World Academy of Science, Engineering and Technology
International Journal of Energy and Power Engineering
Vol:12, No:10, 2018

Harmonic Distortion Analysis in Low Voltage Grid with Grid-Connected Photovoltaic

Authors : Hedi Dghim, Ahmed El-Naggar, Istvan Erlich

Abstract : Power electronic converters are being introduced in low voltage (LV) grids at an increasingly rapid rate due to the growing adoption of power electronic-based home appliances in residential grid. Photovoltaic (PV) systems are considered one of the potential installed renewable energy sources in distribution power systems. This trend has led to high distortion in the supply voltage which consequently produces harmonic currents in the network and causes an inherent voltage unbalance. In order to investigate the effect of harmonic distortions, a case study of a typical LV grid configuration with high penetration of 3-phase and 1-phase rooftop mounted PV from southern Germany was first considered. Electromagnetic transient (EMT) simulations were then carried out under the MATLAB/Simulink environment which contain detailed models for power electronic-based loads, ohmic-based loads as well as 1- and 3-phase PV. Note that, the switching patterns of the power electronic circuits were considered in this study. Measurements were eventually performed to analyze the distortion levels when PV operating under different solar irradiance. The characteristics of the load-side harmonic impedances were analyzed, and their harmonic contributions were evaluated for different distortion levels. The effect of the high penetration of PV on the harmonic distortion of both positive and negative sequences was also investigated. The simulation results are presented based on case studies. The current distortion levels are in agreement with relevant standards, otherwise the Total Harmonic Distortion (THD) increases under low PV power generation due to its inverse relation with the fundamental current.

Keywords : harmonic distortion analysis, power quality, PV systems, residential distribution system
Conference Title : ICPQH 2018 : International Conference on Power Quality and Harmonics
Conference Location : Chicago, United States
Conference Dates : October 10-11, 2018