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PREPARATORY COMMITTEE FOR THE
UNITED NATIONS CONFERENCE
ON NEW AND RENEWABLE
SOURCES OF ENERGY
Second session
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Item 3 of the provisional agenda

INTERIM REPORTS OF THE TECHNICAL PANELS

Report of the Technical Panel on Wind Energy
on its first session

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IV. OUTLINE OF THE DRAFT REPORT OF THE PANEL TO THE UNITED NATIONS CONFERENCE ON NEW AND RENEWABLE SOURCES OF ENERGY

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I. ORGANIZATIONAL MATTERS

1. In accordance with General Assembly resolution 33/148 of 20 December 1978, on the United Nations Conference on New and Renewable Sources of Energy, the Technical Panel on Wind Energy convened at WMO headquarters of the World Meteorological Organization (WMO) at Geneva, from 12 to 16 November 1979. The meeting was opened by the Secretary-General of the Conference in the presence of the Deputy Secretary-General of WMO. In their statements, both emphasized that the winds represent an important source of new and renewable energy and underlined their significance for developing countries in particular.

2. It was agreed that Mr. S. Tewari (India) would assume the chair and Mr. P. Musgrove (United Kingdom) would act as Rapporteur. (A complete list of participants is contained in annex II.) The meeting then proceeded to the adoption of the provisional agenda, which was approved and appears as annex I. The Panel had before it a number of background documents, listed in annex III.

II. REVIEW OF DISCUSSIONS

A. Global wind energy resources

(Agenda item 3)

3. The Panel reviewed the global maps of wind velocity provided in the papers by consultants with a view to possibly including them in a proposed atlas of new and renewable sources of energy.

4. There was considerable discussion concerning the purposes of the atlas, the type of presentation desired (wind velocity or wind power density), the need to include wind direction, questions of accuracy and reliability, whether to include seasonal averages or only annual means.

5. The purpose of the atlas was seen as being to inform non-technical decision-makers and interested parties of the general potential of wind energy in different parts of the world. It would be left to the proposed brochure on local assessment and site evaluation to provide detailed technical information on which to base a national wind programme.

6. The map of global annual mean wind velocities in the Hutter paper provided one model, but the Panel thought that improvement was possible - in particular, by including island and off-shore wind data. A wind-power map of the United States of America was circulated. It showed by colour and spot readings the annual average wind power (W/m^2 at 50m), with hatching for estimated data in mountainous areas. It was possible that maps of that sort could be included in the atlas on a continent-by-continent basis, to the extent available, as an indication of what might be an eventual goal for all national assessments.

7. The question of a table of global wind resources was also discussed. The Panel felt that table I of Hutter's paper, giving wind energy per annum ($Wh/y/m^2$) for the continental areas, could be suitably adapted. A large additional resource, not included, was the potential from offshore wind.

8. In presenting both maps and tables, great stress was laid on indicating the estimates for uncertainty or error, which in some cases might be quite large.

B. Site evaluation of wind energy resources

(Agenda item 4)

9. To assess the resource, two distinct questions must be asked:

(a) What measurements must be made at any given location to assess the wind energy availability at that location?

(b) How should one select locations at which to place anemometry equipment and at how many such locations must one make measurements in order to assess the wind energy potential of a region?

10. So far as the first question is concerned, it was recommended that a one-year sequence of hourly mean wind speeds be made, at the standard meteorological height of 10 metres above ground. Attention was drawn to recent developments in battery-operated solid-state recording anemometer systems (using conventional cup anemometers) that were capable of recording up to about 3 months' data between site visits, at a cost of about $1,000. Though such systems were relatively novel, they were being developed by several companies in the United States and elsewhere, and one could anticipate significant cost reductions in the future. Though, data on wind direction were not so crucial as those on wind speed, the extra expense of recording the direction was relatively small and it was, therefore, recommended that direction should also be measured. (Hourly mean wind speed is a 10-minute average once per hour.)

