UNITED NATIONS

GENERAL ASSEMBLY

Distr.
GENERAL

A/CONF.100/PC/37
27 February 1981

ORIGINAL: ENGLISH

PREPARATORY COMMITTEE FOR THE UNITED NATIONS CONFERENCE ON NEW AND RENEWABLE SOURCES OF ENERGY
Third session
30 March-17 April 1981
Item 2 of the provisional agenda*

SUBSTANTIVE PREPARATIONS FOR THE CONFERENCE

Report of the Ad Hoc Expert Group on Research and Development and Transfer of Technology

CONTENTS

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

I. BACKGROUND

1. The General Assembly, at its thirty-third session, decided to convene a United Nations Conference on New and Renewable Sources of Energy in 1981 at Nairobi. The scope of the Conference was confined to 14 specific new and renewable sources of energy. 1/ At its thirty-fifth session, the General Assembly endorsed the recommendations of the Preparatory Committee for the United Nations Conference on New and Renewable Sources of Energy, one of which was that of the six ad hoc expert groups being established by the Secretary-General, one should deal with the issues of research and development and transfer of technology. 2/

II. INTRODUCTION

2. The United Nations Conference on New and Renewable Sources of Energy will have to identify concrete measures to promote increased use of solar and wind power, hydropower, ocean energy (thermal energy conversion and wave and tidal power), biomass conversion, fuel-wood and charcoal, geothermal power, oil shale and tar sands, peat and draught-animal power.

3. The energy sources identified for examination at the Conference are all available to varying degrees in different locations. Thus, the Conference will have to ensure balanced coverage of these sources, identifying and making some in-depth analyses of the possible constraints affecting each of them individually and the constraints likely to affect all of them, in so far as they have certain problems in common calling for similar solutions.

4. The assessment, development and management, exploitation and utilization of these sources of energy can be viewed as a specific example of the application of science and technology to development. Thus, a discussion of research and development and transfer of technology issues concerning these alternative sources of energy must be undertaken in the light of their potential for generating the political will of the developing countries to overcome both the internal and external barriers to accelerated socio-economic development.

5. A review of research and development activity (see annex I below) shows that while most activity is still concentrated in the developed countries, a significant but still small amount of work is being undertaken by developing countries - albeit, the bigger, more industrialized developing countries. For the reasons discussed below, it is imperative that developing countries undertake more research and development activities regarding the alternative sources of energy identified above.

1/ See General Assembly resolution 33/148 of 20 December 1978, paras. 2, 3 and 4 (d) and (e).

2/ See General Assembly resolution 35/204 of 16 December 1980, para. 3, and resolution 2 (II) of the Preparatory Committee for the United Nations Conference on New and Renewable Sources of Energy (A/35/43 (Part II)).

6. There are many applications of these energy sources that are of significant interest to developing countries but are of negligible interest to the developed countries, which will therefore have little or no incentive to develop equipment for such applications.

7. The design of systems for use in the industrialized countries is geared to minimizing labour inputs during both production and operation. This usually implies higher capital cost manufacturing facilities and higher capital cost equipment, since most functions are carried out through automatic controls. Clearly there will be a need to choose, adapt and even improve such technologies for use in developing countries.

8. Most technologies that have hitherto been transferred to developing countries have already been well accepted in the developed countries. Thus, local markets have been well served and the firms involved are seeking additional markets. In contrast, solar energy systems present a new and unprecedented trend. Some developed countries are now viewing the developing countries as major near-term markets for selected technologies (e.g., photovoltaics) before they come into widespread use domestically. This is because the developing countries possess an excellent renewable energy resource base (high solar intensities), which is essential for these technologies, and also need distributed energy systems. Clearly such systems cannot be developed exclusively in the socio-cultural setting and environment of the developed countries and provide any assurance that they will be suitable for use in the developing countries.

9. A staff paper prepared by the World Bank 3/ for the consideration of the new Ad Hoc Expert Group on Research and Development and Transfer of Technology, contains the following observation:

> "In order to bring about the widespread application of these technologies in developing countries, two significant steps are needed - advances in, or adaptation of, these technologies; and the building of the capability within the developing countries to undertake these advances and apply them effectively. This involves competence in engineering and in both natural and social sciences. It includes the ability to assess needs and resources. It requires the skills to choose, adapt, and create the necessary technologies, and the ability to establish appropriate institutions for their manufacture, commercialization and distribution."

III. REVIEW OF CURRENT SITUATIONS

A. Global overview

10. In order to address the issues of technology transfer and research and development (R and D) needs it may be useful to review, on a general level, the

---

3/ World Bank, "Research and technological capacity for the use of renewable energy resources in developing countries" (Washington, D.C.).

financial resources now being directed towards the technologies under consideration and the geographical distribution of these resources. This will help to identify those areas in which there are already significant R and D activities and to indicate those technologies in which substantial commercial activity is now occurring throughout the world. It will also help to identify those R and D activities which may not be addressed adequately by ongoing programmes and to identify systems which are now readily available from commercial sources. Such a perspective is important to decision makers at both the national and international levels if they are to make the best use of scarce financial and manpower resources.

11. The task of reviewing current activity concerning new and renewable sources of energy on a world-wide basis is complicated by the great diversity of the technologies involved, their varying commercial status, and the absence of a central source of information on the subject. The information contained in tables 1 to 3 below is not comprehensive in nature since it stresses mostly solar, wind and biomass technologies. It is believed, however, that the information indicates approximately the financial resources being directed to these fields, the major participants in technology development, and the technologies receiving the most governmental and commercial emphasis.

Government programmes

12. Many countries having significant indigenous technical capability have new and renewable sources of energy programmes funded by Governments and State agencies. Reasons for this include the relatively modest resources required to develop some forms of technology to exploit new and renewable sources of energy (crop dryers, small-scale hydro projects, biogas generators, etc.), a desire to adapt these technologies to service local needs, and a general policy of building up in-country capabilities so as to avoid dependence on outside resources.

