with the equipment dimension of other energy sources, with which UNIDO has so far not been substantially concerned, e.g.

- (iv) wind energy
- (v) geo-thermal energy.

It is evident that a variety of operational tools, ranging from feasibility surveys and studies to training and advisory missions, will be employed in this part of the energy programme. The Task Force would particularly stress that

- technical assistance will in appropriate cases have to involve the construction and operation of demonstration plants, even if this calls for relatively substantial levels of funding: 8/

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8/ Possibly through the Capital Development Fund or concessional loan financing.

- pre-investment assistance (surveys, feasibility studies, pilot operations) should be closely related to investment follow-up, e.g. by specific investment promotion activities or by linkages with funding agencies;
- opportunities for collaboration among developing countries should be systematically explored and followed up, e.g. by assisting in the establishment of multi-national, regional or subregional production- and marketing arrangements: standardization will play an important role in that connexion.

Reference should also be made to the UNIDO inputs in the preparations for the 1981 UN Conference on New and Renewable Sources of Energy: they will require systematic state-of-the-art surveys and provide an opportunity to identify problems and perspectives for the production of energy-related equipment, as well as for the use of these energies in industry.

All these activities call for the closest possible collaboration at planning and operational level with other UN bodies such as the CNPET and FAO: these organizations may not be concerned with industrial production of equipment and appliances per se, but they have specific mandates and capabilities with regard to the exploitation of natural resources and the formulation of overall resources- and energy policies (CNRET) and, where biomass is concerned, with regard to agricultural production (FAO).

### 3.1 Conventional Equipment for Power Generation, Distribution and the Industrial Production of Fuels

UNIDO already provides assistance to developing countries in the production and operation of conventional power-generation and distribution equipment, as well as of equipment needed for the production of conventional petroleum-based fuels and feedstocks. Since it must be expected that conventional power-generation and distribution technologies will continue to play a pre-eminent role



within Lima parameters (whether or not the source of energy is conventional or "new", though in the latter case the scale of operations is likely to be smaller). the Task Force believes that the strengthening of this sector of UNIDO activity will be essential to the energy programme. Some specific steps are proposed to that end.

### 3.1.1 Policy Level: Sectoral Consultations

The Task Force attributes great importance to the inclusion of power-generation and distribution equipment in the UNIDO consultations on capital goods scheduled for 1981. In the past decade, some developing countries (e.g. Brazil, Korea, India) have gained an important place in this sector. However, their overall share in the production of power-generation and -distribution equipment remains modest, especially in view of the sharp growth of internal demand expected in the developing world. See also, in this connexion, the comments on hydro-electric power (paragraph 3.4, below). Among the specific issues which should be explored in the context of the sectoral consultations are the problem of continuing technological dependencies, gaps in the manufacturing capacity for particular equipment components, opportunities for standardization of equipment and co-operation among developing countries in manufacturing, marketing, repair and maintenance.

### 3.1.2 Technical Assistance

Systematic efforts seem particularly needed at this stage to develop and produce power-generation and -distribution equipment suitable for the needs and conditions of developing countries: this relates both to size, relative simplicity of operation, availability of spare parts, and perhaps the specific requirements of power generation from new and renewable energy resources (especially biomass). To that end, the Task Force proposes that an attempt should be made, using to the extent possible the context of sectoral consultations (regional as well as global) and the preparatory expert meetings organized for that purpose, to draw up a technical assistance programme blueprint including appropriate equipment design: feasibility studies for

multi-national production enterprises in developing countries;  
industrial complementation on a regional or sub-regional basis;  
standardization: supply of spare parts: training: TCDC programmes.

### 3.1.3 Investment Promotion, Investment Follow-Up

The growth of power generation and distribution in developing countries, and the strengthening of their capital goods industry to support it, entails very substantial levels of long-term investment. <sup>9/</sup> Although investment financing per se may transcend UNIDO's area of competence, the Task Force believes that the energy programme should include systematic investment promotion efforts; in that context, funding of power generation facilities and the strengthening of the local capital goods industry to supply the facilities with equipment, spare parts, etc. must be considered in an integrated perspective.

## 3.2

### Biomass

Energy generated from biomass is expected to play a significant role in many developing countries and should provide concrete opportunities to build up the local production of equipment and appliances, as well as to develop multi-national manufacturing enterprises and markets at sub-regional, regional or inter-regional level. Technologies in that area are by and large mature. Before launching any major manufacturing ventures for particular types of equipment and appliances, however, systematic efforts are required to relate production plans to market opportunities, to ensure public acceptance (especially for new types of appliances), as well as to build up an adequate infrastructure for repair and maintenance. It is clear that FAO should be actively involved in developing this particular programme component. Also, to the extent that the utilization of biomass has ecological implications (e.g. better utilization of wood, of agricultural and urban wastes), linkages with UNEP would be desirable.

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In a recent internal UN/DIESA paper the capital needs of developing countries for electric-power generation for the period 1980-90 were estimated at approximately \$344 billion, and the corresponding capital needs for electric power distribution at \$187 billion.

3.4.1 Wood

In terms of its share in overall energy supply, of the substantial savings which could be made by its better utilization, as well as in view of its ecological significance, wood must occupy a very special place in the energy planning of most developing countries.

3.2.1.1 The Task Force thus believes that attention should be given in the UNIDO energy programme to a systematic, multi-country programme for the development of more energy-efficient wood-burning technologies and appliances, primarily for household use. The result will probably be better design, using locally available materials (bricks; clay; etc.). Some of the components - (flues, grilles, etc.), may be industrially or artisanally produced. A preliminary study on this subject has been commissioned. The next steps would be the development of prototypes, demonstration projects and perhaps the local production of particular components.

3.2.1.2 The Task Force also suggests that intensified efforts should be made at industry level to encourage the utilization of wood residues by briquetting, direct combustion and gasification. (See Table I, Chapter 4, below).

3.2.1.3 Both FAO and UNIDO are concerned with programme action on the utilization of charcoal in industry and, generally, as a source of energy. The Task Force suggests that an expansion of this programme should be considered with FAO at an early date.

3.2.2 Bio-gas

UNIDO already has a number of operational or pipeline projects relating to the use of bio-gas. While these have drawn primarily upon technologies developed in India, the Task Force believes that other approaches more suitable for a variety of wastes (e.g. fibrous materials) should be explored. It also suggests that in future the energy programme should concentrate on

- (i) technologies and equipment for relatively large bio-gas production units for village and possibly

for industrial use (e.g. in agro-industrial complexes), and for the utilization of urban wastes: containers for storage and transport:

- (ii) the manufacture of components (tanks, valves, etc.) for smaller bio-gas units currently being developed for household use. <sup>10/</sup>

The Task Force thus proposes that UNIDO should, as a matter of priority, initiate a programme of prototype development, demonstration projects and pre-feasibility or feasibility studies at regional or sub-regional level.

### 3.2.3 Fermentation Alcohol (Ethanol)

Programme action in this area is discussed in greater detail in Chapter 4, industrial production of fuels and feedstocks. It should be possible, in that context, to develop also opportunities for the local production of equipment.

#### 3.2.3.1 Combustion Engines

It is proposed to undertake a systematic survey of current efforts in developed and developing countries (e.g. Brazil) on the production or adjustment of combustion engines for the use of ethanol <sup>11/</sup>, and to prospect opportunities for local production at national or multi-national level. Such a survey might include a technical workshop and the publication of a monograph in the Technology Series.

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<sup>10/</sup> The use of small bio-gas units is being promoted by FAO, as well as by non-governmental programmes;

<sup>11/</sup> It appears that most combustion engines can function without a significant loss of efficiency with fuels containing up to 20% of ethanol.

3.3

Solar Energy

The direct exploitation of solar energy as a source of heat or power (electrical, mechanical) figures prominently in any long-term energy projections. This is especially evident for developing countries, both on account of favourable climatic/metereological conditions and because the substantial growth of energy demand expected in all sectors - households, transport, agriculture and industry - could be met by new energy technologies without displacing conventional energy equipment. There will thus be concrete opportunities for the development and local production of appropriate equipment and appliances.

At present the exploitation of solar energy involves primarily the direct use of solar heat. Efficient power generation (and perhaps, in a futuribles perspective, the use of high temperatures in metallurgy, ceramics industries and in the long run for the production of hydrogen fuels) is still contingent on future technological innovations or breakthroughs. Such breakthroughs, e.g. in photovoltaic conversion, are expected to emerge in the next few years from the very considerable research and development programmes of several countries. A second problem area in which major technological progress is required before solar power can be generated on a large scale is that of storage: in the absence of efficient methods of energy storage, the role of solar energy will be primarily for intermittent uses, or (if substantial solar power generation facilities can be established in future) as an adjunct to power-grid systems based on conventional sources of energy. In some developing countries the coupling of solar (i.e. intermittent) and biomass-derived energy might be feasible in the short- or medium term, e.g. as a heat source or in non-network electric power generation.

