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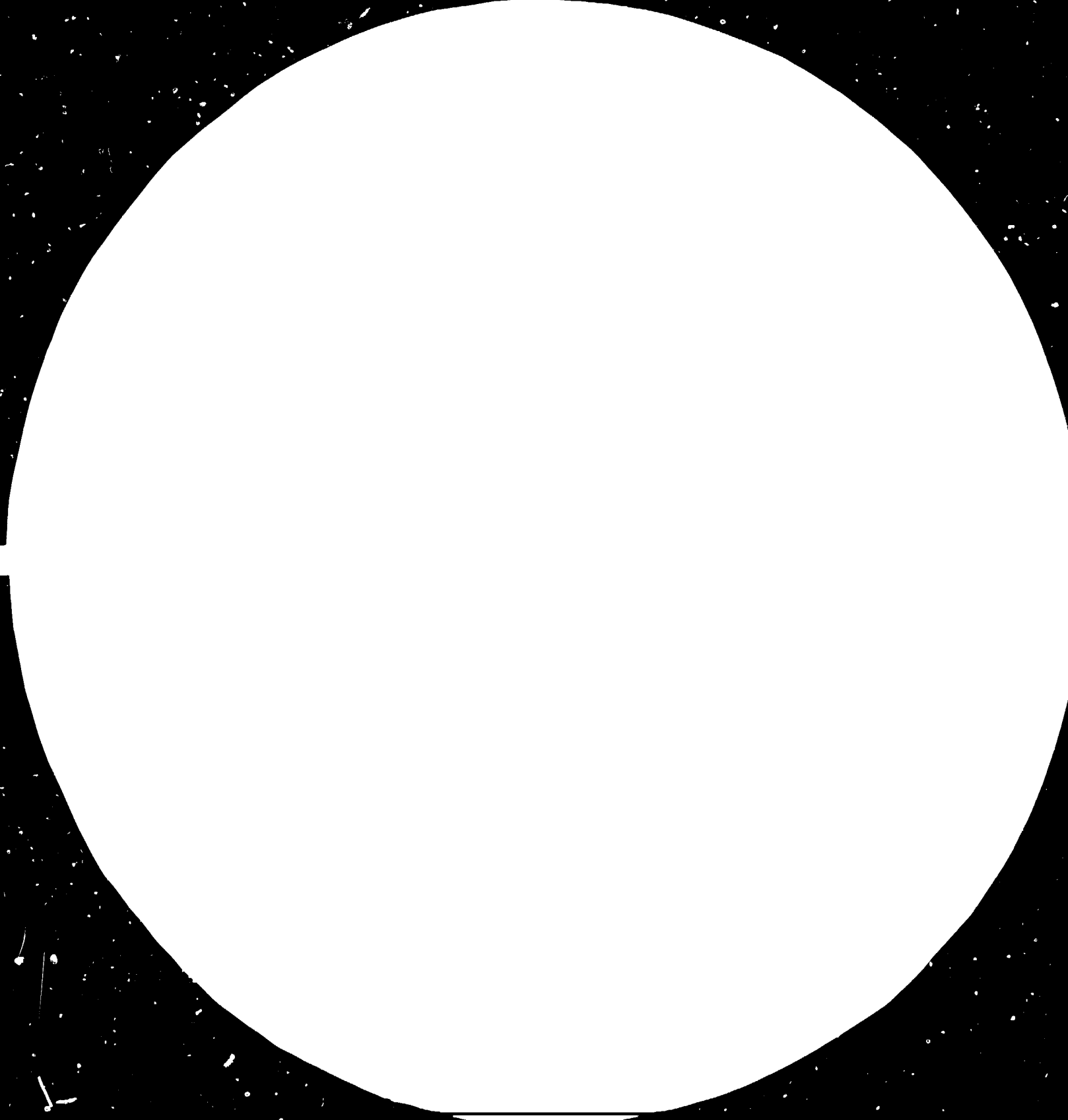
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# **FOURTH GENERAL CONFERENCE OF UNIDO**

