NBRRI

NBRRI REPORT NO. 7

MEASUREMENTS OF GLOBAL SOLAR RADIATION IN NIGERIA

NIGERIAN BUILDING AND ROAD RESEARCH INSTITUTE

Foreword

Nigeria lies in the tropics and therefore receives a great amount of solar energy which could be judiciously harnessed for various applications. However, there appears to be no record of direct and extensive measurement of solar radiation in Nigeria to facilitate and encourage the rational use of this energy.

To correct this situation, the Nigerian Building and Road Research Institute established thirty solar energy measurement stations spread over the country. The global solar radiation data thus obtained by direct measurement on horizontal surfaces are presented in readily useable tabular form in this report. The data presented in this report are the first known comprehensive direct measure ment records of solar radiation in Nigeria.

This report will be an invaluable aid to architects, building scientists, engineers and solar energy technologists in the design of energy efficient buildings, development of efficient solar devices and applications of solar energy in the field of agriculture.

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December 1990

SUMMARY

This report summarises, in tabular form, the records of global solar radiation on a horizontal surface recorded at 30 stations in Nigeria. Integrated values of hourly and daily sums of global radiation recorded with LM–3000/10 solar recorder are given for each month in the units of watt-hours/m^2 wherever the data are available. The records range from a few months at some stations to about 12 months at some others. Monthly means are also calculated and tabulated.

1. INTRODUCTION

Extensive solar data for Nigeria are not available as no detailed measurements of solar radiation have been carried out either by the Meteorological Department or any other organisation in the country. Theoretically calculated reliable solar data are also not available. Therefore, measurement and subsequent production of long term solar radiation data in the form of tables and maps are of utmost practical significance to building scientists, architects, engineers and solar technologists for the design of energy efficient buildings and development of efficient and economic solar devices. Meteorology and agriculture are other fields where solar energy data find frequent applications.

2. THE SOLAR STATIONS

With the aim of determining the distribution of solar radiation in Nigeria, a network of 30 solar radiation stations was established throughout the country. These stations are Abuja, Akure, Azare, Bauchi, Benin, Calabar, Enugu, Ibadan, Ilaro, Ilorin, Jos, Kaduna, Kano, Katsina, Koko (near Yelwa), Lagos, Lokoja, Maiduguri, Makurdi, Minna, New Bussa, Nguru, Obudu, Onitsha, Owerri, Port-Harcourt, Serti (Gongola State), Sokoto, Warri and Yola. These solar experimental sites include all the State capitals and some other points characterised by low or high altitude, e.g. Obudu in Cross River State. Most of the sites are located in higher institutions of learning like Universities and Polytechnics, so that the recorders remain under the supervision of qualified personnel having research orientation. The spread of solar stations throughout Nigeria is shown in Fig.1.

3. THE SOLAR RECORDING SYSTEM

The solar equipment installed at these stations is the LM–300/10 solar recording system (solar integrator) obtained from Hollis Observatory, U.S.A. and is shown in Fig.2. This recording system is unique in that it records both the instantaneous and the integrated values of global solar radiation simultaneously on the same chart. Thus a history is maintained for current and future use. A photovoltaic array provided with the equipment supplies power to the recording system. The pyranometer is a silicon based instrument which has been temperature compensated from $-20^{o}C$ to $+40^{o}C$ and has been designed for the measurement of total sun and sky radiation (global radiation). It is calibrated in comparison to a thermal response pyranometer having a useful band pass of 0.28 to 2.8. micron.

4. THE RECORDING OF GLOBAL SOLAR RADIATION ON A HORIZONTAL SURFACE

The recording of global solar radiation (direct + diffuse) was carried out at all the 30 stations mentioned above for about a year. A typical record of solar data is shown in Fig. 3 for Azare Station (Lat. $11^{o}55'N$, Long. $10^{o}10'E$) for two days, one cloudy and the other clear. The instantaneous values of solar intensity can be read from this type of curve along the vertical axis in watts/m^2 for any time from sunrise to sunset. The integrated values of solar radiation over a given time interval can be derived from a series of event marks on the top of the chart denoted by long (II) and short (I) marks. For example the global radiation on the horizontal surface for the clear day shown in Fig.3 is about 5.2 kWh/m^2/day. Due to error in the chart speed and event marking system of the recorders, the integrated values of global radiation cannot be read directly as should have been the case for a normal instrument. However, a method was devised to determine integrated values of global radiation from the time scale and the event marks on the charts. In this way, hourly and daily variation of solar radiation in the units of watt-hours/m^2 have been prepared for those days and months for which the charts seemed to be good. The time is given in local apparent solar time (L.A.T.) for the place and day. In this system, the sun is at zenith at solar noon. The daily and monthly means of solar radiation are also tabu-

lated. In certain months, the data is not available for all the days and mean monthly values in such cases represent only the mean of those days on which data are available. Due to unexpected failure of the majority of instruments, regular and long term recording of the data could not be carried out. Therefore, data are presented here for whatever days and months they are available. For some of the stations, either there is no recording at all or it is very meagre. In view of all this, the initial aim of determining the distribution of solar radiation over Nigeria in the form of a map could not be immediately carried out. But the results presented here are quite useful as practically no such information was available to users in the past in this country.

ACKNOWLEDGEMENT:

The cooperation and contributions of all the Research Associates in all the 30 solar stations throughout the country and that of Messrs. L. K. Komolafe and J. O. Ojosu are acknowledged. Mr. G. N. Omange assisted in the preparation of this report for publication.