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REPORT OF THE EXECUTIVE SECRETARY ON THE ACTIVITIES OF THE COMMISSION

PROGRESS MADE IN THE IMPLEMENTATION OF THE PROGRAMME OF WORK FOR THE BIENNIUM 1992-1993

Report on the

progress made in the implementation of the Nairobi Programme of Action for the Development and Utilization of New and Renewable Sources of Energy during the last decade

94-0012

CONTENTS

INTRODUCTION

1. The present report has been prepared as part of the work programme and priorities of the secretariat of the Economic and Social Commission for Western Asia (ESCWA) for 1992-1993. It consists, to the extent possible, of a comprehensive review and assessment of progress achieved in the implementation of the Nairobi Programme of Action in the ESCWA region during the last decade.

2. The report reflects the activities undertaken by the ESCWA secretariat and member States in the field of new and renewable sources of energy. It also provides a tentative evaluation of the impact of these activities on the diffusion of renewable energy technologies in the ESCWA region.

3. The Nairobi Programme of Action (NPA)[1/] for the Development and Utilization of New and Renewable Sources of Energy was adopted at the United Nations Conference on New and Renewable Sources of Energy (NRSE) held in Nairobi, Kenya, from 10 to 21 August 1981. The main objective of the NPA is to foster the efforts exerted by national, regional and international organizations and institutions to promote the development and utilization of NRSE and hence contribute to the provision of the overall energy requirements, especially those of developing countries.

4. The NPA defines the NRSE as consisting of 14 sources: hydro, solar, geothermal, wind, tidal, wave energy, thermal gradients of the ocean, biomass, fuelwood, charcoal, peat, energy from draught animals, tar sands and oil shale.

5. The NPA identified five broad policy areas to be integrated into national plans and priorities and supported by the international community through concerted action on the part of concerned regional and international agencies. These policy areas cover: energy assessment and planning; research, development and demonstration; transfer, adaptation and application of mature technologies; information flow; education; and training. Particular emphasis has been placed on the rural energy requirements of developing countries. In this context, the NPA recommends a full integration of energy planning into the overall rural development programmes.

6. During the past decade, significant progress has been made in NRSE technologies and in their commercialization. The success was much more pronounced in the industrialized countries than in the developing countries. A shortage of the technological and technical requirements and a lack of financial resources for the implementation of new and renewable energy projects are among the major factors hindering NRSE utilization in most developing countries. However, there have been some set-backs in promoting the development of NRSE in many countries and even lack of interest in several other countries. This is mainly due to the prevailing situation in the oil market during the past decade.

1/ Report of the United Nations Conference on New and Renewable Sources of Energy, Nairobi, 10-21 August 1981 (United Nations publication, Sales No. E.81.I.24), chap. I.

7. However, there has been a revival of interest world-wide in NRSE and their widespread application, primarily as a result of the adverse effects of excessive use of conventional sources of energy and the heavy burden of oil imports on the balance of payments in many developing countries, in spite of the relatively reasonable price of hydrocarbons over the past few years. Another important factor behind the resumed interest in the utilization of renewable-energy technologies is the fact that non-commercial sources of energy, particularly fuelwood, charcoal, agricultural residues and animal wastes, remain major sources of energy in the developing world. According to some estimates, such fuels account for approximately 60 per cent of total energy consumption in several developing countries. The adverse environmental effects of this situation are now of major concern and can be largely alleviated by the diffusion of modern renewable-energy technologies, especially solar and wind energy technologies.

8. Indeed, the NRSE are an environmentally sound source of energy, and their technologies, though still needing a great deal of development and improvement in terms of equipment and financial cost, can be widely used in developing countries at least to meet the basic energy requirements of rural and remote areas.

9. In preparing this report, ESCWA has reviewed a large number of relevant publications, undertaken missions within and outside the ESCWA region, and consulted with officials from member countries on the various aspects of NRSE development.

I. ACTIVITIES UNDERTAKEN BY THE ESCWA SECRETARIAT

10. The activities undertaken by the ESCWA secretariat in the field of NRSE in the period under consideration mainly include: preparation of studies, organization of seminars, technical meetings, and study tours, and implementation of demonstration projects. Below is a summary of each type of ESCWA activity.

A. Studies and technical publications

11. The objectives of these studies are to evaluate and assess the potential of NRSE in the ESCWA region and to evaluate the various aspects of renewable energy technologies, including the transfer of appropriate technologies and promotion of local capabilities in dissemination of technical information on their operation and maintenance. The following is a brief description of selected studies and publications prepared by the ESCWA secretariat, including those studies conducted within the context of energy conservation by promoting the utilization of alternate and renewable sources of energy.[2/]

1. New and renewable energy in the Arab world (1981)

12. This was among the first publications of the ESCWA secretariat in line with the orientation of the NPA. It includes an overall assessment of solar, wind, geothermal and biomass resources in the Arab world. The publication also deals with the various technological, economic and social considerations in promoting the development of NRSE in the ESCWA region.

2. Energy conservation in the ECWA region: prospects and possible lines of action (E/ECWA/NR/82/2)

13. This study presents a preliminary investigation of the current energy situation in the ESCWA region and outlines a strategy for introducing energy conservation measures to be appropriately applied to the region. It also takes into consideration the fact that energy conservation can be regarded as a new source of energy by introducing processes such as heat recovery systems. Part of this publication is devoted to solar architecture and adaptation of building methods by introducing techniques allowing the use of solar radiation.

3. Regional programme for new and renewable sources of energy with special reference to rural applications (Natural Resources Bulletin, vol. I, No. II, 1984)

14. This study, conducted in implementation of NPA, aims at preparing a regional programme for the development of NRSE mainly in rural areas. It defines the scope and objectives of the most suitable NRSE for the ESCWA region, the follow-up action, work plan, timetable as well as the relevant technologies and references.

