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SUBSTANTIVE PREPARATIONS FOR THE CONFERENCE

Report of the Ad Hoc Expert Group on Education and Training

* A/35/43 (Part II) and Corr. 1, para. 67.

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INTRODUCTION

A. Background

1. In accordance with resolution 2 (II) of the Preparatory Committee 1/ for the United Nations Conference on New and Renewable Sources of Energy, (see A/35/43 (Part II) and Corr.1, sect. VII) an ad hoc group of experts on education and training was established by the Secretary-General of the Conference. According to its terms of reference, the ad hoc group was to prepare a report on the present situation concerning education in the development and use of new and renewable sources of energy, and concerning the training of expert, technical and management personnel, and to make recommendations concerning measures that might be taken, at the national, regional and international levels, to respond adequately to probable needs and opportunities, including the creation of new institutions or the strengthening of existing ones, taking into account the economic and social transformations within each country's national development policies and objectives.

2. The ad hoc group of experts met at United Nations Headquarters from 19 to 22 January 1981. A list of participants in that meeting, including invited observers, is attached (annex). Mr. F. A. Daghestani (Jordan) was elected Chairman and Mr. M. W. Bassey (Sierra Leone) acted as Rapporteur. In carrying out its work, the ad hoc group of experts took note of the work programme to be undertaken in preparation for the Conference, established in decision 3 (II) of the Preparatory Committee. The group based its work on an informal working paper prepared by the secretariat. 2/ Other relevant documents were made available to the group of experts through the secretariat. In particular, the United Nations Educational, Scientific and Cultural Organization (UNESCO) provided a preliminary version of its report on a survey on education and training in the field of new and renewable sources of energy (TER/ESR/395).

3. The ad hoc group of experts on education and training adopted the report of its meeting on 22 January 1981.

B. Structure and approach of the report

4. The core of this report is the set of 19 recommendations, reproduced in section III below, on education and training elements in the "concerted action designed to promote the development and utilization of new and renewable sources of energy", defined by the General Assembly in its resolution 33/148 of 20 December 1978 as the objective of the Conference.

1/ To be incorporated in the report of the Committee to the General Assembly at its thirty-fifth session (Official Records of the General Assembly, Thirty-fifth Session, Supplement No. 43 (A/35/43)).

2/ In the preparation of this paper, the secretariat was assisted by Mr. W. Shearer (United Nations University).

5. It should be emphasised that these recommendations, and the work of the ad hoc group of experts, focus directly on education and training needs that are specific to new and renewable sources of energy. It is, of course, true that the wider use of new and renewable sources of energy may be limited in many countries by an over-all shortage of people with any form of technical training, or by a low general level of literacy and formal education. In 1979, the United Nations Conference on Science and Technology for Development addressed itself to problems of this kind and paragraphs 34, 47, 59, 65 and 99 of the Vienna Plan of Action on Science and Technology for Development 3/ adopted by that Conference, are directly related to such over-all needs for education and training. The effective implementation of the relevant sections of the Vienna Plan of Action may be regarded as essential for the success of the development on an adequate scale of new and renewable sources of energy, especially in developing countries. The needs identified in this report, and the recommendations on education and training which it contains, supplement and make more specific the relevant elements in the Vienna Plan of Action.

6. The remainder of this report is intended to establish the basis for the recommendations set out in section III below. Several categories of people are defined, for whom various forms of education and training related to new and renewable sources of energy may be required. It is pointed out that education and training cannot be considered independently of other elements in an over-all strategy for the development of new and renewable sources of energy. Some of these other elements are being examined by other ad hoc groups of experts, and the report emphasizes the close linkages that exist with their work.

7. The introductory part of the report next considers the implications for education and training of the fact that many forms of new and renewable sources of energy can be used on a small-scale, often non-commercial, basis. The time constraint that this imposes is particularly important; because many techniques for using new and renewable sources of energy depend on decisions and actions by individual people, changes in the attitudes and habits of all or most of the population may be required, and some of these changes may take a generation or more to accomplish. Finally, the introduction emphasizes that the successful adoption of new and renewable sources of energy in developing countries depends to a large extent on education and training.

8. Following this introduction, the principal forms of new and renewable sources of energy are examined in section I, in the context of education and training needs, using the reports of the technical panels. As may be expected, a wide diversity of needs emerges, and there are also significant differences in their relative urgency, depending in part on the present state of research and development of different technologies.

3/ Report of the United Nations Conference on Science and Technology for Development, Vienna, 20-31 August 1979 (United Nations publication, Sales No. E.79.I.21 and corrigenda), chap. VII.

9. This review of technologies enables an identification to be made in section II below of the main types of education and training in new and renewable sources of energy that need to be provided. This in turn leads directly to the Recommendations adopted by the ad hoc group of experts (sect. III).

C. Principal categories of people for whom education and training in new and renewable sources of energy may be required

10. The ad hoc group of experts did not find it useful to define education and training, or to attempt to make a precise distinction between the two. Education and training must always be provided for people, as individuals or in groups, and in relation to new and renewable sources of energy the group of experts found it useful to define the following categories. These categories are referred to frequently in the remainder of this report; in particular, each of recommendations 5-9 (see sect. III) is specific to one of the categories listed below (see also para. 70 below, figure I):

(a) Government policy-makers: senior advisors and administrators who are charged with the responsibility for formulating and advising on major aspects of national policies for social and economic development. They include ministers of planning and presidents of planning councils and their senior staffs, presidents of central banks, members of national energy committees, ministers and vice-ministers of various sectors and their senior staffs, national planning committees, presidents and directors of sectoral institutions such as housing corporations, rural and muncipal governments, electricity authorities etc.

(b) Energy planners: senior administrators and managers responsible for energy planning and supply at the national level, or for large subnational units. These include, inter alia, members of: energy planning directorates or units in national planning organizations, ministries, electricity boards and authorities; specialized units at universities and research institutions; committees concerned with the energy sector of national development plans etc.

(c) Professionals and scientists: highly specialized people, with technical or scientific background, such as engineers, architects, agricultural experts, geologists, biologists, researchers, systems analysts and so on. They are likely to be responsible for plant design or operation, industrial production, building design, research and development activities, governmental operating agencies, public utilities etc. They are usually interested either in specific technologies (for example, wind machines, photovoltaics, geothermal energy conversion) or in specific energy requirements such as residential heating, rural community needs, or small-scale electricity production.

(d) Teachers and trainers: those responsible for the education and training of all sectors of society, in elementary, vocational and high schools, training centres, polytechnics, universities and postgraduate programmes. 4/

(e) Technicians and skilled workers: graduates of technical vocational schools at the secondary level, and those with from one to three years of technical education beyond secondary school level; workers acquiring on-the-job training in industry; operators of private workshops; and those who have acquired some experience through intensive technical training programmes. The trades covered by this category fall into a wide range. Some of these include sheet metal workers, welders, carpenters, blacksmiths, machine shop operators, electricians, pipefitters, draftsmen, construction workers etc.

(f) The general public: this category includes all citizens. Particular emphasis is given to women, young adults and children. Emphasis is also given to those groups in rural and urban areas that are considered as potential elements for change with respect to new and renewable sources of energy, including labour unions, credit organizations, boys' and girls' scout organizations, farm associations, and legislators.

D. Linkages with other elements in Conference preparations

11. Education and training needs for new and renewable sources of energy cannot be considered independently from other needs. For example, many research and development programmes include an important training component to increase the number of specially-qualified personnel to work in a programme. As research and development moves towards the stage where full-scale implementation of a particular technology becomes feasible, specific training needs must be anticipated on an adequate scale. Similarly the manufacturing capability for new and renewable sources of energy systems of local industry may depend on a regular flow of adequately-trained personnel. It may also be very difficult in practice to distinguish between education of future users of new and renewable sources of energy and the flow of information that is simultaneously provided to the public about the advantages and constraints of new and renewable sources of energy and the techniques for using specific systems. The success of a research and training programme may depend very much on the provision of adequate finance. There are many other linkages of this kind, and it is important that education and training be seen as one element in an integrated programme for the development and use of new and renewable sources of energy.

