45684

UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

Distr.
LIMITED

E/CN.14/NRSTD/E/14
11 May 1976

Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA

Second African Meeting on Energy

Accra, (Ghana) 8-19 November 1976

METEOROLOGICAL ASPECTS OF ENERGY PROBLEMS

(Submitted by the Secretary-General of the)
World Meteorological Organization (WMO))

TABLE OF CONTENTS

SUMMARY

Various ways in which meteorology relates to the consideration of energy problems are outlined, and the current and planned activities of the World Meteorological Organization (WMO) in this regard are presented. In the light of this presentation, suggestions are offered as to action which the Governments of African countries might take.

INTRODUCTION

1. As problems related to energy have become world-wide in recent years, it has become more and more obvious that meteorology must play an important role in the consideration of many aspects of these problems. The Seventh Congress of the World Meteorological Organization therefore decided that WMO should consider the need for increased co-ordination in respect of energy problems. In this context plans for future activities in this field have recently been outlined within WMO.

PURPOSE OF DOCUMENT

2. The purpose of this document is to explain the most important meteorological aspects of energy problems and to indicate how WMO currently is, or plans to become, involved with these aspects. Particular emphasis is given to problems of interest to African countries.

DISCUSSION

3. In order to consider meteorological aspects of energy problems, it is convenient to divide them into three main groups, namely, those connected with: (a) energy production; (b) energy transport, exploration, conservation and consumption and (c) new energy resources.

Energy production

4. An understanding of meteorological facts and application of meteorological information are essential in considering the basic problem of possible global, regional and local impact on the atmosphere of continuously increased energy production, for example, through heat release and/or input of CO_2 and particulate matters. In recent years both international organizations and individuals have issued statements in this regard which have not always been based on meteorological facts and information and hence have led to some misunderstanding.

5. In fact it is not possible, without considerable risk, to make definite forecasts about the above-mentioned consequences. This is because there is insufficient information available regarding future developments. With both socio-economic and natural factors involved, it is preferable to present a series of possibilities (scenarios) based upon different reasonable assumptions.

6. The services of meteorologists are required for the provision of data and reliable information for use in formulating appropriate assumptions and, at a later stage, in evaluating the meteorological and climatic effects emanating from the assumptions. WMO is already involved and will increase its activities in formulating the basis for rendering this kind of service to the economists or environmentalists concerned. A formal WMO statement on the possible consequences to the atmosphere of a continued and increased release of heat and pollutants may also be forthcoming.

7. Of crucial concern in all studies of possible consequences to the atmosphere of increasing energy production is the availability of climatological data in different parts of the world. Unfortunately, the climatological data situation in many countries in the world (including African countries) is not satisfactory for these kinds of study and need to be improved through action by Governments. It should also be stressed that suitable information about heat release and emissions of pollutants is also unsatisfactory for the purpose and that steps should be taken to improve this information.

8. As regards the presentation of available climatological data in a way suitable for correlation with data on energy production, emissions of pollutants and heat release, it should be noted that it is intended to study this problem in WMO and in due course to prepare guidelines for member countries.

9. Activities of WMO with regard to the contribution of heat release to the pollution of the atmosphere are mainly dealt with through the groups and rapporteurs, listed against numbers 1, 2, 5, 7, 8, 10 and 11 in Annex I.

10. Many meteorological and hydrological problems are related to the development of hydro-electric schemes and the regulation of rivers for such schemes. It is essential to emphasize the need for using meteorological and hydrological data as well as forecasts in all aspects of the planning and operation of such development projects. The basic requirement for data on precipitation and discharge for such planning purposes are obvious. Here again there is a considerable need to improve the data situation in many countries through the establishment of meteorological and hydrological stations. WMO has important tasks not only in promoting the establishment of more such stations but also in transferring to developing countries the technology to be applied in the use of meteorological and hydrological data for planning of water resource development already in use in developed countries.

11. A word of caution is however in order. The regulation of rivers may have an important impact on the physical, chemical and biological properties of water bodies which could lead to climatic consequences on local and regional scales. As yet very little is known concerning the impact on atmospheric conditions of large and aggregated engineering enterprises dealing with water resource development. Research in this field may be encouraged by WMO, possibly in co-operation with UNESCO.

12. WMO activities related to heat release to waters and hydroelectric energy are being dealt with by the working groups or rapporteurs, listed against numbers 7, 8, 13, 14, 15, 16 and 17 in Annex I.

Energy transport, exploration, conservation and consumption

13. The fields of the application of meteorology to the transport of energy have been identified as being mainly electric power transmission, the shipping of hydrocarbons by sea and the installation and operation of pipelines. Meteorological information is pertinent in planning route selection, structural design, safety and operation.