2/ This part of the report does not include a description of the numerous reports to the ESCWA region or substantial contributions prepared by the ESCWA secretariat for technical, regional and international meetings. A description of publications related to the proceedings of symposia, seminars and workshops is given under section B of this chapter.

15. The policies outlined in the study concentrate on the requirements of the applications of NRSE in decentralized and local energy systems. The study also highlights the major components of an integrated rural energy programme.

4. Introduction of biogas technology to rural and remote areas of the People's Democratic Republic of Yemen (E/ESCWA/NR/87/13 and E/ESCWA/SDP/87/10)

16. This publication contains technical information on biogas systems and an evaluation of their performance. It elaborates on the prospects of biogas technology in the former People's Democratic Republic of Yemen and concludes with concrete proposals for creating demonstration biogas plants in selected sites of the country.

5. Energy conservation in the housing sector of the ESCWA region (E/ESCWA/NR/86/10)

17. This study provides a comprehensive assessment of energy consumption in existing housing schemes and proposals for appropriate styles of architecture aimed at reducing energy consumption in the housing sector of the ESCWA region. The study concludes that building designs suitable for the climatic conditions of the region can achieve a substantial energy savings, particularly through passive designs (e.g., proper shaping, orientation and weather stripping).

6. Comparative study of solar/wind energy utilizations (E/ESCWA/NR/87/8 [Arabic and French only])

18. This publication, prepared in cooperation with the European Community (EC), discusses and evaluates different solar and wind energy systems, designs and applications. It gives detailed comparisons regarding applications and economic advantages between wind and solar systems. It also attempts to study and assess the potential for manufacturing solar and wind energy equipment in selected Arab countries.

7. Application of solar and wind technologies in the ESCWA region (E/ESCWA/NR/87/19)

19. This study has been prepared in the context of ESCWA activities for the promotion of advanced solar and wind technologies. It includes an overview of the energy situation in the economic development of the ESCWA region, an assessment of NRSE, and a review of advanced solar and wind technologies. In examining the renewable energy technologies available, the study attempts to assess the potential application of those technologies suitable for the region, taking into consideration the infrastructural requirements for such a purpose.

8. Generating energy from urban and rural wastes in a selected country of the ESCWA region: The case study of Egypt (E/ESCWA/NR/87/14)

20. Realizing that urban and rural wastes could be a significant source of energy in addition to obvious environmental considerations, the ESCWA secretariat issued this publication to increase awareness of the importance of this energy resource and contribute to the development of its utilization.

Egypt was selected as a case study in urban and rural waste management and treatment because of the availability of expertise and information on the country.

21. The publication elaborates on the technological, economic, environmental and social aspects of energy production from these wastes. It also provides several options for the conversion of a large portion of urban and rural waste into energy.

9. Strengthening of energy institutions in the least developed countries in the ESCWA region (E/ESCWA/NR/87/17)

22. Giving special consideration to energy issues in the least developed countries of the ESCWA region and the importance of an institutional setting for the development of energy resources, this study was prepared to address the case of the former Yemen Arab Republic and People's Democratic Republic of Yemen. It first examines the energy situation in the two Yemens and then surveys the existing Yemeni institutions dealing with different aspects of energy resources and their utilization. In assessing the performance of energy institutions, the study suggests planning methodologies for further improvements in energy management.

10. Prospects for biogas energy utilization in the Syrian Arab Republic (E/ESCWA/NR/88/6 [Arabic only])

23. This study was prepared as part of the ESCWA secretariat's activities in the development of specific renewable sources of energy. It examines the technical, economic and social aspects of the introduction of biogas systems to rural areas of the Syrian Arab Republic, taking into consideration the climatic conditions, demographic distribution, energy requirements and the characteristics of the agricultural and rural sectors.

11. A survey of low grade fuels and the possibility of their use in different applications: Case studies of two ESCWA countries (E/ESCWA/NR/89/15)

24. This publication examines the methods of treating a number of low-grade fuels such as oil shale and tar sand. It also includes a comprehensive assessment of low-grade fuel potential in Jordan and the Syrian Arab Republic and ideas for their development and use.

12. The activities of the Economic and Social Commission for Western Asia secretariat in the field of new and renewable sources of energy (E/ESCWA/NR/89/2)

25. This publication reviews the main activities undertaken by the ESCWA secretariat for the development of NRSE and the promotion of their utilization, particularly in rural and remote areas. It also provides guidelines for present and future ESCWA activities in this field.

13. Latest technologies in the field of new and renewable sources of energy: status and prospects for their application in the ESCWA region (E/ESCWA/NR/89/24)

26. This publication gives an overview of state-of-the-art NRSE technologies and the prospects for their development. It also presents criteria for examining the suitability of these technologies for ESCWA member States. The NRSE discussed in the publication include: solar, wind, biomass, geothermal, small hydropower, and oceanic and tidal energy.

14. Issues of rural energy in the ESCWA region (E/ESCWA/ENR/1992/7)

27. This publication studies the energy requirements in rural and remote areas of a number of ESCWA countries. It gives details on the procedures for evaluating applications of NRSE technologies, including identification and selection of parameters that influence the use of these technologies in rural and remote areas.

15. Survey and assessment of energy-related activities and development in the ESCWA region and energy data

28. Since 1988, the ESCWA secretariat has issued a survey and assessment of activities undertaken in connection with the development of energy resources. In addition, ESCWA issues a bulletin of energy data providing updated information and figures in the field of energy.

