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Handbook of Optimization in Electric Power Distribution Systems

Springer

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Preface

In the recent years, the distribution systems from the substations to the customers are facing significant changes, due to the growing number of distributed and variable energy generation resources and the smart grid implementation. The distribution networks were originally designed to deliver electricity through distribution feeders and radial lines, applying traditional planning techniques, generally sufficient to offer a reliable service at affordable costs. However, the need for greater resilience, power quality, and customer participation cannot be met by this design paradigm. The abilities to dynamically optimize the operation, integrate diverse distributed generation types, and integrate demand response and energy efficiency resources are also needed in this modern power system era. As a result, significant research efforts have been dedicated to the optimal expansion and operation planning of modern distribution networks.

The smart grid implementation brings a large amount of data that can be used to better plan an energy distribution system. The concept of smart grid is related to a grid with high integration of technology information, telecommunication, sensing/measurement, and automation, seeking to enhance the operation and the ability to meet scenarios with intermittent and distributed energy resources, high reliability requirements, low impact to the environment, and adequate to new energy market regulations. The growing energy demand and limited capital for investment are making the distribution system planners look to these advances in smart grid technology in order to identify new approaches to achieve load reliability. Although challenged by methodologies, paradigms, and traditional distribution planning techniques, this "smart" scenario can lead to alternatives that result in lower investment and operational costs.

The main goal when planning a distribution system is to timely meet the demand growth in the most economical, reliable, and safe way. The planning methodology must assure that every opportunity for savings or power quality improvement are exploited. This is not a straightforward task even in traditional systems, since the distribution networks are usually large in extension, with a large amount of data to be analyzed. In addition, new regulations from authorities and the modernization of

power systems highlight the importance of a constant update and improvement of methodologies and planning techniques.

The difficulty in solving energy distribution systems planning problems, including the operation and expansion planning, relies on the combinatorial nature and the large solution space. Several models and techniques are proposed in the literature, covering the allocation of new substations, reinforcement of the existing ones, reconductoring or construction of new distribution lines, distributed generation placement, among other problems. Usually, aspects of network reliability are later considered, allocating protection and automated devices.

Since investments in the improvement of the distribution system are a constant need, the development of investment plans is a routine for power utilities. In this context, the development of models, solution techniques, and computational tools to solve power distribution systems planning problems is of great importance for power utilities. Extensive research have been made over the last decades, handling problems related to the expansion and operation planning of distribution systems. This handbook gathers the state-of-the-art research on topics related to optimization problems in energy distribution systems, covering the classical problems and the challenges introduced by distributed generation and smart grid resources. Several application examples are presented and discussed, which help to understand the importance of optimization applied to power distribution systems.

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