13. Table 1 below summarizes governmental expenditures in this field in selected countries for which information is available. As indicated in table 1, the industrialized countries of Europe, the United States of America and Japan probably account for over 70 per cent. The total outlays are on the order of $1.5 to $2 billion annually. As a practical matter, as a result of the substantial resources being devoted to developing technologies for selected new and renewable sources of energy in the industrialized countries (including some developing ones), many of the related technologies will be incorporated into their industrial infrastructures. On the other hand, many of the better applications for these technologies will be in the developing countries, which makes the implementation of effective technology transfer mechanisms particularly important.

Programmes of aid agencies and international financial institutions

14. Table 2 below summarizes the funding being provided by both bilateral and multilateral agencies and international financial institutions. The total expenditure by these organizations is about $250 million, exclusive of fuelwood, alcohol and hydro projects. The United Nations Interim Fund for Science and Technology for Development (UNIFSTD) is giving high priority to research and development, testing and demonstration, and pilot production projects in the field of new and renewable sources of energy.

15. Several of the bilateral organizations are supporting technologies oriented towards new and renewable sources of energy, such as water pumping (photovoltaics, thermal power), refrigeration (absorption systems), and thermochemical conversion systems. These programmes often have a secondary objective of displaying to advantage the special technical capabilities of the donating country and, therefore, are intended to contribute directly to the transfer of technology.

Commercial activities

16. A quantitative assessment of commercial activities is particularly difficult, owing to the scarcity of consistent information on the national level. Table 3 below provides a rough estimate of the number of firms now engaged in the solar and wind energy business in 12 selected countries, including three developing countries. It should be noted, however, that many of the companies are very small entrepreneurial organizations with limited sales. The sale of solar hot-water heaters is by far the largest such activity. World-wide sales are estimated at several hundred million per year (approximately 30 million square feet of collectors), with almost half these sales in the United States of America. Other countries having significant businesses in this field include Australia, Cyprus, France, the Federal Republic of Germany, Israel, Japan and South Africa.

17. There is also significant world-wide commercial activity in photovoltaics (about $40 million), wind energy systems (about $10 million) and small-scale hydro systems.

18. There is an increasing amount of trade between countries in the equipment required to utilize new and renewable sources of energy. For example, over 50 per cent of the photovoltaic technology produced in the United States is for export, primarily to developing countries; about 8 per cent of the solar heating equipment produced is exported.

19. There is thus already a large amount of international commercial activity in solar energy, and some system categories have already become a significant factor in world trade. The practice of exporting solar equipment to developing countries is likely to increase because of the intrinsically superior performance of many of these systems in those countries (owing to both better solar resources and the highly distributed nature of the energy loads).

Table 1. Government-supported research, development and demonstration for renewable sources of energy a/ in selected countries, 1980

(Millions of United States dollars)

Country	Government expenditures
United States of America	1 100 b/ c/
France	82
Germany, Federal Republic of	40
India	20
Sweden	17
Saudi Arabia	15
Italy	12
Canada	9
Australia	8
United Kingdom of Great Britain and Northern Ireland	8
Spain	7
Denmark	6
Egypt	6
Netherlands	6
Switzerland	6
Belgium	4
Libyan Arab Jamahiriya	2
Algeria	1

a/ Exclusive of large-scale hydro and geothermal systems.

b/ Not including tax credits used to accelerate commercial activities or large-scale alcohol projects.

c/ All numbers are approximate and are based primarily on information contained in World Solar Markets, published by the Financial Times (London).

Table 2. Summary estimate of renewable energy funding by aid agencies a/ b/

Agency	Fiscal years reported	Amount (Millions of United States dollars)	Number of projects
Multilateral			
United Nations Development Programme	Through 1979	43.0	87
World Bank	1979	1-2.0	5
Organization of Petroleum-Exporting Countries	1980	5.7	2
European Development Fund	1979	7.9	23
United Nations Educational, Scientific and Cultural Organization	1980	1.0	20
United Nations Industrial Development Organization	1980	1.0	6
Bilateral			
United States Agency for International Development	1980-81	79.0	35
France	1976-79	26.0	108
Germany, Federal Republic of	1979	86.0	87
United Kingdom of Great Britain and Northern Ireland	1979	3.0	31
Canada	1979	Small	2
Netherlands	to 1979	6.0	18

Source: International Institute for Environment and Development, various agency sources.

a/ Excluding hydropower and fuelwood.

b/ This table is provided as an approximation only, for indicative purposes. Individual numbers may be in error.

Table 3. Commercial activity in solar and wind energy equipment in selected countries: Number of active companies in different countries

Country	Space/water heating	Photovoltaics	Wind	Small-scale hydro systems
Argentina	6	-	2	-
Australia	45	3 a/	4	-
Brazil	27	-	-	-
Canada	7	-	3	1
France	25	3 a/	7	1
Germany, Federal Republic of	90	6 a/	2	1
Israel	10	-	-	-
Italy	15	9 a/	2	-
Japan	100	2	-	-
Mexico	4	-	-	-
United Kingdom of Great Britain and Northern Ireland	15	5 a/	1	1
United States of America	300	20 a/	29	6

Source: Solar Energy Research Institute data on commercial solar activities and World Solar Market, published by the Financial Times (London).

a/ Some firms only distribute or package photovoltaic systems and are not manufacturers.

B. Technical status summary

20. The new and renewable sources of energy which are discussed in this report fall into two general categories:

(a) Technologies which are consistent with utilization on a small scale and where the equipment and devices could be manufactured in many of the developing countries themselves. Such technologies include thermal, solar, biomass conversion, hydro and wind power systems.