29. Both publications are issued on an annual basis and circulated to the relevant authorities in the region to enable them to keep abreast of the latest activities undertaken in the development of energy resources, including NRSE. These two publications are also distributed to regional and international organizations within and outside the region.

B. Organization of seminars, workshops, meetings and involvement in operational activities

1. Seminar on small-scale solar and wind technologies for rural and remote areas in the ESCWA region (29 November - 3 December 1986, Amman, Jordan)

30. This seminar was organized by ESCWA with financial support from the United Nations Development Programme (UNDP) and in cooperation with the Ministry of Energy and Mineral Resources (MEMR) in Jordan. Its main objectives were the exchange of views and the sharing of experiences with regard to the applications of small-scale solar and wind technologies to meet the basic energy needs of rural and remote areas in the ESCWA region. The proceedings of the seminar, including the papers prepared by the ESCWA secretariat and experts from within and outside the region and its final report, were published in 1988 (see E/ESCWA/NR/88/5).

2. Seminar on biogas technology (11-16 April 1987, Aden, Yemen)

31. At this seminar, several papers prepared by the ESCWA secretariat were considered. They covered the various technical, economic, social and

environmental aspects of the introduction of biogas technology. The seminar was held with the financial support of the Government of the Netherlands and in cooperation with the Ministry of Energy and Minerals (MEM) of the former People's Democratic Republic of Yemen (see E/ESCWA/NR/87/7, [Arabic only]).

3. Seminar on biogas technology for rural areas in selected Arab countries (26 November - 1 December 1988, Cairo, Egypt)

32. This seminar, organized with financial support from UNDP and in cooperation with the Egyptian Environmental Affairs Agency (EEAA), examined the different experiences of several Arab countries in the application of biogas technologies and the potential of their diffusion mainly in rural areas. In addition to the papers and studies, a manual prepared by the ESCWA secretariat on the design, construction, operation and maintenance of family-size biogas production units, was presented and made available to interested parties (see E/ESCWA/NR/88/WG.1/19).

33. The seminar was followed by study tours to China and India in order for the participants to become acquainted with the experiences of these two countries in the field of biogas technologies, including the relevant research and training facilities.

4. Establishment of a regional information network on NRSE

34. In the context of the efforts to facilitate the flow and exchange of information in the field of NRSE, the ESCWA secretariat has laid the foundation for a regional NRSE information network in Western Asia. At present the network is composed of three institutions: the Iraqi Council for Scientific Research, the Royal Scientific Society of Jordan, and the Egyptian Academy of Scientific Research.

35. While ESCWA maintains intensive contacts with other member countries to persuade them to join the network, a directory has been issued on new and renewable energy projects as well as institutions and specialists involved in the development of NRSE in the region.

5. Construction of biogas demonstration plants

36. Three biogas demonstration plants of different designs were constructed in a Yemeni village. These biogas units had been designed according to local conditions in the rural areas of southern Yemen. The initial success of this activity led to the construction of 21 family-size biogas units in the same area. ESCWA activities are continuing in this field for the diffusion of biogas technology and the construction of other family-size as well as community-size biogas plants.

6. Implementation of a demonstration project of solar water pumping

37. A demonstration photovoltaic (PV) pump was installed in a mountainous area in southern Yemen. The project was carried out with the financial support of the United Nations Development Fund for Women (UNIFEM) and in cooperation with the Ministry of Energy and Minerals of the former People's Democratic Republic of Yemen.

7. Training workshop on the design, construction, operation and maintenance of biogas production plants (E/ESCWA/NR/88/9/Rev.1)

38. Due to the pressing need for training of nationals from the ESCWA region in NRSE technologies and systems, a training workshop on design, construction, operation and maintenance of biogas plants was organized from 3 August to 4 September 1991 in Damascus, Syrian Arab Republic. The workshop was held with financial support from UNDP and in cooperation with the Syrian Ministry of Agriculture and Land Reclamation. It consisted of lectures, exercise sessions, practical training and round table discussions (see E/ESCWA/NR/88/9/Rev.1). Seventeen participants from Egypt, Oman, Yemen and the Syrian Arab Republic took part in the workshop; among them were four women, for whom training in biogas technology is of particular interest.

8. Preparation of a regional programme for the development of renewable sources of energy in the ESCWA region

39. Following the recommendations of several technical meetings held with the active participation of experts representing organizations and institutions dealing with renewable energy in the region and consultation with UNDP representatives, ESCWA has formulated a comprehensive regional programme for promoting the development and utilization of renewable energy resources and assisting member States in the application of appropriate advanced renewable energy technologies. The programme consists of a number of sub-projects covering resource assessment, training on renewable-energy technologies and execution of pilot projects on solar, wind, biomass energy and small hydropower for meeting the energy requirements of rural and remote areas.

9. Participation in conferences and meetings

40. ESCWA has taken part in most of the conferences and meetings organized at the regional and international levels as well as in those organized by other United Nations entities with the objectives of promoting cooperation and strengthening coordination of activities in the field of NRSE.

II. PROGRESS ACHIEVED BY ESCWA MEMBER STATES IN THE IMPLEMENTATION OF THE NAIROBI PROGRAMME OF ACTION

41. Information on activities undertaken in certain areas by ESCWA member countries in line with the NPA may fall short of reflecting the accuracy desired for a thorough assessment of progress achieved in the development of renewable-energy resources. This is mainly due to the difficulties faced by the ESCWA secretariat in obtaining consistent data collected by necessity from different sources. The following review of activities carried out by ESCWA member States is therefore limited to those activities based on reliable information made available through official documents after collating the various data included in official documents and through consultation with concerned officials of member States.