*Vienna, Austria, 2-18 August 1984*

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*Item 5(d)*

**ENERGY AND INDUSTRIALIZATION,  
WITH SPECIAL EMPHASIS ON DEVELOPMENT  
AND APPLICATION OF ENERGY RESOURCES  
AND MANUFACTURE OF EQUIPMENT**

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**ISSUE PAPER**

7548

Item 5(d) of the provisional agenda

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

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

Issue paper prepared by the UNIDO secretariat

## INTRODUCTION

1. Developing countries are faced with the major problem of how to sustain and expand industrial and economic development in a period of world-wide recession. One very important aspect of this multidimensional problem is energy. While the share of industry in the total energy needs of a country varies considerably, depending on the stage and pattern of its industrialization, energy itself is a critical input into industry. The profound changes in the global energy pattern of the last decade or so were bound to affect industrialization in the developing countries. These changes threw doubt upon a basic assumption in determining the feasibility of industrial projects, namely the availability of regular supplies of cheap energy, mainly in the form of oil. Some 60 per cent of the commercial energy needs of the developing countries are imported. This energy import burden is a crucial factor in the balance-of-payment crisis of many developing countries and their deteriorating financial situation.
2. It is clearly essential, given the two-way relationship, that developments in the energy and industrial sectors should be integrated. At the same time, however, it must be recognized that energy is a requirement for all sectors of the economy.
3. Furthermore any discussion on energy and industrialization will have to bear in mind the considerable differences that exist between the energy-exporting and energy-importing countries, the nature of the energy source, the variety of stages and levels of industrialization and the modes of combining other natural resources with energy resources, as well as the specific needs of various categories and scales of industrial plants.
4. The Conference is invited to examine the issues involved in energy developments in relation to industrialization and to consider policy actions required at the national, regional and international levels.

### I. THE RELATIONSHIP BETWEEN ENERGY AND INDUSTRIALIZATION

5. The complex linkages between energy and industrialization can be grouped under three main headings: energy for industry, industry for energy and industrial energy management. Such a framework is useful for identifying the factors that must be taken into consideration when designing strategies in the energy field.

#### A. Energy for industry

6. The process of industrialization requires adequate supplies of energy in appropriate forms. The target set in the Lima Declaration and Plan of Action on Industrial Development and Co-operation (A/10112, chap.IV), adopted at the Second General Conference, called for developing countries to produce at least 25 per cent of total world industrial output by the year 2000. It

has been estimated that achievement of the Lima target would require a three-fold increase in the energy consumption of developing countries. This brings up a number of questions: for example, what the source for this increased energy requirement will be, in what form the energy will be required, what investment is needed, and what lead time is required for such an expansion of energy supplies.

7. The changes that occurred in the energy market in the last decade, and the resultant much higher oil prices, will have an impact on the optimal energy input in an industrial process in relation to other factors of production. This in turn should lead to changes in industrial patterns, structures and techniques that are less energy-intensive. New technologies are being developed, which may allow developing countries to establish a different pattern of industrialization. For example, small-scale indigenous energy production may foster decentralized and small-scale rural industries. This has many potential benefits in terms of equitable regional employment and income-generating opportunities. In addition, a decentralized approach would allow industrialization to be synergistically integrated with rural development.

#### B. Industry for energy

8. Energy, in all its different forms, requires a great deal of equipment, special materials and engineering services, embracing all stages, from exploration through production, conversion and distribution to final users. The market for capital goods for the energy sector is very large, covering the whole world, and with the exception of a few developing countries it is dominated by large companies from the industrialized countries.

9. Without adequate provision of capital goods and services, the energy resource potential of the developing countries will not be realized and the industrial development goals of many developing countries will be in jeopardy. The question is how industrial goods and services for the energy sector in the developing countries will be provided. Will the practice of importing from the industrialized countries be continued, or will the developing countries be in a position to establish a capacity in at least some of the energy capital goods? If the developing countries wish to follow the latter path, decisions have to be made on which areas to concentrate and what actions are required to establish such an industry.