4/ The ad hoc group of experts noted that category (d) was a very crucial one, since the effects of changes in teaching and training techniques and content would affect the attitude and capabilities of large numbers of people for a long time. It was more effective to influence the teaching and training of future engineers and technicians than to intervene after they had completed their education. Urgent action taken with respect to existing teachers would also have its long-lasting effects through their influence on future teachers and trainers.

E. Commercial and non-commercial uses of new and renewable sources of energy

12. One of the characteristic features of conventional energy development, in both industrialized and developing countries, has been an increasing separation between energy supply and energy use. The end-user is normally supplied with different forms of energy (for example, oil, gas, electricity) through extraction, conversion and distribution systems that are centralized and that may be organized on a vast scale. The so-called "energy crisis" of 1973 was primarily a matter of the price of commercial energy supplied through centralized systems.

13. Some forms of new and renewable sources of energy are also likely to be developed on centralized, commercial lines (for example, large-scale hydroelectric schemes, tar sands development, tidal power) but such sources of energy also have a vital role to play in decentralized and non-commercial applications, that is, in situations where commercial energy is not available, or where significant numbers of people cannot afford to purchase it. While commercial energy prices were relatively low, as they were for the two decades prior to 1973, it was reasonable to see the development process involving a gradual extension of commercial energy to those who could not previously afford it. That transition may have to be delayed indefinitely in many countries in present circumstances, but several forms of new and renewable sources of energy offer or depend on an approach that is quite different. For biogas digesters, mini-hydro, several forms of solar and wind energy, and even some forms of oil-shale development, there may be little separation between supply and use. The energy is converted by the end-users, acting as individuals or as members of small community groups. The use of such energy sources may be of great importance in carrying the development process to the point where full-scale commercial energy supply and use become feasible.

14. This characteristic of new and renewable sources of energy carries with it vitally important implications for education and training. The individual needs to be made aware of the opportunities for using new and renewable sources of energy that lie essentially within his own control, and of the basic techniques by which he can take advantage of local energy resources. Education and training in the use of new and renewable sources of energy should therefore become part of the general education system that equips an individual for life; it is not mainly a matter of specialized training for a minority of people who are employed in making energy available to a large number of potential users.

15. At present there is little provision in the general education system in most countries for conveying an understanding of how the individual can take advantage of the potential that is available. A massive effort is required here. But it should also be noted that often, at present, little attention is devoted to new and renewable sources of energy in specialized professional training either. It seems in principle obvious, for example, that architectural courses should include training in the utilization of solar energy in both active and passive systems. Yet, although solar energy courses may be available in the university or other institution where an architect is trained, it is still rare for solar and other forms of new and renewable sources of energy to be an integral element of that training. The same is true for several other relevant professions.

F. The time constraint

16. The emphasis given in the preceding section to equipping individuals with the capacity to use new and renewable sources of energy as a normal part of daily life inevitably carries with it an important time constraint. Special courses can be provided relatively quickly for small numbers of people, and the impact of such courses can be appreciated in the space of a few years, especially if the participants occupy key positions in economy and society. But to use the basic educational system to change the habits of all or most of the population is a much longer process, requiring at least a generation to have a significant impact on behaviour. The process is likely to be delayed further by the well-known rigidities in educational systems, which render innovation difficult to achieve. The group of experts emphasized that such widespread changes in attitudes and behaviour were vital, and that the process must be initiated as quickly as possible so that the benefits should not be still further delayed. But the group felt it essential to point out that the main constraint imposed by education and training needs on the use of new and renewable sources of energy could be the time constraint: changes in the pattern of behaviour of the whole population could rarely be accomplished quickly.

G. Education and training as a major constraint

17. The most valuable asset and natural resource of any nation is its manpower. A well-educated and trained manpower that possesses the knowledge and skills to identify and solve the problems associated with development in an efficient and effective manner is the key element of progress. One of the key factors in retarding the development of developing countries, regardless of their material wealth, is the lack of quality and quantity of such manpower.

18. Many of the well-known technologies that were developed in industrialized countries have not been effectively applied in developing countries, owing to the latters' limited abilities in understanding, adapting, modifying and developing these technologies to suit their particular needs. These constraints have further diminished their ability to innovate, resulting to a large extent in continued technological and economic dependence on developed countries.

19. The extent and speed of development and use of new and renewable sources of energy in developing countries depend to a large degree on the education and training of a wide spectrum of manpower, ranging from policy-makers to the general public.

I. REVIEW OF TRAINING NEEDS AND EXISTING FACILITIES FOR DIFFERENT TECHNOLOGIES OF NEW AND RENEWABLE SOURCES OF ENERGY

20. Prior to the meeting of the ad hoc group, preparations for the Conference had included the establishment of technical groups on most of the forms of new and renewable sources of energy identified in General Assembly resolution 33/148, namely, solar energy; geothermal energy; wind power; hydropower; biomass; fuel-wood and charcoal; oil shale and tar sands; and ocean energy (thermal gradient, wave power and tidal power). 5/ In their reports, each technical panel made observations and recommendations concerning education and training needs, and this material was taken into consideration by the ad hoc group of experts. Although the following paragraphs rely heavily on the work of the technical panels, it should be noted that the conclusions drawn by the ad hoc group of experts on education and training are not always completely in accord with the views expressed by individual technical panels.

21. It should also be noted that the ad hoc group of experts felt that it was not possible to make useful numerical estimates of the numbers requiring education and training in new and renewable sources of energy. Among the considerations leading the group of experts to this conclusion were the following:

(a) In many cases, especially for small-scale applications of new and renewable sources of energy, those involved may potentially represent all or most of the population, especially those passing through educational systems;

(b) In the case of specialized training for specific individuals or groups, the training requirement will depend very much on the pace and outcome of research and development activities that cannot be judged at the present time;

(c) Global estimates, even for a single form of new and renewable sources of energy, may be of comparatively little utility. Most education and training programmes must be devised and implemented within a national framework, and must take account of the resource base, energy needs, and development policy decisions specific to each country.

22. The following discussion seeks to identify desirable education and training measures, on the basis of a comparison of probable needs and existing facilities, taking into account those specific characteristics of each technology that affect training requirements.

A. Solar Energy

1. Characteristics of the technology

23. Solar energy applications tend to fall into three main categories:

5/ In resolution 33/148, peat and draught animal power are mentioned in addition to these 12 energy sources.

(a) Low-technology utilization. Using unsophisticated technology, it is possible, on the basis of simple instructions, for unskilled people to construct and operate solar energy systems such as small greenhouses, dryers, cookers, simple water heaters and single-effect stills with simple water and rock storage systems. The skills required are possessed by most rural communities throughout the world. What is required for more widespread utilization of this level of solar technology is access to the necessary information in a form understandable to rural inhabitants who in many cases may be illiterate.

(b) Medium-technology utilization. More sophisticated technology and expertise is required for the installation, operation, maintenance and repair of solar energy devices, such as complex water heaters, pumps, small-scale power systems, refrigerators, ponds, multiple-effect stills, large greenhouses, and space heating and cooling systems used in conjunction with sophisticated heat storage systems. This level of technology includes many of the "passive" techniques for using solar energy to heat, and sometimes also to cool, houses and other buildings. In cooler climates, especially in industrialized countries, building heating and cooling (and associated water heating) may account for 30 per cent or more of final energy consumption. This represents a major area for energy conservation, and the low-grade heat requirements also make it particularly suitable for solar and other forms of new and renewable sources of energy. The skills required at this level of technology are widely available in industrialized countries, and even in developing countries they are similar to those of the enterprising automobile mechanics found almost everywhere. What is required is that these persons acquire a greater understanding of the thermodynamics involved, sufficient practical experience, and manuals and other guides similar to those used by plumbers and electricians in their areas of expertise. Packaged photovoltaic systems could also be handled at this level by persons possessing a basic knowledge of electronics and electrical engineering.

(c) High-technology utilization. Specialists are required to handle more complex systems, such as large-scale power plants and the development and production of photovoltaic devices. These specialists fall into two categories: engineers who design and oversee construction and operation, and technicians who undertake the construction and operation. Both require specialized training.

24. Interest in all three levels of technology utilization is growing very rapidly in industrialized nations, but it is anticipated that there will be still more rapid growth in developing countries over the next decade, especially in low-technology and medium-technology systems, owing to increased pressure on foreign exchange reserves to purchase oil and gas and to the widespread availability of solar energy in tropical countries.