11. Where automatic hourly data-logging was not possible, due to limited resources, one should manually observe and record the mean wind speed twice a day - or more often, if feasible - over a 12-month period. Even less frequent "wind run" measurements might still be useful - e.g. where it was difficult to reach a particular site.

12. Data over periods longer than a year were desirable, since in some locations the year-to-year variations might be appreciable. Correlation of measurements made over a 12-month period with the nearest existing meteorological recording station would, however, usually indicate to what extent a given year was typical of a more extended period.

13. Concerning the second question, it was agreed that in the immediate vicinity of the anemometer, one wanted relatively flat ground, with no significant local obstructions, such as trees or buildings. In generally flat terrain, the

location of anemometers was not critical, provided that the above-mentioned requirements were met. In more hilly or mountainous regions, anemometry sites needed to be selected with more care. Work had been done recently in the United States on the use of natural indicators such as vegetation to indicate high wind speed locations, and one member of the Panel indicated that a summary of the techniques involved could be made available, with references to more detailed reports.

14. To define the over-all resource, in theory, the greater the number of locations where one had measured data, the more confidence one could have in the final estimate, but in practice the number of locations would be limited by the cost of making the measurements. However, work had been done in the United States on techniques for spatial extrapolation from limited wind data; for extrapolation of wind data, taken over limited periods, to longer times; for extrapolation of data, taken at one height, to other heights; and to the derivation of the wind velocity duration distribution from limited measurements. Given that data, measured and extrapolated, on how the wind speed varied throughout the year and throughout the region of interest, the wind energy resource could be estimated by presuming a wind turbine spacing of 10 diameters (crosswind and downwind), with interception of the energy in the wind up to a height of 150 metres (representative of a wind turbine 100 metres in diameter on a tower 100 metres high). 1/ The Panel felt that the technical note being prepared by WMO should take into account the analysis of array spacing. For countries with long coastlines relative to their land area (ranging from small islands to countries such as the Netherlands), the off-shore wind energy resource might well be greater than that on land, though it was not clear how far off shore one should extend the wind energy resource area.

15. It was emphasized that present uncertainties in the precise magnitude of the wind energy resource should not be allowed to disguise the very attractive power densities that wind energy had to offer. The average solar insolation in good locations of 200W/m^2 corresponded approximately to the swept area power density at a mean wind speed of 5m/s. But wind energy conversion efficiencies were twice as high as solar electric, and the area of a wind energy collector was only one tenth that of the area of wind intercepted, whereas for solar electrical systems, the collector area was greater than the area of solar radiation intercepted. There was thus a 20-to-1 factor working in favour of wind energy, even at that moderate wind speed.

1/ It was explained that if Vm = 5m/s at a height of 10m, with a power law exponent of 0.14, that corresponded to Vm = 6.64m/s at a height of 75m. With $\overline{V^3} \sim 2\,(\overline{V})^3$ (at least in temperate latitudes) one then had an annual power density (per unit of vertical area) of 360 W/m^2, and a presumed interturbine spacing of 10 diameters then gave a contribution to the resource of 2.8W per square metre of land area.

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Identification of specific sites for wind turbines

16. For small-scale, dispersed systems, the anemometers required to establish the wind energy resource would provide the necessary data (coupled with visual selection of sites with good local exposure), but in regions where it was proposed that wind turbines feeding into a grid be installed, a more detailed measurement programme was required than would be possible for an entire country. For large-scale wind turbines one needed - and could justify economically - much more detailed wind data, measured at the site under consideration for each installation. Additional data needed would include wind speed and direction measurements, up to and above the rotor hub height. Data on rates of change of wind speed and direction (due to gusting) were also needed, together with their return periods and the return periods associated with high wind speeds (e.g., near the shut-down wind speed).

C. Small-scale wind energy conversion: applications, technology, economics

(Agenda item 5)

17. Small-scale wind energy conversion encompassed the needs of farmers and rural communities, especially for shallow-well and deep-well pumping for potable water, cattle-watering and irrigation, and also for small electric-power supply. Certain other applications, such as mechanical grinding and heating, might also be considered.

