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Advanced Algorithms for Multilevel Inverters to Mitigate Harmonics and Improve Power Quality in Renewable-Integrated Smart Grids.

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The global shift towards sustainable energy has driven the integration of renewable energy sources (RES), such as solar and wind, into modern smart grids. While this enhances environmental sustainability, the intermittent nature of RES introduces power quality issues, including harmonic distortion, voltage instability, and poor synchronization, which compromise grid stability and reliability. Multilevel inverters (MLIs) offer a promising solution by generating high-quality output voltages with reduced total harmonic distortion (THD). However, their performance in dynamic environmental conditions depends on the choice of topology, modulation techniques, and control algorithms. Traditional modulation methods often fail to maintain efficiency and power quality under varying conditions like solar irradiance, wind speed, and temperature. This study systematically analyses and enhances the performance of MLIs in smart grids integrated with RES. In this presentation, I compare various MLI topologies and modulation techniques, focusing on their impact on power quality and system efficiency. The effects of environmental variations on grid stability will be evaluated, and advanced control strategies, including hybrid modulation techniques, will be developed to mitigate these challenges. Simulation-based results will demonstrate the effectiveness of proposed algorithms in reducing THD and improving grid reliability. This research aims to provide insights into optimizing MLI performance for robust RES integration, contributing to the development of efficient and stable smart grids.

Keywords
Multilevel inverters, power quality, total harmonics distortion, smart grids