Evaluation of influence of renewable distributed generation on voltage profile and power losses in electric distribution systems[1]

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Abstract

The increasingly expansion of integrating PV and wind generations, which are called renewable distributed generations (RDGs), in electric distribution systems (DSs) has changed the DS from the originally passive DS to a new active DS. The embedded RDG has created several technical impacts on the host DS concerning voltage profile & power losses, fault levels, protection, stability and power quality. These impacts are not generic to any network, and consequently they could be positive, negative or neutral influences, depending on the DS configuration, operation mode, load profile and RDG types used.

The research work objective is to quantify the impact that RDG creates on the voltage profile and power losses. The paper starts with the definition of DG, followed by the identification and classification of RDG interface configurations to the DS. As an optimal tool for the analysis of steady state network operation, the power flow approach has been used. Because of the mostly happening two-way power flow in the active DS branches, and the special character of RDG designs, a mathematical model has been developed, which mainly differs from the conventional power flow model in selection of slack bus and modeling of the generation buses.

[1] For the paper in Arabic see pages (343-391).

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For achieving a systematic methodology, a set of evaluation criteria and indices has been defined and mathematically formulated. Based on this mathematical background, an algorithm has been proposed, which was designed so that it can be applied to any active DS with multiple voltage levels and RDG configurations. The algorithm has been tested on typical DSs using the program Power Factory DigSilent as an advanced simulation tool. The test networks have been modified to be nearly similar to Syrian DN. A wide range of simulations have been carried out, which covered all RDG types in common practice. The simulation results have been thoroughly discussed and very important findings have been concluded. The conclusions would be a useful aid for planning and operation of RDG integration in distributions systems. The performed mathematical models and indicators and the proposed algorithm form a necessary base for quantifying the other impacts of RDG on the host network.