(b) Technologies that generally have to be implemented on a large scale and need to be supplied in a fashion similar to that now used for large conventional projects, such as power plants or chemical plants. These technologies include oil shale, tar sands, geothermal power generation, ocean thermal energy conversion (OTEC), and large-scale hydro and wind power systems.

21. The results of a review of the technologies in the area of new and renewable sources of energy are described in annex I below. It identifies the major participants, technical status, near-term importance to developing countries and the level of action for each of the several technologies. Many of the small-scale technologies are already commercially available 4/ and are now being utilized in developed and developing countries alike. Examples of such technologies are solar heating, photovoltaic power units, small-scale hydropower, biomethanation and small-scale wind pumps and electric generators. It should be emphasized that commercial availability does not mean economic viability and in many of the examples cited, research and development is needed, largely to reduce first costs. Those small-scale technologies referred to above will all undergo normal product improvements by virtue of improved designs and production techniques.

22. The small-scale technologies that have demonstrated technical feasibility via operation at pilot plants include small-scale solar thermal generation, small-scale shale-oil retorting and high-temperature process heat. Although these technologies have not yet demonstrated long-term reliability or favourable economics, they might nevertheless be available by the mid-1980s.

23. Several large-scale systems based on new and renewable sources of energy are commercially available, including large-scale systems based on hydro power, geothermal power and the production of ethanol.

24. Wind power systems in the megawatt range are being tested on a pilot plant basis and are expected to be available for commercialization by the mid-1980s.

25. Ocean energy systems based on OTEC are still under development and are not projected to be commercially ready even in this decade.

26. The research, development and demonstration associated with developing fast-growing plant species to increase biomass yields has been identified as being of particular importance in developing countries. The findings indicate that:

4/ For a definition of the term "commercially available" see para. 2 of annex I below.

(a) Biomass shows promise of being an important energy source in almost all developing countries;

(b) The identification and growing of appropriate plant species will be highly region and nation specific; and

(c) Near-term plant-screening activities and long-term genetic engineering of plants can be done by relatively small groups of scientists without elaborate, high-cost capital facilities.

27. Owing to the above factors, rapid progress could be achieved if research, development and demonstration activities in this field were to be undertaken with international co-operation.

28. In order to develop, large-scale technologies require correspondingly large financial resources and technical infrastructure. As a result, the research, development, demonstration and implementation of these technologies is being undertaken by a relatively few large public and private organizations in the developed countries and in some of the bigger, industrially advanced developing countries. For example, OTEC research and development and shale-oil production is concentrated in the United States of America, alcohol production in Brazil, and tar sands exploitation in Canada.

29. There is little incentive for many of the developing countries to devote scarce resources to equipment-oriented research, development and demonstration in these large-scale technologies, except possibly in those cases where they have a particularly extensive resource base.

C. Major issues concerning research, development and demonstration and transfer of technology

30. A discussion of the issues concerning research, development and demonstration and transfer of technology must be preceded by a review of the technological capacity needed. The full range of technological capacity needed to mobilize alternative energy technology in developing countries is very broad. Resources need to be surveyed and needs assessed. Existing technology has to be reviewed and matched to national resources and needs. Research must be undertaken to develop and/or adapt technologies. The technologies so developed must be tested, improved and demonstrated, after which steps must be taken to ensure their local manufacture, commercialization and diffusion. Also to be addressed are the technological and socio-cultural elements of policy making involving these alternative energy resources, including the establishment of incentives for their use. In addition, alternative energy consideration must be integrated into a broader energy policy and into policy making in such sectors as agriculture, industry, urban development and transport.

31. This comprehensive technological capacity should provide an incentive to institutions ranging from those of the scientific and technological infrastructure - universities, government-sponsored and other laboratories, extension services and

the like - to the engineering groups of operating ministries or of private or public-sector manufacturing firms and consulting and engineering organizations. Also involved will be non-governmental organizations active in community development, resource-survey groups, analysis divisions of energy or planning ministries and private individuals.

32. The effective mobilization of these alternative energy technologies will depend on the co-operation and synergy among these organizations and individuals. The precise form of this co-operation will depend on a specific country's objectives; on its social and cultural traditions; on its financial, material and human resource base; on the level of its over-all development; and on the technologies it needs to use.

33. The alternative energy sources, falling within the scope of the Conference to be held in Nairobi, have hitherto been neglected in the formulation of over-all energy policy. The integration of technological capacity with policy making in the alternative energy field and of alternative energy with over-all energy problems requires the creation of sufficient political awareness and commitment.

34. As a practical matter, technical and financial resources greatly limit the number and scope of research, development and demonstration projects which can be effectively undertaken by developing countries. However, much research, development and demonstration now tends to lack focus and to reflect the technical interest of participants as much as to address identified national needs. The result is often a relatively large number of small projects, many of which lack a critical mass of resources to be effective.

35. One of the major issues that developing countries are now facing is how to evaluate objectively their research, development and demonstration options and to identify those which have a reasonable chance of success given the available manpower and financial resources.

36. The World Bank has made a preliminary review of the capabilities of 19 developing countries for mobilizing renewable energy technologies and has found that they could be placed in three broad groups.

37. According to the World Bank study, the first group of countries possesses the highest level of institutions, technical skills, expertise for social analysis and policy commitment for renewable energy. The next group of countries show a relatively recent policy commitment but only a limited capacity or, conversely, some capability but no policy commitment. The third group was found to have a minimal policy commitment and a low level of capability.

38. The Bank study also found that in certain parts of the world, efforts to promote "regional" co-operation in the field of renewable energy have begun, with a view to enabling the concerned countries to pool their limited financial or technological resources.

39. Assistance programmes undertaken by multilateral and bilateral agencies form important channels for the transfer of technology. The World Bank staff paper notes

that an increasing amount of assistance for renewable energy development is being provided through bilateral programmes, 5/ the Bank itself, the regional development banks and the specialized agencies of the United Nations system.