18. Small-scale systems had been extensively used in many developed countries (and still were used in a few) until they were overtaken by subsidized low-cost electrification. High solidity sail rotors, Savonius rotors, and multibladed fanmills were used, especially for water-pumping, which required high starting torques; small propeller-type HAWTs were used for battery-charging.

19. The question of why such small wind machines were not more popular in developing countries was discussed at length. Relatively high costs, especially for imported equipment, lack of promotion and extension services and, in some cases, poor reliability and availability of low-cost fossil fuels, were cited as reasons. It appeared that where local manufacture, coupled with promotion and extension services, existed, together with adequate winds, small windmills could become popular in rural areas. Recent developments in that direction in Tunisia and Kenya were cited. Nevertheless, doubts about the traditional fanmill, on account of cost, and on the Savonius rotor, on account of reliability, were expressed. The Panel expressed agreement that the sail (or Cretan) type of windmill was a good, low-cost, low-technology design which could be manufactured in rural communities for applications such as water-pumping. Even it could be improved upon, for example, by some kind of easy furling device for high winds.

20. Moreover, it was agreed that the pump-matching problem was crucial and justified as much attention as the windmill itself. Work in India and in the

United Kingdom of Great Britain and Northern Ireland on low-starting torque pumps was cited as an effort in this direction.

21. The major problem in all wind programmes was a lack of experts who combined knowledge of the meteorological aspects, the mechanical aspects and the application aspects (especially in developing countries) of wind energy conversion. That fact alone made international assistance difficult, and, as a partial solution to the problem, some sort of international training centre was proposed.

22. A second major problem was the multiplicity of inadequately tested wind machine types. The Rocky Flats test centre in the United States and the new test centre in the Federal Republic of Germany, were now partially correcting the situation, but one or more international facilities for testing small wind machines intended for use in developing countries was recommended.

23. There followed a discussion of unusual applications for small wind machines, with special reference to the storage problem.

24. The use of wind energy for water-heating was mentioned, but there was some doubt about the cost-effectiveness, except in very special circumstances. On the other hand, an Indian study suggested that the desalination of brackish water by wind-powered reverse osmosis (or possibly electrodialysis) produced potable water for a quarter of the price of solar distillation. A further investigation of what seemed to be a very promising application was recommended.

25. Advanced storage systems, such as compressed air or electrolytic production of hydrogen, seemed to be promising only in the longer term.

26. Small wind electric generators with battery storage were said to be competitive with diesel generators at $0.3-0.5/kWh, with an average wind speed of 5 m/s. However, such small machines are not yet sufficiently dependable to be recommended unreservedly. Small wind electric generators could also be interfaced with the electric grid.

D. Large-scale wind energy conversion: technology, economics, social acceptability

(Agenda item 6)

27. Studies carried out in the United States suggested that wind turbines with diameters in the range of 75m-100m offered optimum economies on land, and machines in that range would soon be operational in the United States. Experience to date with the 200 kW Mod OA (38m diameter) and the 2MW Mod 1 (61m diameter) machines has shown that connecting large wind turbines to a grid system is practicable. The main problem area was to ensure an operational life of 20-30 years. This too was believed feasible, but for confirmation one needed longer operating experience. The first generation designs delivered electricity at a good (5-6 m/s) site (via a synchronous generator) at costs approximately $0.2-0.3/kWh, though in quantity production that cost would be halved. The

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second generation 2.5MW Mod 2 (91 metre diameter) wind turbine, due for completion in 1981, was expected to deliver energy at $0.08-0.10/kWh for the first few machines, though in quantity production that cost should be reduced to $0.04-0.05/kWh. At that price, large wind turbines would be economically attractive in remoter locations which were dependent on oil or gas for electricity generators. To compete with electricity generated from coal or nuclear energy, the target cost was about $0.03/kWh (which was the fuel-saving value of the electricity generated. No capacity credit is presumed). It was believed that costs close to that target would be achieved with third generation wind turbines. It was noted, however, that the economics of the Mod 2 wind turbine would be attractive in many parts of the developing world. The wind turbines in the United States large-machine programmes were all two-bladed, low solidity horizontal axis designs, with the rotor downwind of the tower in the first generation (Mod OA and Mod 1), but in Mod 2, the rotor was upwind of the tower, so as to avoid tower shadow effects.

