# Preface

The aim of this book is to put the reader in contact with real experiences, current and future trends in the context of the use, exploitation and maintenance of renewable energy systems around the world. Today the constant increase of production plants of renewable energy is guided by important social, economical, environmental and technical considerations. The substitution of traditional methods of energy production is a challenge in the current context. New strategies of exploitation, new uses of energy and new maintenance procedures are emerging naturally as isolated actions for solving the integration of these new aspects in the current systems of energy production. This book puts together different experiences in order to be a valuable instrument of reference to take into account when a system of renewable energy production is in operation.

Part I of the book is focused on different aspects about the operation and maintenance of renewable energy systems, and in particular, attention is paid to systems that produce electrical energy by wind, sun and biogas because these are the most extended types of plants using a renewable source of energy. Current practices of operation and maintenance at these plants will be described in order to know strategies for a better use of their life cycle.

"Condition Monitoring and Maintenance Methods in Wind Turbines" presents a review of the main principles supporting different strategies of maintenance. Later, a framework is presented which is able to integrate different aspects related to the life of a wind turbine. In particular, a method is proposed for the detection of abnormal behaviour with respect to the normal behaviour expected and a procedure to obtain failure mode risk indicators that can help apply maintenance in wind turbines precisely when it is needed. This will contribute to a better use of the life cycle of the wind turbines in a wind farm.

"Operation and Maintenance Methods in Solar Power Plants" describes the fundamentals about the operation and maintenance in solar power plants. In these plants, Operation and Maintenance (O&M) is becoming more and more important for improving the performance of the plant. Most of the solar power plants are located in remote places with unreliable communication infrastructure. This makes it very difficult to diagnose and rectify problems in a timely manner. System operations and maintenance (O&M) is a broad area, and it is the continuing focus of several industry/government/national laboratory working groups. This chapter will review their main results.

"Biological Biogas" will review briefly the most significant part of the history of biogas. Here an overview of the microbial process will be provided covering some of the different types of digesters and looking at building, starting and operating a simple type of digester, including fault finding.

"Development, Operation, and Future Prospects for Implementing Biogas Plants: The Case of Denmark" describes different concepts of biogas technology as understood in a Danish context. It emphasises how energy from production of biogas is distributed, either as biogas to regional combined heat and power plants (CHP) or as district heating (DH) to small-scale local networks. The chapter provides an overview of the political situation and a historical outline of the development of the Danish biogas sector, and it presents the biogas process and operational aspects. The chapter ends with a discussion of biogas in both global and European contexts.

"Operation and Maintenance Contracts for Wind Turbines" addresses the fundamental negotiating issues of wind turbine O&M contracts. It includes a conceptual mathematical framework to support the analysis and design of O&M contracts. This will make it possible to investigate mechanisms through which incentives perceived by O&M contractors can be aligned with the objectives of wind farm owners over both the short and the long terms.

Part II of the book addresses how new renewable energy systems can be integrated with traditional methods of energy production, and also, with a new smart environmental use of energy. Within this perspective the hybridation of systems must be considered.

"Grid Integration of Wind Power Generation" discusses how generator technology affects grid integration of wind generation. Wind generators based on squirrel cage and doubly fed induction machines and multi-pole synchronous machines will be reviewed. The performance with respect to stability, load frequency and reactive power–voltage control is discussed.

"Control Methods Applied in Renewable Energy Systems" introduces the control methods used in renewable energy sources. The control methods of power electronics used in renewable energy sources such as solar, wind, and fuel cells are comprehensively explained through the different sections of the chapter. The required circuit topologies of current control methods are explained with grid-connected and island-mode operations of a solar energy system. The rest of the chapter consists of a discussion concerning renewable energy systems based on wind turbines and fuel cells.

"Low-Cost Hybrid Systems of Renewable Energy" is focused on research and development of low cost technologies for attending small and medium energetic demands. The results of such development are related to the use of hybrid systems combining different sources of renewable energy. To obtain the lowest cost of a system it is necessary to obtain the smallest cost in each one of their parts and a better control strategy that integrates the operation of these parts. In this chapter the constituent elements of a hybrid system will be presented along with different technological alternatives. Also control strategies will be presented in order to obtain the maximum efficiency of these elements and connection arrangements.

"Design for Reliability of Power Electronics in Renewable Energy Systems" is focused on the design of reliability of power electronics in renewable energy systems. Typically power electronics are designed for 20–25 years of operation and in order to do this it is crucial to know about mission profile of the power electronics technology as well as how the technology is loaded in terms of temperature and other stressors relevant for lifetime prediction. Hence, this chapter will show the basic power electronics technology for renewable energy systems, describe the mission profile of the technology and demonstrate how the power electronics is loaded for different stressors. Further, some systematic methods to design the power electronics technology for reliability will be given and demonstrated with two cases—one is a wind turbine and another one is a photovoltaic application.

Part III of the book is oriented to describing some experiences about the use of energy coming from renewable energy sources in different fields of industry and society. This is a point of increasing interest that is constantly changing and which future trends show will play a main role in how society uses energy.

"Use of Renewable Energy Systems in Smart Cities" addresses the use of renewable energy systems on a small scale, oriented to distributed generation for households or districts, integrated in a smart city. In this context, the main renewable energies and companion technologies are reviewed, and their profitability investigated to highlight their current economic feasibility. A simplified architecture for the development of a smart city is presented, consisting of three interconnected layers: the intelligence layer, the communication layer and the infrastructure layer.

"Analysis of the Impact of Increasing Shares of Electric Vehicles on the Integration of RES Generation" analyses the medium-term operation of a power system in several future scenarios that differ according to the level of use of electric vehicles and how renewable energy sources can be safely integrated into them. The analysis is performed using different vehicle charging strategies (namely dumb, multi-tariff and smart).

The analysis is based on results produced by an operation model of the electric power system where the charging of electric vehicles is being considered. Vehicles are regarded as additional loads whose features depend on a mobility pattern. The operation model employed is a combination of an optimisation-based planning problem used to determine the optimal day-ahead system operation and a Monte Carlo simulation to consider the stochastic events that may happen after the initial planning step.

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