

Preface

Renewable energy resources such as wind, solar and biomass are well on the way to dominate the supply-side of power systems as their penetration is increasing at a staggering rate all over the world. In this early stage of the renewable energy era, most of these integrations are happening at the distribution system level, close to customers. Increases in renewable energy penetration in distribution systems are expected to revolutionize power systems in many ways.

The number of sub-systems such as airports, businesses and cities fully powered by renewable sources is steadily increasing every year. Large-scale or utility-scale renewable plants will follow in the near future to fill the gap in achieving a so-called “100%” target. However, one of the key concerns about renewable energy including wind and solar, regardless of whether a utility-scale or small-scale Distributed Generation (DG) source is considered, is its intermittency that can bring uncertainty to the supply-side of power systems. This supply-side uncertainty combined with existing demand-side variations has been creating a number of challenges in operation and control of power systems. In order to deal with the issue of intermittency, innovative demand-side programs have been developed and successfully deployed via smart grid solutions. Nevertheless, a higher penetration level of unplanned renewable energy sources in distribution systems could lead to greater technical challenges such as voltage rises, voltage instability, reverse power flows and excessive power and energy losses, to name a few. It is possible to remove some of these challenges with strategic planning and operations, which are called as *intelligent network integration* in this book. There is no doubt that the integration of renewable sources is primarily driven by the availability of resources. However, as the resources are available, DG sizes cannot be arbitrarily chosen; consequently, the technically unsuitable locations should be avoided and the plants should be operated in a smart way to help in alleviating technical challenges and keeping the integrity of the grid.

The main idea behind the intelligent integration is strategically locating, sizing and operating renewable-based DG units coordinated with Battery Energy Storage (BES) units and Electric Vehicle (EV) charging stations in power distribution networks by considering various technical, economic and environmental issues.

Hence, the aim of this book is to develop methodologies for strategic planning and operations of highly penetrated renewable DG units along with an efficient usage of BES units in distribution systems. Biomass and PV power plants integrations are considered comprehensively, along with a combination of PV and BES units and a coordination of PV units and EV charging stations. The time-varying natures of loads and PV outputs are also considered throughout the chapters with step-by-step calculations and in an easy to understand manner. These sections will be useful sources of references to better understand and further conduct research on planning of renewable energy integration with outputs represented as a probability density function.

It can be seen from a number of examples found in this book that a huge quantity of technical, economic and environmental benefits from intelligent integration approaches are highlighted and quantified on different test distribution systems. As the book follows a strong mathematical foundation for various algorithms and methodologies developed, it looks simple and easy to follow. The book is targeted for distribution system planners, operation engineers, and undergraduate and postgraduate students. A wide variety of test distribution systems used in this book for showcasing various methodologies could be useful for further research in this domain.

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