28. The Panel was informed that the Canadian wind energy programme was based on the Darrieus curved blade vertical axis design, and a number of two-bladed machines had been built and tested, giving outputs up to 230kW (the latter corresponding to a rotor height of 37m and a rotor diameter of 24m). Experience with those machines had been encouraging and there were plans to build a multimegawatt Darrieus wind turbine.

29. Vertical axis and horizontal axis wind turbines have similar aerodynamic efficiencies, and both had their advantages and disadvantages; it would be premature to attempt to demonstrate that one was intrinsically superior to the other. Shrouded wind turbines offering a smaller rotor area, for a given power output, had been proposed, but they required a large fixed structure which must be strong enough to withstand extreme wind speeds. There was no evidence at the time that they were economically competitive with unshrouded wind turbines.

30. The environmental effects of large wind turbines were generally minor. Even in locations where the bird population was high, there was no evidence of bird impacts, and the acoustic noise level from large wind turbines was very low - imperceptible above background noise beyond a few rotor diameters. Interference with television reception out to a radius of about 10 rotor diameters could be a problem in areas with poor reception, but that only imposes a fairly minor siting constraint: the exposed areas required for large wind turbines are not usually considered desirable residential locations. Studies in the United States, the United Kingdom and Canada had shown that the availability of energy storage did not significantly affect the value of wind-generated electricity to a utility. Interest was expressed in the methodology used to judge the worth of wind energy to a utility, and details were requested on the way it had been evaluated in the United States, the United Kingdom and Canada, for possible inclusion in the Panel's report to the 1981 Conference.

31. In the United Kingdom wind energy programme, the limited energy output available from on-land sites had led to emphasis being placed on off-shore wind

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energy systems, with arrays of up to 200 multimegawatt wind turbines being studied. Such a cluster, having an energy output roughly comparable with a power station on land, would occupy an area about 12 km square, sited 10 to 50km off shore in the shallow but windy waters around the United Kingdom (especially in the southern North Sea). The wind turbine support towers would extend down to the seabed (water depths are typically 20m), and since much of the total cost was associated with those towers and their foundations, whose size and strength were dictated by wave loads, the economics favoured the use of very large wind turbines. For 100m diameter wind turbines, the energy cost was estimated to be about $0.08/kWh. That was considered sufficiently encouraging to justify more detailed studies, which would soon commence. The over-all potential from offshore wind energy systems around the United Kingdom was large; 20 per cent of the country's electricity needs could be supplied without going deeper than 20m, and since the energy cost was insensitive to water depth in shallow shelf areas, the potential could be much larger. Similar offshore wind energy systems were being considered in the Netherlands, and offshore systems would appear to be applicable in many other parts of the world.

E. Special problems of wind energy conversion in developing countries

(Agenda item 7)

32. It was felt that wind energy had great promise in many developing countries, with applications which included the provision of drinking water for people and animals, irrigation, desalination, small-scale electricity generation in remote "stand alone" situations, and electricity generation on a large scale for use with interconnected grid systems. That was especially true in rural areas and in regions such as the seashore, islands and grasslands far from the electric grid, where it was inconvenient and uneconomical to transmit electric energy and where diesel engines were currently used for generating electric power. It was emphasized that applicable wind energy systems embraced a very wide range of technologies, from modern adaptions of simple "Cretan" type windmills that could be made at low cost in a rural area to the advanced engineering skills required for modern wind turbines ranging in size from small (kW) to very large (multi-MW). The technology in general was developed to such a state that it could be applied in the immediate future, providing that the necessary technological infrastructure existed.

33. The biggest problem, however, hindering the implementation of schemes to harness wind energy in most of the developing world was the acute shortage of trained people - i.e, people who were capable of assessing the magnitude of the wind energy resource in a given country and of advising on the siting of wind turbines and on the design, selection, manufacture, installation and commissioning of suitable hardware. Another major problem was the lack of field test data on the performance and reliability (especially the latter) of the wind turbines that were already being produced.

