SHORT-TERM FORECASTING OF SOLAR POWER GENERATION: WITH REFERENCE TO A CASE STUDY OF A LARGE-SCALE PHOTOVOLTAIC PLANT IN SRI LANKA

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Abstract

Energy is required by all countries in the globe to provide fundamental human requirements and to aid industrial activities. Due to the scarcity of fossil fuels, depletion of energy resources, pollution, unfavorable climatic changes, and rising costs, the use and development of green energy sources is becoming more popular. Manipulation of renewable energy sources also reduces reliance on fossil fuel supplies and carbon emissions into the atmosphere. It's also a technique for dealing with the issues of increased energy demand as a result of population growth. When compared to other renewable energy sources, photovoltaic energy systems have a high energy production potential. Although solar energy has many benefits, anticipating the power generation of photovoltaic systems is important and difficult because it is strongly dependent on weather conditions.

When considering Sri Lankan context, the government, the Ceylon Electricity Board, and other regulatory bodies are focusing on reliable power generation forecasting related to renewable energy sources, particularly related to solar energy due to the current nationwide long power outages caused by fuel scarcity and economic crisis. This study on the development of a statistical time series model to forecast short-term solar power generation in a large-scale Photovoltaic (PV) plant in Sri Lanka considering weather conditions is expected to assist solar power vendors in providing a reliable solar power supply by identifying excesses and shortages in power generation during different time periods and under different weather conditions.

The time series data considered in this study includes historic solar power output and weather data of past two years. Rainfall, temperature, relative humidity, cloud cover, wind speed, and sun irradiation are some of the weather parameters addressed in the study which are all independent variables. The other independent variable is the past solar power output of a photovoltaic facility in the Beliatta area of Sri Lanka, with the solar power output at time T as the dependent variable. The Meteorological Department of Sri Lanka provided historical data of weather parameters.

The timeseries data involved with this study was statistically analyzed and multivariate time series models were developed using FB Prophet machine learning (ML) technology combining with python programming language. Initially, six multivariate time series forecasting models were created to identify the behavior of the dataset based on its descriptive statistics. Then the final time-series forecasting model was created to predict the future weather conditions and thereby the solar power output for near future. The performance of the model was assessed via cross validation and creating a performance matrix.

The findings of this research study demonstrated that FB Prophet can efficiently handle datasets with strong seasonality. Rainfall, cloud cover, wind speed, and relative humidity have all been found to have a negative correlation with solar power output, whereas temperature and solar irradiation have a positive correlation. Finally, a reliable multivariate forecasting model was created using feature engineering approaches in FB Prophet, which anticipated solar power generation for a short period with reduced variance from true values.

Key Words: Time Series Forecasting, FB Prophet, Photovoltaic Plant, Multivariate Time Series Models