DEVELOPMENT OF A SYSTEM FOR SOLAR RADIATION MONITORING BASED ON A BROAD-SPECTRUM SPECTROMETER

Faviola Romero, Oscar Urquidi, Omar Ormachea, Augusta Abrahamse, Joshua Pearce, Rob Andrews, Matthew de Vuono

ABSTRACT

The quantum efficiency of photovoltaic materials depends on the wavelength of the incident radiation; hence variations in the solar spectrum influence the amount of energy produced by a photovoltaic system. In this work we describe the design and construction of a functional prototype based on a broad-spectrum (UV-VIS-NIR) spectrometer for monitoring solar radiation (global and diffuse) in Cochabamba, Bolivia. Together with a similar system installed in Kingston, Ontario, data collected in these two geographically distinct locations will aid in the study and optimization of photovoltaic materials for implementation in various parts of the world where the incident solar radiation likely has have different spectral characteristics.

The mechanical structure of the system, constructed from 60x30mm aluminum profiles, was designed to support a quartz fiber optic cable that transmits the solar radiation to an Ocean Optics USB4000 (200-900 nm) spectrometer. The electronic controls make use of an Arduino UNO microcontroller to synchronize the movement of two PAP bipolar (stepper) motors with the activation of the spectrometer via an external trigger.

A principal characteristic of the system is that it enables the measurement of both global and the diffuse component of the solar spectrum at different angles of incidence. The mechanical system moves the end of the fiber optic cable, oriented to face north from 0 to 90 degrees with respect to the horizontal. Every9 degrees measurements of the solar spectrum are taken. First the global radiation is recorded, then a semicircular shadow band, designed to block out the sun and the circumsolar disk, is moved into position, permitting the measurement of the diffuse component of the solar spectrum. The system takes hourly measurements of UVA, VIS and part of the NIR solar spectrum. We have taken preliminary measurements in El Alto (4062 masl) and Cochabamba (2570 masl) and find, as predicted, differences in the solar spectrum under similar environmental conditions. Notably, measurements show greater amounts of UVA at the higher elevation.

Keywords: Solar Radiation Monitoring, Spectroscopy, Photovoltaic Systems.