34. It was therefore strongly recommended that training centres (possibly on a regional basis) and field testing centres, which might be associated with the training centres, should be established, though their precise form was left undefined. The problem of training the instructors for such centres was recognized, since the number of people with combined experience in meteorology, wind turbine engineering and the problems of developing countries was very limited. The problem might be alleviated by collaboration with workers in developed countries, or by "twinning" arrangements with organizations in developed countries which had relevant expertise. It was agreed that institutions in developing countries which were already active in the wind energy field should be encouraged to strengthen their activities.

35. *Ad hoc* research and development activities, even with inadequate institutional and financial support, had resulted in the development of simple prototypes of windmills. However, there was great need for integrated programmes for transformation of such applied research and development into commercialization, through rural demonstration and encouragement of entrepreneurs. There is also a need for information dissemination on such activities among developing countries.

36. The representative of the Conference secretariat to the Panel listed a number of actions which, it was agreed, should be taken before the next meeting of the Panel. They were taken up and included among the recommendations under agenda item 10 and as contributions from Panel members and specialized agencies under agenda item 9.

37. The WMO technical note under preparation was discussed and it was suggested that the note should include or expand information on resource assessment and siting strategies and methodologies, such as those discussed above in paragraphs 13 and 14.

F. Wind energy to the year 2000

(Agenda item 8)

38. The subject was not discussed in depth. It was felt that the over-all resource could be better quantified once the global wind energy resource map had been produced. Any estimates would inevitably be approximate, but Hütter's estimate of 5×10^{21} Joules per year for the energy in the wind over continental areas - that is, neglecting offshore wind energy - gave the order of magnitude. That could be compared with the current world energy consumption of about 3×10^{20} Joules per year. Within the United States, the potential contribution from wind energy by the year 2000 had been estimated to be 1.7 quads - that is, 1.8×10^{18} Joules per year. One Panel member agreed to provide details of the methodology employed by the United States in making the assessment, so that it could be combined with data collected by the secretariat of the United Nations Conference on New and Renewable Sources of Energy, to help provide realistic estimates of the wind energy potential in developing countries by the year 2000.

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G. Recommendations for intersessional activities

(Agenda item 10)

39. The Panel recommended that the following should be prepared:

(a) A global map of wind energy, in a form suitable for the proposed atlas of new and renewable sources of energy. It could be a revised version of the wind speed map given in the Hütter paper. Additional maps on a larger scale should also be prepared to illustrate what could be achieved by national wind energy assessment programmes (and they should indicate seasonal variations in availability). The atlas would be primarily a document for planners and decision makers.

(b) A methodology for assessing, in a practical fashion, reliable wind energy resources in a country, and possibly global estimates of wind energy resources. The estimates made for the United States could be used as a model. Again, the methodology would be seen as a tool for planners and decision makers.

(c) A brochure on wind energy assessment, site evaluation and instrumentation, for the benefit of potential wind energy users.

(d) A catalogue of wind machines actually installed or on the market and also a similar catalogue of instrumentation for wind measurements.

(e) Case studies on the technical economic viability of wind energy applications, especially as concerns developing countries:

(i) Low-cost, low-power, wind-driven water pumps;

(ii) Desalination of brackish water by wind-powered reverse osmosis or electrodialysis, as compared to solar distillation;

(iii) Application of wind energy for uses other than water pumping and electric power generation, particularly for creating employment opportunities in rural areas;

(iv) Low-cost 1-10kW wind-powered battery charger;

(v) Low-cost 5-50kW wind generator, with diesel back-up;

(vi) Medium-sized (~200kW) HAWT and/or VAWT electric generators for an island or other remote community;

(vii) 500kW wind generator group with pumped storage.

(f) Examination of economic viability of large wind generators and their interconnexion to power grids.

(g) Methodology for technical economic societal assessments of small wind energy applications.

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(h) Technical economic study of development and transfer of technology of small wind machines for developing countries.