Under these circumstances the Task Force believes that at the present stage the UNIDO programme should:

- (i) focus on the design and production of equipment and appliances for the direct utilization of solar energy as a source of heat; and
- (ii) encourage, but only in selected instances where the technologies are proven and economically attractive, the design and production of equipment for the conversion of solar energy into mechanical or electrical power. <sup>13/</sup>

The Task Force has reviewed a variety of on-going and pipeline UNIDO projects in this area, and has commissioned or prospected pilot action designed to give this programme component greater consistency and a sharper focus. One of these pilot projects, carried out in Cuba, concerns the local production of solar collectors. Two other projects considered for UNDP/IPF funding in India, relate to solar energy product development and to the production of photovoltaic cells, respectively. It will also be recalled that, in 1977, UNIDO/TTD organized a symposium on solar energy technologies, and that the proceedings and materials were published in the Technology Series. While the technologies and equipment reviewed in that context have since undergone considerable development, the UNIDO publication still constitutes a valuable background document.

### 3.3.1 Direct Use of Solar Heat

It is suggested that for the short- and medium-term priority attention should be given to the following solar heat applications:

#### 3.3.1.1 Solar Crop Drying

The technologies are relatively well established, and UNIDO has some experience in this area. Although the capacity of present crop drying facilities is limited, experimental work with larger and more efficient installations is underway in several countries. The Task Force notes that numerous requests for technical assistance have recently been

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<sup>13/</sup> UNIDO will of course be concerned not only with the production of solar-energy specific devices (e.g. collectors), but also with the production of other industrial equipment, equipment components or appliances which might be required in that connexion at plant or household level (pipes, boilers, mechanical parts, etc.).

received by UNIDO, and is convinced that opportunities for establishing solar crop drying facilities and developing the local production, repair and maintenance of the requisite equipment will rise sharply; in some instances projects will focus specifically on solar crop drying; in others, probably the more numerous, solar crop drying will be one of the components of broader agro-industrial projects.

### 3.3.1.2 Solar Distillation

#### 3.3.1.2.1 Solar Water Desalination

UNIDO can build on substantive operational experience in this area. A recent project, designed to provide water supply for a hotel, has been initiated in Egypt. Other projects may be expected in the context of industrial, agricultural, human settlements and tourism development calling for additional fresh water supply.

#### 3.3.1.2.2 Other Applications

A pilot project is currently being considered in the Comoros Islands to demonstrate the use of solar energy as a substitute for conventional fuels in the small-scale distillation of ylang-ylang. Other similar requests may be expected in the context of agricultural and agro-industrial development programmes.

#### 3.3.1.4 Solar Cookers

Technologies are well established and relatively simple, and there exists a potential for the manufacture of solar cookers in developing countries. It is evident, however, that costs and industrial production of collectors on a large-scale will pose problems. There is also a specific question of social acceptance, calling for some care in product development and design; in that connexion, the Task Force suggests deliberate efforts to consult potential consumers -- i.e. primarily rural women (such an inquiry could include also other new energy technologies and

appliances for household use, e.g. improved wood-using stoves and cookers: small bio-gas units).

#### 3.3.1.5 Solar Water Heating

The Task Force considers that this is another area to which UNIDO's equipment programme should give priority attention. A pilot project concerned with product development and local manufacture of solar water heaters in Ecuador is being jointly developed by CNRET and UNIDO.

Solar water heating technologies are generally mature, and a variety of systems and system components (including in particular collectors) - mostly manufactured in industrialized countries - are already on the market. This calls for a comprehensive attempt to assess these technologies and products in terms of their suitability for use and production in developing countries, whenever possible in a regional or sub-regional perspective. Also, the Task Force considers it essential to relate solar water heater design and product development to current trends in building design, construction materials, construction industries and urban development. In that sense, it believes that a solar project on applied solar energy research being considered with the Royal Jordanian Society might, in view of the particular interest of the RJS in urban development, provide an opportunity to integrate building design and solar water heater development. Beyond this, the Task Force believes that a comprehensive programme for solar water heater production should now be developed in collaboration with HABITAT and CNRET.

#### 3.3.1.6 Other Solar Heat Applications

Among the other possible low- and medium solar heat applications are the generation of industrial steam (also for mechanical power), as well as non-mechanical refrigeration. It is not clear, at present, what role these direct solar heat applications could have in developing countries. The Task Force suggests that UNIDO should closely monitor technological developments and be prepared



to follow-up, when and as appropriate, with product adaptation, product design and other technical assistance activities. Experimental work is going on with high-temperature solar heat technologies, and may one day lead to practical applications in metallurgy, ceramics, for the generation of electricity and even, in the long run, for the production of hydrogen fuels. At present, however, these technologies have no commercial significance and will not, in the opinion of the Task Force, call for UNIDO programme action.

### 3.3.2 Solar Power

A distinction must be made between technologies using solar collectors and those based on direct generation of electricity by photo-voltaic processes.

#### 3.3.2.1 Solar Collector Technologies

Relatively low temperatures captured by collectors are currently being applied to the generation of mechanical (and electrical) power for special applications.<sup>14/</sup> This obviously opens up perspectives for the local production of equipment or equipment components, including solar collectors. It should be noted, however, that technologies using high-concentration collector systems are not fully mature or reliable. Simpler low-temperature technologies using flat plate collectors have outgrown the experimental stage and are in use for irrigation pumping, electrical power generation for small communities, etc. There is nevertheless some doubt as to whether they will ever be efficient by comparison with other methods of generating mechanical power. In any event, considerable efforts would still be required to adapt them to conditions specific to developing countries. Repair and maintenance of collectors pose serious problems, and installation as well as operating costs are high. Lastly, there is a real possibility that many of the solar collector-based systems will be rendered obsolete in the reasonably near future by photo-voltaic technologies.

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14/

Temperatures of up to 90°C achieved by flat plate collectors can use water as a coolant, while medium temperatures 90° to 250°C and high temperatures over 250°C require higher concentration collectors and use coolants other than water.

The Task Force thus concludes that, while UNIDO should closely monitor technological improvements in this area and perhaps - in selected cases - also assist in building up a local manufacturing capacity by feasibility studies and product development projects <sup>15/</sup>, solar-collector power generation should not at present be given prominence in the UNIDO energy programme.

### 3.3.2.2 Photovoltaic Conversion

There is a general consensus that in the short- and medium-term efficient solar power generation is most likely to be obtained by photovoltaic processes. While at present photovoltaic cells are relatively costly and have practical use in very special applications <sup>16/</sup> this is expected to change in the reasonably near future with the development of new materials and production methods, as well as economies of scale. At that point photovoltaic technologies should become particularly attractive in developing countries for small-scale power generation for community, household and agricultural power supply. Unlike solar collectors, photovoltaic cells pose few maintenance problems, and operational costs are thus low.

Under the circumstances, the Task Force suggests the following approach for the UNIDO energy programme:

- (i) close monitoring of photovoltaic technologies
- (ii) consider the wider potential for the manufacture in developing countries of equipment and appliances using photovoltaic cells produced elsewhere; particular attention should be paid to product adaptation, standardization and marketing
- (iii) identify developing countries with high technological skills in which solar cell production might be possible in the short- and medium-term, even though innovations or breakthroughs in this area are likely to be protected

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<sup>15/</sup> Especially for solar collectors which can also be used for direct solar heat applications.

<sup>16/</sup> e.g. as small, autonomous sources of electrical power. (e.g. in space programmes; signal lights, etc.). In Saudi Arabia, however, a 450 kW photovoltaic project for community electricity supply is currently under construction.

by, or tied to proprietary rights (patents, processes) <sup>17/</sup>:  
advise on planning, product adaptation, investment promotion,  
transfers of technology (and their terms), training.

3.4

#### Hydro Power-generation

Of all the "new and renewable" sources of energy, hydro-power is the most likely to have a substantial and direct impact on the industrial development of developing countries within Lima parameters. In many of them there is a considerable untapped potential for hydro power-generation on a large- to small (micro-) scale. Industry is concerned as a major consumer of hydro-power: this calls for the synchronization of hydro power-generation and industrial development strategies, (e.g. to assure supply, reduce distribution losses: see also proposed programme action relating to the utilization of energy in industry, 2. above). Industry is also concerned with the production, repair and maintenance in the developing countries themselves of equipment, equipment components and spare parts for hydro power-generation and distribution. The technologies involved are mature, though adaptation and improvements seem required to make small or hydro power units more efficient and commercially attractive.

The comments in paragraph 3.5 above on the production of power generation and distribution equipment encompass also programme action on hydro power generation. However, the Task Force wishes at this point to draw attention to the special problems and perspectives of small-scale hydro power generation.