42. In several ESCWA countries, activities in the field of new and renewable energy technologies are undertaken at universities, research institutes or departments within the competence of different ministries. However, remarkable progress has been achieved in a number of ESCWA countries in establishing specialized institutions and agencies for the development and implementation of new and renewable energy projects. Such institutions as the Royal Scientific Society (RSS) in Jordan, King Abdulaziz City for Science and Technology (KACST) in Saudi Arabia, the National Research Centre of Egypt and the Renewable Energy Authority functioning under the auspices of the Ministry of Electricity and Energy in Egypt are now very active in promoting the development of national renewable-energy resources and diffusing new and renewable-energy technologies, particularly in rural and remote areas.

43. Indeed, during the past decade many ESCWA countries have shown interest in sponsoring and harnessing projects and activities for the diffusion of NRSE technologies. As a result, new authorities and organizations have been established with the task of assessing the available NRSE, promoting the applications of NRSE technologies and improving local capabilities for manufacturing components of new and renewable-energy systems. This phenomenon is also noticeable in a number of oil-producing countries as a means of diversifying their sources of energy (which in many cases consist of a single, depletable source), environmental and sustainable development considerations aside.

44. In assessing the progress made in the implementation of new and renewable-energy projects in the ESCWA region, the present report reviews the achievements of member States by area of activity instead of on a country-by-country basis. It is thought that such an approach will give a clearer picture of the development of those renewable-energy sources specifically stressed in the NPA.

45. It is beyond the scope of the present report to elaborate on the activities undertaken by ESCWA member States in the various fields of NRSE. The following sections, therefore, end with a number of examples giving an idea about the trends and developments in these fields.

A. Solar energy

46. Situated within the sun-belt, the ESCWA region enjoys more than 3,000 hours of sunlight per year.3/ Solar energy utilization therefore has a highly promising potential in almost all ESCWA countries. Measurement of insolation has been undertaken in many ESCWA countries to assess resources and study the technical and economic feasibility of various solar energy applications.4/

47. During the last decade, programmes for the development and utilization of solar energy resources have focused on the following: solar collectors for water heating, space heating and industrial process heat, photovoltaic applications mainly in remote areas, solar refrigeration and cooling, solar crop and food drying, solar cookers and solar water desalination.5/

48. In Bahrain, the National Oil Company, in cooperation with the Kuwait Institute for Scientific Research (KISR), has installed several solar collectors for water heating testing and demonstration.6/

49. In Egypt, solar water heaters are manufactured for domestic use according to locally developed standard specifications. The annual production capacity is more than 100,000 units with a capacity of 150-200 litres per day. One public-sector company is producing large-scale systems for industrial heaters and for central units.

50. It has been reported that over 50,000 solar water-heating systems are now used in Egypt. Standard specifications have been developed in accordance with regulations requiring that new buildings be equipped with solar water-heating systems. The Egyptian Government seeks to have 1.3 million systems installed by the year 2005. In addition, a large poultry-processing plant in Heliopolis and a textile complex in Helwan are equipped with flat-plate solar collectors to meet their hot water and steam needs.7/

3/ United Nations, Economic and Social Commission for Western Asia, New and Renewable Energy in the Arab World (Beirut, 1981), p. 1.

4/ United Nations, Economic and Social Commission for Western Asia, Proceedings of the Seminar on Small-scale Solar and Wind Technologies for Rural and Remote Areas in the ESCWA Region, Amman, Jordan, 29 November-3 December 1986 (E/ESCWA/NR/88/5), pp. 116-211.

5/ Subsequent statements on the activities of ESCWA member States in the field of renewable energy draw heavily on country papers and studies by national experts.

6/ G. Warfield and others, Solar Electric Systems (Washington, D.C., Hemisphere Publishing Corporation, 1984), p. 135.

7/ A. I. El-Sharkawy, "Solar Energy Activities in Egypt: A Status Report", The Supreme Council for Research Centres and Institutes, Cairo, Egypt, 1 September 1992, pp. 10-14.

51. In the field of photovoltaic applications, several systems have been installed in Egypt. Two PV systems have been installed at the Sadat City site of the Desert Development Centre at the American University in Cairo (DDC/AUC) to provide power to the headquarters building and to a submersible AC pump.[8/] A 1.2 kWp (p = peak power) deep-well pumping unit has been installed in the Sinai Peninsula to irrigate three feddans of land; the system will be expanded to include a small desalination unit and a lighting system for a small house. A PV system (20 kWp) has been installed at the El-Baharia Oasis to provide electricity for the village of El-Haiz. PV pumps have been installed at Wadi El-Natroun. There are other applications such as a PV ice-maker at Wadi El-Raiyan and PV-powered refrigeration units for rural health centres, loudspeakers, repeaters and microwave telecommunications systems. The possibilities of producing PV modules locally have been studied, and two factories for this purpose are presently under construction.

52. A solar cooling system based on the absorption principle is used to cool a room for vegetable storage and fruit preservation in the National Research Centre (NRC). Another solar system using the triple Rankine cycle was installed in Aswan for fish preservation.

53. Devices for solar desalination of brackish water and sea water have been utilized in arid and coastal areas in Egypt. A PV-powered reverse osmosis (RO) unit for desalination of brackish water was installed at the High-Voltage laboratory building at Giza. The RO unit produces 5-7 m^3 of fresh water per day. Another brackish water desalination unit with an output of 60 m^3 per day of potable water was installed at El-Hamraween on the Red Sea to meet the needs of more than 3,000 workers in the phosphate mines. An 8.3-kWp sea-water desalination unit, serving almost 300 inhabitants, was installed at Abou-El-Ghosoon on the Red Sea shore.[9/,10/]

54. Solar energy is also used for drying of crops and other items in Egypt. The solar drying system designs in use include the natural and forced circulation of air. Experiments are in progress to improve the performance of the drying system. All dryers are locally made using the available materials and technologies.