2. Probable needs for training

25. In view of the increased demand for solar energy systems in developing countries, it seems clear that large numbers of appropriately trained persons will be required to support this demand.

26. The specialized training required for a more widespread use of low-level technology is largely restricted to teachers and trainers, who make local communities aware of the problems of energy procurement and the possibility of alternative solutions. A clear need, linked to this, exists for training materials that these teachers and trainers can use and disseminate effectively.

27. The local mechanics and other technicians who could undertake the construction and maintenance of medium-technology systems will require training that could be acquired through seminars or apprenticeships, or a combination of both. The number required is again likely to be very great.

28. At present, most developing countries have a serious lack of a critical category of personnel who will be responsible ultimately for the success of medium-level solar technology. These are the highly trained professionals and scientists who can develop the manuals and other tools which will be used by the technicians and skilled workers in the installation and maintenance of these systems.

29. The use of high-level technology requires additional professionals, scientists, skilled workers and technicians. The number required will probably not be great for most developing countries during the next decade, but may increase substantially thereafter if cost-effective technologies emerge.

3. Existing education and training facilities

30. Many institutions exist in the industrialized countries that already train professional, scientific and technical personnel in solar energy technology, but very few institutions are yet capable of playing this role in developing countries. Many developing countries have recognized this problem and have designated institutions which require to be strengthened in order to carry out the appropriate training activities. In addition to courses provided in industrialized countries that are open to or, in some cases, are specially designed for participants from developing countries, institutions in several industrialized countries, with the support of their Governments, have developed training systems that can be carried out in individual developing countries on request.

31. The training of teachers and trainers, and of skilled labour, is not generally carried out on an organized basis. The development of adequate schemes represents a major task, in which the national and subnational levels of government are likely to carry most of the responsibility and burden.

4. Specific proposals

32. The group of experts made the following proposals with respect to solar energy:

(a) Regional training centres for new and renewable sources of energy. Because there are very few institutions in developing countries capable of providing specialized training in solar energy, it is recommended that institutions be established on a regional basis to produce personnel capable of initiating and managing modest projects based on solar and other renewable energy

sources, and who might in some cases go on to more specialized training. The type of institution needed is outlined in recommendation 17. In the present context it may be noted that solar energy technologies could be expected to form a significant element in the work of such centres.

(b) Fellowship programme for training in new and renewable sources of energy sponsored by the United Nations. Additional fellowships will be required to enable students from developing countries to undertake the training at regional centres proposed under (a) above, and to participate in other regional and international centres. Such fellowships may be of critical importance in equipping individual countries with the expertise needed for the subsequent organization of training schemes at the national level.

(c) Training at the national level. Developing countries should be assisted in establishing courses for training technicians and, where appropriate, professionals and scientists; for equipping local technicians and skilled labour with additional skills related to solar energy systems; and for training teachers and trainers and providing them with teaching materials through which individuals and groups can be informed about the possibilities of using solar energy.

B. Wind Energy

1. Characteristics of the technology

33. The technology of wind power has the following characteristics:

(a) Low and medium technology applications. Using locally available materials and basic mechanical skills, simple wind devices can be constructed, operated and maintained to power water pumps and similar equipment, or to generate electricity for local use, especially for purposes that do not require a continuous supply. Prefabricated wind systems can be assembled, operated and maintained for such purposes by village mechanics who have acquired the additional practical skills and experience.

(b) High-technology applications. Large-scale wind systems require the skills of qualified engineers. Most of these systems are for electric power generation as part of an integrated and continuous alternating-current supply; they therefore involve electrical as well as aerodynamic and mechanical engineering skills. Engineers need, in addition to their usual training, a practical course in the engineering of wind systems.

2. Probable needs for training

34. With more emphasis being placed on the use of wind energy in areas with appropriate wind régimes, the requirement for engineers and for skilled workers and technicians is rapidly increasing. In view, however, of the more restricted applications of wind energy and the more limited number of suitable sites, as compared with solar energy, the number of personnel required in developing countries may be considerably less than the number required for solar energy.

3. Existing education and training facilities

35. A much smaller number of institutions offers professional and technical training in wind energy in industrialized countries than in the case of solar energy. Very few institutions are capable of carrying out this training in developing countries. Fortunately, the technology involved in small-scale systems is less complex and better known than for some solar energy systems. It would be relatively easy to expand programmes in existing engineering and technical training institutions to cover this field; this is what has been done by most of the institutions in developing countries that do at present provide training in wind energy technology.

4. Specific proposals

36. The following proposals were made with respect to wind energy:

(a) Regional centres for training in new and renewable sources of energy. Wind energy training could be an important element in the regional centres described in recommendation 17;

(b) Fellowship programme for specialized training sponsored by the United Nations; and

(c) Training at the national level. The rationales for both these proposals are similar to those indicated earlier (para.32) for training in solar energy systems.

C. Biomass, including fuel-wood

1. Characteristics of the technology

37. The term "biomass energy", like ocean or solar energy, covers a variety of mechanisms by which plant and animal materials are converted into energy. The technical panel noted that well-known uses included the conversion of wood and agricultural residues by direct combustion (burning) to produce heat, steam or electricity; the conversion of sugar-cane to produce alcohol fuels; the conversion of animal manures by biomethanation to produce methane and carbon dioxide (biogas), the conversion of wood and agricultural residues to gaseous and liquid fuels by thermochemical conversion systems, and the production of vegetable oils that could be used as a diesel-oil extender. Direct combustion includes the use of fuel-wood and charcoal, which was also considered by a separate technical panel.

38. With some oversimplification, the use of biomass can perhaps be divided into commercial and non-commercial applications, as much in terms of the scale of activity as by any other criterion. Much of the biomass that forms the basic cooking fuel of large proportions of the population in developing countries is either collected directly by the end user or purchased from small traders. By contrast, several large-scale commercial uses of biomass involve a clear distinction between the producers of the raw material and those involved in the conversion process, although future systems may integrate production and conversion more closely.

2. Probable needs for education and training

39. The ad hoc group of experts recognized that there was a need in many developing countries to provide professionals and scientists with the capacity to formulate, plan and implement programmes and projects for the efficient use of biomass for energy production. In the implementation of such projects, the actual production will normally be in the hands of farmers or foresters and the role of agricultural extension services may be of great importance in assisting producers to adapt to the requirements of farming for energy production. On the conversion side, the technical expertise required to operate biological and thermochemical conversion systems is relatively easy to provide through the basic structure for technical education in most countries, or through on-the-job apprenticeships.

40. The greatest needs in relation to biomass use, particularly in rural areas, appear to be educational rather than technical. In order for the current crisis to be overcome, the technical panel identified four directions in which action can be taken at once: (a) intensifying the productivity of existing fuel-wood resources; (b) creating new fuel-wood resources; (c) organizing the distribution of fuel-wood; and (d) improving conversion technologies. Although some of these approaches involve new techniques, most will have to be implemented by non-experts. New fast-growing tree species and new heat-conserving stoves are being developed, but their widespread adoption and efficient use depends on mass education programmes that may in many cases be concerned with the alteration of past habits and traditions as much as with the communication of information.

3. Existing training facilities

41. In regard to training facilities, the situation is encouraging. Throughout the world, national and international research centres exist or are being created, and these are frequently linked to systems of agricultural training up to university level and to the vitally important agricultural extension services that assist individual farmers. The situation is often similar, though less well-developed, in regard to forest product training. Although substantial efforts must be made to devise courses and advisory packages related to energy farming, the structure for carrying those messages generally exists already and is familiar to the potential users.

42. To train the specialized personnel involved in the large-scale conversion of biomass for energy, the necessary training systems must be considered and planned as part of an over-all decision to embark on large-scale programmes. Much of the specialized training that is required can probably be acquired by suitable personnel through on-the-job upgrading of existing skills.

43. The educational needs in regard to direct users of biomass are enormous, especially in terms of the millions of people involved. Unless more efficient techniques for the harvesting and utilization of biomass, especially fuel-wood, can become the norm for millions of people, for example, little impact will be made on the present crisis of supply. The problem is complicated by the fact that much of the educational effort must be directed towards women who, especially in rural areas, may be among the most educationally deprived members of the community. The improvements that are required may also be difficult to achieve

because they imply major changes in long-established traditions. Some initiatives have been taken along these lines in recent years, and it is evident that the contribution of voluntary organizations, especially those based in the communities affected, will be vital to success. Learning by imitation, or by word-of-mouth communication, must also play a major role.