40. The major programmes were found to have contributed to the development of renewable energy awareness and technology in a number of ways. Nevertheless, the existing programmes were not thought to have recognized fully the critical importance of building local capacity for renewable energy development. In addition, sufficient attention had not yet been paid to the analysis of end-use needs, the development of local capability to undertake research on the technological, social and economic impact of renewable energy resources, or to planning for the widespread utilization of those technologies. The creation of local institutions and mechanisms for marketing and commercialization had also been neglected. Specific projects had frequently been regarded as ends in themselves rather than as a means of securing - through extensive testing, evaluation and adaptation - the widespread use of the technologies within the country.

41. Programmes of bilateral aid for the development of renewable energy resources were found to be relatively new and still evolving. They tended to be oriented towards the demonstration of hardware developed in the laboratories and enterprises of the donor country. According to the study, some donor countries had tended to use aid to create export markets in the developing countries for their own solar industries. Most of the research was still being done in the home country, and the technologies were not designed to suit conditions in particular developing countries. On the contrary, project conditions often seemed to be chosen to display and test the technologies under particularly favourable circumstances. However, the World Bank found that as the bilateral agencies had gained experience in renewable energy assistance, they seemed to have come increasingly to recognize the importance of building local capacity.

42. The study goes on to state that aid agencies tended to be inadequately informed as to what other agencies were doing. They could benefit from a systematic exchange of information, including interagency meetings. They might discuss the over-all level of effort made by each agency in each country and in each technology, and also might exchange information on project plans and experience. It is suggested that the process would have a three-fold impact. It would enable the agencies to learn from each other's experiences, avoid duplication and agree on priority areas for all activities.

43. In the light of the review of the technological capacity needed by developing countries to mobilize alternative sources of energy, described above, for their social and economic development, research, development and demonstration in the developing countries will clearly be an integral part of the technology-transfer process, both between developed and developing countries and between the developing countries themselves. The reasons are as follows:

5/ Based on a survey of eight bilateral programmes, entitled "Policies and programmes for renewable energy assistance in eight development agencies. Summary and critical evaluation" by T. Barblem and R. T. Hoffman.

(a) Research, development, design, engineering and demonstration in developing countries contributes to manpower training and institution building and thereby helps to establish a core of skilled personnel capable of evaluating and demonstrating the suitability of both domestically produced and imported technologies.

(b) It helps to establish a local presence for the technologies, making it much more likely that policy planners will incorporate the selected alternative energy technologies in their development plans.

(c) Equipment which results at least in part from locally initiated research and development will be more consistent with national needs, more amenable to local manufacture and more likely to come into widespread use.

(d) The presence, in developing countries, of groups that are very much up to date vis-à-vis the latest technology options will provide greater flexibility and improved bargaining positions when it is necessary to import technologies and equipment.

44. Moreover, by undertaking research, development and demonstration activities, either on an individual basis or in collaboration with other developing countries, developing countries will minimize the risk of becoming captives of a relatively small number of transnational corporations based in the developed countries. This is an important consideration, for developing countries must not allow themselves to be constrained to import solar equipment and thus continue the drain of foreign exchange.

45. For those technologies being devised in developed countries, their effective transfer to developing countries is of crucial importance. The developing countries must therefore possess the capacity to assess, select, successfully negotiate, purchase and adapt such technologies. In order to achieve this objective, on the one hand, there is a need to identify and assess different channels for the transfer of alternative energy technologies. On the other hand, there is a need to formulate technology policies and implement them through appropriate institutional machinery.

46. In the case of small-scale technologies that are widely used and publicly known - such as small-scale biomass systems, small-scale hydropower systems and small-scale wind machines - companies find small incentive to enter such markets.

47. A notable exception to the above is the technology associated with the production of photovoltaic cells. It is likely that several companies will develop proprietary solar cell technologies which would provide them with a competitive advantage. The impact of such proprietary positions would be moderated by the need to reduce the panel costs to a level where their widespread use will be economically feasible (say, $500 to $2,000 per peak kW). The total installed costs, corresponding to these panel costs, would then be dominated by the installation costs associated with site preparation, structure, wiring and the like.

48. A study conducted by the United Nations Conference on Trade and Development (UNCTAD) 6/ has concluded that the market for solar energy technologies is

> "characterized by the operation side by side of both large and small enterprises. A particularly interesting aspect of the market composition is the increasing participation of major oil companies. Five of the 12 largest oil companies (i.e., Exxon, Shell, Mobil, Socal and Compagnie Française des Pétroles) are actively involved in research on solar technology. The usual approach seems to be entry into promising markets through purchase, either total or partial, of smaller enterprises with a high degree of technical expertise, taking full advantage of a well endowed capital position."

The study goes on to state that "in order for developing countries to derive real benefit, it is of utmost importance to ensure the active participation of developing countries themselves in the scientific and technological effort and to design a careful policy to avoid the formation of technological monopolies".

49. For the large-scale technologies, such as geothermal power generation, OTEC, tar sands and large-scale alcohol production, it is likely that a relatively few national or private firms will establish the necessary technical capabilities to implement projects on a world-wide basis. The situation will in many ways resemble that now obtaining in the case of large-scale hydropower, with the difference that some of these organizations may be located in some of the bigger, more industrially advanced developing countries as well. The expertise will be based more on know-how and experience than on specific proprietary positions.

50. The UNCTAD study 6/ raises the question of patent rights in the context of government-funded research and development. It considers the question an important one because a large part of the research and development expenditures on solar technology (with the partial exception of solar heating and cooling) is attributable to government funds. This is true in most developed countries, including the United States of America, where patent rights on technical data and innovations developed under federal contract belong in principle to the Government. In this way the Government can ensure the widest dissemination and extensive commercialization of the technologies involved, which is the ultimate objective of research and development subsidy.