10. The industrial processing of primary energy to produce secondary higher-quality fuels is of growing importance. Many of the new industrial technologies and processes require fuels with specific and standardized characteristics. At the same time, it is the advances in technology that have made it possible to process primary fuels or raw materials for the production of higher-value fuels. Many of these developments, for instance the production of fuel alcohol from biomass, have particular relevance for developing countries.

C. Industrial energy management

11. Industrial energy management is best characterized as the actions required for the achievement of the concurrent goals of energy development and utilization and industrialization. Under this broad heading, three key aspects can be identified.

12. First, energy planning must be seen as part of the national industrial development goal and not as an isolated function. It would encompass the development and management of the national energy resource base, optimization of the energy supply and demand mix for the different sectors and the introduction of flexibility and improvements in patterns of energy use in different economic sectors.

13. Secondly, there is energy planning at the industrial plant level, which must take into account energy conservation, substitution of fuels, energy-efficient processes, equipment optimization and operating schedules for equipment. Such planning is important not only for large-scale energy-intensive industrial units but also for the smaller-scale plants which tend to predominate in the developing countries and which are usually very inefficient users of energy.

14. Thirdly, there are the supporting functions for energy management. They include the scientific and technological information needed for better energy use. Such information may be common knowledge in the industrialized countries but it is generally not widely available yet in developing countries. Education and training related to energy production, conversion and utilization are another vital element of energy management and are especially important in relation to technological advances in the energy sector and the move towards the conversion and utilization of new and renewable sources of energy.

II. MAJOR ISSUES: GENERAL AIMS AND OBJECTIVES

15. There has been no shortage of international reports and meetings on the world energy situation and its implications for the developing countries. General recommendations have been made and there seems to be general agreement on the path that developing countries should follow. One of the key questions is why, despite all the recommendations, the energy situation of the oil-importing developing countries has generally deteriorated over the last 10 years. Perhaps one answer is the scale of the problem and the difficulty of establishing areas of priority that are of manageable proportion.

16. The problems of the developing countries in relation to energy and industrialization have been the particular concern of UNIDO. It has been fully recognized that the goals of industrialization by developing countries will not be met without adequate energy in the right form and at the right price. The Third General Conference of UNIDO and the New Delhi Declaration and Plan of Action on Industrialization of Developing Countries and International Co-operation for their Industrial Development (ID/CONF.4/22 and Corr.1), which stemmed from it, specifically included a section on energy and



industrialization. The High-Level Expert Group Meeting on Energy and Industrialization, held at Oslo preparatory to the Fourth General Conference, was the latest meeting to examine the energy problems faced by the developing countries in relation to their industrial development goals. This Meeting, taking account of earlier international meetings on the subject, concluded that the general aims and objectives of developing countries in the field of energy and industrialization should be:

- (a) To develop integrated energy/industry planning;
- (b) To increase their energy self-sufficiency and to develop and widen their energy resource base;
- (c) To enhance capital goods manufacture in support of the energy sector;
- (d) To improve industrial energy efficiency.

17. An examination of the issues involved in relation to each of these objectives may be helpful in identifying some of the constraints that must be overcome before the objectives can be met. An analysis of the issues is also necessary before an agreed and workable action programme can be implemented.

#### A. Integrated energy and industry planning

18. The planning and co-ordination of different sectors of national economics is recognized to be an important and valuable activity. The essential two-way relationship between energy and industry is well-known and the aim is to integrate the two to allow the maximum rate of industrialization and economic growth compatible with all other social and economic objectives. In practice, energy planning is an extremely complex activity, covering many aspects of national and regional policy. It is to be noted that many industrialized countries have not yet developed a comprehensive energy plan. Industrial planning is an activity no less difficult than energy planning and has to take account of national and international considerations relating to resource endowment, trade, technology, human resources, finance etc.

