# Abstract

This thesis focuses upon forecasting of solar irradiance using historic data. The main contribution of the thesis is to utilize the advantages of standalone models and combine them for better accuracy. Although, we present a review of some of the existing data driven models but our primary objective is to predict the solar irradiance only for short horizon time. With the fast growth of solar power plants, especially in developing countries, there is an increasing demand of precise forecasting of solar irradiance. It plays key role in successful integration of solar power generation and the electricity grid and ensures stable operations of the grid by minimizing the impact of solar intermittency. The solar irradiance forecasting models are primarily classified into two broad categories; physical models and data driven models. Physical models utilize science of physics and depend on interactions between the physical state and dynamical motion of the sun. The data driven or statistical models utilize past observations to predict the futuristic values. These statistical models are further categorized into time series models and machine learning models. Choice of model also depends upon the time horizon. Time series models, such as AR (Autoregressive), MA (Moving Average) and ARMA, are more suitable for short term forecasting. Applications of these models are limited because these models require the data to be stationary. Although, there are techniques which convert the non-stationary data into stationary data but this conversion does not work for the data with high variability. Subsequent research outcome confirms that use of learning based models gives better forecast accuracy as compared to the time series models. This has opened doors for the applications of artificial neural networks (ANN) and other machine learning models in the field.

Combination of two or more techniques (hybrid models) is seen as a recent advancement in the field of solar forecasting. These hybrid models are more advantageous than the stand-alone models as they perform better than those individual models. Sometimes, preprocessing techniques are also used in the construction of a hybrid model. These data processing techniques help in better understanding of data and underlying patterns. These techniques are effective in controlling the outliers, seasonality and various trends present in the solar irradiance data and make hybrid models more suitable for all forecast time horizons. In this thesis, we have presented few frequently used preprocessing techniques that are used in the construction of hybrid model.

Two hybrid models that utilize preprocessing techniques in their construction are proposed in the thesis. In the first proposed model we implement an ensemble model that comprise of discrete wavelet transform (DWT) and feed forward neural network (FFNN). The results obtained from the stated hybrid model are compared with the model that does not use DWT. In continuation to that we propose second ensemble model that comprises of data mining techniques DWT and STL and uses FFNN as a predictor. We also compared the forecast error with other candidate models like (1) FFNN (2) hybrid of STL and FFNN and (3) persistence model. The results show that the performance of proposed model is better than the other candidate models.

Lastly we analyze the performance of two solar PV systems of 43 kW amorphous-silicon and 58 kW multicrystelline-silicon grid-connected PV systems. Along with solar irradiance prediction, proper analysis of PV power plant is also needed to predict the energy injected into the grid for a given PV power plant. It is also useful to evaluate the system loss and development of technology. The performance indices that are used for study of systems are performance ratio, specific yield, reference yield, capture loss, system loss, system efficiency, PVUSA rating and performance indicator based on ratio of ac power at PTC to dc power at STC.

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