14. In relation to energy exploration, attention should be drawn to the need for meteorological information, particularly in connexion with the exploitation of new sources of oil and other energy sources in areas with severe climatic conditions.

15. With regard to the important area of the conservation and consumption of energy, it should be noted that WMO has for several years been involved in work on urban climate problems and building climatology, in the context of which the application of meteorological information to the planning of human settlements and the design of buildings and heating and air-conditioning systems have been considered. In view of the important economic and environmental implications, WMO is considering increasing its activities in this area, in particular in connexion with the study of the need for improving the situation in respect of climatological data and their relevant presentation in different parts of the world. The usefulness of issuing special weather information and forecasts for planning for construction work and heating purposes has also been emphasized.

16. The present activities of WMO in the above respects are mainly dealt with by the rapporteurs and groups listed against numbers 4, 5, 7, 8, 9 and 10 in Annex I.

New energy resources

17. Meteorology is of course highly relevant to various aspects of the exploitation of both wind and solar energy. Meteorological information is essential for any proper assessment of possibilities for and the design of wind energy systems. Information about vertical wind profiles is of particular importance.

18. Solar radiation observations both from networks of radiation stations and from special research sites are needed for any type of planning for the utilization of solar energy. WMO plans to consider the need both to secure more reliable data from existing stations and to extend the global network of radiaition stations. Instrument problems also have to be considered as well as the possibilities of estimating the radiation information needed on the basis of other meteorological information (see Annex II).

19. The present activities of WMO in connexion with new energy resources are carried out by the rapporteurs and groups listed against numbers 3, 6, 10 and 12 in Annex I.

CONCLUSIONS AND ACTION PROPOSED

20. In view of the energy problem areas involving meteorology, as outlined in the preceeding paragraphs of this document, it may be concluded that the most important action for African Governments to take in this regard (through national meteorological and hydrological services, as appropriate) would be to:

(i) Expand, as required, and according to WMO specifications, their networks of stations providing climatological and hydrological data;

(ii) Provide, as required, meteorological data tailored to the design and planning needs of the energy industry and to assist the industry in achieving its goals by communicating information on established procedures and providing other advice as appropriate;

(iii) Organize their activities on problems related to the transfer of pollution and to the release of heat into the atmosphere in such a way that appropriate co-operation is ensured between the national meteorological services on the one hand and architects, engineers, city planners and health authorities on the other;

(iv) Provide, through appropriate authorities, their national meteorological services with data on heat release and on the emission of various pollutants for the purpose of carrying out studies on their impact on the atmosphere at local, regional and global levels;

(v) Raise the priority given to research in and application of urban and building meteorology related to energy problems with particular emphasis on economizing on the consumption of energy by implementing conservation measures based on climatic conditions;

(vi) Stress the role of meteorological information in studies of the utilization and design of wind energy systems, paying particular attention to the need for a proper understanding of wind variations according to height;

(vii) Expand, as required and according to WMO specifications, their networks of stations providing data on solar radiation parameters and to ensure proper quality controls over radiation data;

(viii) Emphasize the role of data on relevant solar radiation parameters to solar energy utilization, insisting on co-operation between meteorologists and solar energy technology specialists in general.

21. WMO for its part will make every effort to increase its efforts to ensure that proper guidelines and specifications are made available to member countries with a view to assisting them in undertaking the action recommended above.

22. It is suggested that the second African Meeting on Energy consider the information presented in this document and decide as appropriate on the suggestions for governmental action which have been presented.

LIST OF WMO WORKING GROUPS AND RAPPORTEURS DEALING WITH PROBLEMS RELATED TO METEOROLOGICAL AND HYDROLOGICAL ASPECTS OF ENERGY PROBLEMS

Executive Committee

1. Panel of Experts on Environmental Pollution

2. Panel of Experts on Climatic Change

Commission for Special Applications of Meteorology and Climatology

3. Rapporteur on Radiation Climatology and its Application

4. Working Group on Applications of Meteorology to Housing and Building for Human Settlements

5. Rapporteur on Applications of Meteorology to Atmospheric Pollution Problems on a Local and Regional Scale

6. Rapporteur on Applications of Meteorology to the Development of Atmospheric Energy Resources

7. Rapporteur on Applications of Meteorology to Effects of Industrial Energy Sources on the Environment

8. Working Group on Climatic Fluctuations and Man

9. Rapporteur on Applications of Meteorology to Problems of Transmission and Consumption of Energy

Commission for Atmospheric Sciences

10. Working Group on the Physics of Climatic Fluctuations

11. Working Group on Air Pollution and Atmospheric Chemistry

12. Rapporteur on Atmospheric Radiation

Commission for Hydrology

13. Rapporteur on Water Yield

14. Rapporteur on Operational Assessment of Areal Evaporation

15. Working Group on Hydrological Data for Water Resources Projects Design

16. Working Group on Hydrological Forecasting

17. Rapporteur on Cost/Benefit Relationship of Hydrological Forecasts

18. Rapporteur on Stream-flow Water Quality Relationship

NOTES ON SOLAR RADIATION MONITORING FOR SOLAR ENERGY TECHNOLOGY

By L. Machta, United States of Ameriaa

There are three reasons for measuring solar radiation for solar energy technology:

