FORECASTING OF WIND POWER GENERATION USING WIND SPEED AND TEMPERATURE FOR THAMBAPAWANI WIND FARM IN SRI LANKA

Mestiyage Dona Chathumini Pramashi Gunathilaka

189056V

Dissertation submitted in partial fulfillment of the requirements for the degree Master of Science in Business Statistics

Department of Mathematics

Faculty of Engineering

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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:

The above candidate has carried out research for the PhD/MPhil/Masters thesis/dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

Name of Supervisor:

Signature of the Supervisor: Date:

DEDICATION

This study is wholeheartedly dedicated to my family, who have been the source of inspiration and gave me the strength when I thought of giving up, who continually provide their moral, spiritual, emotional, and financial support.

ABSTRACT

Wind power generation is a rapidly growing renewable energy resource in the world, both on a small and large scale. By integrating wind power generation systems, it helps to maintain grid stability, meet renewable energy targets, reduce greenhouse gas emissions, and promote economic growth while enhancing energy security by diversifying energy sources. Due to the intermittent nature of the wind and the influence of several weather parameters such as wind direction, ambient temperature, humidity, atmospheric pressure, the utilization of energy produced by the wind is challenging while maintaining the grid stability. Addressing this challenge involves the development of accurate forecasting models. Hence, in this study, accurate wind forecast models are built using two main weather parameters: wind speed and temperature for the newly implemented largest on-shore wind farm, "Thambapawani", A univariate model is built for the active power variable using the Seasonal Autoregressive Integrated Moving Average (SARIMA) method. Two different Vector Autoregressive (VAR) models were built with average wind speed and average temperature. However, all these models fail to grasp the intermittent nature of wind power alone. Therefore, hybrid models were generated using the above-mentioned models as mean models and Generalized Autoregressive Conditional Heteroskedasticity models as conditional variance models. All hybrid models were validated using the same test data set and evaluated with one of the goodness of fit tests called the root mean squared test. In this research, the forecasting horizon is 48 hours and the data resolution is 1 hour. The hybrid model of SARIMA (1,1,1) $(1,1,1)_{24}$ with GARCH (1,1) is selected as the best-fit model that has the lowest RMSE value compared to the other two hybrid models in order to forecast wind power generation at “Thambapawani” Wind Farm in Sri Lanka.

Keywords: wind power, grid stability, SARIMA, VAR, GARCH

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LIST OF ABBREVIATIONS

ACF	-	Autocorrelation Function
AR	-	Auto Regressive
AP	-	Average Active Power
ARMA	-	Auto Regressive Moving Average
ARIMA	-	Auto Regressive Integrated Moving Average
AWD	-	Average Wind Direction
AWS	-	Average Wind Speed
MA	-	Moving Average
MAE	-	Mean Absolute Error
NRES	-	Non-Renewable Energy Sources
PACF	-	Partial Autocorrelation Function
PV	-	Photo Voltic
RES	-	Renewable Energy Sources
RMSE	-	Root Mean Squared Error
SARIMA	-	Seasonal Auto Regressive Integrated Moving Average
SL	-	Sri Lanka
TEMP	-	Temperature
VAR	-	Vector Autoregressive