European Association for the Development of Renewable Energies, Environment and Power Quality (EA4EPQ)	International Conference on Renewable Energies and Power Quality (ICREPQ'11) Las Palmas de Gran Canaria (Spain), 13th to 15th April, 2011

Survey on knowledge based methods to assist fault restoration in power distribution networks

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Abstract. The motivation behind this paper is the many changes that happen in power distribution networks, theoretical developments, and their consequences on power distribution restoration. The stages of this process are defined with a focus on steps taken after the fault isolation. The final purpose of the operators is defined, as are the rules which must be strictly respected. Power quality issues are stressed. Moreover, recent techniques (metaheuristic and learning methods) are discussed. Heuristic rules also known as expert rules or knowledge based rules used in power restoration are outlined for their supportive role. Finally, a comparison of some selected papers is given. This enables to illustrate how the defined goals and changes in the network are reflected in recent literature. Our conclusion from the study of the state of the art is that there is still a lot of work to be done in developing novel techniques, integrating the goals and inserting the evolving features of power distribution networks.

Key words

Distribution System Restoration, Artificial intelligence, Power Quality, Reliability index, Metaheuristic

1. Introduction

This paper analyses knowledge based strategies proposed in the literature for power restoration in distribution systems and gives a comparison of different goals and restrictions dealt in the different papers. We consider the stricter meaning of restoration, as many papers do: the reduction of the power outage zone after the fault has been isolated.

The last significant review on power restoration was presented ten years ago and presented the maturity of the field [1]. There is also an older paper reviewing restoration techniques [2]. But recently distribution systems have experienced a radical change due to the progress of distributed generation which can impact the reliability indexes [3], [4]. This change will be bigger when SmartGrids are definitely implanted (electric vehicles, energy storage, smart metering and smart field devices, active demand management, *etc.*). At the same time, data management and related artificial intelligence techniques have also evolved offering a variety of methods for data mining and knowledge discovery that can be introduced in the decision support systems.

Restoration goals, strategies, constraints and methods are analyzed from a reliability and power quality perspective. Sudden disturbances caused by weather and environment (*e.g.* tree flashover), unbalance between demand and generation, plant failures, shortage of plant capacity and other similar incidents can result in power quality problems or a loss of supply in the power distribution systems [5]. Basic stages to recover power involve fault detection, diagnostic, isolation, restoration, reconfiguration and reparation. But their execution can obey to different goals and strategies and have implication on quality of delivered power. General principles to be considered in the restoration procedures and common used guidelines are put together with knowledge based solutions and methods recently proposed to support operators decisions. This paper is organized in three additional sections. The following