

Topic: Short-Term Wind Speed Forecasting by Time-Series Modeling for Rayong, Thailand

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ABSTRACT

The increasing demand for primary energy due to growing economies has led to the search for alternative energy sources, which also include clean or non-polluting sources (such as wind energy and solar energy). Wind energy has long been utilized for electricity generation. From the viewpoint of wind-turbine operation, the main challenge is always the intermittent or fluctuating nature of winds. Wind speed and power forecasting is then considered important as a technical tool to mitigate uncertainty in how much electricity can be generated or available and then supplied to an electricity grid. This study deals with the prediction of hourly wind speed over a short-term horizon of 24 hours using time-series models for a site located in Rayong, Eastern region of Thailand. Observed 100-m wind speed data recorded at a meteorological tower in 2001-2006 were used. The models considered in this study are in the autoregressive integrated moving average (ARIMA) class for a univariate case (here, wind speed) and vector autoregressive (VAR) for a multivariate case. For the latter, wind speed were considered jointly with additional meteorological variables (here, global solar radiation, vertical air temperature difference, and land-sea temperature contrast). The data of the first four years were used in model identification and fitting, while those of the last two years were used to support forecasting and forecast evaluation. Forecasting was implemented in each individual calendar month to resolve the monthly variation of wind speed. A simple persistence model was employed to assess the merit of the time-series models.

The results show that a process of de-diurnalization on the input detrended series in dARIMA and VAR effectively deals with diurnality and leads to better performance. The models were mostly seen to outperform the persistence model, with positive monthly skill scores (in all time-series models (maximum = 0.4), except for VAR in June with zero scores. Overall, every tried model achieves a correlation of 0.52 or higher (maximum =

0.6). In view of model performance as a function of magnitude of wind speed, difficulty in forecasting very low ($< 2 \text{ m s}^{-1}$) and very large ($>10 \text{ m s}^{-1}$) wind speeds is seen in all time-series models. Accordingly, the model performance during the months with relatively high wind speed (on average), generally becomes relatively poor. The model accuracy as a function of forecast hour tends to decrease with increasing hours. With a focus on a forecast window of six hours, mean error (ME) stays within 25-30% of mean wind speed for dARIMA, SARIMA in 11 months and for VAR in all months. From an overall perspective, dARIMA, SARIMA and VAR possess a degree of applicability in actual wind-energy operation. Nevertheless, their enhancement or further adaptation or modification is encouraged for future work so that lower ME is achieved.

Keywords: wind speed; forecast; dARIMA; ARIMA; SARIMA; VAR; performance.