1. Routine monitoring
   (a) Network configuration;
   (b) Specific sites for proposed solar collectors;
2. Testing the efficiency of solar collectors;
3. Research.

National weather services normally handle the routine network monitoring and sometimes help in the other types of measurement mentioned above. This discussion will deal mainly with generalized routine network monitoring.

The requirements for the type, number, and accuracy of instruments used in research depend on the research effort. Research includes the determination of: (1) secular trends in solar radiation; (2) the effect of albedo on collected solar energy and (3) the effect of turbidity on solar radiation transmission.

Network scale instruments are generally confined to global (total or 180°) pyranometers and normal incidence sensors. Requirements for many other measurements have been stated. These include (1) radiation received on inclined surfaces (theoretically this can be deduced from direct and diffuse radiation); (2) radiation in the vicinity of the solar disc; (3) spectral distribution of direct and diffuse radiation; (4) long-wave sky radiation or sky temperature; (5) polarization. The United States of America is following Canada's lead in using sun shields rather than pyrheliometers to meaure the direct solar radiation.

Accuracy is crucial to network instrumentation. In the United States of America the user community has asked for data as accurate as the state of the art of designing instruments for network operations will permit. This accuracy has generally been quoted at 5 per cent. On the other hand, those who are skeptical of the need for such accuracy point out that (1) engineers invariably allow a large margin of safety which can accommodate the insolation uncertainties and (2) that the natural variability of solar radiation due to changing cloud cover is very large. Solar energy proponents argue that because of the need to make solar collector systems economically competitive with fossil fuel devices, there will not be a large margin of safety in engineering solar collector systems.

With respect to the relative contribution of natural variability and observational errors, some preliminary but fairly convincing studies carried out in the United States of America suggest that a 5 per cent error of observation is very small compared to climatological variability. The introduction of hypothetic random errors of 5, 10, 25 and 50 per cent (standard deviations) into winter solar radiation values obtained daily by the Monte Carlo technique at a station near Chicago, Illinois, and at Mauna Loa, Hawaii, in the United States of America resulted in virtually no change in the frequency distribution of the percentage of values in different classes of solar radiation amounts at 5 per cent but in significant differences at 50 per cent. At the station near Chicago, the errors of 10 and even 25 per cent also resulted in little change in the frequency distribution; but at Mauna Loa, where the distribution was sharply peaked at a high insolation value, the distribution flattened out somewhat even with 10 per cent errors. The mean values were altered insignificantly with all errors; the mean value is not sensitive to random errors introduced into the data. The number of runs (successive days) with solar radiation readings less than some prescribed values were also not altered significantly for 5 or 10 per cent errors but were changed with 50 per cent errors. In general, the year-to-year differences were much larger for both the frequency distributions and the number of runs than were introduced by the 5 or 10 per cent errors.

While the above study contains certain flaws and must be viewed as provisional, it very much suggests that natural variability of solar radiation rather than small random errors of observation controls the statistics needed by the solar energy technology community.

An improved network of solar radiation instruments will not satisfy current demands for insolation data. It is necessary to evaluate and, if possible, to improve the existing data base. Regression equations have successfully related global solar radiation both to daily sunshine duration and daily cloudiness. Completely theoretical calculations of direct and diffuse radiation can also be obtained.

In the United States, the quality of the data base has been examined by studying the clear-sky, true solar noon values (corrected for the earth-sun distance and zenith angle of the sun). In theory, if the radiation transmitted is the same on all days, the corrected readings should be constant. The degree of variability may be viewed as reflecting observational errors (although variable absorbers such as water vapour and dust play a role). Provisional studies in the United States show that when various instrumental corrections are applied after the fact to the reported values of solar radiation, the variance of the corrected values decreases significantly over the uncorrected values. An analysis of a record of clear-sky, true solar noon values (corrected for earth-sun distance and zenith angle) can reveal the quality of the data base and provide an objective guide in deciding which data is reliable. Wherever instrument corrections are known, they should be applied.