19. The difficulties of integrated energy and industrial planning should not prevent developing countries from making at least a start in this direction. A first requirement is for planners trained in both energy and industrial aspects. Information will need to be obtained covering both energy availability and industrial requirements and such information will have to be available to those responsible for energy and industry. It is important that this planning should not be limited to the higher policy-making level but should also apply at the sectoral and regional levels. The scientific and technical training for energy and industrial planning is available within the international community and the cost in relation to potential returns is very small. Building up a capacity in energy and industry planning must be regarded as an essential commitment.

B. Increased self-sufficiency and strengthening of the resource base

20. The energy-deficient developing countries are more dependent on imported hydrocarbon energy than the industrialized countries. Many developing countries have reached the position where they can no longer finance their required energy imports. For them, the choice is between increased indigenous supplies or a reduction in energy consumption, with its probable negative consequence for industrial development.

21. Developing countries differ widely in their known energy resource endowments, but, taken as a whole, energy resource potential is not a limitation on industrial development. It has been estimated that about 44 per cent of the hydrocarbon resource potential of the world lies in the developing countries. On the other hand, the exploration rate in the developing countries is very low. Only about 3 per cent of all exploratory drilling is carried out in the oil-deficient developing countries. The question is why the rate should be so low and what can be done to increase it.

22. The same pattern emerges in relation to other energy resources. In hydroelectric power, only 9 per cent of the potential in the developing countries has been harnessed, in Africa the figure is only 1.5 per cent.

23. Economic exploitation of resources requires technology and finance. The technology for many areas of energy exploration and development is available within the developing countries themselves, but a better system of information exchange is needed. The finance for large-scale energy developments is a problem that calls for action by international funding agencies and co-operation among developing countries to share jointly the cost of developing a major energy project.

24. The developing countries are in a favourable position for making the inevitable transition from depletable fossil fuel to new and renewable sources of energy. The hydropower potential of the developing countries, referred to above, is a major energy option for the developing countries and can be developed with known technology. One important aspect of hydroelectric power, especially in view of the current financing problems, is the fact that it can be developed on a small decentralized basis. This can have important advantages for financing the project and for the time-scale for its completion and is appropriate for small-scale and rural industrial applications.

25. The developing countries, because of their geographical location, are generally well placed in terms of biomass and solar energy production. These new and renewable sources of energy have some uses that can be developed in the short term. In the medium and long term, they represent a major potential, opening up the possibility of energy self-sufficiency for many developing countries. Research, development and demonstration is required for large-scale industrial application of these new energy technologies. Currently, most of the research on them is being carried out by the industrialized countries. If the developing countries are to exploit the full potential of these energy resources and achieve energy independence, it is essential that they keep abreast of technological developments and adapt them to their own needs.

### C. Capital goods in support of the energy sector

26. The market for capital goods and services in the developing countries is expanding and represents a major opportunity for the development of an important industrial sector. It covers such a wide area and range of technologies that all developing countries should be able to select areas appropriate to their national capabilities. Some developing countries have developed capital goods in the traditional energy sector, such as oil exploration, production and processing. At a more modest scale is the development and local manufacture of simple mini-hydro plants, conductors, insulators and pylons for distribution networks using traditional materials; or the fabrication of biomass conversion plants and the fabrication and packaging of solar energy systems for specific purposes suited to local needs.

27. The development of an energy capital-goods market will need vigorous efforts on a national and regional scale, with support from industrialized countries and regional and international organizations, in research and development and design capabilities in a variety of fields. The full potential of South-South co-operation and the transfer of technologies from newly industrializing countries that have made remarkable progress in such areas is yet to be mobilized to enable less developed capital goods sectors in other developing countries to support the energy sector more effectively.

28. The role of the energy capital-goods sector in the developing countries will increase as the new energy technologies mature and the need arises for the large-scale production of equipment and products that do not have to be similar in concept or design to those appropriate to the industrialized countries. This underscores the need to maximize the domestic component in the total of capital goods needed by the energy sector, since some, at least, of the renewable source technologies are likely to be capital-intensive.

