National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Design and Implementation of Filter-based Control Techniques for Power Quality Enhancement of Grid Interfaced PV-BES Systems for Residential Applications
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Venue	: EE Seminar Room EE-205
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Abstract

: With the rapid increase in electricity demand and continuous use of fossil fuels leading to ecological problems, there is a paradigm shift in attention towards integrating renewable energy sources in the global energy market. In the past few decades, there has been rapid development in solar photovoltaic (PV) systems and its integration with the existing power system. However, the intermittent nature of PV and grid blackout conditions are familiar issues, which can be curved by integrating auxiliary source of energy like battery energy storage (BES). This increases the reliability of the grid-interfaced PV (GIPV) system. As PV generates DC power, a voltage source inverter (VSI) is required to integrate to the existing grid or utility. Also, the power quality (PQ) at the utility system gets disturbed due to the use of nonlinear loads, unbalanced loads, and disturbance in the power source, which can be compensated using different active/passive compensators integrated additionally. However, it adds extra circuitry to the grid-interfaced PV-BES (GIPB) system. Therefore, an efficient control algorithm is essential for switching of the VSI while addressing these issues.

Several indirect current control algorithms like synchronous reference frame (SRF) and instantaneous power (*pq*) theory, which are based on phase lock loop (PLL), are still predominantly applied due to their ease in practical implementation. The other type of control algorithm is derived from signal processing-based filtering techniques that depends on the unit templates and amplitude of the weight component of load current for the reference current generation. These control techniques have better dynamic responses than conventional PLL-based control techniques. Therefore, in this work, the traditional filtering techniques like least mean square(LMS) and affine projection (AP) algorithms are modified using the Gaussian kernel function and variable step-size, resulting in Gaussian kernel normalized LMS (GKNLMS), modifiedaffine projection (MAP), Gaussian kernel affine projection (GKAP) and adaptive affine projection (AAP) algorithms that enhance their dynamic performances. Furthermore, the PLL-based control techniques fail to address the nonideal grid condition. Therefore, adaptive notch filter (ANF), amplitude adaptive notch filter (AANF), and enhanced adaptive notch filter with DC offset rejection capabilities (EANF) are combined with the aforementioned filter algorithms to generate significant reference currents. Additionally, during grid unavailability, the PV-BES standalone system is controlled using a voltage control method in which the magnitude and phase angle of the grid and PCC voltage are estimated using these filters. In addition, a phase angle error minimization based on the AANF and EANF algorithm is utilized for grid resynchronization. The AANF estimates the amplitudes accurately and has a faster settling time. Further, power management algorithm based on the source availability, load demand, and % SoC of the battery is presented in this work to achieve effective active power flow management and better battery lifecycle.

The proposed control techniques for the GIPB system for residential applications are precisely described using mathematical and diagrammatic methods. The simulation and experimental results validate the practicality of the proposed control approaches.