Preface

Growth of wind power during the recent years is highly impressive. Over the past decade, on an average, the global wind power capacity could be doubled by every 3 years. With the addition of 38 GW in 2009, the total global wind power installations could reach up to 158.5 GW, registering an annual growth rate of 31.7% during the year. As a result, wind is the fastest growing energy resource in the world today. Estimates by the Global Wind Energy Council (GWEC) indicate that this trend would continue during the next decade as well and even under the moderate growth scenario, the total wind power installations would reach up to 709 GW by 2020, contributing 8.2% of the world's electricity demand.

One of the major driving forces behind this rapid growth of wind power is the technological advances in wind energy conversion technology in the recent years. Wind turbines are getting bigger in size, efficient in performance and reliable even under adverse working environments. For example, advanced tools in fluid dynamics have made it easier for us to understand the aerodynamics of the wind turbines and thereby improve the efficiency and reliability of wind energy conversion systems. With an insight to the wind regimes characteristics, we could identify better locations for wind farm installations, yielding higher project capacity factors. Advanced forecasting methods empowered us to predict the availability of wind generated electricity even over short time scales, making wind energy more dependable and despatchable. Similarly, developments in the electrical and electronics technologies could provide wind turbines with better generation and regulation systems. Objective of this book is to share some of these recent advances with the wind energy students and researchers.

The book is divided in to eight chapters. The first chapter describes the aerodynamics of wind turbines, specifically applicable for the horizontal axis designs. At the beginning, the basic aerodynamic issues are discussed which is followed by the analysis based on the momentum theory. The blade element and the blade element momentum theories are then introduced followed by the vortex wake model for HAWTs. The chapter concludes with brief descriptions on advanced aerodynamic techniques applying Navier–Strokes, Euler and hybrid CFD methods.

The second chapter focuses on the wind energy resource analysis. Methods for characterising the wind regimes are explained and performance models for wind energy conversion systems are described. This is followed by the chapter on the offshore wind resource estimation which starts with the salient features of the offshore wind resource. Further, applications of LiDAR, SoDAR, SAR and scattometers in assessing offshore wind energy potential are demonstrated with examples from some offshore locations.

The fourth chapter discusses the methods for short term forecast of wind power. At first, various forecasting techniques are introduced followed by the details of different models used for the point forecasts. Some of the probabilistic forecast models are then considered and finally up-scaling of forecasts and evaluation of forecast quality are discussed.

The next chapter analyses the wind turbine loads under varying operating con-ditions. A general description of the origin of the loads is first presented to create the basis for the following load assessment methods and procedures. The design and certification perspectives of wind turbines are emphasized while developing this analysis.

The major characteristics, objectives and strategies of the control system of a wind turbine are described in the sixth chapter. Control strategies to attain effi-cient, stable and reliable operation of modern wind turbines are described and the classical control loops for the systematic regulation of the critical operating vari-ables are analysed. A dynamic model describing the dominant characteristics of a wind turbine is then introduced.

The seventh chapter discusses the basic issues in integrating the bulk power available from the offshore wind farms with the electrical grids. The basic re-quirements for the grid integration are first explained and various grid connection methods like HVAC, LCC HVDC and VSC HVDC are described. Alternate inte-gration strategies are also explored and at the end, various grid integration meth-ods are compared.

The last chapter of the book is devoted to the small wind turbines. The large and small systems are differentiated with respect to their design and operational requirements. Emphasis is given on the starting performance, yaw behaviour, gy-roscopic loads, over speed protection and control requirements.

The chapters of this book are contributed by experts working on different aspects of wind energy conversion technology. We would like to thank them for sharing their expertise with the readers through this project.

Sathyajith
Geetha

http://www.springer.com/978-3-540-88257-2

Advances in Wind Energy Conversion Technology
Sathyajith, M.; Philip, G.S. (Eds.)
2011, VIII, 216 p., Hardcover
ISBN: 978-3-540-88257-2