51. Studies conducted by the United Nations Industrial Development Organization (UNIDO) suggest the need for relating research and development in developing countries to possible time horizons for local manufacture of equipment. 7/ In solar technologies, there might be three approaches: production and testing of prototypes

---

6/ United Nations Conference on Trade and Development, "Energy supplies for developing countries: Issues in transfer and development of technology" (TD/B/C.6/31/Rev.1).

7/ United Nations Industrial Development Organization, "Technology for solar energy utilization" (DTT Series No. 5); "Appropriate industrial technology for energy for rural requirements" (Monographs on Appropriate Industrial Technology, No. 5).

for immediate manufacture in low-temperature technology; initiation of research and development programmes on medium- and high-temperature technology; careful monitoring of research and development in sophisticated high-temperature technology, before embarking on further research and development. In rural energy, research and development should include socio-economic factors; isolated trials cannot have an impact unless integrated with total approaches to rural development.

IV. MEASURES FOR CONSIDERATION

52. It is important that the developing countries assume a major role in applied research, development and demonstration for renewable energy technologies, particularly in:

(a) Generating detailed identification and analysis of specific needs in developing countries and the engineering of the entire systems involved in meeting those needs;

(b) Testing the technical and economical viability and assessing the social and environmental impact of such systems;

(c) Assisting local manufacture;

(d) Adopting systems designed to increase the quantum of in-country manufacture and to facilitate local operation and maintenance, which is especially important for renewable energies with their relatively high initial investment;

(e) Research and action programmes to overcome social or cultural barriers.

53. Most research, development and demonstration will be undertaken at the national level, albeit often with financial and technical support from bilateral and multilateral assistance organizations. The Technical Panels indicated, however, that there were several research, development and demonstration initiatives which could be better addressed at the regional and international levels. The following reasons were given:

(a) By reducing the amount of duplication in the more widespread/identical research, development and demonstration activities, developing countries can direct their scarce resources to programmes of special relevance to their individual needs;

(b) The objectives, methodologies and procedures of some research, development and demonstration programmes must be agreed at the international level and consequently require international co-ordination (for example, in establishing performance standards, testing methodologies and the like);

(c) Such research, development and demonstration is primarily non-proprietary, has a relatively long pay-back time and is applicable on a regional or world-wide basis;

(d) Conducting research, development and demonstration activities at the regional and international level would help to co-ordinate and rationalize the input of resources to new and renewable sources of energy by national Governments and various bilateral and multilateral assistance organizations;

(e) Demonstration is intended primarily to generate information for facilitating decision making and to provide information to end-users on a national or international basis and therefore requires strong co-ordination at that level.

54. There are a number of research, development and demonstration initiatives in many specific technologies which could be considered for regional and/or international action. Five broadly defined initiatives which appeared to be consistent with the above guide-lines and consistent with the recommendation of one or more of the technical panels are:

(a) Energy assessment and planning;

(b) Regional centres for technology transfer;

(c) International biomass development programme;

(d) Long-term testing of systems;

(e) Development of technologies for meeting special needs.

55. An important issue relating to transfer of new and renewable energy technologies to developing countries concerns the appropriation of technologies developed by the public research and development institutions. It is recommended therefore that:

(a) New and renewable energy technologies resulting from public research and development institutions should be made freely available to all countries, taking into account different national policies;

(b) Developed countries should provide incentives to encourage their institutions and firms to undertake research and development for the creation of technologies especially suited to the needs of developing countries.

A. National energy assessment and planning

Recommendation

56. In view of the overriding importance of obtaining the results of those assessments in adequate detail as soon as possible, it is recommended that a task force should be set up immediately under United Nations auspices and through United Nations funding. Within a period of 6 to 12 months, the task force would report on:

(a) The energy assessments that are in progress or will begin during the next three years on a global, regional or national level;

(b) The adequacy of such efforts, in terms of their scope, depth of coverage, scheduling and constraints;

(c) The additional work to be done, including proposals for the co-ordination and mobilization of resources, with a view to formulating a programme of action.

Background

57. Several of the technical panels stressed the fact that discussions of the potential role of new and renewable sources of energy had to be qualitative at this time owing to a general lack of government planning in the energy area. The resultant lack of information on the potential market for different technology options makes it difficult to assign research, development and demonstration priorities to new and renewable sources of energy. In particular, it is difficult for national Governments and the various multilateral and bilateral assistance organizations to determine the technology options with potentially the greatest beneficial impact and thereby to specify research, development and demonstration programmes which will most effectively utilize the available financial and technical resources.

58. The proper role of renewable energy sources in meeting the needs of developing countries can only be determined in the context of national energy planning. An essential input into such planning are national energy assessments. Through such assessments, the role of various new and renewable sources of energy can be better quantified, the types of systems required to satisfy key end-use functions identified and assessments made of research, development and demonstration needs, institutional arrangements and financial and manpower commitments from Governments.

59. Specifically, such assessments should include:

(a) The analysis of present energy-use patterns in all important sectors, including rural and urban, commercial, industrial, agricultural and transportation sectors;

(b) The projection of future energy-use requirements if development goals are to be achieved and the identification of energy-related constraints;

(c) The identification and assessment of indigenous sources of energy - both conventional and new and renewable - which can be used to satisfy present and future energy requirements;

(d) The critical examination of the relative costs of developing the various energy options and of their capital requirements, taking into consideration such factors as the potential for increasing the manufacture of systems, with attendant beneficial foreign exchange and industrial development implications;

(e) The formulation, on the above basis, of strategies for satisfying present and future energy needs using both conventional and new and renewable sources of energy and defining the policy implications of each strategy.

60. A number of national, regional and international agencies are providing assistance to interested countries wishing to undertake national energy assessments. The World Bank, with assistance from the United Nations Development Programme (UNDP), has begun a programme under which assessments will be made in approximately 60 countries during the next three years. These assessments will focus on the identification of major energy-strategy options, their policy implications and requirements for strengthening national planning and other institutional capabilities for the formulation and implementation of energy plans.

