Long-term Solar Irradiance Forecasting Approaches – A Comparative Study

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***Abstract*—The need of solar irradiation forecast at a specific location over long-time horizons has attained massive importance. In this paper, we study the machine learning techniques to predict solar irradiation in 10 min intervals using data sets from Killinochchi district, Faculty of Engineering, University of Jaffna measuring center. The accuracies of the prediction models such as ARIMA, Random Forest Regression, Neural Networks, Linear Regression and Supportive Vector Machine is compared. This study suggests that ARIMA performs well over other approaches.**

Keywords— Solar irradiance, forecasting, correlation, exogenous inputs, prediction, models

I. INTRODUCTION

Photovoltaic (PV) energy has experienced enormous growth in electricity generation [8]. Recently, the installation of PV systems increased rapidly in on-grid and off-grid systems. PV power is the outcome of the solar irradiance which is absorbed by the PV panel. There are numerous parameters including weather parameters affect the performance of PV systems. Depending on the meteorological condition, amount solar irradiance varies and due to that solar power production also differs. In many cases it essential to know about how much solar power will be produced depending on the data that stations have already collected. So all these past values of solar irradiance and weather data is very important to get an accurate solar forecasting model and build a profitable power plant.

Wang et al. [1] investigated weather classification based modeling is an effective way to increase the accuracy of day-ahead short-term (DAST) solar PV power forecasting because PV output power is strongly dependent on the specific weather conditions in a given time period. Prasis et al. presented solar power output prediction using long short term memory (LSTM) network of artificial neural network[2]. Jordi et al. derived a probabilistic forecast of the solar irradiance during a day at a given location, using a stochastic differential equation model[3]. Alex et al. assessed the performance of machine learning techniques and their validity in improving short term solar forecasting[4]. The machine learning approach was compared to other forecasting methods, and individual machine learning algorithms were compared against each other[4]. Peder et al. approached to online forecasting of power production from PV systems. The method is suited to online forecasting in many applications and it is used to predict hourly values of solar power for horizons of up to 36hrs[5]. Atsushi et al. proposed the power output forecasting for PV system based on insolation prediction by using Neural Network[6]. The merit of the proposed method is that it does not require complicated calculations and the mathematical model with only meteorological data.

For a comprehensive review of application of Artificial Intelligence (AI) methods in solar PV systems one can refer to the work by Mellit et al. where they concluded that AI methods are interesting in PV systems because they need less computational effort and do not require knowledge of the internal system parameters[7]. Another review paper is that by Inman et al. who categorized the methods used for developing solar forecasting as regression methods, time series, artificial neural networks (ANN) and other methods, and under each category briefly discussed basic ideas and reviewed the relevant literature[8].

Lauret et al. used machine learning techniques along with an AR model to predict solar radiation using historical data from three French islands[9]. They observed that at 4-hour ahead horizon, machine learning models slightly outperform the Linear AR model but the gap becomes more significant in the case of unstable sky conditions[9]. Koca et al. used ANNs to predict solar radiation using state and meteorological data and concluded that input variables can significantly affect the performance of ANN models[10,11].

For our research study, we have chosen Killinochchi district, Faculty of Engineering, University of Jaffna has its own solar measuring station which was donated by Sri Lanka Sustainable Energy Authority (SLSEA) with the support of Asian Development Bank (ADB). Temperature, wind speed, wind direction, humidity, air pressure, diffused solar irradiance and global solar irradiance from the solar measuring station are recorded using data logger. We selected this geographical location for our research study because it has a lot of potential for solar PV.

In our research study, time series approaches such as ARIMA model is used to forecast the solar irradiance. Further machine learning approaches such as Random Forest Regression, Neural Networks, Linear Regression and

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