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# Solar Energy for Power Generation: A Review of Solar Radiation Measurement Processes and Global Solar Radiation Modelling Techniques

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*Abstract* - *Solar Energy is the cleanest and the most abundant renewable energy in the world. Solar radiation data are the most important resources needed for solar energy system design. Knowledge of the amount of available solar radiation in any location of interest is of prime importance to the solar energy design experts. This study examines the influence of atmospheric components on solar radiation passing through the earth's atmosphere. The intensity of solar radiation is attenuated as it passes through the earth's atmosphere. Also, methods of solar radiation measurement and the various empirical models for estimating global solar radiation in areas where such data are not available are presented. However, no method can be acclaimed to be the best as the performance of the models vary with location. Hybrid parameter based models have been reported to predict global solar radiation on horizontal surface with a high degree of accuracy in many locations across the globe. Finally, two simulation tools for analysing solar power system were discussed. RETScreen software is majorly used for photovoltaic applications while HOMER includes additional renewable energy simulation features which make it suitable for analysing hybrid power system.*

***Keywords: Solar Radiation, Meteorological Data, Empirical Models, Simulation Models, Homer***

## 1.0 INTRODUCTION

The need for adequate and sufficient power generation to meet the energy need of the populace is a global issue. Power generation (Electricity supply) is of great concern either due to its inadequacy, as in the case of some developing countries, or the exhaustible nature of the conventional power sources and its associated environmental challenges. This has turned people's interest to renewable energy as a means of bridging the energy gap and providing environmentally friendly energy.

Solar Energy is the cleanest and the most abundant renewable energy in the world. Solar radiation data is the most important resource needed for solar energy system design. So the knowledge of the available solar radiation in any location of interest is of prime importance to a solar energy design expert. To generate electricity from solar energy, there is need to understand the spatial and temporal variation of solar energy on earth, and the factors responsible for such. Also, due to unavailability of solar radiation data in many locations, the solar energy system design expert must be familiar with the various models used to estimate global solar radiation so as to determine the amount of global solar radiation available at any location from the available meteorological parameters. Therefore, the focus of this paper is to address the above issues by: reviewing the processes of solar radiation transmission to earth, exploring some empirical models for estimating global solar radiation, as well as simulation models for solar power system design.

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## 2.0 BASICS OF SOLAR RADIATION

Solar radiation is the electromagnetic radiation emitted from the sun. The sun is the source of almost all the energy on earth. Solar energy therefore refers primarily to the light and radiant energy from the sun. The temperature of the sun decreases from a central value of about $5 \times 10^6$ K to about 5,800 K at the sun's surface. The source of solar energy is believed to be generated from the steady conversion of four hydrogen atoms to one helium atom in the interior of the sun with temperature up to many millions of degrees.

It is estimated that the sun radiates energy into space at the rate approximately $3.8 \times 10^{20}$ MW (Smil, 1991). The earth intercepts only a small fraction of the energy ranging from the ultraviolet (UV) to the infrared (IR) in the wavelength range between 0.3 and 3.0 μm. The earth receives 174 petawatts (PW) of incoming solar radiation known as insolation at the upper atmosphere. Approximately 30% of this is reflected back to space while the rest is absorbed by clouds, oceans and land masses. The total solar energy absorbed by the earth's atmosphere, oceans and land masses is approximately 3,850,000 exajoules (EJ) per year (Smil, 2006). The