PI Controller for Hybrid Biomass- Solar Photovoltaic- Wind in Microgrid: A Case Study of Mersing, Malaysia

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Abstract

Renewable energy (RE) is alternative energy to replace fossil fuels in electric power generation and has evolved into microgrid technology. Integration of RE has caused voltage stability issues in the power system. Reports in earlier studies have included three voltage control methods such as Model Predictive Control (MPC), Proportional Integral (PI) controller, and negative feed-forward voltage control implemented to ensure the voltage stability of microgrids. However, very few research reports apply voltage control in hybrid biomass (BM)-solar photovoltaic (PV)-wind microgrid, choosing only to focus on energy management, economic analysis, and best sizing. For this reason, the main objective of this paper is the integration of a hybrid BM-Solar PV-Wind off-grid microgrid comprising PI controller as the voltage control based on an actual input database at a location in a small rural town named Mersing in Malaysia. Additionally, this paper also intends to illustrate the implemented efforts to support the voltage stability of the system in Mersing. PI controller with a harmonic filter voltage controller is implemented in this study to reduce the total harmonic distortion (THD) percentage. Concurrently the measured THD voltage and current at each RE and distribution line show a percentage below 10%. It is thus shown that a hybrid BM-Solar PV-wind microgrid is stable, especially for distribution lines, according to harmonic standards in the electricity supply application book by the local electricity provider Tenaga Nasional Berhad (TNB). Indeed, a PI controller with a harmonic filter has proven as an effective method for controlling the voltage instability in this study.

Keywords

Author Keywords: Microgrids; Voltage control; PI control; Biomass; Power system stability; Maximum power point trackers; Circuit stability; Voltage control; Renewable energy sources; Hybrid renewable energy; Mersing Malaysia; off-grid microgrid; proportional integral controller; total harmonic distortion; voltage control
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