Abstract

Renewable energy sources are gaining attention due to continuously increasing demand of electricity. These sources and their power electronic circuits would have large impact on power quality. Quality of power supplied to customers is further affected by their operations such as islanding, outage and grid synchronization. Power quality also depends on the combination of renewable energy sources, their location and sizes. Power quality disturbances which depend upon the designs of wind generator, solar photovoltaic plates and their converters are reported in literature. However, the influence of operational events such as outage and synchronization of renewable energy sources found to be missing in the literature is focussed under this research work.

In this work, algorithm which explores the pattern recognition capability of Stockwell's transform has been proposed for the detection of power quality disturbances associated with the grid integrated renewable energy sources with the aid of rule based decision tree and Fuzzy C-means clustering techniques. The techniques have been tested successfully for detecting simple and complex power quality disturbances modelled as per IEEE-1159 standard. The classification results of Fuzzy C-means clustering and decision tree based techniques are compared with each other. A single bus utility grid interfaced with solar PV system and wind generator has been emulated to investigate power quality disturbances in the events of outage and synchronization using the proposed technique. The proposed algorithm is evaluated on a modified IEEE-13 bus test system integrated with solar photovoltaic system and wind generator to form hybrid power system. The investigated events include islanding, wind speed variations, solar insolation variations and operations of renewable energy sources. The effect of penetration levels on power quality has also been investigated in terms of proposed power quality index. An effort has also been made to detect the operational events such as outage, synchronization and islanding as well as presence of renewable energy sources (type) during these events by proposing a separate algorithm.

A distribution static compensator equipped with battery energy storage system using a synchronous reference frame theory based control algorithm has been used to mitigate the power quality disturbances in an IEEE-13 bus test system in the presence of solar PV and wind energy generation. Developed technique is found to be effective in power quality improvement under the events of grid disturbances, change in solar insolation, wind speed variations, outage and synchronization of renewable energy sources. The results have been tested using real time digital simulator.

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