4. Specific proposals

44. The proposals made by the group of experts are outlined below:

(a) Training of experts on biomass production for energy. Appropriate United Nations bodies and specialized agencies should encourage and support national governments in the organization and implementation of training schemes in order to ensure that the results of current research and experience on such matters as fast-growing plant species, harvesting régimes etc. are available to those responsible for the planning and management of biomass production and conversion for energy, including those who can influence the production of fuel-wood and other biomass intended for non-commercial uses. The technical panel on biomass identified a special need for training biotechnologists. As well as specialized seminars and similar events, this may involve study tours and other means of sharing practical experience, especially among developing countries with common problems.

(b) Strengthening the capacity of national agricultural and forestry extension services to promote biomass production for energy. Extension services represent the most practical and effective means of assisting individual farmers and other biomass producers to adapt themselves to the new needs and opportunities of biomass production for energy. As a rule, however, agricultural extension services are overburdened in relation to current activities and have little capacity to develop new information and advice packages for new activities. Since the requirements are generally similar in many countries, United Nations agencies could play an important role in organizing such information and advice in forms suitable for use in extension activities.

(c) Education in the improved use of biomass resources by individuals. The World Bank and other major development agencies are at present developing substantial plans to respond to the present or anticipated fuel-wood crisis in many countries. Central to such plans and programmes must be educational activities designed to influence the behaviour of those who use fuel-wood at present for cooking and other small-scale purposes. The effectiveness of action in regard to this very urgent problem should indicate the needs and opportunities for similar education programmes in regard to other types of biomass energy production and conversion.

D. Hydropower

1. Characteristics of the technology

45. Hydropower technology may be characterized as follows:

(a) Large-scale systems. The large-scale commercial projects for using hydropower (for example, major dam construction and turbine operation) involve high technology to produce electricity. For projects of this size, highly trained specialists and experienced technicians are required. These persons generally receive their training in the traditional civil engineering disciplines and receive further on-the-job training as well.

(b) Small-scale systems. Small-scale commercial and non-commercial systems have been used for a long time to produce electricity and mechanical power, using a medium level of technological expertise. Such systems require the attention of specialists and technicians, especially in the construction phase. Any nation with even limited experience and some civil engineering and maintenance capability possesses the skills necessary to design, construct and operate small-scale hydropower facilities. However, placing such small-scale systems in operation usually requires a limited amount of highly qualified expertise.

2. Probable needs for training

46. Although there is a marked increase in interest at the national level in the exploitation of sites for large-scale hydropower projects, and most sites in the developing world have yet to be developed, lack of financing will probably be the main brake on the rate at which such projects are implemented. Therefore, it does not appear necessary to take special measures at this time to organize additional training programmes for specialists and technicians in the developing world, although much could be done to strengthen and expand the local university engineering courses of those developing nations planning a series of major hydropower projects. Supplementary expertise is available from abroad until nationals have been trained in sufficient numbers to fill any specialized manpower requirements.

47. In the area of small-scale hydropower, a need does exist for the training of specialists and technicians, owing to a great renewal of interest in this alternative source of energy. Training requirements will vary greatly according to the number of suitable sites, their proximity to populated areas, and national priorities accorded to this form of energy. Much could be learned from a systematic arrangement for information exchange on new techniques in this field, and their training implications.

3. Existing training facilities

48. Existing training facilities in this field mainly consist of university and technical school engineering courses, supplemented by special seminars and on-the-job training. Present facilities for training specialists and technicians in the undertaking of small-scale hydropower projects are not sufficient and some effort should be made at the regional and international levels to focus attention

on this need, and to provide specialized courses for civil engineering graduates so as to familiarize them with the techniques involved.

4. Specific proposals

49. The proposals made by the group of experts are outlined below:

(a) Regional renewable energy training centres. The proposal for regional centres outlined in recommendation 17 could include a training component in small-scale hydropower.

(b) Fellowship programme for training in new and renewable sources of energy sponsored by the United Nations. The needs under this heading are similar to those already identified with respect to solar energy and wind energy.

(c) Technician training at the national level. It is apparent that the increase in demand for technicians in this field can best be met through national technical training centres or programmes.

E. Marine energy

1. Characteristics of the technology

50. The technical panel on ocean energy had considered several different types of ocean energy systems: ocean thermal energy conversion, tidal power, offshore wind energy, wave energy, ocean currents and salinity gradients, and marine biomass. The group of experts noted the view of the technical panel that ocean thermal energy conversion and a few large-scale tidal power developments were the only forms of marine energy that were likely to be harnessed in the foreseeable future.

2. Probable needs for education and training

51. Although the group of experts had some reservations about the optimistic view taken by the technical panel concerning the speed with which ocean thermal energy conversion was likely to be introduced as a large-scale source of energy, this did not affect its conclusions on education and training needs, which are almost impossible to define in a situation where practically all marine energy technologies are still in the research and development stage.

3. Existing education and training facilities

52. For practical purposes, specialized training courses for marine energy do not exist. If systems such as ocean thermal energy conversion do prove feasible, it seems probable that several will come into existence in the industrialized countries, initially on an ad hoc experimental basis. As with geothermal and other energy forms of a similar character, much valuable training must necessarily be accomplished at experimental and prototype sites.

4. Specific proposals

53. The following proposals were made by the group of experts:

(a) Education on marine energy possibilities. This should be provided primarily for energy and development planning decision-makers, in the form of information on current research and development and their possible implications, especially for developing countries.

(b) International marine energy training and education programme. The establishment of a successful, commercial-scale, ocean thermal energy conversion or other widely applicable marine energy system by any country might well signal the need for a programme to provide instruction in marine energy technology, resource assessment, project evaluation, construction and operation. Such a programme organized at the international or regional level would facilitate the subsequent creation of similar programmes in individual countries that embark on marine energy developments.

F. Geothermal energy

1. Characteristics of the technology

54. Geothermal energy technology may be characterized as follows:

(a) Large-scale utilization. This includes the commercial use of geothermal energy resources to generate electrical power, provide district heating and provide power for industry. The cost of proving and developing large resources is substantial, since deep drilling is involved. Several countries anticipate a major expansion of their geothermal resources over the next two decades.

(b) Small-scale utilization. This covers both commercial and non-commercial uses employing a medium level of technology to warm greenhouses, heat water, dry agricultural, forest and industrial products, etc. Many such systems are in operation at present and their use is becoming widespread.

2. Probable needs for training

55. In view of the recent sharp increase in interest in developing large-scale geothermal resources, there will be a demand in the next two decades for a relatively small number of highly trained specialists and managers with practical training experience, and for a large number of skilled technicians and equipment operators for exploration, evaluation and utilization. A recent survey found that 26 developing countries had proved or probable geothermal resources, and forecast that about 700 more professionals and scientists would be needed in the next decade for these countries to achieve their 1990 geothermal development targets. Little manpower planning has been done in most countries and the ability to

achieve geothermal development targets may depend primarily on the number of appropriately trained specialists available. 6/

56. The training required for small-scale applications can best be met by providing technicians and skilled workers with additional skills either through courses or on the job. The numbers involved are not likely to be large in any single country.

3. Existing training facilities

57. The United Nations and its specialized agencies have sponsored four post-graduate international training courses in the field of geothermal energy, at Pisa, Italy; Kyushu, Japan; Auckland, New Zealand; and Reykjavik, Iceland. The total number of persons participating in these courses is between 60 and 65 per year. In Central America, the United Nations Development Programme (UNDP) also sponsors a regional training seminar for 25-30 persons, as a supplement to on-the-job training for those participating in geothermal energy development projects in the region. Several industrialized countries have established facilities to train the personnel they require in this field, and some of these facilities are open to participation by personnel from developing countries through bilateral agreements.

58. The technicians and skilled workers required on large geothermal development projects have in the past been trained on the job, adding to their previously acquired skills. It is difficult to substitute other forms of training for the practical experience gained in working at geothermal sites and associated facilities.

59. The skills required for medium-technology uses of small geothermal resources are similar to those found among local entrepreneurs in many developing countries. In most cases, the additional skills and experience can be acquired through informal apprenticeships on existing projects.