#### 3.4.1 Small-scale Hydro Power-Generation Facilities <sup>18/</sup>

Micro-, mini- and small hydro power generation is not likely to solve the energy problem of developing countries: it may, however, play a significant auxiliary role, especially in conjunction with de-centralized

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<sup>17/</sup> Note the example of micro-electronics, where some developing countries gradually took over a large share of production within a decade of the major technological breakthroughs.

<sup>18/</sup> The following definitions were proposed in the UNIDO Nepal Workshop referred to in this paragraph: micro-hydro; 10-100 kW; mini-hydro; 100-1000 kW; small hydro generation units; 1000-5000 kW.

patterns of development, by supplying energy to specific industries, communities or agriculture. Its specific advantages are (or should be) simplicity of operation, relatively short construction time and investment needs, and minimal distribution losses by comparison with large grid-distribution systems. At present, however, the principal constraint appears to be the high cost of civil works (usually this amounts to over 90% of the cost of the plant) and the lack of generally accepted equipment standards.

UNIDO has already initiated, in co-operation with CNRET and regional bodies such as OLADE, a series of pilot activities in this area. Thus a study tour of micro-hydro installations was organized in China: a preliminary consultation on micro- to small hydro power generation was held in Quito, in co-operation with OLADE, and is expected to lead to a systematic survey and action plan for the production of micro-hydro equipment in Latin America: a UNIDO workshop on mini-hydro technologies took place in Nepal and UNIDO is planning a substantial input in the preparation of the 1981 UN Conference on New and Renewable Sources of Energy.<sup>19/</sup>

#### 3.4.2 Tidal Energy: Thermal Gradients, etc.

Beyond traditional methods of hydro power generation other related approaches - e.g. the use of tidal energy - may become important in the medium- and long term. UNIDO should be prepared to consider their capital goods dimension, the more so as technologies and equipment are not basically different from traditional hydro power generation. Other generation methods, e.g. based on the exploitation of thermal gradients, or wave power, are still at the experimental stage.

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<sup>19/</sup> See also the specific recommendations of the MHG Seminar-Workshop held in Kathmandu 10-14 September, 1979.

3.5

Wind power

Subject to a more systematic survey of meteorological conditions and wind constancies in specific locations, the use of aeolian energy for electric power generation and pumping may become significant in agriculture and for community or farm power supply. Current research, experimentation and product development focuses not only on the traditional small units (up to 3 or 4 Kw: pumping) but increasingly also on larger aggregates (200 Kw to several MW) intended primarily for electric power generation, e.g. a part of local power grid systems. The Task Force suggests that UNIDO should closely monitor these developments and be prepared to handle specific technical assistance involving the local production of equipment and equipment components: particular attention should be paid to standardization, repair and maintenance: a survey of repair and maintenance problems of aeolian equipment in Africa is being considered as a UNIDO input in the 1981 UN Conference on New and Renewable Sources of Energy. Beyond this, it might be possible to assist in the production and commercialization of small aeolian units, e.g. for pumping: it is noted that UNIDO is already backstopping a project in that area in Kenya.

3.6

Geothermal Energy

UNIDO has had limited experience in this area. It is suggested that in future UNIDO should collaborate more closely with UN/CNRET, which is handling a number of geothermal projects, paying particular attention to local production, standardization and repair and maintenance of equipment, and to the use of geothermal energy as a source of heat power in industry.

3.7 Information on Equipment Production

This programme component also calls for systematic efforts to ensure adequate, continuing and timely inputs of technological information internally, when operational activities are planned within UNIDO, as well as to outside users. This is particularly important where the production of equipment or appliances relating to new and renewable sources of energy is concerned. In fact, technology choices and product choices presuppose a comprehensive picture of available options or alternatives. In that sense, and quite apart from direct contributions to technology development, adaptation and transfer as part of the energy programme, the Task Force would stress the following activities in the information sector:

3.7.1 INTIB

As already noted in paragraph 2.5.1 above, INTIB should on the one hand help programme staff to monitor and project technological developments, and determine which technologies are emerging from the experimental stage, and on the other hand make available to member countries, on request, data (including bibliographies, surveys and abstracts) on technologies and types of equipment relating to new and renewable sources of energy. This presupposes an effort to gather all information available within UNIDO, and link-ups with data systems at national and international level.

3.7.2 Publication of Monographs

This part of the energy programme may be expected to generate materials suitable for publication - possibly in the Technology Series - on a variety of topics. In the short term the Task Force would suggest the following: mini-hydro equipment; technologies and equipment for the production of ethanol; solar water heaters and other equipment for the direct utilization of solar heat.

4.

FUELS AND FEEDSTOCK

The industrial production of fuels and related chemical feedstocks<sup>20/</sup> is a third area in which intensified operational action is recommended, keeping in mind that these are sectors in which close and continuing co-operation with CNRET and (for biomass-derived fuels or feed-stocks) with FAO is particularly necessary.

For operational purposes, the Task Force recommends that UNIDO's action should focus on

- fuels produced on a relatively large scale. This would thus not include wood for direct use in stoves, or biogas produced in household units, except to the extent that the manufacture of equipment or appliances might be included in the equipment programme suggested under (3) above: it would, on the other hand, cover briquetting of wood residues, and biogas production in larger units;
- fuels which are either transportable, storable or directly used in industrial processes;
- a medium-term time perspective: this would for instance cover coal conversion, to the extent that technologies currently being developed might become significant in certain developing countries, but not large-scale energy farming - an area which requires further study and perhaps experimentation by bodies such as FAO, UNESCO, and UNITAR.

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<sup>20/</sup> Chemical feedstocks are considered in the energy programme to the extent that they are derived from the same raw materials, or involve the same or related processes. In that perspective, and recognizing that the demand for fuels and for chemical feedstocks implies a potential competition for the use of scarce fossil resources, the first Consultation Meeting on the Petrochemical Industry, (Mexico City), explicitly recommended that: "UNIDO should study alternative sources of feedstocks for chemical production, such as natural gas, coal and fermentation alcohol".

#### 4.1 Conventional Petroleum Fuels and Feedstocks

UNIDO already has an active technical assistance programme in this area, involving petroleum refining and other downstream activities (plastics, fertilizers, etc.). Since fuels and chemical feedstocks derived from petroleum resources are likely to continue playing a key role within Lima parameters, the Task Force recommends that this programme should be continued and strengthened, focussing quite specifically on the better use and recovery of energy throughout the transformation processes. It is thus envisaged to analyse opportunities for the use of flared gas, and possibly to organize a workshop on that subject.

The Task Force particularly wishes to stress the importance of the UNIDO system of consultations in this sector. A first consultation meeting on petrochemicals was held in 1979, and a second meeting is scheduled for 1981. Quite apart from their impact on industrial restructuring, redeployment and collaboration in the petrochemical sector, these consultations should also identify opportunities and priorities for technical assistance and ECDC action.

#### 4.2 New Fuels and Chemical Feedstocks

The Task Force believes that a major and systematic effort should be made at this stage to promote the application of new technologies and the use of non-critical raw materials for the production of fuels and chemical feedstocks. For operational purposes, it suggests that UNIDO should concentrate on proven or promising technologies which have already grown beyond the experimental stage. Table I (pp. 33-34) presents a comprehensive picture of the raw materials, processes and end-products on which the energy programme might focus, as well as of the type of equipment and appliances which would be involved (and should therefore be covered by its second programme component, Energy-Related Equipment, Chapter 3, above). The following examples illustrate the approach suggested by the Task Force.