(i) Studies of the technical, economic, social and environmental constraints on the future of wind energy in relation to other energy sources.

(j) Searches of patent files to provide information on state-of-the-art technology of wind machines and water pumping and electric power generation and storage relevant to wind energy application.

(k) Study of training requirements for wind energy specialists, estimated numbers of specialists required, especially in developing countries, and how their needs could be met by international assistance.

(l) Study of how the need for field testing of wind machines and associated equipment, especially for developing countries, could be met. That would include the role of one or more possible field testing centres in developing countries and the requirements for international assistance to establish such centres, if appropriate.

(m) The Conference should encourage national meteorological services to improve the availability of reliable wind measurement data and to prepare national climatic maps on wind. With a view to ensuring the maximum possible comparability between different geographical areas, WMO should be requested to prepare appropriate guidance material and specifications for the preparation of national wind maps.

(n) A WMO technical note on meteorological aspects of wind energy should be prepared in time for the Conference.

(o) Other studies on such subjects as the social acceptability of wind energy devices in rural communities. Such studies might include the problem of suitable curricula for training workers in the field of new and renewable sources of energy.

H. Contributions of Panel members and of the United Nations system to the work programme

(Agenda item 9)

40. Panel members and representatives of the specialized agencies agreed on various activities which corresponded to the recommendations of agenda item 9 below as contributions to the intersessional activities of the Panel - except for recommendation (m). The contributions are listed below and those recommendations which are not covered by the contributions will be considered for implementation by consultants within the Conference programme.

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1. Canada

41. Canada agreed to cover recommendation (f) with a cost-effectiveness study of wind energy for Prince Edward Island.

42. Prince Edward Island is Canada's smallest province, with a population of roughly 40,000. It is located a few miles off shore in the Gulf of St. Lawrence. At present, electrical energy is supplied by a mix consisting of low-cost base-load power by cable from the mainland and by an oil-fuelled thermal plant of about 65MW capacity on the island. The present cost of electricity is about 9 cents/kWh and is rising as the price of oil rises. Recently a study has been carried out to examine the cost-effectiveness of adding wind energy to the island grid system. Average wind speeds are roughly 6.5 m/sec at 10m height. An hour-by-hour simulation of the power system was carried out using a proprietary computer program called PROMOD, without wind energy and also with wind energy addition of up to 25MW maximum installed capacity, on the assumption that vertical axis wind turbines could be installed beginning in 1984. Preliminary results indicate that, up to 10MW installed wind capacity, the wind system is cost-effective, provided that capacity credit, which turned out to be significant in this case, is taken into account.

43. The study was carried out by a consultant for the Government of the Island, and a check would have to be made to determine whether a report or summary of the study could be made available. There should be no problem, since a short technical paper has already been published.

44. The case study may not be particularly relevant to island communities in developing countries for the following reasons:

(a) The climate is a northern climate with cold winters. The largest energy demand is in the winter, and there is a good correlation between seasonal variations in demand and variations in wind energy supply;

(b) The Island is fully electrified, and the wind energy system is primarily for fuel-saving.

2. India

45. India agreed to cover recommendations (e)(ii) and (g).

3. Malta

46. Malta agreed to cover recommendation (e)(vi).

47. The United Nations agreed to cover recommendations (e)(iv) and (v), part of (d), (h), e(i), (k), (l), and (e)(iii).

4. United Kingdom of Great Britain and Northern Ireland

48. A study of the use of wind energy in conjunction with diesel engines (plus small amounts of battery storage) for the generation of electricity in remote

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locations was in hand. Systems in the range 1 kW to a few MW were being considered, but the study would focus on the needs of a particular Scottish island where the maximum demand was of the order 100 kW. This could be written up before the next wind energy panel meeting.

49. The Intermediate Technology Development Group (ITDG) had prepared catalogues of small wind turbines for water pumping and electricity generation, based on manufacturers' data. These could be made available.

50. The Industrial Services division of ITDG had recently commissioned an economist to examine the cost-effectiveness of small water pumping wind turbines. The draft has already been completed, and it should soon be available in its final revised form. It is hoped that it can be made available to the Panel.