4. Specific proposals

60. The following proposals were put forward by the group of experts:

(a) Regional training in geothermal energy. As only four international institutions are involved in training professionals and scientists in geothermal energy, it seems clear that a need exists for additional centres capable of training at a high level of expertise. This training of specialists can be most advantageously carried out at or close to existing geothermal projects, preferably in the region where the participants will later use their expertise. The distribution of geothermal resources suggests that such training facilities could best be located in Central America, East Africa and South-east Asia. Urgent

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6/ R. S. Bolton and M. P. Hochstein, "Present and future geothermal progress in developing countries and manpower training", paper presented at the New Zealand Geothermal Workshop, held at Auckland, New Zealand, from 3 to 5 November 1980.

consideration should be given to training the course instructors who will be required, through the four international institutions that now exist. This was the view of the Standing Advisory Committee on Geothermal Energy Training at its meeting at Pisa in November 1980. Emphasis should be placed mainly on training the managerial and other personnel required throughout the entire development of a project, and only secondarily on the training of experts required for relatively short periods.

(b) Assistance for access to expertise required on a short-term basis. Although not strictly speaking a training requirement in itself, this follows from the preceding proposal. If the main emphasis in geothermal training for developing countries should be placed on quasi-permanent managerial and operational experts, consideration should be given to providing technical assistance to developing countries to ensure the availability of the other professionals and scientists required for shorter periods (for example, in proving the existence and size of geothermal resources.)

(c) Technical training at the national level. It is apparent that the increased demand for technicians in this field can best be met through national training centres or programmes associated with national geothermal projects.

G. Oil shales and tar sands

1. Characteristics of the technology

61. Oil-shale and tar-sand technology has the following characteristics:

(a) Oil shales are sedimentary rocks containing solid, combustible organic matter; shale oil is obtained by heating the shale to a temperature of about 500° C. Oil-shale industries have existed for 100 years and more in several countries. In practically all cases, the industry has been organized on a commercial basis, requiring significant degrees of organization and infrastructure. The technical panel noted, however, that in some cases, especially in developing countries, the possibility existed of developing small-scale, decentralized, low-cost, labour-intensive retorts, producing a liquid fuel suitable for cooking purposes, lighting etc., the technology was available and the components were suitable for manufacture in developing countries. The example used by the technical panel, related to the needs of developing countries, envisaged a retort with a 200-tonne capacity operating at approximately one batch each month, for an annual throughput of 2,400 tonnes of shale and a production of 240 tonnes of shale oil. Several retorts might be operated in conjunction with one labour-intensive mining operation and requiring one or two technical and supervisory personnel for the operation. Morocco has undertaken recent encouraging experiments along these lines.

(b) Tar sands differ from oil shales and similar deposits in that the organic matter they contain is essentially soluble in petroleum solvents; they differ from heavy oil resources in the lack of fluidity of the reservoir. Significant tar-sand deposits exist in several countries, including Canada, Venezuela and the Union of Soviet Socialist Republics and in total may represent

at least one-and-one-half times the world conventional crude oil base. The bitumen extracted in the first phase of recovery can be further treated to yield synthetic crude oil suitable as refinery feedstock. In the past, tar sands have been worked solely for bitumen, but since 1967 the Alberta deposits in Canada have been the site of large-scale, highly capitalized mining and crude oil production systems.

2. Probable needs for training

62. The key factors in assessing education and training needs are probably the global distribution of oil-shale and tar-sand resources, and the scale of the technologies likely to be used in their development. Oil-shale deposits are distributed world-wide and an apparent lack of such resources may be due to the fact that little effort has been made in the past to locate them. For tar sands, though more exploration and evaluation needs to be done, the situation is probably different. Very large deposits exist in Canada and Venezuela but the technical panel noted that only the Bemolong deposit in Madagascar might be classed as a known major deposit in a developing country.

63. The Canadian experience indicates that the methods of tar-sands extraction are relatively straightforward and the number of people requiring specialized training in tar-sand technology will be relatively small, limited mainly to a few senior engineers and other professionals. For oil shales, the situation is more complex, both because the resources are widely distributed and because they offer opportunities for small-scale, low-cost development as well as for more highly-capitalized commercial energy applications. In the case of both oil shales and, to a lesser extent, tar sands, one of the most urgent needs is for professional training to enable the identification and economic and technical appraisal of deposits.

64. If Moroccan and similar experiments demonstrate that small-scale oil-shale development is also feasible, there will be a substantial demand for technicians with appropriate skills and for a broad-based education programme for potential users.

3. Existing education and training facilities

65. These are limited at present, for understandable reasons. The oil-shale industry that used to exist in many countries declined or disappeared in the two decades before 1973, because the cost of production was not competitive with the world price of conventional crude oil. Full scale-tar sand development projects exist only in one country, Canada. But the techniques are well known and the training courses required can probably be provided relatively easily in response to demand. For professionals and scientists, the specialized skills can probably be provided at little additional cost through geology, engineering and similar departments in universities and technological institutes; similar courses at a lower level can be added to technical college syllabuses. The main additional need may be for international exchange of experience; the key personnel of any nation embarking on oil-shale or tar-sand development for the first time should have the opportunity to study similar projects elsewhere at first hand.

4. Specific proposals

66. The group of experts put forward the following proposals:

(a) Resources inventory. Because of the great gaps in knowledge of world-wide potential resources, especially of oil shales, the technical panel recommended that an oil-shale and tar-sand resource inventory should be undertaken as soon as possible. In view of the nature of the task, it seems probable that many of those involved may be employed in several different countries in succession. Their training (for example, in petroleum geology) may be acquired at a few schools that are internationally recognized for their excellence.

(b) Provision of appropriate courses at the national level. Relatively small numbers of highly trained individuals will be the main requirement, and the necessary courses can probably be provided at small extra cost in existing universities or similar institutions.

(c) Technical training for small-scale oil-shale development. It is one of the attractions of these small-scale systems that training requirements are not substantial and can be provided relatively easily, especially by on-the-job apprenticeships once a project is under way.

(d) Education and training facilities at the site of major developments. The few countries that have active oil-shale or tar-sand developments at present can make a substantial contribution to the wider use of these technologies through the establishment of training facilities at the development sites. For some foreign visitors (for example, national energy planners) the main need may be for short briefings (no more than a few days in length) indicating the main opportunities, needs and constraints involved. Such briefings could be quasi-continuous or arranged as special seminars at fixed dates. Additionally, however, opportunities should be provided for senior engineers and other qualified personnel from abroad to work in a supernumerary capacity on such projects, to gain practical experience over a few weeks or months. Financial or other assistance may be required in many cases, and this might be provided as part of a wider international programme to encourage the use of new and renewable sources of energy.

H. Some general remarks on training needs

67. The general picture that emerges from the preceding review is encouraging: training needs are substantial, and may be critical for success in many cases, but they are also probably manageable, provided that substantial commitments are made at national and international levels to the development of new and renewable sources of energy. Training needs, in other words, are not likely to prove an insuperable barrier to the development of such energy sources.

68. Furthermore, it should be recognized that the opportunities for employment that both small-scale and large-scale projects in new and renewable sources of energy can offer represent a significant contribution to the development process itself in many countries. The skills required represent a realistic and valuable opportunity to upgrade the qualifications and capabilities of large numbers of people as an important part of development activities.

69. The work of the various technical panels and their observations and suggestions concerning education and training needs were of considerable assistance to the ad hoc group of experts, and had a substantial influence in shaping the conclusions and recommendations contained in sections II and III below.

II. EDUCATION AND TRAINING IN NEW AND RENEWABLE SOURCES OF ENERGY

70. In the opinion of the ad hoc group of experts, the education and training requirements related to the various forms of new and renewable sources of energy described in section I above can be represented in skeletal form as shown in figure I, using the categories defined in paragraph 10 above. It will be evident that detailed responses to particular needs may depart significantly from this structure. The anticipated requirement, method of meeting these requirements and the institutions that may be used are shown in figure 1 only in the form of examples, not as prescriptions. Nevertheless, the group of experts believed that the framework presented in figure 1 may provide a useful point of departure for those who may be responsible for the provision of education and training programmes in national Governments and international organizations.