TABLE I

IV

III

II

I

Raw Material	Processes	Product	Equipment and Appliances
<p>1. <u>Wood residues (bark, sawdust, lumber mill wastes, forest thinning, etc.)</u></p>	<p>Briquetting</p>	<ul style="list-style-type: none"> <li>- Briquettes:</li> <li>- Steam, including steam co-generation and electricity</li> <li>- Intermediate BTU gas (IBG) synthetic natural gas (SNG)</li> <li>- Low BTU gas</li> <li>- Ammonia</li> <li>- Methanol</li> <li>- SNG, fuel oil, char</li> <li>- Wood chemicals (on small-scale) - e.f. turpentine, acetic acid, furfural, etc.</li> </ul>	<ul style="list-style-type: none"> <li>- Briquetting equipment</li> <li>- Cheap and better wood stoves for domestic cooking</li> <li>- Suitable furnances</li> </ul>
<p>2. <u>Crop Wastes and residues of low moisture content</u> ( e.g. bagasse, straw, rice husks, peanut hulls, coffee husks, etc.)</p>	<p>Gasification</p> <p>Pyrolysis</p>	<p>Ethanol, for use as fuel and chemical feedstocks</p>	<p>Pilot and demonstration plants, as appropriate</p>
<p>3. <u>Surplus fermentable crops and by-products (e.g. sugar cane, cassava, sugar beet, molasses, etc.)</u></p>	<p>Fermentation</p>	<p>Ethanol, for use as fuel and chemical feedstocks</p>	<ul style="list-style-type: none"> <li>- Small distilleries</li> <li>- Pilot plants for small distilleries, and for evaluating different raw materials</li> <li>- Cheap alcohol stoves</li> <li>- Combustion engines (or engine adaptation) for use of ethanol as fuel or fuel additive</li> <li>- Containers for storage and transport of ethanol</li> </ul>
<p>4. <u>Industrial cellulosic wastes (pulp and paper wastes)</u></p>			

TABLE I (p. 2)

<u>Animal Wastes</u> (wastes from cattle, pig, poultry, farms, etc.)	Anaerobic digestion, with or without other organic wastes	Biogas (methane)	- Equipment for gas storage and transportation - Pilot and mobile demonstration plants, especially larger units - Equipment components
<u>Municipal solid waste</u>	Composting	Compost refuse derived fuel (RFT)	Pilot plants for process adaptation
<u>Urban sewage</u>	Recovery from treatment plant	Methane	(see 5 above)
<u>Special Plant Species</u>	Chemical synthesis	Fuels, polymers and chemicals	Pilot and demonstration plants
<u>Natural gas</u>		Methanol Gasoline Petrochemicals	Plants
<u>Coal</u>	- Liquefaction - Gasification - Pyrolysis - (Other processes of synthesis)	Liquid and gaseous fuels, chemicals	Pilot plants
<u>Peat</u>	Wet carbonization and liquefaction	As feedstock for making gaseous and liquid fuels and for power generation via combustion	Carbonization/liquefaction equipment

#### 4.2.1 Ethanol

In March 1979, UNIDO convened a technical workshop on fermentation alcohol (ethanol). This workshop confirmed that the technologies in this field were generally mature, and that in several developing countries ethanol production could provide an additive or substitute for petroleum fuels, as well as for petroleum-derived chemical feedstocks. There remained some problems, however, with the economics of ethanol production, including questions of alternative land- and crop-uses. For that reason, the Task Force believes that the opportunity of ethanol production from a variety of fermentable crops (especially sugar cane, but also cassava and cellulosic materials) should be considered in each country in line with a comprehensive cost-benefit matrix to be developed by UNIDO in collaboration with FAO.<sup>21/</sup> Meanwhile, project requests concerning ethanol production will be discussed jointly by UNIDO and FAO. UNIDO is considering with the Brazilian Government the possibility of organizing in 1980 a second technical workshop, which would pay major attention to economic parameters and operational follow-up (e.g. the establishment of pilot or demonstration plants: advisory services, training, etc.). Simultaneously, UNIDO is considering at staff level the problem of combustion engines or engine adjustments for ethanol use. (See paragraph 3.2.3.1, above)

#### 4.2.2 Coal Conversion

Several developing countries have known deposits of low grade coal which might in future constitute a significant energy resource if their exploitation became commercially feasible. It is expected that systematic exploration will reveal coal deposits also in other locations. In that context, a UNDP/IPF project on coal conversion technologies (liquefaction, gasification) carried out in Poland by UNIDO (in collaboration with CNRET and UNESCO) could serve an important pilot function. In fact,

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<sup>21/</sup> See also, in that connexion, the in-depth study of energy utilization in the sugar industry discussed in paragraph 2.2, above.

while in most locations coal conversion is costly and second generation technologies still experimental, it is hoped that the Polish experience might, in the medium- or long-term, become relevant also to other developing countries with known coal resources. A Consultative Group with comprehensive international representation is being established for that purpose as part of the project.

#### 4.3 Dissemination of Information

##### 4.3.1 INTIB

The Task Force believes that while INTIB coverage of technologies for the production of fuels and feedstocks, especially those derived from biomass, would be desirable, it is less important from an operational perspective than coverage of the other two programme components. In fact, the areas for programme action are relatively well defined and operational staff seem to be aware of the relevant technologies, the more so as these technologies are by and large mature.

##### 4.3.2 Publication/Monographs

The publication of materials generated by this part of the energy programme would, in the opinion of the Task Force, be desirable in the short-term for topics such as the utilization of peat, and the production of fuels from wood residues, animal wastes (biogas), and urban sewage and solid wastes. The production of ethanol by fermentation processes has already been mentioned.

5. INSTITUTIONAL IMPLICATIONS

Throughout its report the Task Force has stressed the need for

- integrated, though modular, programme development and management within UNIDO
- close collaboration with other UN organization or agencies, as well as access to outside expertise.

5.1 Institutional Implications within UNIDO

5.1.1 Policy Group on Energy

At the policy level, the Task Force proposes that programme consistency and co-ordination be assured on a continuing basis either by maintaining the Energy Task Force or by an inter-divisional group serviced by PDC and including not only IOD, TECH and ICIS, but also ICPO, PCD/NEG and perhaps CPE/REL. Its function would be to develop the programme, both in its technical assistance and non-technical assistance aspects; evaluate progress and particular constraints; examine all new project proposals relating to energy; consider intra- and inter-programme linkages, funding and fund-raising, major policy statements and relations with other UN organizations. The group could meet informally, if and as required, e.g. once a month. For the first year, it is suggested that representation, especially for PCD, IOD and TECH, should be at Director level. Other units might wish to designate a senior staff member to ensure continuity of attendance.

5.1.2 Responsibilities and Staff at Division Level

At division level, PCD plans to continue servicing the programme out of the Office of the Director, but each of the various sections concerned (in particular PDES, NEGS, ECDCS, LDCS, and NGOS) will be asked to designate a staff member who would be responsible for energy matters. In ICIS, both Sectoral Studies Section and Global and Conceptual Studies Section will be directly involved in various programme activities; the identification of a focal point in each of these units would

... In the Technology Group the Industrial Information

Section and the Development and Transfer of Technology Section both have specific roles in the proposed energy programme. The brunt of programme implementation will, however, fall on IOD. It is in fact evident from the present report that the energy programme calls for the involvement of all IOD units - the substantive sections concerned with particular branches of industry, and the sections concerned with particular types of technical assistance. It is also evident, and has been indicated under each programme component, that while primary backstopping responsibility will be assigned to one or the other section, there would have to be continuing collaboration and interaction among them, as well as a substantial degree of central co-ordination and monitoring by the Director of IOD.

5.1.3 This management pattern evidently calls for a gradual but systematic build-up of the requisite expertise by staff replacements or new staff funded from future overheads. The Task Force believes, however, that there is a particularly urgent need to strengthen the Secretariat by:

- the appointment of a senior technical adviser for energy: his help will be required for both programme development and implementation (e.g. advice on energy utilization).
- adding some professionals familiar with energy problems to IOD/ENG and to IOD/CHEM; these two sections are in fact primarily responsible for much of the energy programme, and it is urgent that they be strengthened in order to handle projects already in hand or in the pipeline.
- in the Technology Group, an information specialist familiar with the energy sector.

Beyond this, it will be important that at least some of the SIDFAS be technically qualified to assist in the design and

and implementation (possibly on a regional or sub-regional basis) of energy- and energy-related capital goods programme.

## 5.2 Institutional Implications and Co-ordination Outside UNIDO

### 5.2.1 Within the UN family

Co-operation with the relevant UN organizations and agencies may, to some extent, be facilitated by such system-wide mechanisms as CCSQ (PROG), the UNDP Inter-Agency Task Force and co-ordinated Medium-Term Programme budgeting (assuming that agencies are prepared to participate in it). Also, joint preparations for the 1981 United Nations Conference on Science and Technology may provide an opportunity to consider and develop collaborative patterns within the UN family. The Task Force believes, however, that co-operation in the design and implementation of the UNIDO energy programme should, at this stage, be ensured by bilateral or multi-lateral arrangements between the agencies concerned -- in particular UNDP, UN/CNRET, FAO and UNESCO. This would not exclude an informal inter-agency co-ordination mechanism for the specific purposes of the energy programme, though past experience has shown how difficult it is, over time, to maintain the requisite level of representation and technical expertise in any inter-agency task force or committee. Specific arrangements for cooperation with other UN organizations and agencies are discussed in Annex A hereto.

### 5.2.2 Linkages and Access to Expertise outside the UN Family

#### IGOs

Among the inter-governmental bodies with which close contacts should, in the opinion of the Task Force, be explored in the context of the of the UNIDO programme are the International Energy Agency, the EEC (especially its Lomé fund), OPEC, the International Institute for Applied System Analysis (IIASA) and regional institutions such as the Latin American Energy Development Organization (OLADE), as well as Regional Technology Institutes. As regards OLADE, co-operation is already underway

on a series of projects - e.g. micro-hydro development: energy balances in the sugar industry: local production of equipment - and should be further consolidated. The Task Force has had periodic contacts with IIASA, and proposes that they should be continued and extended on a systematic basis. In that connexion, the practice of informal periodic meetings with the staff of Vienna-based organizations concerned with energy (IIASA, OPEC, IAEA and UNIDO) appears particularly valuable.

