Evaluation of artificial neural networks with satellite data inputs for daily, monthly, and yearly solar irradiation prediction for Pakistan

ABSTRACT

Solar irradiation is the most critical parameter to consider when designing solar energy systems. The high cost and difficulty of measuring solar irradiation makes it impractical in every location. This study's primary objective was to develop an artificial neural network (ANN) model for global horizontal irradiation (GHI) prediction using satellite data inputs. Three types of ANN, namely, the feed forward neural network (FFNN), cascaded forward neural network (CFNN), and Elman neural network (EMNN), were tested. The findings revealed that altitude, relative humidity, and satellite GHI are the most effective parameters, as they are present in all the best-performing models. The best model for daily GHI prediction was FFNN, which decreased daily MAPE, RMSE, and MBE by 25.4%, 0.11 kWh/m^2/d, and 0.01 kWh/m^2/d. The FFNN daily MAPE, RMSE, and MBE values were 7.83%, 0.49 kWh/m^2/d, and 0.01 kWh/m^2/d. The EMNN performed best for monthly and annual prediction, reducing monthly MAPE, RMSE, and MBE by 50.62%, 0.13 kWh/m^2/d, and 0.13 kWh/m^2/d, while the reduction for yearly was 91.6%, 0.11 kWh/m^2/d, 0.2 kWh/m^2/d. The EMNN monthly MAPE, RMSE, and MBE values were 3.36%, 0.16 kWh/m^2/d, and 0.16 kWh/m^2/d, while the yearly values were 0.47%, 0.18 kWh/m^2/d, and 0.004 kWh/m^2/d.