COMPUTER AIDED SIZING OF PV SYSTEMS TO SUIT DIFFERENT GEOGRAPHICAL REGIONS IN KENYA

BY

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DECLARATION

This Thesis is my original work and has not been presented for a Degree in any other University.

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This Thesis has been submitted for examination with my approval as a University supervisor

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ABSTRACT

In theory, Photovoltaic (PV) systems can be sized to meet any load demand. The size and viability of such systems depend on the load demand and its variability, availability of solar resource at the site, and the efficiency of the individual components involved between the energy source and the load.

The design of a photovoltaic system, therefore, relies on a careful assessment of solar radiation at a particular site. Although solar radiation data have been recorded for many locations in the world, they have to be analyzed and processed before a sufficiently accurate estimate of the available solar radiation for photovoltaic system can be made. Among the common statistical characteristics computed from the solar radiation data for the purpose of solar system design, is the expected number of days in a year or in a given period of time in which daily radiation data falls within a specified range of values. Knowledge of the frequency of occurrence of periods of successive days of low radiation is also needed as a storage requirement in a solar system. The global solar radiation, and its angular dependencies on tilted surfaces is also of paramount importance, since most solar collectors are always positioned on an inclined plane. In Chapter 2 of this work, daily data from the Meteorological Department for 8 years (1985-1992) of 9 stations representing the whole country fairly well, has been collected and analysed. The main aim was to study the site potentiality for solar systems applications. It has been established that the country receives ample solar radiation the whole year round, typical of an average insolation of 20MJ/m^2 day^{-1} with little possibility of less than 13MJ/m^2.

A Photovoltaic system is composed up of several components, e.g. the solar panel, the storage system, charge controller, maximum power point tracker etc. However, different types of these components are made by use of various technologies which ineffect affects the performance of a PV system. Knowledge of the performance of each component is of vital importance in the design of the PV system. Secondly, the performance of the PV modules and other components varies from place to place depending on the weather conditions at the site. Outdoor tests performed over a period of time is the best way of evaluating the components, and hence, the system performance. In chapter 3 of this work, a manual data acquisition method has been designed and employed to characterize the two most commonly used photovoltaic modules for a period of time. From these tests, the efficiency of the monocrystalline panel was found to be 10%, while that of the amorphous solar panel is 6%. However, the manual method has been

found to be slow and inaccurate due to the rate of change in the weather conditions. Due to this, an automatic data logger has been designed and implemented in Chapter 4, using the versatile BBC microcomputer's 1MHZ bus.

Since the capital cost is the major component of the solar systems, the sizing procedure determines the cheapest combination of array size and storage capacity that will meet the load requirements with an acceptable level of security over the expected lifetime of the installation. Where 'cheapest' means the system with the lowest life cycle costs and 'availability' (reliability) is the percentage of a specified period of years over which the system is likely to meet all load demands. A software program in dBASE IV has been developed, to enable users and designers to get the optimum size of the system, given the station of interest, latitude, albedo and load demand as inputs. Also the software computes the economic analysis of different types of energy sources given the number of years of interest, inflation rate etc. This enables users and designers to evaluate the system with low life cycle cost given a number of energy supplying systems.