#### NGOs

At the level of world-wide institutions, collaboration might be developed with the International Chamber of Commerce: staff contacts have already prospected the possibility of a top level ICC Energy Advisory Panel, which might advise on energy conservation, energy utilization, capital goods industry development and other aspects of the UNIDO programme. The Task Force believes that such a Panel could be particularly useful to locate expertise for technical assistance projects. Similarly, the international labour union federations might be in a position to help with training programmes on energy conservation at plant level.

Beyond these institutional linkages, the Task Force believes that a systematic effort should be made by IOD, NGO Sections and the Technology Group to develop contacts with professional associations, universities and industry: these contacts should, ultimately, lead to concrete arrangements for expeditious, high-quality expert recruitment and consulting services in the context of the UNIDO energy programme.

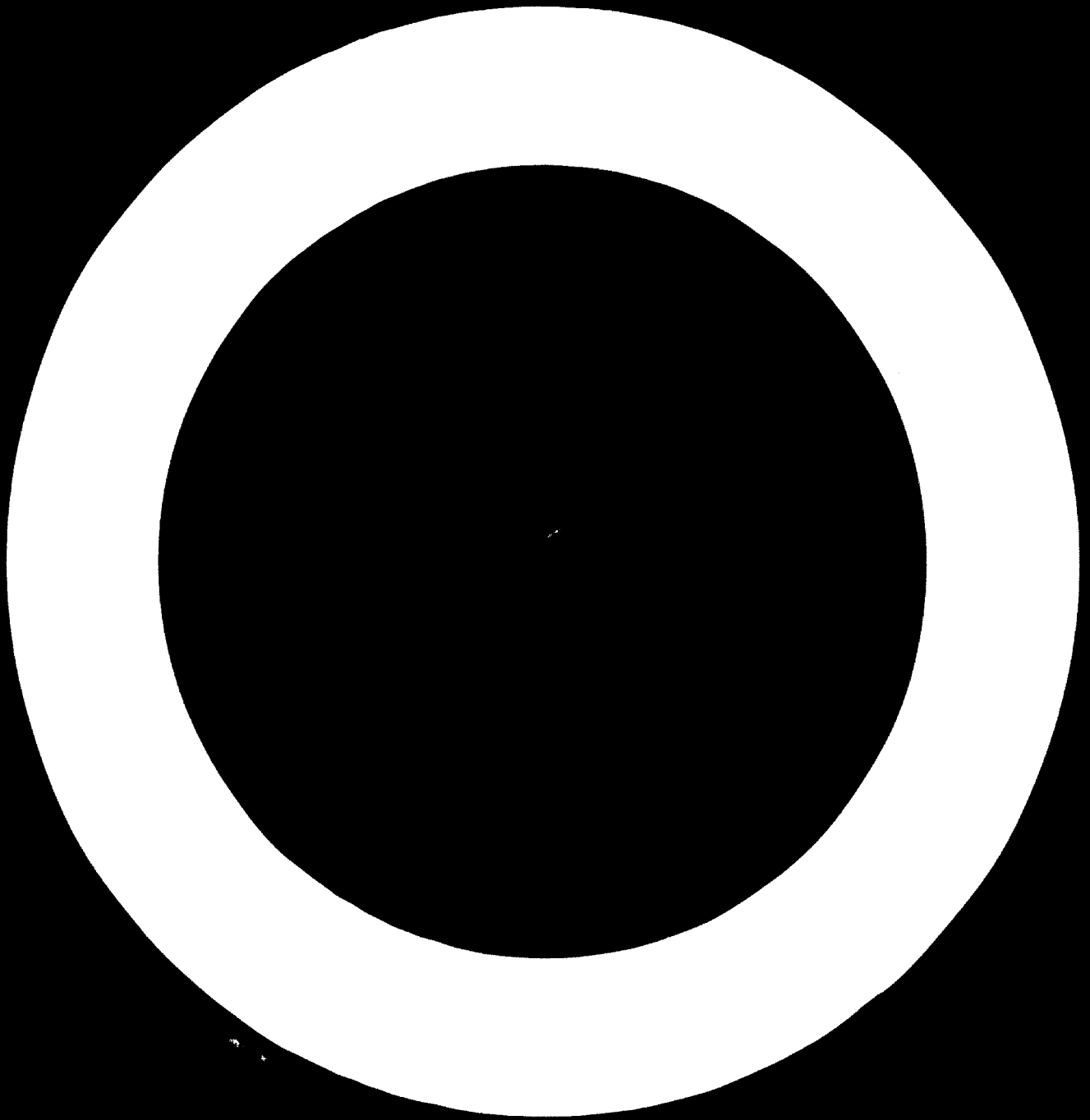


UNIDO Energy Advisers

Lastly, the Task Force believes that UNIDO should develop networks of top level external advisers in particular programme areas. <sup>22</sup>/ These advisers, who would not receive any compensation except for specific services which they might be called upon to render, could be consulted by UNIDO both on programme development and on the recruitment of experts. They might, if and as appropriate, meet as a group or groups to advise on programme orientation, but their main role would be through informal and individual contacts.

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<sup>22</sup>/ In this sense, such a group of advisers was recently established in the context of the Polish coal conversion project (paragraph 4.3.2, above).



## ANNEX A

### COLLABORATION WITH OTHER UN ORGANIZATIONS

#### AGENCIES AND FUNDS

##### UNDP

UNDP is, and will no doubt remain, the principal source of funding for UNIDO operational activities, including those proposed under the energy programme. It may thus be expected that country programming exercises, and a continuing dialogue with UNDP staff at headquarters, regional bureau and field level will play an important role in programme development. This includes also the direct involvement of the Senior Industrial Field Advisers operating out of UNDP field offices. The Task Force thus proposes the following steps:

- the present Report should be submitted for information and comment to SIDFAS and UNDP Resident Representatives (UN Resident Co-ordinators): it might be discussed at regional or global SIDFA meetings in 1980 and, if UNDP Regional Bureaus consider it opportune, at regional Resident Representative meetings.
- the proposed energy programme should be discussed with UNDP Headquarters, including the Regional Bureaus; this discussion should focus on programme orientation, allocation of backstopping responsibilities within the UN system and long-term funding prospects under IPFs (especially the Third Cycle) and the CDF.

##### UN Science and Technology Fund

Support from the new Science and Technology Fund should be discussed at an early date with the Office of the Director-General for Development and International Economic Co-operation and UNDP. It might be possible to do this jointly with CNRET and other UN agencies or organizations concerned with particular aspects of the energy/industry programme.

##### UN/CNRET

While mandates and areas of competence of UNIDO and CNRET will no doubt continue to overlap, they are also complementary; inter-staff contacts indicate that CNRET is prepared to contribute to the proposed UNIDO programme on the energy/industry interface. 1/ It seems particularly important that

- CNRET ensure the linkage between UNIDO's industry-specific programme activities and broader action in such areas as energy planning, resource-exploitation and management, conservation and utilization;
- UNIDO provide energy-specific inputs in CNRET activities, especially in connexion with national energy planning, policy formulation and conservation.

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1/ See exchange of letters between UNIDO/PCD and CNRET in July and August 1979, and the joint note submitted by CNRET and UNIDO to the CPC.

For purposes of the UNIDO energy programme, collaboration with CNRET should range from mutual consultations on programme and project formulation to co-ordinated or synchronized operational action and, whenever appropriate, joint responsibility for particular projects or studies. <sup>2/</sup> In areas such as micro-hydro generation and the development of solar water heaters, for instance, joint action between the two organizations is already underway. Other opportunities have been identified in this report. The Task Force would thus attribute great importance to joint projects in energy planning and energy conservation, as well as CNRET participation in the UNIDO consultations on energy-related capital goods.

It should also be noted that close contact between CNRET and UNIDO has been established in the preparations for the 1981 UN Conference on New and Renewable Sources of Energy. CNRET is substantially involved in the backstopping for that Conference, and UNIDO has agreed to

- host the Technical Panel on Hydro-power
- make substantive inputs into all other panels, especially as regards production/repair/maintenance of equipment, and energy supply to industry
- consider convening a colloquium - which could draw on the results of the technical panels - to examine the overall significance of new and renewable sources of energy to the Lima targets.

At present, consultations and co-ordination among CNRET and UNIDO are ensured by ad hoc staff contacts both at policy and technical level. The Task Force believes, however, that annual or semi-annual policy meetings focussing on the proposed energy programme would be justified.

