Sustainable Development in Energy Systems

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Editor

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Preface

Recent large-scale penetration of distributed renewable energy sources (RES) within the electricity grids has resulted in the need for more supervisory control and operation. This is giving rise to different application scenarios such as microgrids, nanogrids or just islanding of electrical energy systems within a controlled environment. The main bottleneck is that energy systems simply cannot cope with demand–supply mismatch. Therefore, further integration of clean generation such as RES entails increasing levels of complexity not only on the electric power networks but also on the electricity market and regulations contributing to new business and management modelling, finance and investment schemes for sustainable energy. Hence, it is important that cost-effectiveness is also considered together with the security and high quality of supply for customers. This book includes different renewable and alternative energy systems integration solutions for mostly existing infrastructures.

Chapter "Overview on Microgrids: Technologies, Control and Communications" of this book introduces the concept of microgrids from three perspectives: (i) technologies, (ii) control and (iii) communications. Microgrids are an ideal platform to integrate renewable energy sources on the community level, allowing for prosumers full market participation. The aim of this chapter is to provide a brief overview on microgrids, including the state of art about the main motivation for the emergence of these grids. The chapter starts with a survey on some existing microgrids around the world, followed by a typical microgrid's architecture presentation. Then, in Chapter "Hybrid Nanogrid Systems for Future Small Communities", the principles of hybrid nanogrid systems are introduced for future small communities where the dynamic performances connected via ac and dc buses are explored in particular during islanding operation.

Various aspects of grid management such as interconnectivity to support neighbouring microgirds are discussed in Chapter "Interconnected Microgrid Systems for Remote Areas". A communication assisted multi-agent system (MAS) control scheme is proposed in Chapter "Distributed Agent-based

Coordinated Control for Microgrid Management" to establish the coordination between the power sharing and energy management through agent communication which further ensures the sustainable operation of microgrids by effectively controlling the inverters.

The sustainable development of regional energy systems is presented through a case study in Chapter "Sustainable Development of Energy Systems in the Baltic Region" for the Baltic States, Lithuania, Latvia and Estonia, which until recently operated in non-EU electricity frequency system, having comparatively low level of interconnections between the other countries in the region. One of the main aims of the EU internal market legal regulation, so-called the third energy market package (electricity and gas), is to develop well-functioning energy market, ensuring integrated net of infrastructure within entire EU territory. The idea foresees to create capable enough interconnections between all the EU member states therewith eliminating considerable dependence of particular countries on energy imports from non-EU countries, as well as ensure that the interconnected EU market operates according to harmonised EU principles and regulations. A closer integration of networks is particularly important to the states considered to be "energy islands", when electricity and gas networks are not connected with the other EU member states.

The most important integration bottlenecks for RES and its contribution to energy systems sustainable development are access to the market and the grid itself. A number of renewable energy sources and configurations are addressed in the next four chapters. Chapters "Active Distribution Networks Operation within a Distribution Market Environment" and "Critical Performance Evaluation of a Few Intelligent Controllers for Effective Power Control in Variable Speed Wind Generators" address this through wind energy integration, Chapter "Power Flow Constrained Short-Term Scheduling of CHP Units" considers combined heat and power units (CHPs) and Chapter "Optimal Utilization of Solar Energy Resources in Hungary" addresses this through solar resource analysis in Hungary. The methodologies vary from technical, semi-technical to techno-economic analysis such as optimal power flow in Chapters "Active Operation within a Distribution Market Environment" and "Power Flow Constrained Short-Term Scheduling of CHP Units".

The latest trends in the area of renewable energy integration are the self-consumption and islanding operation. Chapter "Microgrids Operation in Islanded Mode" investigates control and management issues in microgrids islanded operation mode, while Chapter "Islanding of Energy System" explores the islanding capabilities and benefits to increase the reliability of supply, especially in countries where infrastructure is still developing.

Overall, this book collects the latest broad, holistic and different aspects of energy systems integration for sustainable development. The importance of different resources and alternatives is discussed, to distinguish the advantages and challenges for each system. The integration of systems is also covered with detailed

experiences and lessons from different regions and states in the effort to balance environment and development needs, and getting these to work in harmony with other social challenges. The complexity of multi-systems integration has given this book the approach to include some analysis to investigate the characteristics of smart integration. This book is intended for those working in the area of sustainable development in energy systems.

Paola, Malta Dr. Inġ. Eur. Ing. Brian Azzopardi

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