### D. Improved industrial energy efficiency

29. Energy conservation represents for most energy-deficient developing countries a low-cost method of dealing with part of their energy problem. A reduction in the amount of energy needed per unit of industrial output is equivalent to an increase in energy supplies. From the standpoint of economic efficiency, the increase in energy prices makes an examination of the possibilities for energy conservation a necessity.

30. Another important point is that much of the needed energy conservation can be obtained by "good housekeeping" and is therefore possible in the short term. Much larger savings of up to 30 per cent can be achieved in as little as three years by retrofitting and installation of controls.

31. The major requirement for energy conservation is "know-how". As most of the present energy equipment was produced in the industrialized countries, it is clear that these countries have the advantage in techniques for energy conservation. Many of the improvements in energy efficiency can, however, be obtained from simple plant audits, and training in such functions can be provided fairly cheaply and over a relatively short time. In addition, a number of plants in developing countries are known to be run inefficiently and therefore the room for improvement is even greater.

32. Given all the theoretical advantages of increased energy efficiency in the industrial sector, why has so little action been taken up to now? Perhaps it is because trained manpower required for efficient plant operation is in short supply. Another factor may be the poor repair and maintenance of facilities in developing countries, which makes the efficient utilization of energy equipment difficult if not impossible.

### III. SUGGESTIONS FOR NATIONAL ACTION

#### A. Energy planning and industrialization

33. Developing countries should aim at achieving the maximum degree of self-sufficiency in energy resources. To do so, they will need to survey and assess their national reserves of fossil fuels, hydropower and biomass resources, to develop appropriate strategies for their exploitation, and to co-operate with other developing and developed countries in acquiring the required expertise, equipment and financing. Biomass merits particular attention in countries within the sun-belt that consume a great deal of non-commercial energy. In such efforts, undesirable impacts on the environment must always be borne in mind, particularly when they affect food resources or involve health hazards.

34. Coupled with this, developing countries need to draw up comprehensive national energy policies and plans as an integral part of their national development plans. Such plans would decide the optimum mix of imported and indigenous resources within the general framework of the trade pattern of the country, and would determine the energy needs of different economic sectors according to a clear set of national priorities. The possibilities of combining energy resources in one country with other natural resources in another to their mutual advantage may provide a solid basis for optimum utilization of an abundance of either resource in any one country.

35. In such national energy plans, both the needs of industrial development plans and the contributions the industrial sector is expected to make to national development have to be carefully examined, and particularly the needs of basic energy-intensive industries (iron and steel, building materials etc.). These plans have to take account of the availability of raw materials and the industries' role in providing essential inputs to other important sectors. The manner in which industrial and rural development are integrated determines the patterns of energy supply that have to be taken into consideration in national energy planning. The implications of developing new industrial energy sources need to be studied from the point of view of location and type of industry.

36. Industrial development plans, on the other hand, should maximize the role of the capital goods industry in satisfying national demand for energy-related equipment. The range of equipment covered is extremely wide, starting with simple energy-efficient stoves and other items needed in rural areas, all the way to large-scale thermal, hydro- or even nuclear-power generation and

distribution equipment. In this respect, the possibilities offered by technological advances in micro-electronics, biotechnology and photo-voltaics should always be borne in mind and action initiated whenever significant break-throughs emerge.

#### B. Industrial energy management

37. In order to achieve the maximum possible efficiency in the utilization of energy resources in the industrial sector, a series of actions has to be initiated at the national and plant levels. These include proper repair and maintenance of energy supply and distribution systems to ensure their reliability and uninterrupted functioning; and the initiation of programmes for efficient energy utilization and conservation in industry. A number of measures will be called for, including sensitization campaigns, the collection and dissemination of energy information to industrial managers and government officials from a national focal point, the building up of expertise and the acquisition of necessary hardware, by means of co-operative programmes with developing and developed countries and international organizations. Both incentives (grants, subsidies, loans, tax reliefs) and penalties will be needed to encourage good energy management throughout the industrial sector, and an institutional framework will have to be established for implementing the incentives and penalties and monitoring their results. While spectacular savings can easily be made in large-scale industry, the gains may also be considerable for small and medium-scale industries, particularly those using increasingly scarce non-commercial energy sources that cause environmental damage.