#### UNESCO

It is evident that UNESCO should be involved in the proposed energy programme from the perspective of scientific research. This will be particularly important for long-term technological projections regarding new and renewable sources of energy, and to identify scientific research and experimental projects which may be ready for practical application and the development of industrial technologies. Also, UNESCO would be in a position to consider the social implications (including problems of social acceptance) of energy technologies, as well as professional training programmes. Inter-staff contacts should be maintained, wherever appropriate, at technical level, and on an ad hoc basis also at policy level.

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<sup>2/</sup> The two organizations are also considering the possibility of synchronizing (possibly by joint representation) their participation in the many technical/scientific meetings and symposia on energy problems, especially new and renewable sources of energy. Given UNIDO's and CNRET's scarce manpower resources, participation in all these meetings poses serious problems.

## FAO

FAO involvement in the energy programme concerns primarily

- the use of biomass (and of agricultural or forestry wastes) for the production of energy and energy-appropriate equipment for agricultural uses.
- the availability of energy and energy-appropriate equipment for agricultural uses.

Collaboration between FAO and UNIDO should thus be close and continuing, and range from joint planning to co-ordinated, synchronized or joint operations. A start has already been made in connexion with ethanol production (see paragraph 4.2.1 above) and energy utilization in the sugar industry (see paragraph 2.2.2 above). It is expected that FAO and UNIDO will jointly elaborate a comprehensive economic matrix for that purpose: as regards ethanol, project requests received by either organization will be submitted to the other for comments and possible joint execution. The Task Force believes that this pattern of collaboration should be extended to other areas, e.g. biogas production, wood (and charcoal), and all agro-wastes or primary products which might be considered as a source of energy, fuel or feedstocks. Also, FAO should be involved in the development of energy-related technologies and equipment (e.g. solar heat utilization, solar pumps) for use in agriculture.

The Task Force has been informed that in 1980 FAO plans to convene a Conference or Symposium on the food/energy interface, including in particular "energy cropping". It believes that UNIDO should make a substantial contribution and, if desired, co-sponsor the conference.

In view of the scope of potential FAO/UNIDO co-operation, the Task Force considers that regular consultations at policy level - annual or semi-annual - would be necessary in the context of the UNIDO energy programme. These might be combined with similar policy consultations with CNRET.

## HABITAT

It is proposed to explore opportunities for joint planning and operations in areas of mutual interest, e.g. the integration of solar water heaters design and building design, industrial processing of urban residues, etc.

### ILO

Collaboration with ILO will concern primarily training, and the social implications (e.g. on employment) of particular energy policies or strategies. A start has already been made by the joint implementation with the ILO (Training Centre) in Turin of a Training Programme on Energy Utilization and Conservation, using UNIDF funds (see paragraph 2.1.1 above).

### UNEP

The generation and use of energy, especially in industry or by industrial processes, has obvious environmental significance. The Task Force thus suggests that the UNIDO energy programme should be discussed with UNEP at an early date with a view to consolidating the co-operation between the two organizations at policy and operational level.

### WMO

Meteorological and hydro-geological conditions (insolation, wind forces and constancies, water flow and temperatures) are critical to the exploitation/utilization of new and renewable (but to some extent also of conventional) sources of energy. Since these problems are within the competence of WMO, the Task Force suggests that the proposed energy programme should, as soon as possible, be discussed with that organization with a view to future collaboration: it is also noted that WMO has been asked to handle the Technical Panels on Solar and Wind Energy for the 1981 UN Conference on New and Renewable Sources of Energy. UNIDO/WMO staff contacts in 1978 had already prospected the possibility of developing a matrix and surveying meteorological conditions for the use of solar energy (e.g. crop drying).

### UNCTAD

No contacts have been established yet on energy problems. The Task Force believes, however, that co-operation between the two organizations could be useful with regard to

- trade- and trade-related aspects of the production of equipment and fuels
- multi-national production enterprises among developing countries.

### IBRD

The Task Force has not at this stage considered inter-linkages between the IBRD activities relating to energy, and the energy programme proposed for UNIDO and other UN bodies with a similar geographic composition and emphasis on technical assistance.

Initial staff contacts indicate a great deal of potential complementarity. Since it appears that, IBRD is establishing its own internal Energy Task Force, it is suggested that a dialogue should be initiated at an early date:

- to ensure appropriate linkages between UNIDO operations (including technical assistance, investment promotion and consultations) and IBRD lending activities in the energy field
- to explore possible synchronization or complementarity of the UNIDO energy programme and IBRD technical assistance in the energy field (especially pre-feasibility/feasibility studies: technology, prototype and product development: market studies and projections, demonstration plants).

#### IAEA

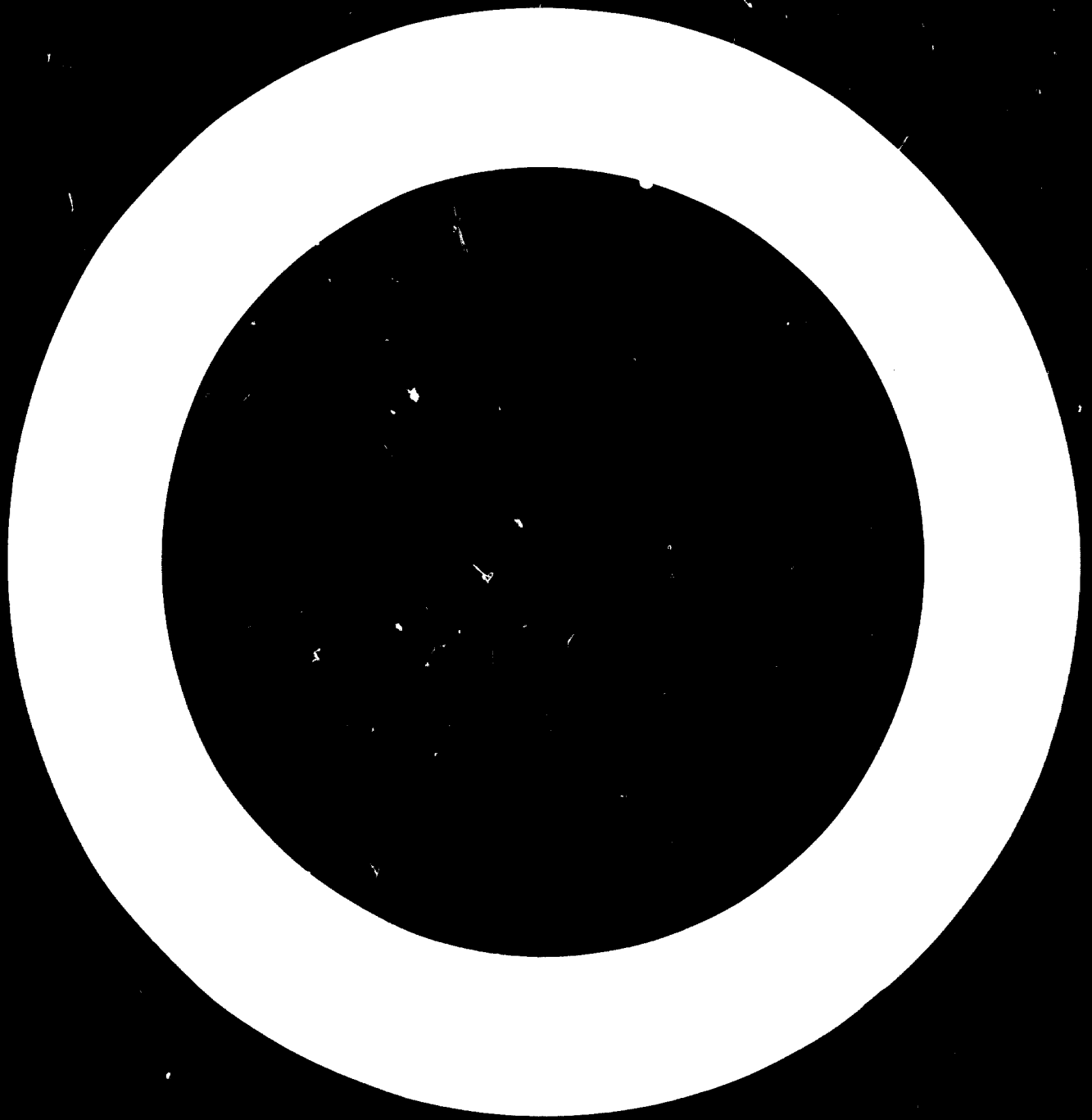
The Task Force did not consider or include in the proposed programme any action relating to nuclear energy, although it assumed that, in the next two decades, this source of power could play a significant role in many countries. Nevertheless, informal staff contacts at policy and technical level confirm that co-operation with IAEA in the context of the UNIDO energy programme would be desirable and possible. This is particularly evident with regard to energy planning: IAEA's electrical power demand/supply projections and related advisory services (WASP) are not limited to nuclear energy: such services, to which UNIDO could contribute its specific knowledge of industrial energy demand, including energy conservation/utilization technologies and non-nuclear fuel production, could thus be extremely useful in developing overall as well as industrial energy policies (see paragraph 2.2.1 above).

