

Solar irradiation prediction using empirical and artificial intelligence methods: A comparative review

ABSTRACT

Solar irradiation data is essential for the feasibility of solar energy projects. Notably, the intermittent nature of solar irradiation influences solar energy use in all forms, whether energy or agriculture. Accurate solar irradiation prediction is the only solution to effectively use solar energy in different forms. The estimation of solar irradiation is the most critical factor for site selection and sizing of solar energy projects and for selecting a suitable crop selection for the area. But the physical measurement of solar irradiation, due to the cost and technology involved, is not possible for all locations across the globe. Numerous techniques have been implemented to predict solar irradiation for this purpose. The two types of approaches that are most frequently employed are empirical techniques and artificial intelligence (AI). Both approaches have demonstrated good accuracy in various places of the world. To find out the best method, a thorough review of research articles discussing solar irradiation prediction has been done to compare different methods for solar irradiation prediction. In this paper, articles predicting solar irradiation using AI and empirical published from 2017 to 2022 have been reviewed, and both methods have been compared. The review showed that AI methods are more accurate than empirical methods. In empirical models, modified sunshine-based models (MSSM) have the highest accuracy, followed by sunshine-based (SSM) and non-sunshine-based models (NSM). The NSM has a little lower accuracy than MSSM and SSM, but the NSM can give good results in sunshine data unavailability. Also, the literature review confirmed that simple empirical models could predict accurately, and increasing the empirical model's polynomial order cannot improve results. Artificial neural networks (ANN) and Hybrid models have the highest accuracy among AI methods, followed by support vector machine (SVM) and adaptive neuro-fuzzy inference system (ANFIS). The increase in efficiency by hybrid models is minimal, but the complexity of models requires very sophisticated programming knowledge. ANN's most important input factors are maximum and minimum temperatures, temperature differential, relative humidity, clearness index and precipitation.