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Second session
14-25 July 1980
Item 3 of the provisional agenda

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INTERIM REPORTS OF THE TECHNICAL PANELS

Report of the Technical Panel on Hydropower
on its first session

I. Introduction and nomination of officers (agenda item 1)

1. The first meeting of the Technical Panel on Hydropower was opened by the Executive Director of the United Nations Industrial Development Organization (UNIDO), Mr. Abdel-Rahman Khane, who welcomed the Panel members. He conveyed the greetings also of the Secretary-General of the United Nations Conference on New and Renewable Sources of Energy, Mr. Mohamed Habib Gherab, and his regrets that he was unable to be in Vienna to join in welcoming the Panel.

2. Following his opening statement to the Panel, Mr. Khane announced that after consultations, Mr. B. Crawford (Guyana) and Mr. A. Vinjar (Norway) agreed to be chairman and rapporteur, respectively. Mr. Crawford then assumed the chair. (A list of participants is given in annex I.)

II. Adoption of agenda and organization of work (agenda item 2)

3. The secretariat explained the purpose of the Panel, which was to provide technical recommendations to the Conference to be held in Nairobi in August 1981. The deliberations of the Panel would be guided by the annotated agenda, and by the issue paper. At the same time the Panel should keep in mind that the second meeting, tentatively scheduled to be held from 5 to 9 January 1981, at New York, will discuss the draft report and recommendations to the Conference, and the Panel may wish to consider also the outline of the draft report proposed by the secretariat. The report and recommendations to the Conference will be submitted to the Panel of Chairmen and other experts, to be convened in early 1981, to review the recommendations of the Technical Panels and to present the consolidated recommendations to the Conference.

4. A further point to be borne in mind is the recent decision taken by the Preparatory Committee at its first meeting of the Conference to consider inviting national papers.

5. In organizing the work of the first meeting of the Panel, it became clear that the 13 substantive agenda items could be reduced to the following: national and global hydropower potentials and hydrology; technology of hydropower; economics of hydropower; legal, political, institutional, social and environmental problems with special reference to developing countries. The provisional agenda (see annex II) was revised to reflect this.

Note on mini-hydropower units

6. Hydropower projects may be classified by size. While various such classifications are possible, the Panel took notice of the definitions used in the seminar-workshop on mini-hydroelectric generation units organized by UNIDO, the Economic and Social Commission for Asia and the Pacific (ESCAP) and the Regional Centre for Technology Transfer (RCTT), held at Kathmandu in September 1979. According to this, plants of less than 0.1 MW are classified as micro-hydro and from 0.1-1.0 MW as mini-hydro. While the potential contribution of mini-hydro

plants to the total production of hydropower would be very small, their significance may be very great in the rural areas of some developing countries. The Panel reviewed the draft report of the Kathmandu workshop and agreed to adopt its conclusions and recommendations. It agreed on the need for studies to reduce costs and to improve the reliability of mini-hydropower units and to determine ways of improving their integration into larger systems.

III. National and global hydropower potentials
and hydrology (agenda item 3)

7. Data on national hydropower installations and potential is reported by Governments to the Conservation Commission of the World Energy Conference, a non-governmental organization in consultative status to the United Nations and the national data are aggregated to provide the global data. Data are regularly updated.
8. It was noted that the hydropower potential of China was seriously understated being in fact 580 GW of which only 3 per cent was installed.
9. The Panel recommends that the World Energy Conference survey of hydropower potential should be taken as authoritative and each country which is a member of that body should be encouraged to give up-to-date data on their hydropower resources to the World Energy Conference.
10. The Panel noted that regional activities such as those of the Economic Commission for Europe (ECE) and the Latin American Energy Organization (OLADE) should be encouraged to the extent that they complement the work of the World Energy Conference. In the case of ECE an ad hoc group was recently set up to re-evaluate the resources of hydropower which might be considered feasible in light of the new energy prices.
11. Adequate hydrologic data in turn is dependent on well-developed stream gauging networks. These may be very well developed in many regions of the industrialized countries which have stream inventories in some cases, for the last 100 years. In most developing countries, however, the situation is much less satisfactory.
12. The meeting was informed of the Operational Hydrology Programme of the World Meteorological Organization (WMO), which was concerned with hydrological networks, instrumentation, data acquisition, hydrological forecasting etc., that is, those operational activities with which national hydrological agencies were concerned. The newest project of the Operational Hydrology Programme, the Hydrological Operational Multipurpose Subprogramme (HOMS), was outlined as an organized transfer of operational hydrological technology to meet user requirements such as those for hydropower. Also WMO has, under preparation, a report on the use of operational hydrology in solving energy problems. The Panel was also informed of the International Hydrological Programme of the United Nations Educational, Scientific and Cultural Organization, the successor of its International Hydrological Decade (1965-1974), designed to study water balances, floods, low flow and other such aspects of water resources.

