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The Impact of Weather Forecasting on Battery Optimisation for Hybrid Power Plants

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Solar and wind power are the two primary renewable energy technologies around the world aside from hydropower. From renewable statistics [1], wind power and solar PV accounted for 17.26% and 5.91% of global renewable energy generation. Based on an investigation [2], there exists great potential to utilise the complementary characteristics of wind and solar resources and build hybrid PV and wind power plants in Australia.

However, the integration of solar and wind power generation for a hybrid power plant will also bring challenges. For example, the uncertainty will increase with two intermittent renewable resources. In this regard, the implementation of battery energy storage systems (BESS) will be important to smooth out the variability of the renewable energy generation and add more values for hybrid power plants from both economic and technical perspectives. Another critical impact factor is the forecasting for solar and wind, especially for the case that large scale systems are participating in the national electricity market (NEM). When the forecasting is not accurate, there will be causer payment for the renewable energy power plant from Frequency Control Ancillary Service (FCAS) markets. Except for minimising the forecasting errors, battery storage can also be optimised to reduce the uncertainty associated with forecasting, thereby avoiding this penalty.

In light of this, this study focuses on the investigation of the impact of weather forecasting on the battery optimisation for hybrid power systems. Four different forecasting methods were applied for both solar PV and wind forecasting, including persistence, Elman neural network (ENN), wavelet neural network (WNN) and autoregressive integrated moving average (ARIMA). The forecasting accuracy of these approaches is evaluated by forecasting metrics such as mean absolute error (MAE), mean biased error (MBE), root mean square error (RMSE) and normalised root mean square error (nRMSE).

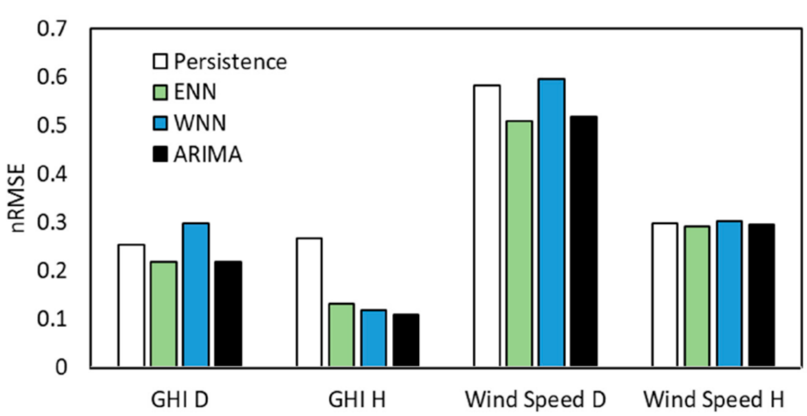

Figure 1. The nRMSE of Different Forecasting Methods (D: Day-ahead forecasting; H: Hour-ahead forecasting)

From the forecasting results, we can see from Figure 1 that hour-ahead forecasting with a shorter forecasting horizon demonstrates higher forecasting accuracy than day-ahead forecasting. Of the four forecasting methods, ENN and ARIMA tend to show higher forecasting accuracy than the persistence and WNN.

This study aims to optimise the scheduling of the BESS using forecasting information from different forecasting methods. Several optimal control strategies, including a mixed receding horizon control (RHC) strategy, are applied to minimise the total operation cost of the entire system, including the operating profits of selling electricity, the costs of ancillary services for undersupply and oversupply, and the operation and maintenance costs of each component [3]. It shows that using a better forecasting method, such as ARIMA, will result in an improvement of 4.5% in the total profit than using the persistence method. Another important finding is the significant impact of the extremely high electricity prices on the total operating profits. The results show that a less accurate forecasting method (WNN) can outperform a more accurate forecasting method (ENN or ARIMA). This is because the less accurate forecasting method is taking advantage of the extremely high electricity prices. Therefore, the forecasting accuracy during the period of time when the electricity is extremely high is really significant to the performance of the battery optimisation.

References

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