55. Solar cookers are also manufactured in Egypt. The box shape with plane reflector is common due to its simple design and low cost.

56. In Iraq, many water heating systems for domestic use are imported by local companies. These systems were tested under prevailing weather conditions

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8/ A. I. Hegazi, "A Simple Approach Towards Enhancing the Performance of Photovoltaic System Performance" (sic), International Conference on Applications of Solar & Renewable Energy (ASRE), Cairo, Egypt, 19-22 March 1989, vol. 1.1, No. 3, pp. 21-30 (Egyptian Solar Energy Society).

9/ El-Sharkawy, op. cit., pp. 5-7.

10/ H. S. El-Din, "NREA Activities and Programs as Related to Egyptian Development Plans", International Conference on Applications of Solar & Renewable Energy, vol. 2, No. 90, pp. 1,048-1,049.

in the country, and recommendations were made for those found optimally effective (after modifications) to be manufactured and used in Iraq.11/

57. Passive solar measures have been implemented in a kindergarten for the purpose of heating and cooling. Several greenhouses utilizing passive solar designs for heating and cooling have been installed in different locations in Iraq, in cooperation with the RSS of Jordan, for research and development.

58. A 10 kW PV power station was built at a village in the marshland of southern Iraq to meet the basic needs of local communities. A PV pump is used to decrease the level of underground water and solve the soil salinity problem at one location in Iraq, while a PV car-park lighting system has been installed for demonstration and testing.12/

59. The RSS in Jordan has pursued the development of domestic solar water heaters, designing and producing pilot systems in its workshop and concluding three agreements with local manufacturers for mass production for both the local and export market. In 1988, the number of houses utilizing solar water heaters was estimated at 100,000. RSS, with the aid of international agencies, established an indoor-outdoor test facility with a total area of 4 m^2, thereby facilitating the testing of such collectors according to international standards and hence allowing for their development.

60. Among the full-scale projects are the large solar water heater systems manufactured in the RSS workshop, one of which has been installed at a dairy factory and another at a hotel in Aqaba.

61. Active and passive designs have been used for space heating in several projects such as the RSS cafeteria heating system which utilizes solar water heaters, a wind energy conversion system and conservation measures, and agricultural greenhouses utilizing locally made plastic covers.

62. In PV application fields, several studies, projects and activities are carried out by the Ministry of Energy and Mineral Resources (MEMR) and RSS. The application of PV technologies in Jordan include the installation of PV pumping systems, PV remote-site electrification systems, and 88 PV radio telephone systems in rural and remote desert locations. Other demonstration projects are awaiting implementation to evaluate the technical and economic feasibility of such systems.

11/ Proceedings of the Third Arab International Solar Energy Conference, 21-24 February 1988, Baghdad, Iraq, Section 9, p. 78.

12/ New and Renewable Energy Resources Directory (First Draft) Regional Centre for NRSE Information Network (Solar Energy Research Centre, Baghdad, and United Nations Economic and Social Commission for Western Asia), pp. 4-11.

63. The significant savings potential of improved thermal efficiency in buildings has led the MEMR to consider conservation of energy in the building sector as one of its priorities.13/,14/

64. In various locations in Kuwait, several demonstration projects have been implemented, for example: PV-powered traffic lights in three locations, a PV system for school lighting, and a lab for testing PV modules.

65. The use of solar energy for air conditioning has received considerable attention during the last decade. The code of practice for energy conservation in buildings was developed to include the proper thicknesses of insulation materials in outer walls and roofs. An absorption solar cooling system has been installed and tested at a Kuwaiti school. The thermal performance of building assemblies is being tested by means of a calibrated hot/cold box facility at KISR.

66. Passive solar energy designs have been used in several agricultural green-houses, e.g. partially underground structure, movable insulation and reflective inside coating.

67. An RO desalination unit operates at the Sulaibiyah complex. Part of the electrical output of the thermal power plant, which was installed in Sulaibiyah in 1979, is used to operate the RO unit.

68. A solar pilot pond was constructed in 1983 and used to gain experience in pond filling and in maintaining the salinity gradient.15/,16/

69. According to a country paper on solar energy in Lebanon, "the first large solar installation was completed in 1981 in a hospital near Beirut to supply 30 m^3 of hot water at 50° C, with 480 m^2 of flat plate collectors imported from France. This kind of installation was extended to a number of hotels in Tripoli and Beirut, individual houses, as well as buildings in the mountains and near the coast".17/ PV lamps are also used to light car parks and gardens for demonstration purposes.

13/ H. Al-Taher, "New and Renewable Energy Activities in Jordan", Ministry of Energy and Mineral Resources, pp. 2-4.

14/ United Nations, Economic and Social Commission for Western Asia, Proceedings of the Seminar on Small-Scale Solar and Wind Technologies for Rural and Remote Areas in the ESCWA Region (E/ESCWA/NR/88/5), p. 135.

15/ Kuwait Institute for Scientific Research (KISR), Annual Reports, 1983-1988.

16/ Warfield and others, op. cit., pp. 135-139.

17/ United Nations, Economic and Social Commission for Western Asia, Proceedings of the Seminar on Small-Scale Solar and Wind Technologies for Rural and Remote Areas in the ESCWA Region (E/ESCWA/NR/88/5), p. 140.

70. In Oman, solar water heaters are used in some residential areas with the oil refineries. A flat-plate collector and a parabolic collector have also been installed for testing.

71. In Qatar, there is a solar cell tester designed to measure the power produced under the prevailing weather conditions. A hybrid PV consisting of PV cells mounted on flat concentrating collectors simultaneously delivers electricity and thermal power. An 8.9-kW, dual-axis PV tracking system has been installed for demonstration and testing.