51. ITDG had assisted a Kenyan entrepreneur to market a simplified, multibladed, horizontal axis wind turbine, 6m diameter. It was now being made and sold commercially (that is, without any subsidy) in Kenya. The project officer, Peter Fraenkel, would be asked to write up the venture as a case study.

52. With respect to a field test and training centre, Professor Lipman of Reading University is intimately involved in the United Kingdom programme to measure - in the field - the characteristics of five different designs of wind turbines. Professor Dunn, who heads the Reading University Energy Group, has a very strong interest in the energy-related training of people in/from developing countries. They will be asked to consider the problem of specifying the requirements for a wind energy field test and training centre.

53. A case study is being prepared by Dr. R. Todd of the Centre for Alternative Technology, United Kingdom, of low-cost, small wind turbines for battery charging applications (1-10 kW range).

54. The member noted that a small contribution from the consultant funds towards the costs of producing the reports in (i), (iv) and (vi) above might be needed.

5. United States of America

55. The United States agreed to cover recommendations (a), (b), (c) and possibly (f

6. United Nations Industrial Development Organization

56. Subject to approval by the appropriate UNIDO authorities and availability of funds, UNIDO proposed to cover recommendation (h) with a techno-economic document entitled "Development and transfer of technology: small windmill systems suited to the needs of the developing countries".

57. The document is to be submitted by UNIDO to the Conference secretariat by the end of October 1980 for consideration by the Panel at its second session, scheduled to meet by the end of 1980, and for submission to the Conference in 1981. The techno-economic document will cover the state of the art on various types of windmills for irrigation, small (10 kW) generators and other applications for rural

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development; technological choice in windmills under various conditions; development and testing facilities and procedures; case studies of experience in selected developing countries on development, adaptation, usage and manufacture; manufacturing technologies, technological choices, repair and maintenance; and guidelines on entrepreneurship promotion in rural areas.

7. World Meteorological Organization

58. The contribution of WMO will cover recommendations (m) and (n) with a technical note on the meteorological aspects of the utilization of wind as an energy source. The note is being prepared.

8. Economic Commission for Europe

59. The Commission will cover recommendations (b) and (i) with studies of technical, economic and environmental constraints on the future of wind energy applications, especially as concerns developing countries, and will evaluate (projections) of the possible contribution which could be made by wind energy to the energy balance.

9. World Intellectual Property Organization

60. The organization will cover recommendation (j) by arranging for the establishment of an analysis of the state of technology published in patent documents and other literature contained in patent office search files with regard to the transformation of natural wind energy into useful mechanical power and the transmission of such power to its point of use. The analysis could be prepared in the form of a monographic survey of patent and non-patent literature covered by the sub-class of the International Patent Classification F03D "wind motors".

61. A more detailed description of the content of the monography with an estimate of the cost for its establishment could be transmitted to the Conference secretariat by 31 January 1980.

10. United Nations Educational, Scientific and Cultural Organization

62. Recommendation (o) will be covered by UNESCO.

I. Adoption of the report of the Panel on its first session

(Agenda item 11)

63. The report of the Panel was unanimously adopted.

Annex I

AGENDA

1. Nomination of officers

2. Adoption of the agenda and organization of work

3. Global wind energy resources

4. Site evaluation of wind energy resources

5. Small-scale wind energy conversion: applications, technology, economics

6. Large-scale wind energy conversion: technology, economics, social acceptability

7. Special problems of wind energy conversion in developing countries

8. Wind energy to the year 2000

9. Contributions of Panel members and of the United Nations system to the work programme

10. Recommendations for intersessional activities

11. Adoption of the report of the Panel in its first session

Annex II

LIST OF PARTICIPANTS

Members of the Panel

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China: G. C. Zhang

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Malta: L. Ciantar

Tunisia: H. Boussoffara

United Kingdom of Great Britain and Northern Ireland: P. J. Musgrove

United States of America: L. Divone

United Nations Secretariat

Economic Commission for Europe: V. Korjenko

United Nations Industrial Development Organization: A. A. Swamy Rao

Specialized agencies

World Intellectual Property Organization: H. Konrad

World Meteorological Organization: R. Schneider
S. Jovičic

Annex III

LIST OF DOCUMENTS

Conference documents

Provisional agenda	(UNERG/WP/1/1)
Issue paper on wind power	(UNERG/WP/1/2)

Information documents

Commission consultative pour l'Utilisation de l'Energie du Vent dans les Pays du Tiers Monde, Amersfoort, Pays-Bas. Utilisation de l'Energie du vent en Tunisie. Rapport de progrès No. 1.

