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Microgrid-Based Solutions for Enhancing the Resilience of Power Systems in Agricultural Regions: A Smart Grid Approach for Green Energy

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Abstract

The potential of smart grid technologies is becoming solutions for the integrity of sustainable energy demand. These concepts will contribute to enhancing the resilience of power systems, particularly in agricultural regions. Despite being highly dependent on reliable power sources, agricultural operations are dealing with challenges such as adverse weather conditions, intermittent renewable energy sources, and interruptions in the grid. This study investigates how smart grid technology combined with microgrid-based systems can improve the sustainability and resilience of power networks in agricultural regions. The objectives include assessing the impact of high renewable energy penetration on grid stability, optimizing energy storage systems for agricultural operations, and implementing demand response techniques to prioritize critical loads. Additionally, the analysis explores methods to address renewable energy intermittency by integrating energy storage systems and implementing strategies to manage the transitions between grid-connected and islanding modes of microgrids. These methods aim to ensure a stable energy supply and reduce disruptions in power distribution during fluctuations in renewable energy generation. The study utilizes MATLAB Simulink to simulate the performance of microgrids under various scenarios, including extreme weather conditions. The simulations are enhanced with a fuzzy logic controller, which facilitates real-time decision-making by dynamically managing changes in energy demand for agricultural operations. This approach enables the evaluation of microgrid resilience in maintaining uninterrupted energy supply for critical agricultural activities while adapting to demand and generation variations. The findings indicate that microgrids can improve the continuation of essential agricultural operations, grid stability, control of renewable energy intermittency and minimize the interruption during the grid disturbances. In order to improve microgrid performance under increasingly unpredictable climate conditions, future implementations will focus on expanding the integration of developing renewable energy technologies and improving adaptive control systems.

Keywords: *Demand management, Microgrids, Renewable energy, Resilience*