#### UNITAR

UNITAR has initiated a series of future-oriented studies and symposia relating to energy and particular sources of energy. It appears desirable that UNIDO should participate in these activities, and explore with UNITAR possibilities of co-sponsorship.

#### UN Regional Economic Commissions

The Task Force proposes that the UNIDO energy programme should be discussed with all UN Regional Commissions. Collaboration with some of them (e.g. ESCAP, with regard to biogas and micro-hydro projects) has already been initiated.





ANNEX B

ENERGY PROJECTS

(This list is not comprehensive, but illustrative  
of the nature of UNIDO energy projects for which  
there exists a substantial demand in member countries)

I. UTILIZATION OF ENERGY IN INDUSTRY

Program component 1	UNIDO projects, including project concepts 2	UNIDO Secretariat involvement: primary back-stopping and other support functions 3	Involvement of other UN or non-UN organizations 4
<p>1. <u>Training in Energy Conservation and Auditing</u></p> <p>a) <u>Special Training Courses on Energy Conservation</u></p>	<p>*UF/INT/78/173 - Training Programme on Energy Utilization and Saving in Industrial Enterprises. (Similar activities would be undertaken in the Latin American Region in 1980)</p>	<p>IOD/TRW in collaboration with IOD/ENG and substantive IOD units concerned with particular</p>	<p>ILO International Centre for Advanced Technical and Vocational Training in Turin (for UF/INT/78/173) OLADE</p>
<p>b) <u>Power Plant Operation</u></p>	<p>*Organization on a regional basis a series of training courses focusing on the efficient operation of electrical power plants with regard to equipment maintenance, replacement and the availability of spare parts (probably for the Mediterranean region)</p>	<p>IOD/TRW in collaboration with IOD/ENG</p>	<p>Involvement of UN regional Economic Commissions</p>
<p>c) <u>Training in the Field of Electrical Power Technology</u></p>	<p>*US/INT/79/801 - In-Plant Group Training Programme in the Field of Electrical Power Technology, Sweden.</p>	<p>IOD/TRW</p>	<p>SIDA</p>
<p>2. <u>Advice on Energy Utilization and Resource Management</u></p>			<p>Possible Collaboration in future with CNRET, FAO, OLADE, IAEA</p>

\* At a conceptual or early stage of development

<p>1</p>	<p>2</p>	<p>3</p>	<p>4</p>
<p>a) <u>At National Level:</u> Industrial Energy Strategies; Energy Planning</p>	<p>*Examination of the possibilities of using locally available agro-wastes and primary agro-products in Kenya for the supply of energy to new industries. *Development of a comprehensive technological matrix to guide the formulation of industrial energy strategies and resources management at national level.</p>	<p>IOD/TMG in cooperation with other substantive IOD sections concerned with particular industries and problems</p>	<p>Overall: cooperation with COMPT and PAO  USSR Academy of Sciences</p>
<p>b) <u>At Sectoral Level:</u> Advisory Projects; In-depth Surveys</p>	<p>SI/CUB/78/002 - Exploratory mission on solar energy and other alternative sources of energy development. TS/CUB/78/006 - Improvement of Heat Economy in the Cane Sugar Industry. TS/TUR/78/004 - TS/TUR/79/803 - Technical Cooperation on Energy Conservation in Industry. *A study by the UNIDO/CSSR Joint Programme for International Cooperation in the Field of Ceramics, Building Materials and Non-metallic Minerals Based Industries as a guidance material for developing countries on state-of-the-art and possibilities of energy conservation in non-metallic minerals based industries to be prepared by March 1980. (A study on the sugar industry, as well as on food processing industries might be prepared in future.)</p>	<p>IOD sections responsible for the particular industry in collaboration with Technology Group and ICIS/SEC</p>	

1	2	3	4
<p>b) continued</p>	<p>Seminar workshop on energy consumption and conservation in the sugar industry to be possibly held in May 1980 on Cuba. As a second step, a similar workshop might be convened in ESCAP region.</p>	<p>IOD/AGRO in collaboration with IOD/CHEM, IOD/ENG, Technology Group and ICIS/SEC</p>	<p>FAO, OLADF, CEPLACFA</p>
<p>c) <u>At Plant Level:</u> <u>Mobile Diagnostic Units</u></p>	<p>*Utilization of the CSSR mobile diagnostic unit with initial emphasis on the building materials industries. *Utilization of diagnostic equipment and experts of BNF (U.K.) in non-ferrous metals plants. - Other mobile diagnostic units, at regional level (Latin America; ESCAP).</p>	<p>IOD/ENG and/or IOD/CHEM (depending upon industries and processes concerned)</p>	
<p>3. <u>Non Waste-Technology Production Processes</u></p>	<p>DP/ROM/77/003/B/01/37 - Recycling of Industrial Waste: Introducing technologies in recycling textile, leather, plastics and rubber compatible with local conditions; setting up experimental and pilot facilities to enable development of new reprocessing technologies and new uses of recycled products; designing and constructing special purpose equipment for the recycling of the above mentioned wastes.</p>		

Throughout General Technical Assistance Activities, energy utilization and conservation should be an issue in project formulation and implementation. The utilization of energy in industry would also involve INTIP, the preparation of training materials and manuals, as well as in-depth studies and specially prepared papers on energy utilization in particular branches of industry. A co-operative effort involving the Technology Group, ICIS and IOD is envisaged with regard to information dissemination.

II. ENERGY-RELATED EQUIPMENT

1	2	3	4
<p>1. <u>Conventional Equipment for Power Generation, Distribution and Production of Fuels</u></p> <p>a) Policy Initiatives Sectoral consultations</p>	<p>Inclusion of power-generation and distribution equipment in the UNIDO consultations on capital goods scheduled for 1981. Programme action on hydro-power generation and distribution equipment to be regarded as an essential part of such activities.</p>	<p>IOD/ENG, IOD/CHEM for fuel production</p> <p>DPC/WEG</p>	
<p>b) Operational Action</p>	<p>Drawing up a technical assistance programme blueprint including appropriate equipment design; feasibility studies for multi-national production enterprises in developing countries; industrial complementation on a regional or sub-regional basis; standardization; supply of spare parts; training; TCDC programs</p>	<p>IOD and DPC sections concerned</p>	
<p>2. <u>Biomass</u></p> <p>a) Wood</p>	<p>Multi-country program for the development of more energy-efficient wood-burning technologies, and appliances, primary for household use. *A preliminary study on this subject has been commissioned. Development of proto-types, demonstration projects and perhaps local production of particular components.</p>	<p>IOD/CHEM in collaboration with other IOD substantial sections</p>	<p>Collaboration with FAO. Linkages with UNCTAD would be desirable for examining ecological implications. Collaboration with regional Technology Institutes.</p>

1	2	3	4
<p>a) continued</p>	<p>Production of charcoal            Programme action on the utilisation of charcoal in industry and, generally, as a source of energy.            DU/GHA/74/002 - Charcoal Production and Utilization            SI/UGA/78/002 - Development of Charcoal Industry and Establishment of a Demonstration Plant for Charcoal Production and By-Products            SI/PNG/79/806 - Assistance in Charcoal Production</p>		<p>Collaboration with FAO</p>
<p>b) Biogas</p>	<p>UF/UPV/78/039 - Demonstration of Biogas Technology            UF/URT/77/056 - Integrated Biogas Plant Development in Tanzania and Regional Promotion in Ten Least Developed Countries in Africa            UC/INT/79/159 - Technical Consultations Among Developing Countries on Large-Scale Biogas Technology in China.            In future the energy programme should concentrate on:            (i) technologies and equipment for relatively large biogas production units for village and possibly for industrial use (e.g. in agricultural complexes), and for the utilisation of urban wastes;            containers for storage and transport</p>		<p>See 2.a), p.4</p>

1	2	3	4
b) continued	<p>(11) the manufacture of components (tanks, valves, etc.) for smaller bio-gas units currently being developed for household use.</p> <p>(UNIDO should, as a matter of priority, initiate a programme of prototype development, demonstration projects and pre-feasibility or feasibility studies at a regional or sub-regional level.)</p>		
o) Fermentation Alcohol (Ethanol)	<p>UF/INT/78/167 - Workshop on Fermentation Alcohol for Use as Fuel and Chemical Feedstock in Developing Countries</p> <p>SI/ZAN/77/002 - Processing of Molasses Manufacture of Ethyl Alcohol and Poddier Yeast.</p> <p>See also part III.</p>		See 2.a), p.4
- Combustion engines	<p>Systematic survey of current efforts in developed and developing countries (e.g. Brazil) on the production or adjustment of combustion engines for the use of ethanol and to prospect opportunities for local production at national or multi-national level. A summary might include a technical workshop and the publication of a monograph in the technology series.</p>	IOD/ENIG in collaboration with IOD/CHEM and Technology Group	

