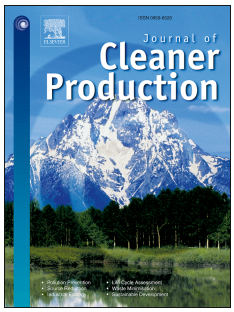
Accepted Manuscript



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PII: S0959-6526(16)30805-8

DOI: 10.1016/j.jclepro.2016.06.128

Reference: JCLP 7499

To appear in: *Journal of Cleaner Production*

Received Date: 2 September 2015

Revised Date: 26 April 2016

Accepted Date: 21 June 2016

Please cite this article as: Chiteka K, Enweremadu CC, Prediction of global horizontal solar irradiance in Zimbabwe using artificial neural networks, *Journal of Cleaner Production* (2016), doi: 10.1016/j.jclepro.2016.06.128.

Prediction of global horizontal solar irradiance in Zimbabwe using artificial neural networks

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Abstract

Reliable knowledge of solar radiation is a requirement for informed design and deployment planning of solar energy delivery systems. This study presents the artificial neural network approach for predicting global horizontal irradiation for major locations in Zimbabwe. The prediction of global horizontal irradiation was carried out using geographical data of altitude, latitude and longitude and meteorological data of humidity, pressure, clearness index and average temperature. A neural network with an input layer that has seven inputs was used together with one hidden layer and an output layer with one output. A network with 10 neurons and a tansig transfer function in both the input and output layers was found to be the best predictive model of all of the models evaluated. This network achieved a coefficient of determination of 99.894%, a root mean square error of 0.223 kWh/m^2/day, a mean absolute error of 0.17 kWh/m^2/day and a mean absolute percentage error of 2.56%. The study shows that the artificial neural network model can also be used to predict global horizontal irradiation the day before and the day after with mean absolute percentage errors of 5.9% and 7.6%, respectively. Statistical analysis of the results indicates that the clearness index, temperature and humidity had significant contributions of 19%, 18% and 17%, respectively, to the general performance of the artificial neural network model. An artificial neural network model developed using the clearness index alone as the input parameter gave a mean absolute percentage error of 5%. It may, therefore, be concluded that the clearness index could be used as the only parameter to predict global horizontal irradiation.

Keywords: Artificial neural networks, Global horizontal irradiation, Solar radiation, Renewable energy, Prediction model

1. Introduction

Renewable energy has become an essential part of our global economy and there has been a tremendous push towards its use as an alternative energy source due to the increasing global shortage of energy and other environmental concerns. Solar energy is considered to be the most effective and economic alternative energy resource. It is regarded as one of the most important clean and renewable energy sources; solar energy is derived directly from the sun in the form of radiation (Qazi et al., 2015).

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