13. At the meeting there was a discussion about the various possibilities of how to determine the appropriate low flow period to be used for designing hydropower schemes in connexion with complementary energy sources. Those attending the meeting were informed of the publications of UNESCO on the monthly, yearly and extreme discharge of the major rivers of the world as well as of the recent International Hydrological Programme (IHP) projects on low flow hydrology. The panel secretariat will shortly receive information on publications of UNESCO under preparation in this field.

14. In so far as many countries, especially developing countries, do not have adequate hydrological networks, and records over many years are required for proper development of hydropower resources, the Panel strongly recommends countries to establish, as soon as possible, adequate and sufficient meteorological and hydrological networks. For the above purpose, countries should establish a hydrological service if it does not already exist. In this connexion attention is also drawn to the HOMS project for making appropriate technology available. Both WMO and UNESCO assist developing countries in establishing adequate stream-gauging networks.

15. For planning large hydropower projects, preferably 30 years or more of hydrological data are required with an absolute minimum of 10 years. This is often not available and many important projects have been implemented only on the basis of precipitation data for the river basin. In order to provide the data for periods not adequately covered by sufficient readings of data, UNESCO has supported research on methods to extend data series, and reference was made to pertinent publications and to the Madrid symposium of 1973.

16. Where adequate hydrological data do not exist, there are now available statistical sampling models using meteorological data, together with limited hydrological data, to estimate stream flows. This may be adequate for reconnaissance surveys of hydropower projects. In the case of small catchment areas and corresponding small hydropower projects, special models exist which, inter alia, combine meteorological data with hydrological data from neighbouring areas. These developments in computer modelling of river basins were important. Such technology will be available from the HOMS project.

17. The Panel finally stressed the importance of additional meteorological, geomorphological and cartographic material for making preliminary estimates of hydropower potentials. Reference was made to hydropower inventories recently carried out in a number of the Latin American countries (Plan Maestros) which, inter alia, supplied this type of information.

IV. Technology of hydropower (agenda item 4)

18. There was an extended discussion of various technical aspects of hydropower. It was generally agreed that this was a mature technology with relatively few major new technical developments to be expected. There is a considerable amount of information on hydropower technology available through a variety of sources such as the electrical supply industry, professional bodies, national and international

organizations and meetings. The ECE Symposium on the Prospects of Hydroelectric Schemes under the New Energy Situation, held at Athens in November 1979, was cited as an abundant source of recent information.

A. Hydraulic control structures

19. It was generally agreed that there were few major developments to be expected in hydraulic control structures. Some developments in the simplification of control gates were noted.
20. For mini-hydro units the use of locally available construction materials, such as soil-cement for dams and dykes, was mentioned as was the extensive use of pre-stressed concrete in conduits and piping to replace steel.
21. Siltation can be a serious problem both because of turbine erosion and reserve sedimentation. It was agreed that there were no satisfactory solutions. In some cases, it may be possible to reduce the problem by upstream control of soil erosion.
22. Attention should be paid to site geology in planning hydraulic structures.