72. The solar pilot project in Qatar includes a multi-stage flash-fluidized bed (MSF-FB) desalination unit which "was designed to operate with a solar power source, in conjunction with a heat storage system".18/ The MSF-FB unit was installed in the early 1980s, and the solar power source is an east-west tracking type with flat concentrating collectors. A solar pilot laboratory pond was also constructed and used to gain experience in pond-filling techniques.18/

73. Saudi Arabia has introduced various solar application technologies. Projects for domestic hot water systems have been implemented in several housing compounds around the kingdom. One of the projects has a solar collection area of 2,244 m^2 and generates 68.5 MWh of useful heating energy per day.

74. A newly established Solar Energy Programmes Department at the King Abdulaziz City for Science and Technology (KACST) will be the authority in charge of managing the country's search for energy in the future.

75. A solar PV power system for a village was completed in 1981 followed by the installation of two PV lighting systems for tunnels in remote areas. A 3-kW system was installed in 1987 to evaluate the effects of different parameters on the performance of PV modules.

76. Four different solar cooling systems were installed in cooperation with an international organization to explore the possibility of using solar energy to cool buildings. The systems are tested under normal operating conditions, and the test results are used to modify the design of the system components for optimum performance.

77. A solar-powered pilot plant for sea water desalination that was completed in 1984 uses an indirect heat transfer freezing process to produce 200 m^3 of potable water per day. Solar energy is collected by a distributed point focusing collector. The project is used as a test bed for new concepts.

78. A solar hydrogen programme, managed jointly by KACST and the German Aerospace Establishment (DLR), was started in 1984, and a solar hydrogen pilot

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18/ United Nations, Economic and Social Commission for Western Asia, Proceedings of the Seminar on Small-Scale Solar and Wind Technologies for Rural and Remote Areas in the ESCWA Region (E/ESCWA/NR/88/5), pp. 160-184.

plant is under construction. Considered the world's first 350-kW PV-powered hydrogen plant, it has a production capacity of 463 m^3/day of hydrogen at normal pressure.19/

79. In the Syrian Arab Republic, solar water heaters are manufactured by public and private companies. The number of water heating systems in use stands at more than 4,000. An outdoor test facility was established to gauge the quality and efficiency of the solar water heaters.

80. Passive solar energy systems are utilized in heating buildings. In the design of the airport housing complex and a primary school, energy conservation measures were taken into consideration. A Trombe wall design was used in both projects,20/ and transparent plastic covers, solar tube collectors and water filled pillows have been used for heating agricultural greenhouses.

81. In the field of PV applications, a PV pumping system was installed in 1985 for irrigation purposes.21/

82. In Yemen, electricity generated by solar cells is used in telecommunications systems.22/

B. Wind energy

83. Wind energy activities in the ESCWA region include resource assessment, research and development, demonstration projects, commercial applications and manufacture of components.

84. In the majority of ESCWA countries, data on wind are gathered for meteorological purposes. However, the potential of wind energy in several ESCWA countries has been explored and assessed.

85. In Egypt, several power generation facilities using wind power have been built. Some examples are: the wind powered electric water pumping system that was installed in 1987 at Camp Barkouky in the East Oweinat area to gain

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19/ F. Huraib, "Saudi Arabian R&D Effort in the Field of Renewable Energy," King Abdulaziz City for Science and Technology (KACST). This paper is to be presented at The Fourth Arab International Solar Energy Conference which will be held in Amman, Jordan from 20-25 November 1993.

20/ The Trombe wall consists of three main elements: interior solid wall, movable plastic curtain and exterior glass wall.

21/ M. Kurdhab and A. Al-Zin, "Renewable Energy in Syrian Arab Republic: Status and Prospects". This paper is to be presented at The Fourth Arab International Solar Energy Conference which will be held in Amman, Jordan from 20-25 November 1993.

22/ United Nations, Economic and Social Commission for Western Asia, Proceedings of the Seminar on Small-Scale Solar and Wind Technologies for Rural and Remote Areas in the ESCWA Region (E/ESCWA/NR/88/5), p. 187.

experience with wind powered electric pumping systems;[23] the 400-kW wind farm which was installed in Ras Ghareb and has been connected to the local grid; and the wind-powered ice-maker installed at Abo El-Ghosoon in 1987. Wind-driven desalination systems are being installed in many locations in Egypt.[24]

86. The RSS in Jordan has prepared a study on the potential of wind energy applications. Two prototype wind mills have been designed and installed by the RSS for demonstration and testing purposes. Different wells with water demands of between 30 m^3/day and 150 m^3/day are equipped with various types of wind energy conversion systems. A wind-powered generator farm with a capacity of 320 kW was installed in a remote area in northern Jordan. Some components of the wind energy conversion systems are manufactured locally.[25]

87. The Wind Energy Atlas in Saudi Arabia was published in 1986 by King Fahd University for Petroleum and Minerals.[26]

88. In the Syrian Arab Republic, mechanical wind pumping systems have been used in several locations to provide drinking water and for irrigation. The number of systems operating now exceeds 1,000, and a wind energy atlas is being developed.[27]

89. In Yemen, a 1-3 MW windmill was tried in a mountain location.[28]

C. Biogas

90. In Egypt, about 200 residential and agricultural biogas energy systems have been installed and tested. Local modular designs have been developed based on this experience, and extensive utilization of municipal solid waste is being considered.[29]

23/ H. El-Din, T. El-Tablawi and K. El-Bassyouni, "The Wind Electric Pumping System in East Oweinat", International Conference on Applications of Solar & Renewable Energy, vol. 2, No. 70, pp. 815-826.

