

Preface

We have been in a fossil fuel era and ended up with such a desperate picture! The key question here is: how to cure this problem? The common consensus to tackle this problem is that we need sustainable energy solutions which cover the following six key pillars, namely, (1) better efficiency, (2) better cost-effectiveness, (3) better resources use, (4) better design and analysis, (5) better energy security, and (6) better environment. These are essentially the main pillars and what makes this book really unique as “sustainable energy systems and applications.”

This book is research oriented, and therefore includes extensive practical features not found in solely academic textbooks. This book is essentially intended for use by senior undergraduate and graduate students in various disciplines ranging from mechanical to chemical engineering, and as a basic sustainable energy source on, even a handbook, for practicing energy engineers. Analyses of sustainable energy systems and their applications are undertaken throughout this comprehensive book, providing new understandings, methodologies, models, and applications, along with several illustrative examples and case studies. The coverage is extensive, and the amount of information and data presented is quite sufficient for several energy-related courses, if studied in detail. We strongly believe that this book will be of great interest to researchers, scientists, students, engineers, and energy experts, and that it provides a valuable and readable reference text for those who wish to learn more about sustainable energy systems and applications.

Chapter 1 addresses general aspects of thermodynamics to furnish the readers with background information on thermodynamic aspects, covering essentially two main laws (first and second law of thermodynamics) through energy and exergy analyses and efficiency assessment, along with some examples related to the analyses of sustainable energy systems and their applications. Chapter 2 discusses energy and environmental issues and energy sources and options and their impact on environment. Chapter 3 is a continuation of Chapter 2 by focusing primarily on global warming and climate change issues and their consequences. Chapter 4 focuses on energy conservation with some specifics on issues, measures, policies, strategies, and their assessments, and offers some illustrative examples. Chapter 5

discusses energy policies and assessment of various options for sustainable development. Chapter 6 delves into fossil-fuel alternatives and provides some examples and case studies. Chapter 7 is specifically about using ammonia as a potential substance for various options as the fuel, refrigerant, and working fluid in numerous applications and discusses ammonia as a key source of hydrogen especially for transportation vehicles. Chapter 8 provides comprehensive coverage on the nuclear energy option, addressing a broad range of topics from historical perspectives to nuclear-based hydrogen production. Chapter 9 renewable addresses comprehensive by energy systems and applications, including integrated and hybrid systems for a more sustainable future. Chapter 10 deals with district energy systems, including various subtopics from cogeneration to system analysis and offers case studies. Chapter 11 discusses energy storage options as part of sustainable energy systems and applications, and presents various examples and case studies. Chapter 12 describes integrated multigeneration systems for the production of various commodities, including power, heat, hot water, cooling, hydrogen, as well as desalination. Chapter 13 is the heart of this book as it focuses on hydrogen and fuel cell systems, covering hydrogen production, storage, transportation, distribution, and use, and fuel cell systems and their applications and analyses. Chapter 14 discusses carbon dioxide technologies and their implementation for various applications. Chapter 15 is another important chapter, focusing on life-cycle assessment for various systems and applications for better efficiency and environment. Chapter 16 provides some details on industrial ecology and its possible applications in some areas of sustainable development. Chapter 17 gives some perspectives on sectoral energy and exergy utilization to provide a comprehensive picture of economies and their activities. Chapter 18 discusses economic analysis of systems, especially sustainable energy systems.

Incorporated throughout this book are many wide-ranging, illustrative examples and case studies that provide useful information for sustainable practical applications. Conversion factors and thermophysical properties of various materials are listed in the appendices in the International System of Units (SI). Complete references and a bibliography are included in each chapter to direct the curious and interested reader to further information.

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