61. In evaluating the existing programme and in recommending any complementary action, it will be necessary to ensure that:

(a) The analysis of the present role and future potential of new and renewable sources of energy is given high priority in the energy assessment programmes and is fully integrated into the resulting national energy plans;

(b) Sufficient efforts are made to assess the research, development and demonstration requirements for the exploitation of new and renewable sources of energy and the measures necessary to strengthen national, scientific and technical capabilities for this purpose;

(c) Emphasis is placed on strengthening capabilities within the countries to maintain continuity in the energy assessment and planning processes and to establish the infrastructure required to collect and evaluate the necessary data;

(d) Attention is paid to the preparation of a number of energy assessment methodologies appropriate to a range of developing country needs, which will help ensure some degree of consistency between assessments made in different countries.

B. Regional centres for technology transfer

Recommendation

62. It is recommended that the United Nations regional commissions should continue to play an important role in establishing regional centres for technology transfer and in obtaining support from international organizations and developed countries.

63. In order to assess the need for assistance to existing regional centres for technology transfer and determine the need for establishing new centres, possibly devoted to specific areas of new and renewable sources of energy, the immediate establishment of a task force under United Nations auspices is recommended. Within a period of 6 to 12 months this task force will report on the need for financial, physical and human resources for the proposed new and/or existing regional centres and will propose a priority financing scheme, taking into account the financial resources already available, as well as possible means for obtaining additional funding.

Background

64. During the past four years, regional centres for technology transfer were established in the regions represented in the Economic and Social Commission for Asia and the Pacific, the Economic Commission for Latin America and the Economic Commission for Africa. Centres in other regions are planned. The functions of the regional centres for technology transfer should be to:

(a) Promote implementation of co-operation and joint research, development and demonstration programmes and increase transfer of technology flows in the area of new and renewable sources of energy;

(b) Promote prototype projects and the establishment of pilot plants and demonstration units;

(c) Help establish, where needed, special centres to carry out research, development and demonstration in specific areas in the field of new and renewable sources of energy;

(d) Augment facilities in existing institutions of excellence to do research development and demonstration work, to carry out testing and standardization of equipment and materials in the field of new and renewable sources of energy;

(e) Promote exchange of experience, information and personnel among developing countries, in order to accelerate technical co-operation among developing countries;

(f) Provide support, as required, for professional and semi-professional training in the field of new and renewable sources of energy;

(g) Organize conferences, seminars, panel discussions and workshops for the exchange of experience.

65. Through the activities listed above the following objectives will be reached:

(a) Stimulation of joint research, development and demonstration programmes among the countries of the region in order to optimize the use of manpower and financial and institutional resources;

(b) Establishment of regional research, development and demonstration networks;

(c) Provision of assistance to:

(i) Small enterprises;

(ii) Potential end users;

(iii) Government policy makers;

(d) Assistance to decision makers in developing countries when negotiating for and indigenizing imported technologies;

(e) The active promotion of technical co-operation among developing countries for accelerating research, development and demonstration of technology in the area of new and renewable sources of energy;

(f) Assistance to countries in training the required specialists, by employing staff from all the countries in a particular region, which is particularly important in terms of training cadres for national institutions.

C. International biomass development programme

Recommendation

66. In view of the numerous gaps in the present research effort in the areas of special interest to developing countries, it is recommended that an internationally funded and co-ordinated programme of research and development on biomass energy systems should be established, taking the following into consideration:

(a) The biomass energy systems identified by the Technical Panel on Biomass Energy and the Ad Hoc Group on Research and Development and Transfer of Technology should be implemented. To that end, a special task force of experts on bicmass energy should be assembled to perform the following functions:

(i) Assessment of scientific and technological capabilities;

(ii) Diagnosis of requirements in human resources and physical facilities;

(iii) Diagnosis of needs for technical and financial assistance;

(iv) Regional priority programmes drawn up on the basis of the above and presented to the international body responsible for further implementation.

The task force projects must complement national and regional programmes already under way. The task force should be created immediately in order to have the programme under way by 1981.

(b) The project should be funded through the United Nations (see the report of the Ad Hoc Expert Group on Financing New and Renewable Sources of Energy (A/CONF.100/PC/29)).

(c) Those responsible for the project must also be delegated to the group made responsible for implementing the recommendation of the Conference.

(d) The direction of the projects should be undertaken with assistance from a group of internationally recognized biomass energy experts. This group must be involved in the final design, construction, operation and final evaluation of the research, development and demonstration projects.

Background

67. It is recognized that biomass could be an increasingly significant source of renewable energy. Specifically, developing countries could benefit greatly from this source. Even though considerable information and experience on biomass production and conversion are already available in many parts of the world, further research, development and demonstration is required in order to utilize biomass on a much larger scale.

Biomass conversion and production-conversion systems

68. Several systems are identified in the report of the Technical Panel on Biomass Energy that require attention. These include the following:

(a) Biomethanation;

(b) Gasification of biomass to produce fuel gas;

(c) Energy farming and conversion to electricity;

(d) The gasification and indirect liquification of biomass;

(e) Ethanol form lignocellulosic biomass.

Identification and distribution of energy plant species

69. The provision of an adequate supply of raw materials matched to specific biomass technology is a prerequisite for a successful biomass conversion programme. At present, many traditional crops are also used as energy crops (sugar-cane, eucalyptus and the like). However, insufficient attention has been given to the identification and development of plant species specifically for energy.

D. Long-term testing of systems

Recommendation

70. A group of international experts should be formed to undertake the following tasks, in order that a programme for long-term testing of systems for new and renewable sources of energy utilization on a world-wide basis may be undertaken within 18 months. The task will be executed in two phases as follows:

Phase I

71. Establishment, within six months, of a test programme comprising technical specifications, cost forecast and organizational structure (based on a survey of existing national and regional competence).