24/ NREA Activities and Programs as Related to Egyptian Development Plans, International Conference on Applications of Solar & Renewable Energy, p. 1,048.

25/ Al-Taher, op. cit., pp. 1-2.

26/ Huraib, op. cit., p. 9.

27/ Kurdhab and Al-Zin, op. cit., pp. 16-19.

28/ See note 22.

29/ New and Renewable Energy Authority, An Overview of Egypt Renewable Energy programs and the Renewable Energy Field Testing Projects, 1990, p. 19.

91. In Jordan, ongoing activities in biogas utilization are limited to gathering data and studying the experiences of other countries. Selected biogas systems suitable for Jordan and a pilot project are also under consideration.30/

92. In the Syrian Arab Republic, several studies were conducted and much data collected in this field. The studies showed that 286 million m^3 of biogas could be produced annually in the Syrian countryside. A prototype family biogas digester was designed and built at the Mechanical and Electrical Engineering College. Another two digesters were built in rural areas. Both digesters are operating, and the data collected from them will be analyzed and used for the development and diffusion of biogas technology.31/

D. Geothermal energy

93. In Jordan, two geothermal wells were located in 1985 by the Natural Resources Authority (NRA), which is currently preparing for the drilling of these sites. The technical and economic feasibility of electrical power generated from these wells will influence further exploration.32/

94. The geothermal resources in Saudi Arabia were surveyed by the Ministry of Petroleum and Minerals Resources, and technical and economic feasibility studies on the utilization of geothermal resources for power generation will be conducted.33/

95. Geothermal energy in Yemen is presently receiving increasing attention. An Italian company conducted geophysical investigations in some regions and reported good prospects. However, the greatest obstacle which faces Yemen in attempting to utilize this resource is the lack of financial resources.34/

96. A working group in the Syrian Arab Republic was established in 1990 to conduct studies on the identification of existing geothermal wells, the technical and economic potential of geothermal energy in appropriate applications, the production of maps and tables showing temperature gradients at different levels of geothermal wells, and the experiences of other countries and preparation of cooperation agreements.35/

30/ Al-Taher, op. cit., p. 5.

31/ Kurdhab and Al-Zin, op. cit., pp. 20-21.

32/ United Nations, Economic and Social Commission for Western Asia, Proceedings of the Seminar on Small-Scale Solar and Wind Technologies for Rural and Remote Areas in the ESCWA Region (E/ESCWA/NR/88/5), p. 134.

33/ Huraib, op. cit., p. 11.

34/ Al-Motawakel, op. cit., p. 187.

35/ Kurdhab and Al-Zin, op. cit., p. 22.

E. Oil shale

97. In Jordan, shallow resources of oil shale are estimated at 50 billion metric tons with an average calorific value of approximately 1,500 kcal/kg. Feasibility studies have been carried out to assess and define plans for utilizing oil shale to generate power "at a cost competitive with other sources of electricity generation".[36/] It seems, however, that the lack of financial resources is a major obstacle to this objective.

36/ H. Al-Taher, op. cit., pp. 5-6.

III. PROSPECTS FOR RENEWABLE ENERGY IN THE ESCWA REGION: OPPORTUNITIES AND CONSTRAINTS

98. The succinct statements and selected examples given in the preceding chapter on the development of renewable-energy resources reveal that there is a great potential for a much wider spectrum of renewable-energy applications in many countries of the ESCWA region.

99. As indicated earlier, assessment of solar and wind resources carried out in a number of ESCWA countries and measuring stations erected by government authorities and specialized institutions reconfirm the suitability and convenience of a solar and, in several areas, wind resources base. Studies conducted for the assessment of biomass indicate that in this area, too, the prospects for renewable energy are promising and a range of biogas units can be constructed and used to provide the basic energy requirements of rural and remote communities, particularly those located in mountainous, desert or coastal areas.

100. Another area of significant potential for rural electrification and agricultural development is the utilization of mini hydropower systems. In several ESCWA countries, water canals, barrages and main rivers and streams have locations technically and economically suitable for mini hydropower plants.

101. Even the rather limited geothermal energy sources in the region can be utilized for a variety of purposes in at least two or three member countries. Also, although much less research effort has been made in the field of ocean energy, a number of applications, particularly those of tidal and wave power, are feasible in the region.

102. Regarding the potential of low-grade mineral, tar sands and oil shale deposits are known to occur in several areas throughout the region. Many of those oil shale deposits are found in significant quantities in some ESCWA countries and represent an important potential for the development of additional energy sources.

103. As partners in a variety of regional organizations basically established for strengthening cooperation and coordination of activities, ESCWA member countries appear to be advantageously placed for facilitating the information flow, sharing experiences in the fields of research, education and training, and co-financing renewable-energy projects.

104. On the other hand, national capabilities have been improving and substantial expertise in renewable-energy technologies and their utilization has been accumulating in the majority of ESCWA countries.

105. Several ESCWA countries have established institutional focal points and entities for NRSE. The institutional arrangements extend from task forces in universities and research institutes to departments within ministries and specialized organizations with clearly specified mandates for the promotion and implementation of renewable-energy projects.

106. Awareness of the important role of renewable-energy sources has increased. The need to meet basic energy requirements in rural and remote areas through the diffusion of renewable-energy technologies is now widely recognized in the ESCWA region. In those ESCWA countries deprived of significant conventional energy resources, renewable-energy sources are regarded as highly promising alternatives.

107. However, given the trends in the production and use of NRSE over the past ten years, it is clear that the achievements are still far from matching the potential in this field. Institutional arrangements, though extensive and effective in a number of ESCWA member States, still lack the level of coordination required to mount national renewable-energy programmes.

