

Handbook of Renewable Energy Technology, edited by Ahmed F. Zobia and Ramesh C. Bansal (Singapore: World Scientific Publishing Company) 876 pages, ISBN 978-981-4289-06-1, hardback.

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Recent years have seen a renewed focus on increasing our use of renewable energy sources. Environmental, geopolitical, and supply concerns associated with traditional fossil fuels are making renewables an increasingly important part of the future energy mix. There are, however, major technological, technical, and economic barriers to widespread use of renewable energy. There is also uncertainty regarding how technology, manufacturing, and integration improvements can affect the viability of different renewables in the future. This book, *Handbook of Renewable Energy Technology*, offers a broad view of different renewable energy sources available to us today, as well as ‘up and coming’ technologies that may be technically and economically viable in the future. It also provides a discussion of some of the power engineering challenges that renewable electricity sources raise and proposes means to address and mitigate these issues.

The book is a collection of edited chapters, divided into six sections, written by experts in the respective fields and technologies discussed. The first four sections cover specific renewable technologies—wind, solar, bio-based, and hydro and ocean energy. The remaining two sections cover more general renewable integration issues.

Chapter 1 provides background information on wind generation, including the basic physics behind wind energy, turbine design considerations, grid integration issues, and cost estimates. Chapter 2 provides more details on turbine design, including different generator types and power electronic converters. Chapter 3 discusses wind turbine, generator, and power electronic modeling. Chapter 4 delves into wind resource assessment. The authors discuss the types of data needed for a robust wind assessment, standard software tools available, and other considerations (*e.g.* right of way and infrastructure) that can affect siting decisions. Chapter 5 provides a more detailed discussion of the cost of wind and introduces a number of standard metrics used to compare the cost of wind to other generation technologies. Chapter 6 describes line-side converters, which are used to control active and reactive output from variable-speed wind generators. Chapter 7 introduces wake effects from wind turbines on overhead transmission lines and discusses associated implications for wind turbine spacing and siting.

Chapter 8 introduces the second section on solar energy by providing fundamental derivations used to model real-time solar resource availability. This includes modeling of seasonal and diurnal patterns, the coordinates of a candidate location, and cloud cover. Chapters 9 and 10 describe photovoltaic and solar thermal (which is also referred to as concentrating solar power) technologies. Chapter 11 discusses the important issue of maximum power point tracking in photovoltaic solar systems, which is the real-time control of the bus voltage to maximize energy yield. Chapters 12 and 13 introduce non-electric uses of solar energy. This includes solar drying, cooking, and water and building heating.

Chapters 14 and 15 introduce biomass as a source of energy. Chapter 14 discusses different types of biomass and their energy contents and harvesting and conversion processes. Whereas chapter 14 discusses all possible feedstocks, chapter 15 focuses on the use of forest species. It also includes a discussion of how local climactic conditions can affect the viability of forest-based biomass. Chapters 16 and 17 focus on the conversion of biomass to liquid fuels, specifically bioethanol and biodiesel. This includes a discussion of different feedstocks, preparation and conversion processes, and issues raised by the use of mixes of bio-based and conventional liquid fuels in vehicles and other end uses.

Chapter 18 introduces a number of different marine energy technologies, including ocean wave and tide energy. Since these technologies have, thus far, largely been restricted to demonstration projects, the chapter estimates the potential for marine energy and possible locations for development. The chapter also includes a discussion of potential environmental impacts that may be encountered with wider development of the technology. Chapters 19 and 20 focus on operational and frequency control challenges with small-scale hydroelectric power. These issues

become especially pertinent in distributed generation settings, wherein the hydroelectric plant is the primary (or possibly only) electricity source.

Section 5 focuses on feasibility studies and grid-integration challenges raised by renewables. Chapter 21 summarizes a number of software tools that are available for feasibility, economic, and emissions analysis of pure and hybrid renewable energy systems. This includes a comparison of their modeling capabilities, as some tools are limited in being able to model all facets of a renewable energy system. The remaining three chapters of this section delve into issues raised by distributed renewable generation. Chapter 22 introduces the range of effects that distributed generation can have, for instance on ancillary services, power voltage and harmonics, and power flows. It also uses a case study to demonstrate how the physical location of distributed generation assets can affect losses within a distribution system. Chapter 23 builds off of this by introducing a number of different algorithms that can be used to optimize the location of distributed generation to minimize such losses. Chapter 24 introduces the concept of a virtual power producer (VPP). The VPP is an aggregation of multiple distributed generation resources that can participate in the market to provide energy and ancillary and other services. The chapter also explains the use of a multi-agent simulator to model the potential interactions between VPPs and other market participants.

The final section returns to the issue of power electronics and quality, which is first introduced in the context of wind. Chapter 25 discusses different power electronic converters available for wind, solar photovoltaic, and energy storage systems. Chapter 26 presents models that can be used to study the use of induction generators in wind turbines, while chapter 27 treats voltage control of doubly-fed induction generator in wind systems. Chapter 28 raises the issue of power quality instrumentation and measurement with renewables. This includes how often power quality measurements should be conducted, where meters should be physically sited within a power system, and how to process the resulting data. Chapter 29 finally introduces a goal programming model to determine how energy resources should be allocated to different uses. The chapter uses a number of case studies based on rural villages in India, and demonstrates that depending on the priorities of the planner, different energy technologies should be promoted or put to different end uses.

The clear strength of this book is its broad coverage of many technologies. This ranges from the well known (*e.g.* wind and solar) to the niche (*e.g.* solar drying). Thus, the overview chapters that discuss the various technologies can serve as a handy reference for anyone dealing with renewables, whether seasoned or a novice. These chapters may also be of interest to people simply wanting to know more about renewable technologies. Many of the chapters, especially those dealing with power engineering issues, can be rather terse, however. These often include complicated derivations, which may prove indecipherable to those without an electrical engineering background. Unfortunately, these derivations typically lack a more rudimentary explanation for the layperson to follow, making it difficult to recommend this book to readers without strong engineering backgrounds.

Another weakness of this book is that it does not address some important power system engineering issues raised by renewable integration. This includes resource forecasting, unit commitment and dispatch, and long-term capacity planning. These are real challenges facing the power system engineering and energy economics communities, with real market-design, policy, operational, planning, and economic consequences. Chapters 21, 24, and 29, deal with feasibility studies, participation of renewables in energy markets, and energy resource planning. These come the closest to touching on these important issues, although additional chapters that further explore these issues would be a welcome addition to this volume.

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