Phase II

72. Formulation, within a further 12 months, of a detailed plan which should also have been discussed with, and agreed by, concerned organizations for:

(a) Funding;

(b) Programme implementation and supervision.

Background

73. Long-term system testing means testing of the installed components of the system under actual operating conditions for a period of several years. Until 1980 nearly no long-term testing of equipment for new and renewable sources of energy had been done either in developing or in developed countries. This has produced several undesirable consequences:

(a) It discourages large investments in systems for new and renewable sources of energy and inhibits market expansion;

(b) No guarantee can be given for the appropriate design choice with regard to local production, operation and maintenance of the system;

(c) The technology may not be adapted to specific climatic and social conditions;

(d) It becomes difficult to evaluate the world-wide results of research, development and demonstration.

74. In response to this situation it is necessary to establish a long-term system-testing programme, which takes the following questions into account:

(a) What technologies are to be covered by this programme;

(b) What existing standards are adaptable;

(c) What different climatic conditions are to be considered;

(d) How will testing be defined, supervised and reported;

(e) Will existing institutions (for example, regional centres for the transfer of technology) be assigned this task or will a new arrangement be needed;

(f) How can the collaboration of users and producers be assured from the beginning.

E. Development of technologies for meeting special needs

Recommendation

75. It is recommended that two task forces should be set up to determine the modalities for ensuring that, within the next five years, technologies will be developed for using new and renewable sources of energy to meet the following needs:

(a) Stand-alone power sources capable of delivering between 5kW and 50kW of either mechanical or electrical power;

(b) Domestic cookers.

Such task forces should report back within six months and propose viable technical and financial strategies.

Background

76. Viable strategies for the utilization of stand-alone power sources are needed to meet the following needs:

(a) Power sources for rural industries;

(b) Pumping water for agriculture and drinking purposes;

(c) Electricity for educational television in rural areas;

(d) Refrigeration, when necessary, of agricultural and medical products.

77. Cookers are needed for meeting three basic types of cooking: high-temperature short-duration, medium-temperature medium-duration and low-temperature long-duration.

78. It is clear that if there is no escalation in the level of current efforts, it is extremely unlikely that the above needs will be met in the next five years. Perhaps large companies will develop photovoltaic technologies for those purposes. But because no feasible alternatives are foreseeable, it is desirable to build in a calculated degree of redundancy in the effort deployed to ensure that viable alternatives will be developed over the next five years.

Annex I

SUMMARY OF TECHNOLOGY REVIEWS

1. The status of the technologies considered in the preparation of this report is summarized in the table below. Designation of technology status is complicated by the fact that there is often disagreement on definitions. Even within a given technology sector there can be some systems that are commercially ready while others are still at a pilot plant or experimental stage. For example, digester systems in China and India use animal and human waste as feedstock. Systems for using a wider variety of feedstocks, such as selected crop residues, are still in the experimental stage. The designations used in the table below are defined as follows:

(a) Commercial - Technology is well demonstrated and systems are available for use from a number of sources.

(b) Pilot plant - Technical feasibility of systems is being demonstrated by field systems generally not yet available on a commercial basis.

(c) Experimental - Technical feasibility has not yet been demonstrated but hardware tests are taking place.

2. As indicated in the table below, many technologies in the area of new and renewable sources of energy are currently available commercially. Many of these could be particularly important in developing countries. These include solar heating, small-scale wind power, hydropower and digester systems as well as direct combustion systems for using biomass and geothermal energy (power and direct heating). The fact that a technology is designated commercial does not imply that it is necessarily economical for use on a general level. For example, photovoltaic panels are commercially available from a number of companies but are so costly that they can only be considered for specialized applications.

3. The general availability of systems implies that the availability of technology is not usually the major barrier to widespread use of selected new and renewable sources of energy. For these systems the major barriers are more often associated with a lack of adequate transfer of information, trained manpower or financing - all of which are critical issues which must be addressed in the technology transfer process.

4. The table below identifies several of the major participants in the technology development and utilization programmes. The list of countries shown is not intended to be comprehensive and is merely indicative of the geographical spread involved. It can be seen that the developed countries are major participants in almost all the technologies; however, a number of developing countries - e.g., Brazil and India - are becoming important participants in selected technologies.

5. The relative importance that various technologies merit in the research, development and demonstration programmes of developing countries is also indicated. The ranking of the technologies is as follows:

H - High; Applies to technologies that have already demonstrated technical viability, have potentially wide applicability in developing countries and can be pursued with modest research, development and demonstration resources;

M - Medium; Applies to technologies which may eventually be important in developing countries but whose reliability and cost effectiveness have yet to be demonstrated;

L - Low; Applies to technologies which are either highly experimental or require very large manpower and financial resources to pursue the necessary research, development and demonstration programmes.

It should be emphasized that these designations apply only to the importance of the technology for the research, development and demonstration activities of developing countries and not necessarily to the importance of the resource itself. For example, oil shale might be an important resource in many developing countries, but few of them have the resources to actively participate in the research, development and demonstration of large-scale retorting processes.

6. Also indicated in the table below is the level at which primary action steps to implement appropriate research, development and demonstration activities might be taken. As a practical matter, various research, development and demonstration activities will almost always have some participation at all levels - national, regional and international. In the table below the letter designations are intended to indicate the relative level of action steps and are defined as:

E - Major activity in research, development and demonstration is undertaken at the level indicated;

S - Primary inputs are to support programmes taking place at the national level;

T - Developing country activity is primarily to track the technology with little supporting research, development and demonstration.

These designations are somewhat arbitrary and are only intended to indicate relative levels of activity.