108. Although the need for the mobilization of adequate financial resources has been recognized, allocation for renewable-energy projects is very limited, and the assistance provided by regional or international organizations is barely sufficient to conduct some research and implement demonstration projects. It was anticipated in the NPA that different types of financial requirements would be provided. This ranges from financial resources for supporting activities to investments in renewable-energy projects. In many ESCWA countries, financial requirements were mostly limited to some supporting activities and expenditures in pilot and demonstration projects. Consequently, apart from solar water heating for mainly domestic uses, few examples can be cited as viable large-scale application of renewable-energy technologies.

109. In the ESCWA region, the financial requirements for the development of renewable-energy resources remain the responsibility of governmental institutions and their subsidiaries. The quasi-absence of non-governmental organizations in sharing the financial burden is another factor affecting the spread of renewable-energy technologies in the ESCWA region.

110. Left to itself, as in the case of the ESCWA region, the private sector is not expected to play a major role in the development and utilization of NRSE. Incentives, exemptions and full awareness of the profitability of involvement in renewable-energy projects must be taken seriously into consideration in any legislation or other activity aimed at encouraging private investors in manufacturing systems components, importing and adapting technologies, and large-scale use for industrial, agricultural and domestic purposes.

111. In spite of the remarkable progress made in the field of research, the intensification of efforts to promote the development of demonstration and pilot projects, and the fact that several new and renewable-energy technologies have reached the stage of technical maturity and economic feasibility, the wide utilization of these technologies has been hampered by a variety of obstacles. The high initial cost in some cases, and the doubt raised about their economic viability as oil substitutes in other cases, are among the major impediments to the development of renewable-energy sources in most ESCWA member States. This is clearly reflected in the limited scope of projects aimed at developing the manufacturing capabilities and the marginal contribution of renewable-energy sources to the overall energy requirements, except in the case of large-scale hydropower systems in a number of countries.

112. Disparities in the level of development and use of renewable-energy sources are largely evident in ESCWA countries and often do not reflect differences in need or even local capabilities. Obviously, non-availability of financial resources, differences in technical capabilities and expertise, and lack of adequate tools for thorough assessment and planning explain to a large extent these disparities in the ESCWA region. However, lack of close regional cooperation has precluded an environment where resources could be pooled and common facilities for education and training established. It is surprising that, with the exception of some regional meetings and conferences and a number of joint projects implemented on a limited scale, there is no single regional mechanism with the required assurances for cooperation and coordination of activities within the region.

113. A review of the various factors bearing on the development and utilization of NRSE in the ESCWA region leads to the belief that constraints in promoting renewable-energy projects reflect not just inadequacy of financial requirements, shortage of technical and technological capabilities, or techno-economic considerations relevant to the status of renewable-energy technologies. In several cases, strengthening of policy-making and planning is needed as much as the other requirements and probably more so as this constitutes the catapult for renewable-energy programmes. Policy-making and planning include surveying, mapping and assessing resources, evaluating energy supply and demand, projecting future energy requirements, undertaking intensive research and development programmes, and establishing the institutional infrastructure required for the implementation of renewable-energy projects. In these areas, as in others, much remains to be done in the ESCWA region.

IV. RECOMMENDATIONS

114. In order to avoid the repetitions and general statements which have regrettably become common in the drafting of reports, the following remarks by the ESCWA secretariat are couched in terse terms and limited to specific priority areas:

(a) The ESCWA secretariat believes that it is appropriate for member countries now to consider joining the Regional Information Network on NRSE, which was established several years ago and is still confined to only three countries. This network, conceived to facilitate the flow of information on renewable-energy projects, specialists in renewable-energy technologies, and institutions dealing with the development of NRSE, is now the only existing regional mechanism for close regional cooperation, particularly in joint renewable-energy projects;

(b) An energy database has been established in the ESCWA secretariat. The ultimate objective of this undertaking is to set up an energy data bank and improve the energy information systems in the region. At present, ESCWA issues two recurrent publications on energy-related activities and their development, including and updating figures on the energy sector in each member country. Active participation by member States is not only highly desirable but is considered as a major factor in providing the required information and securing feedback for further improvement;

(c) It is suggested that a committee on NRSE be established to examine the priorities of member States in this field, take part in the formulation of ESCWA's work programmes, and monitor relevant activities undertaken by the national authorities concerned as well as those carried out by ESCWA and other regional entities. The proposed committee may comprise representatives of member States, regional organizations and ESCWA and meet regularly, preferably on an annual basis, and recommend appropriate action to the ESCWA Technical Committee at its session;

(d) Greater efforts are needed on the part of ESCWA member States to integrate renewable-energy programmes into the overall national development plans, particularly those aimed at the economic and social development of rural and remote areas. The issue of rural energy supplies is a particularly important one because, as stated earlier, many rural, remote and coastal areas in the ESCWA region still lack the energy requirements for their economic and social development, and also because policies in many instances have contributed to the lack of success in boosting investment in renewable-energy projects in rural areas;

(e) As renewable-energy projects are financed mostly through external funding and government budget allocation, intensive joint efforts among ESCWA member countries are greatly needed in this respect. The establishment of a regional fund for the development of NRSE may be worthy of consideration. This, combined with active involvement by the private sector, could greatly assist member States in coping with the financial requirements of renewable energy development projects;

(f) Member States may consider contributing to an intergovernmental expert group meeting that would comprehensively review the progress made since the adoption of the NPA and assess the results of actions taken by member States in this field. The proposed meeting could also make decisions regarding the course of action needed to formulate and implement appropriate renewable-energy programmes; ESCWA considers such an intergovernmental meeting of particular importance because it would enable ESCWA to secure policy commitments from member countries for concerted action to achieve the objectives of the NPA as well as to introduce whatever changes are deemed necessary in the light of the respective experiences of each country.