Preface

This book is intended to discuss a variety of recent and vital technical and non-technical issues related to the global energy, environment, and socioeconomic developments for professionals and students who are directly and indirectly involved in the relevant fields. The impetus for this book comes from our view that there is lack of a clear vision in the development of technology and policy on how to reach the mandatory renewable energy targets of the world to reduce greenhouse gas emission and exhilarate socioeconomic development. The chapters of this book have been structured in such a way that it provides a consistent compilation of fundamental theories, a compendium of current research and development activities as well as new directions to overcome critical limitations. This book will be of benefit to researchers, planners, policy makers, and manufacturers.

Chapter 1 aims to present the importance of renewable energy, its sources, present situation, and future prospects. In the modern and fast-growing civilization, the growth of energy consumption is the measuring parameter of social and economic growth. To meet this high energy demand, suggestions are also made to make the renewable energy more popular among investors. Implementation of these suggestions will help to increase the smooth penetration of renewable energy sources in electrical power systems to preserve economy and environment.

It has been becoming obvious that renewable energy can overcome the challenges thrown by conventional fossil fuel-based power plants. Among renewable energy sources, the solar photovoltaic (PV) has been gaining a significant popularity since last decade, and nowadays, the cost of electricity generation from solar PV system is comparable with those from traditional generation systems. By the end of 2016, the cumulative installed capacity reached around 300 GW, whereas it was only 17.06 GW in 2010. About 15,000 tons of carbon dioxide emission can be reduced every year by a 10 MW solar PV plants. The comparative technical specifications of different components of large-scale solar PV plant, e.g., solar module, inverter, tracker, and transformer, are presented in Chap. 2. In addition, necessary factors that influence the selection of a site for a solar PV plant are also discussed.

Existing power transmission infrastructures are not robust and less efficient due to the power loss over long distance. High-temperature superconducting (HTS) materials and technologies have become available to design and build power cables. Chapter 3 aims to present basic theoretical background knowledge of HTS cables. The necessary improvements required have been comprehensively identified to reach the goal of industrial and board application of HTS cables and transmission technologies which are potential critical elements for future power system renewables.

The oceanic wave, also known as a wind wave, has the high-power density compared to the other popular renewable energy sources. The conventional machineries are not suitable for the energy conversion from the sea wave. To extract maximum power, scientists around the world proposed a wide variety of new electrical machines. Some of such electrical machines with their properties and the prospects of a high-power density linear generator are discussed in Chap. 4.

A converter is an essential part of a wind energy system. The conventional rectifier–inverter arrangement contains a giant capacitor and produces harmonics distortion in its output. A matrix converter is now popular as it does not contain capacitor which has a bulky size. It can be provided in a simple construction to provide a wide range of output frequency. Chapter 5 introduces a modified algorithm for space vector modulation that reduces total harmonic distortion of the output voltage. Moreover, a modified open-loop control of matrix converter with indirect space vector modulation is introduced to provide constant frequency and output voltage even if the wind speed changed.

Recent trends of connecting small-scale generator lead to the concept of micro-grid. In smart grid environment, several micro-grids will work parallel to support the load demand. It is essential to keep the nodal voltage of grid-connected renewable energy systems within an acceptable limit. The major advantage that attracts the matrix converter for grid-interactive applications is its inherent capability of bidirectional power flow. It can be used as voltage regulators in the low-voltage (LV) distribution network by adding a series compensation voltage with a transformer. However, to achieve these functionalities, a proper switching scheme and commutation process are necessary. The major focus of Chap. 6 is to discuss different types of switching and commutation strategies for matrix converter that considers silicon carbide (SiC)-based junction field-effect transistors (JFETs), MOSFETs, and SiC-based MOSFETs. The experimental results reveal that the SiC-based MOSFET devices are the best for designing the matrix converter for micro-grid applications.

In the near future, multiple energy sources having diverse characteristics will come into play in power systems. When a large number of renewable energy sources are interconnected with traditional power systems, it arises several critical challenges for the operation of the system. Intermittent nature of renewable energy and variable load demand on power systems make the control tasks more challenging. These challenges might cause the interruption of steady-state operation of the system and interrupt power supply to consumers. Chapter 7 attempts to present technical challenges related to the operation and protection that arise due to

the large-scale interconnection of renewable energy. A detailed discussion on the necessity of implementation of control techniques is highlighted to ensure the continuity of service.

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