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Name of the Topic: Reactive Power management in Grid Connected Distributed Generation System

Key Words: Solar PV inverter, MPPT, ANN, grid connected inverters, reactive power, LVRT, voltage sag, active power, STATCOM, Shunt Capacitor, DC link capacitor, Inverter Control, Voltage source Inverter (VSI), PI controller, PCC, voltage stability.

Findings

The rising electricity demand and global push to cut greenhouse gas emissions have accelerated the adoption of renewable energy, especially solar PV systems. Their environmental benefits, scalability, and falling costs have driven rapid growth. As countries transition to sustainable energy, integrating solar PV into power grids is vital—but it brings technical challenges, particularly in managing reactive power, which is crucial for voltage stability and efficient power delivery.

This thesis investigates advanced strategies for reactive power management in grid-connected distributed generation (DG) systems, with a specific focus on solar PV systems. The research study begins with the detailed design and control of single-phase grid connected solar PV system and three phase grid connected solar PV system. The study explores reactive power control in both single-phase and three-phase configurations, providing in-depth analysis on how these systems can contribute to voltage stability and enhance grid reliability.

The research undertakes a comprehensive analysis of reactive power compensation techniques in grid-connected solar PV systems. It further explores the application of Flexible AC Transmission Systems (FACTS) devices, specifically the Static Synchronous Compensator (STATCOM), to enhance reactive power compensation. STATCOM provides dynamic and responsive reactive power support, proving to be highly effective compared to other compensation methods.

The thesis also explored the Low Voltage Ride Through (LVRT) capability of the solar PV inverter and how it can help in maintaining the stability of the grid under voltage sags. By employing advanced inverter control algorithms, the study proposes techniques that enable inverters to dynamically adjust reactive power support in response to real-time grid conditions, effectively mitigating voltage instability and enhancing overall power quality.

The proposed reactive power management strategies demonstrate substantial improvements in grid stability and reliability. Simulation results indicate that the dynamic reactive power control algorithm effectively mitigates voltage sags, ensuring uninterrupted operation of solar PV inverters.