Qualitative and quantitative analysis of system stability and power quality in networks with DG of different penetration levels

ABSTRACT

The benefits offered by distributed generation (DG) in electric power systems have opened opportunities for the increasing penetration of DG in distribution networks. In normal operating conditions, the penetration level of DG can go up to 50 % of the load demand of the system, especially in radial networks, before it begins to have a negative impact on the power loss. However, this is not the case when the system experiences some contingencies, such as loss of a central generator, short circuit faults, sudden disconnection of a DG unit, loss of a main transformer or a transmission line, etc. For this reason, it is necessary to limit the capacity of DG to be penetrated in a particular power network. This paper investigates the impact of different penetration levels of DG in both subtransmission and distribution networks. In the study, a 15-bus test system is employed and modelled in detail using Power System Analysis Toolbox (PSAT). Only synchronous type of DGs is considered since it is the most popular type is use. In this work, the impact of DG of different penetration levels on system stability and power quality are thoroughly examined under different fault scenarios. The results obtained suggest that 20 % penetration level of DG is optimal for both normal and during contingencies in the case study system.

Keyword: Distributed generation; Transient stability; Rotor angle; Voltage stability; Synchronous generator; Short circuit fault