71. The education and training requirements of three of the categories identified in figure 1 emerge fairly clearly from the work of the technical panels and the summary of this in section I above. Professionals and scientists, teachers and trainers, and technicians and skilled workers have relatively well-defined needs that are often specific to a particular form of new and renewable sources of energy. Some further explanation of the education and training required for the other categories may, however, assist in understanding the significance of the relevant recommendations in section III below.

A. Courses for policy-makers and energy planners

72. Very few countries have been able to develop and implement rational energy policies in the context of the current world energy supply situation. Yet it is very important that each country should aim at using as quickly as possible the energy mix that is most appropriate for its available resources and socio-economic conditions, taking into account all existing options, including new and renewable sources of energy.

73. In many countries, the key constraints preventing a wiser use of energy resources are a lack of information on the resources of these countries, and an insufficient understanding by the leaders and decision-makers of potential options, their importance, and the steps necessary to adopt them.

74. So far as energy planners are concerned, there appear at present to be only four international courses that attempt to provide such broad training for representatives of developing countries. 7/ These are post-graduate courses of several months' duration, provided at Bariloche, in Argentina; Saclay, in France; Stony Brook, in the United States of America; and Turin, in Italy. These courses treat all the energy options but focus mainly on conventional energy sources. It is important to ensure that new and renewable sources of energy are dealt with adequately in the curricula of these courses and of others that may be offered in the future.

7/ UNESCO document SC/TER 395; see also para. 2 above.

Figure I. Education and training for new and renewable sources of energy by categories of people involved

Category	Typical Background	Information and training requirements	Suggested mechanism	Institution
1. Government policy-makers	Social Sciences	Role of energy in the development process, and potential direct and indirect contributions of new and renewable sources of energy to development	Short courses	Regional or international centres
2. Energy planners	Social sciences or technological	Potential contribution of new and renewable sources of energy in over-all energy needs; assessment of energy supply and use, including decentralized and non-commercial sources	Short and medium courses	Regional, international and national centres
3. Professionals and scientists	Scientific or other specialism	Detailed state-of-the-art reviews; technologies, tools, products, research and development needs and results	Medium and long courses	As (2) above
4. Teachers and trainers	Scientific and educational	Extremely variable according to type and role of participants (e.g. elementary teachers, extension service workers)	Medium and long courses	As (2) above
5. Technicians and skilled workers	Technical school, plus experience on the job	Training related to a specific technology of new and renewable sources of energy	Short courses with practical experience	Local centres or mobile units
6. General public	Basic education	Opportunities, constraints and simple techniques for using new and renewable sources of energy	Mass approach through media and use of voluntary organizations to reach special groups	Media, local groups, basic education system

Note: Although no precise figure need be determined, "short" courses may last several days or weeks, "medium" courses for several months, and "long" courses for a year or more.

75. In addition to the need to ensure that these courses give adequate recognition to new and renewable sources of energy, it will be necessary to determine the extent to which additional centres of training may be required in order to meet current and future needs, including the rather different needs of those for whom energy is only one element, though a vital one, in the over-all programme of social and economic development with which they are concerned. Recommendations 5 and 6 are particularly addressed to the needs of policy-makers and energy planners respectively.

B. New and renewable sources of energy and the general public

76. Relatively little space has been given in this report to broad educational needs for the population as a whole, compared with the specific training requirements for particular groups needed for the development and use of new and renewable sources of energy. The role of the public as users of energy is, however, of vital importance. As the World Bank has pointed out:

> "Many developing countries depend heavily on traditional sources of energy, most of which are renewable, such as firewood, charcoal, crop residues and animal dung. In poorer countries these sources supply one-half to three-quarters of the total energy used; the proportion varies from 50-65 per cent in India to 70-90 per cent in Africa ...". 8/

77. At first sight, this suggests that the populations of developing countries are well aware of opportunities for new and renewable sources of energy and make good use of them. In fact, such is not the case; extensive and frequently excessive use is made of a few forms of renewable sources of energy, such as firewood, but other sources are neglected because the people are not aware that their use is feasible. The World Bank goes on:

> "The developing world is, by and large, amply endowed with solar and biomass resources. These resources are particularly well suited to meeting the widespread need for small, decentralized sources of energy in rural areas where, owing to the lack or high cost of energy from conventional sources, renewables may prove economical sooner than in the industrialized countries ... . To use these resources on a wide scale will require extension and other delivery systems that are capable of reaching the urban and rural poor with technical and social assistance and credit facilities." 9/

Other experts would add mini-hydro and wind technologies to solar and biomass.

78. The crucial needs in promoting the greater use of new and renewable sources of energy by the general public, especially on a self-help basis, are probably: (a) some form of community organization capable of identifying opportunities for

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

9/ Ibid.

new and renewable sources of energy and of taking responsibility for their development and operation; and (b) information in appropriate forms on what can be achieved, on the physical and other requirements, and on the necessary construction and operation techniques.

III. RECOMMENDATIONS

79. Although the recommendations by the group of experts set out below are, as far as possible, self-contained and self-explanatory, two general points should be kept in mind. First, the sequence of recommendations is arranged so that what is required generally precedes proposals on the mechanisms through which this may be achieved; the earlier recommendations are concerned primarily with the content of education and training programmes, the later recommendations with the process of implementing them, especially the role of international bodies such as the United Nations. Secondly, the limitation noted in paragraph 5 above needs to be repeated at this point: the recommendations are addressed only to those education and training needs that are specific to new and renewable sources of energy; they do not encompass the wider problem of the lack of trained personnel in many developing countries, that was a principal concern in the Vienna Plan of Action on Science and Technology for Development, 10/ adopted by the United Nations Conference on Science and Technology for Development in 1979.

Recommendation 1

The establishment or strengthening of appropriate national structures for science and technology is recommended as an imperative need in social and economic development, so as to give adequate recognition to the significance of new and renewable sources of energy.

The need to strengthen the science and technology capacities of developing countries has been recognized in section I of the Vienna Plan of Action on Science and Technology for Development. 10/ In the context of new and renewable sources of energy, the recommendations contained in the Plan of Action have particular force, because of the scientific and technological character of the various forms of new and renewable sources of energy and because of the vital role that energy plays in the development process. Despite the renewed attention given to new and renewable sources of energy in recent years, there is a danger that developing countries may neglect the potential contribution that such sources of energy can make to development, or fail to provide within the country adequate scientific and technological capacity for their development. New and renewable sources of energy should be given high priority in the planning and activities of national structures established for science and technology.

10/ Report of the United Nations Conference on Science and Technology for Development, Vienna, 20-31 August 1979 (United Nations publication, Sales No. E.79.I.21 and corrigenda), chap. VII.

Recommendation 2

The establishment of national energy policies is recommended, incorporating short-term, medium-term and long-term elements, that give full recognition to the potential role of new and renewable sources of energy and that include explicit strategies for implementing the policies.

Traditional energy policies have usually been concerned with ensuring supplies of conventional fuels, and their use through centralized energy distribution systems. The inclusion of new and renewable sources of energy in revised policies will entail the adoption of new concepts and attitudes on the part of energy planners, which may need to be achieved through special training programmes on new and renewable sources of energy and through other similar mechanisms.

Recommendation 3

It is recommended that a comprehensive assessment be undertaken, at the national level, of the current situation in regard to energy supply and use, including social, economic and environmental considerations.

Energy budgeting in many countries at the present time is confined to commercial energy produced and distributed through centralized systems; this ignores, for example, the vital and often dominant role played by fuel-wood and similar fuels in meeting the energy needs of the majority of the population in many developing countries. The methodologies and models available for comprehensive assessments are not well-developed or universally accepted; each country must shape the assessment according to its own characteristics and the key personnel will probably require special training in order to accomplish the task.

Recommendation 4

It is recommended that education and training be provided to enable adequate energy resource inventories to be made for each country.

For effective assessments of energy needs and options, many more data are required, especially in developing countries. There is little quantitative information on existing levels and systems of use of new and renewable sources of energy (for example, number and depths of wells for drinking water and irrigation systems) and even fewer reliable data on the character and scale of under-utilized resources (for example, solar and geothermal resources and oil shales). What are required are improved systems for data collection and qualified people to conduct the surveys, maintain data collection systems, and analyse the results. Some of the data requirements may be difficult to meet (for example, geothermal resources need to be proved by drilling) but other needs (for example, some of those related to solar and wind energy) may be met by relatively minor modifications to existing climatological and similar data collection systems. Similarly, some forms of training in making inventory assessment of new and renewable sources of energy can be provided in most countries, and should preferably always be organized on a

national basis. However, some forms of training (especially in connexion with the inventory of resources that have not been utilized in the country on a significant scale in the past) may require access to appropriate training programmes organized on a regional or international basis.