B. Hydraulic turbines

23. Developments in hydraulic turbines include:

- (a) An increase in the capacity of the largest units to 700 MW;
- (b) Increased heads for Francis turbines and pump turbines up to 700 m;
- (c) The development in a number of countries of standard and semi-standard turbines for small-scale hydro units now extending up to approximately 10 MW;
- (d) Increased size of bulb units to 54 MW;
- (e) Development of the straight flow turbines for mini-hydro and small hydro units with a 7.6 m diameter (17.6 MW) now under construction in Nova Scotia, Canada.

24. Bulb turbines, while they have many advantages, nevertheless have low inertia which presents stability problems in a lightly loaded isolated system.

25. Another new development was the floating in of complete power houses to save the costs of on-site assembly. Underground power developments give economies by reducing the requirements for construction materials permitting increased turbine speeds without incurring cavitation and have other advantages such as improving the environmental amenity.

C. Electrical generating equipment and controls

26. The importance of remote control of hydropower generators for developed countries as a labour and cost saving factor was noted. A large number of older and smaller hydro plants in developed countries have been closed down because of high operating and maintenance costs associated with manual control systems.

27. Emphasis should be put on applying technical solutions which enable developing countries to maintain and as far as possible renew for themselves the equipment used. Development of industrial units in the developing countries which can undertake these kinds of services should be encouraged.

28. For mini-hydro units (to 1 MW) integration into a large grid may be achieved more economically with induction generators rather than with synchronous generators.

29. Again, for mini-hydro units the use of load levellers which balance load fluctuations by transferring changes electronically to a ballast are more cost effective than the use of mechanical governors to control load fluctuation.

D. Electrical transmission and distribution

30. The trend to higher transmission voltages (1000 kV and up) and use of dc as well as ac was noted. This has advantages for long distance inter-ties and also for hydroelectric developments in remote areas. The importance of planning future transmission systems at an early stage of designing new hydroelectric systems was emphasized.

E. Pumped storage

31. Pumped storage schemes ranging from 100 MW to 2500 MW were of increasing importance in highly developed grids where they permitted smoothing of daily, weekly or, in some cases, seasonal cycles. They are particularly advisable when integrated with large fossil fuel units and even more especially with nuclear units.

32. A further development is the proposed use of underground pumped storage with depths of 600m (1 stage) or 1200m (2 stages) now under study in the United States of America.

33. These technologies were not seen to be as important for systems which were predominantly hydropower-oriented. In these cases simple hydropower capacity could provide for peak levelling.

34. Pumped storage schemes can be used with advantage in conjunction with wind or solar power or run of river hydro-stations. The planned wind power pumped storage scheme for Malta was quoted as an example.

F. Tidal power

35. Although tidal power was discussed by the Technical Panel on Ocean Energy, the Hydropower Panel was able to offer valuable additional information.

36. The Phase II of the Korean Tidal Power Project Study for a 300-400 MW plant is now out for tender. The results of the Canadian Bay of Fundy reassessment study showed that the exploitation of tidal power was economically possible under costs and prices of 1976-1977. The Cobscook Bay and Cook Inlet (Alaska) schemes of the United States of America are both considered uneconomic for the time being.

37. A feasibility study for a small (5-15 MW) tidal scheme in Half Moon Cove, Maine, is under way. It was suggested that mini-tidal power schemes might be a case where a successful technological innovation would be a factor in achieving economic viability. A small tidal project in the Union of Soviet Socialist Republics and another in China were described.

G. Wave energy

38. It was noted that this technology has some similarities with hydropower, but was only briefly discussed as it is within the scope of the Technical Panel on Ocean Energy.

V. Economics of hydropower (agenda item 5)

39. It was agreed that economic costing was extremely difficult to generalize in one country let alone among different countries. Cost of turbines, generators and transmission equipment was relatively standard since there was a competitive international market in these items. However, civil construction works were usually the biggest item in a hydropower project. These costs were highly variable since they are site specific and being local they are sensitive to local labour costs and markets. Also, financing costs were variable.

40. The evaluation, moreover, should quantify the accuracy of some of the economic parameters such as fuel prices and discount rates as well as externalities of the project.

41. Attention was drawn to the benefits of multi-purpose projects involving not only power, but irrigation, navigation, flood control and recreation. In these cases the costs of dams and other common structures could be shared among a number of activities with offsetting benefits.