1	2	3	4
<p><u>3. Solar Energy</u></p>	<p>Development and local production of appropriate equipment</p>	<p>IOD/ENG in cooperation with other substantive sections</p>	<p>Cooperation with CNRETT, FAO, UN regional economic commissions</p>
<p>A) <u>Direct Use of Solar Heat</u></p>	<p>Establishing solar crop drying facilities and developing the local production, repair and maintenance of the requisite equipment</p>	<p>IOD/AGRO in cooperation with IOD/TNG</p>	<p>"</p>
<p>a) Solar Crop Drying</p>	<p>SI/EGY/78/803 - Establishment of a Solar Energy Desalination Plant. A number of projects on solar salt production: SI/BEN/77/806 - Development of Solar Salt Production SI/KEN/78/801 - Development of Solar Salt Production Basic Chemicals SI/SOM/78/804 - Development of Solar Salt Production SI/FIJ/79/801 - Assistance in Solar Salt Production and Establishment of a Solar Salt Factory SI/PNG/78/802 - Development of Solar Salt Production SI/SAM/77/802 SI/CYP/77/801 - Examination of Alternative Site for Setting Up a Solar Salt Plant in Cyprus</p>	<p>IOD/CHEM in collaboration with IOD/MEF (to cover specific metal corrosion problems)</p>	<p>"</p>
<p>b) Solar Distillation</p>	<p></p>	<p></p>	<p></p>
<p>b') Solar Water Desalination</p>	<p></p>	<p></p>	<p></p>



1	2	3	4
b") Solar Distillation	<p>*Project idea of solar energy utilization on the Comoros Island as a substitute for conventional fuels in the small-scale distillation of Ylang-Ylang</p>	IOD/AGRO	
c) Solar Cookers	<p>Promotion of local production. Consultations with potential consumers to clear the problem of social acceptance.</p>	IOD/ENG	
d) Solar Water Heating	<p>Product development and local manufacture of water heaters in Ecuador. SI/CUB/77/801 - Chauffe-Eau Solaire - Preparatory Assistance</p>	IOD/ENG	Collaboration with CNRET. Possible collaboration with HABITAT on the subject.
e) Other Low and Medium Temperature Solar Heat Applications; High Temperatures	<p>RP/SEN/77/001 - Solar Energy RP/MLI/78/001 - Assistance to the Laboratory for Solar Energy. SI/AFG/77/801 - Utilization of Solar Energy RP/CUB/78/001 - Solar Energy Exploratory Mission</p>	IOD/ENG in collaboration with IOD/TW and other substantive sections	-"-
B) Solar Power			
a) Solar Collector Technologies	<p>UNIDO should closely monitor technological improvements in this area and also assist - in selected cases - in building up a local manufacturing capacity for feasibility studies and product development projects; solar-collector power generation should not at present be given prominence in the UNIDO energy programme.</p>	IOD/ENG in collaboration with Technology Group	

1	2	3	4
<p>b) Photovoltaic Conversion</p>	<p>(i) Close monitoring of photovoltaic technologies.                      (ii) *Identify developing countries with high technological skill in which solar cell production might be possible in the short- and medium-term, even though innovations or break-throughs in this area are likely to be protected by, or tied to, proprietary rights (patents, processes); advise on planning, product adaptation, investment promotion, transfers of technology (and their terms), training.                      (iii) *Consider the wider potential for the manufacture in developing countries of equipment and appliances using photovoltaic cells produced elsewhere: particular attention be paid to product adaptation, standardization and marketing.</p>	<p>ICD/TMG in collaboration with other ICD substantive sections and Technology Group</p>	
<p>c) <u>Hydro-Power Generation</u></p> <p>a) Micro-, Mini-, and Small Hydro-Power Generation Facilities</p>	<p>US/INT/78/251 - Seminar/Forksh p n the Exchange of Experiences and Technology Transfer on Mini Hydro-Electric Generation Units                      SI/RLA/7/801 - Assistance to OLADE                      US/INT/78/14 - Group Study Tour in the Field of Medium and Small-scale Hydro-Power Units</p>	<p>see B), p.8</p>	<p>Cooperation with CWRPT, OLADE, UN Regional Economic Commissions</p>

1	2	3	4
<p>b) Tydal Energy; Thermal Gradients, etc.</p> <p>D) <u>Wind Energy</u></p>	<p>*Consideration of the capital goods dimension, the more so as technologies and equipment are not basically different from traditional hydro-power generation</p> <p>*Utilization of wind energy in Africa: problems of local production of equipment, maintenance, repair, operation. (In future the similar approach might be applicable to the Latin American region)</p>	<p>see B), p.8</p> <p>-"-</p>	<p>SEWA</p>
<p>E) <u>Information on Equipment Production</u></p> <p>a) INTIB</p> <p>b) Publication of Monographs</p>	<p>Publication in the Technology Series on the following topics: mini-hydro equipment (with problems of standardization); technologies and equipment for the production of ethanol; solar water heaters and other equipment for the direct utilization of solar energy.</p>	<p>Technology Group in collaboration with substantive IOD sections</p>	

III. FUELS AND FEEDSTOCKS

1	2	3	4
<p>1. <u>Conventional Petroleum Fuels and Feedstocks</u></p>	<p>- Fuels produced on a relatively large scale. This would not include wood for direct use in stoves, or biogas produced in household units, except to the extent that the manufacture of equipment or appliances might be included in the equipment programme suggested under (II) above; it would on the other hand cover briquetting of wood residues, and biogas production in larger units.</p> <p>- Fuels which are either transportable or directly used in industrial processes.</p> <p>- A medium-term perspective; this would e.g. cover coal conversion, to the extent that technologies currently being developed might become significant in developing countries, but not large-scale energy-farming - an area which requires further study and perhaps experimentation by bodies such as FAO, UNESCO and UNITAR.</p>	<p>IOD/CHEM</p> <p>IOD/CHEM, DPC/NEG</p>	<p>Collaboration with CNRET, FAO, UNESCO, UNITAR</p>

1	2	3	4
<p>2. <u>New Fuels and Chemical Feedstocks</u></p> <p>a) Ethanol</p> <p>b) Coal Conversion</p> <p>c) Others</p>	<p>Application of new technologies and the use of non-critical raw materials for the production of fuels and chemical feedstocks (see table I, pp. 30-31)</p> <p>See part II, 2.c)</p> <p>*Organization in 1980 of a second technical workshop on fermentation alcohol in Brazil, which would pay major attention to economic parameters and operational follow-up, e.g. the establishment of pilot or demonstration plants; advisory services, training, etc.</p> <p>DP/POL/77/002 - Integrated Coal Conversion</p> <p>A Liaison Group with comprehensive international and UN bodies representation is possibly created for the purpose of information exchange.</p> <p>A variety of projects relating to processes/products listed in Table I have been undertaken or are in preparation; e.g. UNIDO staff and the SIDFA are currently exploring the possibility of a major project (starting with a feasibility study) for the utilization of peat as a substitute for charcoal and fuel oil in Burundi in existing agro-industries, especially tea, for urban household consumption and possibly for future industries, including in particular the processing of nickel ores.</p>	<p>IOD/ENG. in collaboration with other IOD substantive sections and Technology Group</p> <p style="text-align: center;">-"-</p>	

1	2	3	4
3. <u>Publications and Monographs</u>	Utilization of peat; production of fuel's from wood residues, animal wastes (biogas), urban sewage and solid wastes, production of ethanol by fermentation processes, etc.		

ADDENDUM TO THE ENERGY PROJECT LIST

The Investment Co-operative Programme Office proposes to initiate and implement the following activities in the field of energy:

1. Promoting investments in mini hydro-power manufacturing: 2 meetings to be held in Austria in 1980
2. Promoting investments in "alcohol from biomass" plants S/S co-operation (e.g. with Brazilian technology) and in manufacturing such plants
3. Meeting sponsored by FRG Government on production of solar energy equipment in developing countries (subcontracting, joint ventures, etc.)
4. Promoting investments in plants for manufacturing equipment for biogas plants in developing countries
5. Investment promotion (subcontracting) for producing combustion engines to use ethyl and methyl alcohol - partly S/S co-operation ventures -
6. Investment promotion in factories for power generating and distribution equipment manufacture
7. Promoting investments in "quasi"-petrochemical plants using fully or partly non-petroleum feedstock such as wood, ethyl alcohol, etc.
8. Issuing a continuing service on investment costs for the above mentioned projects

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