Green Energy and Technology

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Renewable Energy Integration

Challenges and Solutions

Springer

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Preface

Recent concerns regarding the environmental protection and sustainable development have resulted in there being a critical need for cleaner energy technologies. Some potential solutions have evolved including energy conservation through improved energy efficiency, reductions in the use of fossil fuels, and increases in the supply of environmental-friendly energy sources which has led to the use of intermittent renewable energy sources (RESs). These RESs are connected close to loads in the distribution network to reduce transmission losses and delay in the upgrade of transmission systems. The inclusion of renewable sources gives rise to a new set of problems which are due to the intermittency of the sources and the dynamics of interfacing equipments. Therefore, it is essential to investigate the potential challenges of renewable energy integration and to find out the effective and innovative solutions. This book includes different aspects of renewable energy integration—from the current trends of renewable energy integration to the current development of smart grids.

Chapter 1 of this book discusses the importance of green energy which is structured into two parts: (i) the available knowledge with regard to the general decision-making processes is described, followed by a critical perspective about today's decision making and (ii) a review of three enhanced approaches using Real Options Theory, Multi-Criteria Decision Analysis, and Multi-Criteria Cost Benefit Analysis, which are applied to RES decision making from the personal or investment point of view as well to the policy and the latter pan-European point of view.

Various aspects, such as classification and specifications of the grid codes, the anomalies that exist between the grid codes developed and standards used in conventional power plants are discussed in Chap. 2 and a fault-ride-through criteria by satisfying these grid codes are developed in Chap. 3 where the criteria is tested on New Zealand power systems.

Chapter 4 presents a voltage imbalance sensitivity analysis and stochastic evaluation based on Monte Carlo method carried out based on the ratings and locations of single-phase grid-connected rooftop PVs in a residential low voltage distribution network. On the other hand Chap. 5 includes comparative studies on the performance evaluation of grid-connected photovoltaic systems with different maximum power point tracking techniques.

One of the most important tasks in renewable energy integration is to determine optimal size and location of renewable energy sources which is discussed in Chap. 6 in which wind energy is considered as a renewable energy sources (RESs). After determining the optimal size and location, it is essential to investigate the characteristics of RESs and the steady state characteristics of wind energy conversion systems (WECSs) is presented in Chap. 7 from where it can be seen that WECSs affect the performance of power systems. A detailed study in which the effects of variable-speed wind generators to frequency regulation and oscillation damping is discussed elaborately in Chap. 8. The behaviors of power systems change with the penetration of RESs and Chap. 9 discusses some power management approaches for low and medium voltage distribution networks.

The negative impacts of RESs need to be minimized for stable and reliable system operation. Keeping this in mind, a new control methodology is proposed in Chaps. 10 and 11 which incorporates a review study on a new load, plug-in hybrid electric vehicles in power distribution networks. The coordination and aggregation of RESs during emergency conditions are discussed in Chaps. 12 and 13, respectively. Since the cost is an important issue for power system operation, this aspect of study for a residential application is presented in Chap. 14.

The latest trend in the area of renewable energy integration is the operation of power system in a smarter way. The operation of interconnected smart grids with self-healing capability is addressed in Chap. 15 and an agent-based scheme for smart-grid protection and security is presented in Chap. 16. In the last two chapters (Chaps. 15 and 17), the vulnerability analysis of complex smart grids is discussed from the cyber attacks and renewable energy integration points of view.

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