42. Economic evaluation of the costs and benefits of a particular hydropower project should take account of the medium and long-term effect of its incorporation into the total system cost.

43. The Panel was unanimous in cautioning against the misuse of notional cost breakdowns on the basis of cost per kilowatt or of cost per kilowatt-hour,

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projectwise. It was emphasized that hydropower was a mature technology and each case should be compared on its merits with competing mature technologies such as thermal power and (with qualifications) nuclear power and geothermal power.

44. The finite nature of fossil fuels and the effect of fossil fuel imports on balance of payments are important factors favouring hydropower and should be taken into account in economic assessments of new power developments.

VI. Legal, political, institutional, social and environmental problems with special reference to developing countries (agenda item 6)

Legal, political and institutional

45. There was considerable discussion of experience with national legislation of water and land rights and of international instruments for similar questions concerning boundary and transboundary waters. The Panel stressed the necessity of establishing efficient general principles for the utilization of hydropower resources on transboundary rivers, if possible within the framework of the United Nations. It was stressed that relevant information should be made available to developing countries to assist them in framing suitable legislation conducive to the development of their water resources.

46. Hydropower development should be examined in the context of a national water resources development policy.

47. The Panel emphasized the importance of establishing efficient institutional arrangements to undertake the different tasks involved in hydropower planning and development. These include hydrological, cartographic, geologic and other engineering services.

48. Mini-hydropower units, as part of rural electrification programmes, require special promotional, extension and financing activities, which, in turn, require special institutional provisions.

Social and environmental

49. There is now some experience which permits estimating environmental impact as part of an assessment of hydropower projects. However, it is understood that there is need for considerably more research on this matter.

50. In the case of projects requiring re-location of populations, considerable sensitivity was required by planning authorities, and the people concerned should be involved at an early stage.

51. The Panel underlines the great importance, in view of guaranteeing the success of a project, to assure the co-operation among the different persons in charge who are concerned with this project and to be able to use an institution capable of assuring that co-operation.

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52. In developing countries there were special requirements for training, for information flows, for assistance with technology transfers and with financing. Each of these requirements would be covered by special working groups to be convened for this purpose.

VII. Recommendation for intersessional activities (agenda item 7)

53. The recommendations for intersessional activities were as follows:

(a) Mr. Baburin offered to provide a report on the experience of the Union of Soviet Socialist Republics in physical modelling as an integral part of design of hydroelectric projects.

(b) Mr. Zhu offered to provide information on Chinese experience on small scale hydroelectric development. He also offered to provide up-to-date information on Chinese hydroelectric resources.

(c) The Economic Commission for Europe was invited to prepare a paper on trends and prospects for hydropower schemes in the new energy situation, based on the findings of the Athens Symposium.

(d) The Commission was invited to report on the development of the recommendation adopted by the Athens seminar to set up:

(i) An ad hoc meeting: to compare electric generating system models used in different countries by different organizations;

(ii) An ad hoc meeting to examine the hydropower resources of the ECE region.

(e) The Commission was invited to prepare a basic paper on long distance power transmission for the next session.

(f) The Secretariat was asked to approach the International Commission on Large Dams (ICOLD) to obtain up-to-date material on dam design and construction technology.

(g) The World Bank should be asked for their guidelines on hydropower project evaluation, as well as information on evaluation of environmental factors. The Panel thought it would be useful if a representative of the World Bank could be present at the next Panel meeting.

(h) Mr. Rohde was asked to provide information on problems caused by silting in turbine equipment. The Panel is also interested in the possibility of solving the sedimentation problem caused by silting.

(i) Mr. Darlot was invited to supply information on the structures and measures that are applied in France in order to establish consultation with all the

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parties concerned (technicians, representatives of the administration, locally elected representatives, consumers) for all aspects of a project. Different aspects which include production, irrigation, flood prevention, fish culture, recreation, required to work out priorities and also to exploit additional possibilities concerning the use of water, should be taken into consideration.

