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Assessment of optimal Auxiliary Services for High Renewable Power Systems using Frequency Response Model

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Abstract

The increasing penetration of renewable energy reduces the inertia of the power system, posing a challenge to frequency stability. This study developed a frequency response model based on MATLAB/Simulink for the Taiwan power system. The model integrates TGOV1, dReg, FRR, and RoCoF control components. The frequency response model parameters are fitted to the historical trip frequency data from 2021-2024, which are acquired from the wide-area measurement system (WAMS). The experimental results achieved an average error of only 0.019 Hz.

The model simulated an extreme low-inertia scenario during the future Lunar New Year periods. Results indicate that traditional thermal units, constrained by mechanical response delays, are no longer sufficient to effectively arrest frequency drops. While procuring approximately 1,000 MW of dReg can meet the inertia reference, the introduction of an additional 300 MW of FRR further expands the system's secure operating boundary. Furthermore, this study confirms that RoCoF control technology can provide virtual inertia to suppress the rate of frequency decay. Under optimal configuration, it significantly reduces the minimum inertia required for stability and effectively increasing the margin for renewable energy integration. The results can provide concrete technical reference for Taiwan's future dispatch and resource planning.