OPTIMAL GRID-CONNECTED TARIFF OF WIND ENERGY CONVERSION SYSTEMS FOR MALAYSIA

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DEDICATION

I dedicate this PhD dissertation to my parents in Sandakan, Sabah. I extend the dedication to my siblings, my relatives, friends and well-wishers for their endless support in each and every one of my endeavours.

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The growing interest in wind energy in Malaysia is driven primarily by the government's aspiration in achieving the national target on renewable energy generation capacity. Hence, prior to embarking a commercial wind energy project in Malaysia, a detailed study should be conducted on the potential of wind resources and identification of appropriate policy. The designed policy should take into account the quality of the local wind speed and existing renewable energy incentives in Malaysia. This study predominantly aims for identifying the best policy framework model that suits the wind energy condition in Malaysia. Therefore, to accomplish this goal, the research endeavours the evaluation of potential wind resources based on three aspects, namely (i) installation of wind masts, measurement and analysis of primary wind data, (ii) establishing wind-related models that accomodate Malaysia's scenario, and (iii) derivation of a closed-form equation and determination of the best tariff rates and remuneration models. Initially, the

dependence of power law indexes on surface temperature and terrain types was studied as they are associated with the form of exponential fits. Next, the wind turbine ranking method was improved by incorporating the crucial factors such as height restriction law, wind park capacity target and wake losses into the recent wind turbine ranking framework method. Finally, the optimal tariff modelling was carried out by deriving the generation-cost-based tariff rate determination model, front-loaded remuneration models, and tariff rate differentiation for implementation in Malaysia. The sensitivity analyses were employed to determine the impact of several factors such as the investment costs, discounting rates, debt and equity share, debt interest rates, and capital allowance. The suggested tariff rate differentiation was based on the wind turbine size capacity: small, utility and combine scale. Based on the assumed economic parameters and inclusion of the capital allowance, the conducive baseline tariff rate for a wind park with small-scale wind turbines was 0.9245 RM/kWh and for utility-scale wind turbines was 0.7396 RM/kWh. For a wind park with combined-scale wind turbines, the rate was different for different WTG ratios; in the case where the ratio is 1.4, the tariff rate was 0.7652 RM/kWh. Additionally, the Exponential-Flat remuneration model was the best front-loaded model as it could generate adequate tariff rate interval, as it is a simple model, and can adapt to a few deviations in the wind park generation.