38. Whenever possible, a cheaper or more readily available energy source (e.g. gas, coal or oil) should be substituted for a less economically attractive one, particularly in small and medium-scale industries, where the continued use of non-commercial energy sources has caused serious environmental damage.

#### C. Strengthening of national capabilities

39. The measures mentioned thus far call for supporting actions covering the strengthening of the institutional framework, the development of the human resources to undertake these tasks and the setting-up of the energy information systems needed.

40. Developing countries should aim at having a nucleus of staff in every industrial plant who will be responsible for good energy management, carrying out energy audits, introducing energy-efficient techniques and plant modifications, instituting preventive maintenance for energy equipment and waste energy recovery, and ensuring optimization of schedules etc.

41. At the national level, an entity responsible for industrial energy management should be established in the government department or departments, entrusted with planning and monitoring industrial development. The entity would ensure the integration of industrial energy needs in national energy planning, formulate the demands of the energy sectors to be met by industry,

collect and disseminate energy-related information for industry, institute programmes for efficient energy utilization through conservation, substitution and modification measures, formulate plans, legislation and procedures for incentives and penalties for the purpose and monitor their implementation and results.

42. Good policy formulation and the planning and implementation of the various actions at the national level will call for a variety of skills. The national education and training system, supported by regional co-operative programmes, and technical assistance from other developed and developing countries and international organizations, will have to undertake a major effort to provide these skills through accelerated training and retraining courses, on-the-job training, visits, fellowships and study tours.

43. Developing countries need to allocate the maximum possible level of financing to the energy sector and to ensure that the finances are optimally used. The possibilities of various forms of joint activities on equitable terms should also be investigated and suitable incentives for encouraging such activities provided.

#### IV. INTERNATIONAL CO-OPERATION AND THE ROLE OF UNIDO

44. The High-Level Expert Group Meeting on Energy and Industrialization held preparatory to the Fourth General Conference noted that the developing countries were in a stage of transition and decision-making regarding their industrial energy situation. The transition is from the past and current dependence on imported energy to an energy future based on increased use of indigenous sources and improved energy management. Each country must of course evolve its own industrial and energy policy and the role of international co-operation of UNIDO is to assist them in their endeavours.

45. International co-operation will be valuable in assisting developing countries in strengthening their capabilities in areas such as energy planning, industrial energy management, information systems and production of energy equipment. There is considerable scope for co-operation among developing countries in these and other areas. As indicated in the annex to the background paper (ID/CONF.5/7), the Group of 77 Meeting on Energy Development, Supplies and Rationalization of Energy consumption held at Bangkok in August 1983 has made a series of recommendations in this respect.

46. The Oslo Meeting commended UNIDO on its technical assistance and information activities in this field. It also made recommendations for future work by UNIDO, and other appropriate international organizations, in the areas of energy development, energy capital goods and industrial energy management. These are described in full in background paper ID/CONF.5/7.

47. It has been recognized that the setting of general aims and objectives relating to energy and industrialization policy for developing countries is not enough. Priorities have to be identified and specific actions and programmes undertaken. In this regard, five priority areas have been identified for future work by UNIDO in developing countries. These are:

- (a) Methodologies for developing and implementing industrial energy policies;
- (b) Capital goods and services for the energy sector;
- (c) Hydroelectric (including mini-hydro) power;
- (d) Biomass energy development;
- (e) Industrial energy conservation.

48. Following the establishment of these priority areas for future work, a number of specific programmes have been proposed, namely that UNIDO should:

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

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

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

- (d) Elaborate and implement a systematic programme of assisting developing countries, particularly in the African region, in regard to hydroelectric power for industrial development;

- (e) Initiate a mini-hydro development programme in Africa similar to the programme it promoted in the Asian region;

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

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