(j) The Secretariat was asked to assist in obtaining a study from Kenya on environmental impact of an already commissioned hydropower project in that country.

(k) Mr. Wayne was asked to provide information from the International Joint Commission established by the United States of America and Canada on their experience of existing agreements on international water courses. Information on the Delaware River Basin Commission might also be furnished.

(l) The United Nations Industrial Development Organization was asked to send to the Secretariat for distribution to the Panel members the following documents:

- (i) Manual on mini-hydro turbines;
- (ii) Guidelines for standardization of hydro equipment;
- (iii) Guidelines on standardization of design hydro structures.

(m) The Panel endorsed the Secretariat proposal for an Atlas of New and Renewable Sources of Energy as a tool for policy makers on the understanding that existing material would be used to provide the section on hydropower resources.

(n) Mr. Telleria offered to make available to the Panel a cost manual on hydropower plants, currently being prepared for Venezuela.

(o) Mr. Wayne offered to make available to the Panel a summary of National Inventory of hydro sites prepared by the United States Corps of Engineers.

(p) The States participating in the Conference should be asked to supply information concerning the assistance they could offer in the following fields:

- (i) Hydrologic research of small catchment areas;
- (ii) The construction of hydroelectric micro or mini-plants;
- (iii) Methods of economic analysis;
- (iv) The organization of consultations with the local inhabitants and of co-ordination with the parties concerned;
- (v) A list of manufacturers of equipment for micro and mini-hydroelectric power plant as well as specifications thereof.

(q) Mr. Baburin was asked to evaluate experience of the Union of Soviet Socialist Republics in the assessment of the impact of hydropower development on environment.

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(r) Panel members were requested to circulate to other panel members documents and information material which they felt would be of value for the further work of the Panel - and to assure that the Secretariat be given a copy of each document or be otherwise informed. Documents may also be sent to the Secretariat for distribution to the members.

(s) The United Nations Educational, Scientific and Cultural Organization was invited to provide material on its activities in the hydrology field.

(t) The World Meteorological Organization was invited to provide information on the use of operational hydrology for the use of hydropower planning and also details of the HOMS project.

(u) Mention was made of hydropower inventories recently carried out in a number of Latin American countries. Mr. Rohde offered to provide the Panel with information about these activities.

VIII. Contribution to intersessional activities (agenda item 8)

54. Contributions to intersessional activities have been indicated in the appropriate places in the preceding agenda item 7.

IX. Adoption of the report (agenda item 9)

55. The interim report of the Panel was adopted by consensus.

Annex I

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Annex II

UNITED NATIONS CONFERENCE ON NEW
AND RENEWABLE SOURCES OF ENERGY

Technical Panel on Hydropower
First Session
Vienna, 18-22 February 1980

PROVISIONAL AGENDA

1. Nomination of officers
2. Adoption of Agenda and organization of work
3. World hydropower potential
4. Evaluation of hydropower potential in each country
5. Time frame of probable development
6. Hydrology, topography, geology
7. Hydraulic control structures - dams - conduits - control gates
8. Hydraulic turbines
9. Electrical generating equipment and controls
10. Electrical transmission and distribution
11. Economic methodology and financing
12. Environmental and social considerations
13. Legal and political problems
14. Pumped storage
15. Special problems of hydropower programmes in developing countries
16. Contributions of Panel members and of the United Nations system to the work programme
17. Recommendations and draft report

Annex III

DOCUMENTATION

Conference documentation

- HP/1/1 Annotated agenda for the Hydropower Panel
- HP/1/2 Issue paper for the Hydropower Panel
- HP/1/3 Interim report of the first meeting of the Hydropower Panel

Information documents

1. Report entitled "Present status and outlook for water power utilization in the USSR" by L. Mikhailov.
2. Set of the documents on the prospects of hydro-electric schemes under the new energy situation and on the related problems issued at the Symposium sponsored by ECE at Athens (5-8 November 1979).
3. Set of the documents on the exchange of experience and technology transfer on mini hydro-electric generation units issued at the Seminar-Workshop sponsored by UNIDO at Kathmandu (10-14 September 1979).