Recommendation 5

The establishment is recommended, initially using international and regional facilities, of courses for policy-makers on the role that energy plays in social and economic development, giving adequate attention to the present and potential future role of new and renewable sources of energy.

The courses might have the following characteristics:

(a) Intended participants: senior advisers and administrators working in national governments, organizations for regional co-operation and similar bodies, who are charged with the responsibility for formulating and advising on major aspects of policies for social and economic development;

(b) Scope: to provide participants with an appreciation of the role of energy in the development process and the contribution that new and renewable sources of energy might make to development (including indirect contributions through employment generation, etc.);

(c) Format: short courses or seminars, led by experts familiar with the needs and constraints of policy-making at the macro level, for a limited number of participants (15-20 per course);

(d) Method of organization: initially using international or regional centres of excellence if necessary, but subsequently becoming a national responsibility as facilities and expertise become available;

(e) Institutions to be used: universities with appropriate staff and expertise; institutes for public policy development and analysis;

(f) Duration: probably limited to one to three weeks, because of constraints on participants;

(g) Examples of existing courses: United States of America, State University of New York (Stony Brook); France, Sophia-Antipolis: Institute for Energy Policy, short courses and seminars on energy systems, energy planning and energy economics.

Recommendation 6

It is recommended that, using international or regional institutions where national capacity is not yet adequate, courses be established for energy planners on the application and potential contribution of new and renewable sources of energy and on the over-all assessment of energy needs and supply mechanisms.

The courses might have the following characteristics:

(a) Intended participants: senior administrators and managers involved in energy planning and supply at the national level or for large subnational units;

(b) Scope: to provide energy planners with the extra dimensions of new and renewable sources of energy, and to enable them to undertake over-all assessments of energy supply and use, including decentralized and non-commercial sources. Existing energy planning courses should be revised and strengthened in order to give adequate attention to new and renewable sources of energy;

(c) Format: short or medium-length courses initially, with longer courses added to or incorporated in the training of the next generation of energy planners;

(d) Method of organization: some countries, including several developing countries, already possess the capacity to provide such courses at the national level; others may need, for some time to come, to participate in courses offered by regional or international centres of excellence;

(e) Institutions to be used: universities with appropriate engineering, economic and related expertise; international or regional centres of training and research;

(f) Duration: initially, the courses may need to be limited to short periods (about one month) but the nature of the task ideally requires a more prolonged training, which should be provided for the next generation of energy planners;

(g) Examples of existing courses: United States of America, Brookhaven National Laboratory. Argentina, Bariloche: Instituto de Economía Energética. France, Sophia-Antipolis: Institute for Energy Policy, short courses and seminars on solar energy and buildings, and biomass use, including industrial implications. Norway, University of Oslo: international summer school on energy planning and the environment.

Recommendation 7

It is recommended that the knowledge and expertise of scientists and other professionals be strengthened and extended through the provision of training programmes in specific technologies for new and renewable sources of energy.

(a) Intended participants: those who have already acquired a professional or scientific training in fields where significant opportunities exist for using new and renewable sources of energy;

(b) Scope: provision of detailed information on the state of the art in specific areas of new and renewable sources of energy. Among the many topics that might be touched upon or considered in some detail are: available technologies and products, system design, current research and development needs, simulation techniques etc. - since the intended participants will be drawn from widely differing backgrounds, specific courses will be needed for different groups;

(c) Format: courses of medium to long duration, to ensure that participants acquire the necessary knowledge and skills;

(d) Method of organization: through nationally organized programmes where possible; otherwise through courses held on a regional basis;

(e) Institutions to be used: universities and research centres in individual countries; regional centres for specialized training;

(f) Duration: from a few weeks to one year;

(g) Examples of existing courses: Norway, Trondheim: Royal Norwegian College of Technology, one-year international course on hydroelectric design, technology and practice. Latin America, Latin American Energy Organization, (OLADE), seminars and courses on geothermal energy, biogas and energy balance assessment. France, Perpignan: one-year course on geothermal energy. United States of America, University of Florida: 15-week course on solar energy.

Recommendation 8

It is recommended that the knowledge and capability of teachers and trainers be extended in regard to the scope, opportunities and problems of new and renewable sources of energy, including techniques of utilization.

(a) Intended participants: teachers and trainers, particularly, but not limited to those who are involved in vocational training in fields related to energy supply and use;

(b) Scope: the scope will vary greatly according to the character of the participants. Consequently a wide range of courses will need to be provided to cater for different needs - for example, teachers in elementary schools will have very different needs to those involved in vocational training. Examples of the courses that may be included under this heading are:

(i) Short courses for elementary school teachers, on basic energy principles;

(ii) Courses for teachers in vocational schools or training centres, on the knowledge and skills in specific technologies of new and renewable sources of energy;

(iii) Courses or seminars for university, college and school teachers, to review existing curricula or course content, or to define new degrees and diploma courses and new career-training opportunities related to new and renewable sources of energy;

(iv) Courses or workshops for extension service workers;

(c) Format: courses of varying duration: short in the case of participants involved in general education; longer for those who are directly involved in vocational training related to new and renewable sources of energy;

(d) Method of organization: courses (especially with a high technical content) may need to be organized initially at the regional level, but should be transferred to a national framework as soon as possible;

(e) Institutions to be used: regional training centres, technical colleges, polytechnics and universities; there are also many opportunities for co-operation between industrial establishments and educational institutions in the provision of specific courses; the school and training systems from which the participants will be drawn can also play a significant role, especially in defining the needs that specific courses should be designed to meet;

(f) Duration: A few weeks to a few months, depending on technical content;

(g) Examples of existing courses: Italy, Turin: ILO International Centre for Advanced Professional and Technical Training.

Recommendation 9

It is recommended that training programmes for technicians and skilled labour in specific technologies of new and renewable sources of energy be established or strengthened.

(a) Intended participants: those who will find employment in projects and operations for new and renewable sources of energy. The requirements for such technicians and skilled labour should be determined as part of the national energy planning process, and provision for recruitment and training made accordingly. Participants may already possess general technical or other skills, but require further training specific to a particular technology of new and renewable sources of energy;

(b) Scope: specific to and defined by the new and renewable sources of energy technology concerned; generally, the training should include:

(i) The basic principles of the particular new and renewable sources of energy;

(ii) Operation of production machines;

(iii) Manufacture of components and assembly;

(iv) Installation and operation;

(v) Trouble-shooting and maintenance;

(vi) Environmental implications;

(c) Format: several options exist, including both special courses and regular training provided by:

(i) Vocational schools (at secondary education level);

(ii) Polytechnics and technical colleges (post-secondary);

(iii) Research institutes and universities;

(iv) Industrial establishments active in new and renewable sources of energy;

(d) Method of organization: although training at this general level (though not normally at present in new and renewable sources of energy) is well-established in most countries, the role of local industry may play an essential role also: assistance in developing and operating courses may be required from regional or other centres of expertise and finance, and legal and economic incentives to assist training may be included in measures to promote industrial development of new and renewable sources of energy;

(e) Institutions to be used: as noted above, this training will normally make use of the existing framework for technical training, with substantial industry involvement and external assistance where available and needed; training opportunities provided by demonstration projects supported by United Nations bodies should be used;

(f) Duration of courses: variable, depending on course content;

(g) Examples of existing courses: Senegal, Dakar: University Institute of Technology and Research Centre on Renewable Energy.

Recommendation 10

The development is recommended of curricula, teaching aids, performance recognitic awards and other materials required to implement the training programmes called for in recommendations 5-9.

In developing curricula and providing the other materials required, national educational bodies and other relevant organizations would be greatly assisted by the creation or adaptation of activities by international bodies (such as UNESCO), by bilateral assistance and by technical co-operation among countries with similar needs.

Recommendation 11

It is recommended that national programmes and materials be established for general public education on new and renewable sources of energy and the optimization of energy use.