Hütter, Ulrich. Report for the Technical Panel on Wind Energy. (UNERG/WP/1/2/Inf.1, and Corrigenda)

Tewari, S. K. and others. A horizontal axis sail windmill for use in irrigation.

Tudor, J. L. Developing a wind energy program in Barbados.

__________. Institutional infrastructure supporting the search for local energy sources in Barbados.

Annex IV

OUTLINE OF THE DRAFT REPORT OF THE PANEL TO THE UNITED NATIONS CONFERENCE ON NEW AND RENEWABLE SOURCES OF ENERGY

I. Introduction and executive summary

A. Brief history

B. Brief description of breadth of applications, uses, types

C. Brief description of state of the art; examples of key systems

D. Brief statement on the economic status and expected developments for the several classes; sensitivity to wind resource

E. Summary of related issues:

1. Potential impact and advantages

2. Over-all potential

3. Environmental and social issues

4. Barriers to commercialization or large-scale use

F. Summary of recommendations

II. Wind as a resource

A. Global resource

B. Need for resource assessments

C. Need for site locating

D. Typical programme or strategy for resource assessment and siting

E. Reference to WMO technical note

F. Reference to instrumentation and siting needs and guidelines

G. Recommendations:

1. National resource assessments needed

2. Advice and support for nations to perform resource assessments and preliminary screening of geographical areas

3. Other

III. Technological and economic status

A. State of the art in various sizes and applications:

1. Small water pumping - high solidity

2. Small water pumping - low solidity

3. Small electrical generation - rural electric

4. Desalinization, heat, other applications

5. Large electrical generation

B. Storage for certain applications - stand alone

C. Examples or case studies of specific projects or analyses

D. Economics, both present and projected, in several of the above applications

E. Reference to key more detailed reports

F. Related issues: energy payback times, environmental effects, public acceptance, safety

G. Example of economic analysis methodology

H. Recommendations

IV. Development and use of wind energy in less developed countries

A. Current or recent ad hoc activities

B. Case studies, special requirements

C. Types of applications and needs

D. Discuss barriers:

1. Technology

2. Commercialization

3. Financial

4. Social

E. Potential significance of wind energy to developing countries:

1. Rural development, rural electrification

2. Local construction

3. Development or evolution of manufacturing capability in LDCs

F. Recommendations:

1. Regional test centres

2. Training programmes

3. Training of the trainers

4. Others

V. Policy and programme considerations

A. Need for national policy

B. Need for programmes and co-ordination

C. Socio-economic implications

D. Need for verification of system capabilities

E. Need for information dissemination, co-ordination and technology transfer

F. Test standards, standardization of terms, guidelines

G. Manufacturing capability and needs, and relationship between universities/research laboratories, manufacturers and commercial firms, technical schools and users

H. Patent, proprietory information and technology transfer issues

I. Recommendations:

1. Programmes at the national level

2. Others

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VI. Future potential

A. Long-term implications

B. Estimates for the year 2000

C. Recommendations for the long term

Annexes

I. TECHNICAL NOTE BY THE WORLD METEOROLOGICAL ORGANIZATION

II. LIST OF KEY REPORTS

III. EQUIPMENT LISTS

A. Instrumentation

B. Water pumpers

C. Small electric

D. large electric

IV. MORE DETAILED INFORMATION ON METHODOLOGIES FOR TESTING, WIND ASSESSMENT AND MEASUREMENT AND ECONOMIC ANALYSES REFERENCING KEY REPORTS
