JOURNAL OF RENEWABLE AND SUSTAINABLE ENERGY 7, 053105 (2015)

Estimation of mean monthly global solar radiation using sunshine hours for Nairobi City, Kenya

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(Received 26 January 2015; accepted 21 August 2015; published online 17 September 2015)

This study estimates the total solar radiation potential over Nairobi City. Several theoretical models based on the initial work of Angstrom have been used to estimate the global solar radiations on a horizontal surface for the city, using bright sunshine hours for the period 2004–2014. The models were developed using the 2004–2012 sunshine hours data and validated by comparing with measured values for 2013 and 2014. Dependencies of the models were tested using Mean Bias Error, Root Mean Square Error, the Nash–Sutcliffe Equation and *t*-statistics. The result of clearness index for Nairobi shows that the sky is clear all year round except during the June-July-August season where K_T is less than 0.5. Most models tested in the current studies were able to adequately estimate daily mean monthly global radiation from sunshine duration with Akinoglu and Ecevit model giving the best estimation. © *2015 AIP Publishing LLC.*
[http://dx.doi.org/10.1063/1.4930530]

I. INTRODUCTION

Mapping of solar radiation on earth's surface is essential in assessing the climatological potential of a region with regard to solar energy utilization and estimation of the expected values of the output of concentrating solar collectors. According to Iqbal (1983), information on distribution of solar irradiance is essential in weather and climate studies, agriculture, hydrology, food industry, environmental pollution, and non-conventional energy development programs. In many solar energy applications, the average global solar radiation and its components are the most important parameters. However, the equipments required to carry out these measurements are often expensive and difficult to maintain and calibrate (Hunt *et al.*, 1998). As an example, in Kenya, although all the weather stations are equipped with pyranometers, the consistent global solar radiation measurement can only be found at Dagoretti Corner in Nairobi.

In order to overcome these challenges, numerous models have been developed to estimate the global solar radiation using readily available meteorological parameters. These parameters include precipitation (Rietveld, 1978), relative humidity (Trabea and Shaltout, 2000 and Alnaser, 1993), sunshine hours (Koussa *et al.*, 2009 and Akinoglu and Ecevit, 1990), cloudiness (Kumar and Umanand, 2005), and air temperature (Fletcher and Moot, 2007). The models require calculation of constants which need to be evaluated for site specific meteorological and geographical conditions (Marwal *et al.*, 2012). However, Iziomon and Mayer (2002) observed that sunshine based models performed much better than other meteorological parameters models. Recently, predictive models based on artificial intelligence techniques such as neural network (Lopez, 2000; Sözen, 2004; and Krishnaiah *et al.*, 2007) and satellite derived (Frulla *et al.*, 1988; Olseth and Skartveit, 2001; Janjai *et al.*, 2009; and Senkal, 2010) have been developed. The latter models can handle large amount of data and provide comparatively good estimations.

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