7. The largest number of research, development and demonstration activities are indicated as taking place primarily at the national level; particularly for those technologies which are considered commercially ready and therefore ready for implementation. Research, development and demonstration activity at the international level can play a significant role in the following major areas:

(a) Solar cooking, owing to its prevalent need in many countries having minimal technical capabilities and financial resources;

(b) Biomass resource development, owing to the need for international co-operation in applied and basic research, development and demonstration on a world-wide basis to increase biomass yields by screening plant species and through genetic research on improved species.

8. It should be emphasized that regional and international arrangements or mechanisms will play an important role in the transfer of all the technologies under consideration. The main role will be in such vital functions as manpower training, transfer of information, system financing, resource evaluations and institution building. The above issues were identified by all the technical panels as being equally if not more important in encouraging the use of new and renewable sources of energy on a world-wide basis than in research, development and demonstration.

9. On the other hand, many of the research, development and demonstration activities are themselves an integral part of the manpower training, transfer of information and institution-building processes. Therefore, the regional and international arrangements or mechanisms will have a significant supporting role to play in many of the research, development and demonstration programmes when they participate in the over-all technology transfer processes.

Table. Summary of technology

Technology	Status	Major research, development and demonstration participants	Near-term importance	Level of developing country actions		
				National	Regional	International
1. Solar energy						
Heating	Commercial	Over 30 countries included	H	E	S	S
Cooking	Experimental	Primarily developing countries	H	E	E	E
Thermal power	Distributed pilot plants Central receiver experimental	United States, USSR, France, Germany, Federal Republic of, India, Israel	M	E	S	S
Photovoltaics	Commercial	United States, France, Germany, Federal Republic of, Japan	M-H	E	S	S
2. Wind energy						
Mechanical pumps	Commercial	United States, Argentina, South Africa, Australia	H	E	S	S
Wind generators (small)	Commercial	United States, France, Australia	H	E	S	S
Wind generators (large)	Pilot plant	United States, Germany, Federal Republic of, Denmark, Sweden	M	E	S	S
3. Ocean energy	Experimental	United States, Japan	L	T	T	T
4. Hydropower						
Large-scale	Commercial	United States, Germany, Federal Republic of, Japan, United Kingdom, France, Switzerland	H	E	S	S
Small-scale	Commercial/ demonstration	United States, Canada, France, Germany, Federal Republic of, China	H	E	E	S
5. Geothermal	Commercial	United States, Philippines, New Zealand, Mexico, Hungary, Japan, Italy	M-H			
6. Oil shale						
Large-scale	Pilot plants	United States, Brazil, USSR	L			
Small-scale		China	M			
7. Biomass						
Biomass resources:						
Agricultural and forest residues	Commercial	Many	H	E	E	S
Short rotation forestry	Demonstration	Many	M	S	S	
Other energy crops	Demonstration	Many	M	S	S	
Aquatic biomass for bio-methanation	Pilot	Many	L	S	S	

/...

Table (continued)

Technology	Status	Major research, development and demonstration participants	Near-term importance	Level of developing country actions		
				National	Regional	International
7. Biomass (continued)						
Biomass resources: (continued)						
Hydrocarbon plants	Experimental	United States, Brazil, India	L	L	L	
Technology:						
Thermochemical						
Direct combustion	Commercial	Many	H	E	E	
Pyrolysis	Demonstration	Many	H	E	E	
Gasification						
low joule value gas	Commercial	Many	H	E	E	
intermediate or high value gas	Demonstration	Many	H	E	E	
Gasification and indirect liquefaction	Demonstration	Many	M	S	S	
Liquefaction	Experimental	Many	L	T	T	
Biological conversion						
Biomethanation	Commercial	Many	H	E	E	
Ethanol fermentation	Commercial	Many	H	E	E	
Cellulose saccharification	Pilot	United States, India, Brazil	M	S	S	
Others						
Biophotolysis	Experimental	United States, United Kingdom, France	L	T	T	
Fuels from vegetable oil	Commercial	Brazil, South Africa	M	S	T	

Annex II

LIST OF PARTICIPANTS

Members of the Panel

F. K. ALLOTEY	Chairman Ghana Atomic Energy Commission Legon Accra Ghana
A. BOETTCHER (Chairman)	Jülich Federal Republic of Germany
A. H. CHOTANI	Karachi Pakistan
B. H. KHOSHAIM	Saudi Arabian National Centre for Science and Technology Saudi Arabia
Horst LOHMANN	Ministerium fuer Kohle und Energie Berlin German Democratic Republic
Prapath PRAMMANI (Rapporteur)	National Energy Administration Bangkok Thailand
Clovis Walter RODRIGUEZ	Divisao de Energia e Recursos Minerais (DEM) Ministerio das Relacoes Exteriores Brasilia Brazil
Arthur SHAVIT	Georgia Institute of Technology Atlanta, Georgia United States of America
P. SUTER	Institute du Thermique Appliquée Ecole Polytechnique federale Lausanne Switzerland
Masatake WADA	Tokyo Japan
Raymond WRIGHT	Director of Exploration Petroleum Corporation of Jamaica Kingston Jamaica

United Nations	
Department of International Economic and Social Affairs	G. V. Subba Rao
Economic and Social Commission for Asia and the Pacific, Research Centre for the Transfer of Technology	C. V. S. Ratnam
Economic Commission for Latin America	B. A. Gibbs
United Nations Centre for Human Settlements	H. Nagarwalla
United Nations Conference on Trade and Development	Jorge d'Oliveira e Sousa
United Nations Industrial Development Organization	K. Venkatarama
Specialized agencies	
International Labour Organisation	P. Adossama
United Nations Educational, Scientific and Cultural Organization	Theodore Beresovski, Dominique Akl
World Bank	R. S. Dosik, C. Weiss
Intergovernmental bodies	
Organization of American States	C. Martínez-Vidal
Latin American Organization of Energy	Enrique Indacochea
Secretariat of the United Nations Conference on New and Renewable Sources of Energy	Morris Miller Brahman Sivaprakasapillai Roscoe F. Ward

---