At the present time, in practically all countries, such programmes are required to educate the general public in the opportunities that exist for using new and renewable sources of energy, especially in small-scale, centralized applications, and in the necessary techniques. At a later stage, much of this effort should be accomplished through the basic educational system, and additional programmes would be developed to extend and support such education. Each country, working where appropriate in co-operation with international organizations, regional training centres and similar bodies, should identify the main groups in the population to which information on new and renewable sources of energy should be addressed, and the best means of reaching them. For example, special efforts should be made in most developing countries to reach women and young people, especially in rural areas; the available means include the mass media (television, radio, press), films, cartoons, posters and other audio-visual means, and exhibits and demonstration projects in individual communities. Voluntary non-governmental organizations have a vital role to play in communication.

Recommendation 12

It is recommended that a report be prepared based on a sample survey of a small number of industrialized and developing countries, on the attention that is given to the optimal use of energy resources, including new and renewable sources of energy, in the content of systems of general and specialized education, with recommendations for the future.

It seems probable that detailed study of a relatively small number of countries will allow general conclusions and recommendations to be formulated that will assist all countries in making desirable changes in educational systems. The survey should include consideration of both the present extent, form and content of specific courses on new and renewable sources of energy, and the extent to which characteristics of new and renewable sources of energy are, or should become, an integral part of general education for all and of specialized courses for architects, engineers and other experts.

Recommendation 13

It is recommended that appropriate model curricula, teaching aids and other activities be developed for use in national education systems that familiarise students with the potential for and problems involved in the utilization of new and renewable sources of energy.

The approach should be both general (oriented towards making the use of new and renewable sources of energy a normal element of daily life) and specific

(ensuring, for example, that techniques relating to new and renewable sources of energy are included in educational systems for all experts who can use them in their professional work). Vocational courses, adult education and refresher courses should be taken into consideration. Special attention should be given to the particular advantages of new and renewable sources of energy for improving the life of women, especially in rural areas. As with the development of curricula etc. for the special courses proposed in recommendation 10, the task facing national Governments and educational bodies can be eased through relevant activities of international organizations and through other co-operative activities. The report called for in recommendation 12 should provide guidance that will be found useful in a large number of countries.

Recommendation 14

It is recommended that the exchange of information on educational systems, training programmes and technical experience related to new and renewable sources of energy among countries with common interests be facilitated.

Education and training to promote new and renewable sources of energy offer significant opportunities for technical co-operation among countries, especially among developing countries. For example, many of the techniques for utilizing new and renewable sources of energy have already been adopted in many parts of the world, and in some cases form part of long-established patterns of urban and rural life. Exchange of this experience can contribute to an understanding of the social and economic context needed for successful use of new and renewable sources of energy and a more optimal approach to energy use in general. Within the United Nations system, this aspect of technical co-operation among developing countries may be facilitated by seminars, study tours and other initiatives taken by the regional commissions and other bodies.

Recommendation 15

A review, is recommended using the appropriate existing interagency co-ordination mechanisms, of the extent to which greater and more effective use of new and renewable sources of energy would contribute to the success of existing programmes and objectives of United Nations bodies and specialized agencies, and the contribution that these bodies can make towards meeting the related education and training needs.

Some United Nations bodies and specialized agencies are already directly involved in activities related to education and training in the field of new and renewable sources of energy (for example, UNESCO and the United Nations University (UNU)). Other United Nations bodies and agencies have substantial programme activities to which the increased use of new and renewable sources of energy could make a significant contribution. These include the International Labour Organisation (ILO) (use of simple systems of new and renewable sources of energy in rural development country projects), the Food and Agriculture Organization of the United Nations (FAO) (use of undervalued land resources to produce biomass for

energy, and the use of new and renewable sources of energy in irrigation pumping), the World Health Organization (WHO) (pumping and purifying drinking water), the United Nations Environmental Programme (UNEP) (reduction in forest loss through better management and use of fuel-wood resources), the United Nations Industrial Development Organization (UNIDO) (development and application of mini-hydro projects), and several others.

Such a review should be completed within 12 months of the adoption by the General Assembly of the recommendations of the Conference.

Recommendation 16

The strengthening and expansion of fellowship programmes within the United Nations system are recommended to ensure adequate training of personnel from developing countries in selected aspects of new and renewable sources of energy and the optimal use of energy.

Although some fellowships are already offered by UNESCO, UNDP and UNU, more are needed to meet the analytical and training needs identified in preceding recommendations. In particular, the fellowships would facilitate the advanced training of appropriately qualified persons from developing countries at regional centres such as those proposed in recommendation 17 or at international centres of excellence.

Recommendation 17

It is recommended that regional centres be established for specialized training in energy assessment, planning and policy development and in technologies of new and renewable sources of energy.

Appropriate United Nations bodies could participate in the designation and support of about six regional centres. Existing centres could also be recognized and strengthened to perform the required functions. These functions would include:

(a) The provision of specialized training for policy makers, planners, professionals and scientists on the methodologies of energy surveys, assessments, planning and policy development related to new and renewable sources of energy and conventional energy; this training would be offered through seminars, panel discussions, workshops and short courses. The object should be to strengthen the ability of participants to formulate and implement national energy policy, plans and programmes that would form an integrated part of national social and economic plans and would take into account short-range and long-range implications for research and development, education and training, local industries, optimization of energy use, scientific and technological infrastructure and public services, and the appropriate organizational structures involved;

(b) Provision of training for technicians and skilled manpower in the various technologies of new and renewable sources of energy relevant to the region. Training may include:

(i) Technical aspects of new and renewable sources of energy;

(ii) Methods of data collection and measurements related to new and renewable sources of energy;

(iii) Manufacturing and production methods for equipment for new and renewable sources of energy;

(iv) Installation and maintenance of equipment;

(c) Provision of training for professionals and scientists in various aspects of new and renewable sources of energy, such as:

(i) The scientific and technical principles involved;

(ii) Design criteria for equipment and systems design;

(iii) Testing methods, specifications and codes related to the design, manufacture and use of equipment and systems for new and renewable sources of energy;

(d) Assistance to Governments in the region in the design of programmes and materials for general and specialized public education in new and renewable sources of energy and optimal energy use;

(e) Assistance in establishing curricula and educational materials related to new and renewable sources of energy.

Each centre would, in the implementation of these functions, co-operate with and utilize existing facilities and expertise in the region; other regional centres; institutions and centres outside the region; international organizations; and regional and other industries relevant to new and renewable sources of energy.

The permanent staff of the centre should be kept at a minimum. Small display equipment could be obtained free in the form of donations from manufacturers within the region and elsewhere. Larger display units would be purchased.

Recommendation 18

The inclusion of a significant education and training component for new and renewable sources of energy is recommended in the terms of reference of any possible United Nations centre of responsibility for energy.

In the event that a centre of responsibility for new and renewable sources of energy is established in the UN system, this body should contain a unit for the initiation, funding and organizing of activities to meet education and training

needs in regard to new and renewable sources of energy in developing countries. Such a unit could also facilitate the implementation of several of the previous recommendations, including: courses for government policy-makers (recommendation 5), energy planners (recommendation 6) and professionals and scientists (recommendation 7); survey of new and renewable sources of energy in present education systems (recommendation 12) and development and introduction of appropriate curricula (recommendations 10 and 13); the exchange of technical information and experience (recommendation 14); fellowship programme (recommendation 16); and the development of regional capability (recommendation 17). It would also make possible the periodic review of the adequacy of education and training facilities, especially those designed to meet the needs of developing countries.

Recommendation 19

It is recommended that assistance be provided for the work undertaken by international and national nongovernmental organizations in promoting the development and utilization of new and renewable sources of energy.

Non-governmental organizations have already indicated their willingness and demonstrated their effectiveness in several successful activities. Some organizations have played a valuable role in developing new techniques for utilizing new and renewable sources of energy, especially for use on a self-help, non-commercial basis, but the main contribution likely to be made by non-governmental bodies is in communicating the opportunities and techniques of new and renewable sources of energy to large numbers of people, and by providing organizational mechanisms through which projects can be initiated, constructed and maintained. Assistance to non-governmental organizations with the requisite skills, interest and membership is likely to be very cost-effective when compared with other forms of education and training.

Annex

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