Solar Radiation Prediction Models Analysis for Varying Climatic Conditions

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Abstract:

This study has investigated global solar predictive models, modified, validated and compared five models, for prediction of monthly daily mean solar radiation in four different locations of Kenya that represents the four major climatic conditions. The input variables to the models were; latitude, day length, sunshine hours, relative sunshine hours, temperature, and precipitation. Solar radiation data from 2000 to 2013 was used to obtain the monthly daily mean global solar radiation, to analyze, validate and compare the performance of the models. The predicted and measured data was simulated using MATLAB. Statistical indicators, MBE, RMSE, t-test and R, were performed to determine the models performance. The results showed that sunshine hours based models predicted global solar radiation with higher accuracy in wet and cold, wet and warm climatic conditions, while the temperature and precipitation models were accurate in solar radiation prediction in hot and dry climatic conditions.

Key words: Global solar radiation1, Sunshine hours2, Day length3

I. INTRODUCTION

Solar radiation energy is the direct abundant and permanent form of energy resource available on the earth due to the nuclear fusion on the sun. The sun receives about one hundred thousand TW of this renewable energy. The clouds, gases, and pollution in the atmosphere decrease this energy to less than 800 times the energy available on earth surface [1].

Solar radiation data for different locations is required for many applications such as calculation of water budget, architectural engineering, determination for power levels in PV modules, and calculation of cooling load in buildings [2]. The design of solar energy application systems requires precise data and knowledge of the available global solar radiation at the location of interest for accurate design of the systems [3].

Solar radiation is only measured by a few weather stations in developing countries due to economic and historical reasons, particularly in remote areas of the developing countries [4].The study of solar radiation under local meteorological conditions is essential as the solar radiation reaching the earth surface depends on the local meteorological conditions [5]. For this reason, location where meteorological data is unavailable, solar radiation can be estimated from models and empirical correlations based on available data. Several formulated models have been explored for estimation of solar radiation with reasonable accuracy from available meteorological data. However, most of the models require astronomical and physical parameters that are unavailable in most developing countries [6], [7].

According to [8], [9], meteorological parameters used as inputs in the relationships includes; astronomic (solar constant, world sun distance, solar declination and hour angle); geographical (latitude, longitude and altitude); geometric (surface azimuth, surface tilt angle, solar altitude and solar azimuth); physical (albedo, scatterings of