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Preface

The ongoing concerns about climate change have made renewable energy sources an important topic of research. Several scholars have applied different methodologies for examining the relationship between energy consumption, environment and economic growth of individual countries and groups of countries, in order to understand the effects of energy policies. In particular, previous studies have analyzed carbon dioxide emission savings made through the use of renewable energy from an individual source or in combination with traditional sources of energy by applying life-cycle analysis methods. This research has shown that after a certain period, economic growth leads to the promotion of the environmental quality. However, econometric critiques have opposed the results of these studies. Moreover, the effectiveness of governance-related parameters has been neglected in these studies. In this research, among others we analyze the impact of renewable energy development on carbon dioxide emission reduction.

In this volume, a number of issues are discussed that play a crucial role in enhancing the deployment of renewable energy, namely, the energy–environment relationship, alternative renewable energy production technologies, regulation frameworks for renewable energy sources, financing renewable energy development, and the market design for trading commoditized electricity generated by small renewable energy sources. Local power generation, which is the basis of renewable energy production, encourages the production of renewable energy resources, decreases transmission loss, increases saving energy, and enhances energy efficiency. Therefore, the integration of local, renewable energy sources and smart grids through local marketplaces that trade renewable energy in small units is a promising solution.

There are several points making this book unique compared to others. It analyzes important aspects of renewable energy development and its challenges. A model is developed to evaluate the effectiveness of renewable energy development, technological innovation, market for trade, and market regulations with respect to carbon dioxide emission reduction. For this purpose, a panel data model is applied to data from the EU-15 countries between 1995 and 2010. The effects of renewable energy on carbon emission reduction in EU-15 is investigated. The findings show that the effects of climate change can be mitigated by governance-

related parameters in addition to regulations, economic incentives, and technology development measures. It proposes a marketplace for trading renewable energy sources and provides suitable and evidence-based policy recommendations to promote renewable energies to substitute fossil fuels.

The subject of this work is development of renewable energy sources and their significance for the environment. A number of issues of particular interest to the readers are raised. We present the development of different renewable sources in recent decades and forecasts for future illustrated in figures and tables. Some regression analysis is also used for establishing relationship between emission and use of renewable energies. The key features of this work is its deep review and analysis of technologies, finances, environment and trade markets for renewable energy sources. It provides an up-to-date review of the literature considering production and consumption of renewable energy sources at country, regional and global levels.

Deployment of renewable energy and technological innovations can be used to reduce carbon emissions. Tariffs, finances, tax policies, and energy efficiency are used by governments to develop renewable energy. State research and development support, innovation, finances, and regulations have impacted the market for renewable energies. The effects of different technology, regulations and financial support factors on emission reductions are estimated. The structure of a marketplace for renewable energy sources is proposed and the requirements for the marketplace to function are outlined. Suitable policy recommendations are provided to enhance the efficient operation of market for renewable energies. Researchers, professionals, decision makers, environmentalists, non-governmental organizations, graduate students, postgraduate students, and public and private utilities will benefit from reading this research.

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Almas Heshmati Almas Heshmati is Professor of Economics at Jönköping University and Sogang University. He held similar positions at the Korea University, Seoul National University, University of Kurdistan Hawler, RATIO Institute (Sweden), and the MTT Agrifood Research (Finland). He was Research Fellow at the World Institute for Development Economics Research (WIDER), the United Nations University during 2001–2004. From 1998 to 2001, he was Associate Professor of Economics at the Stockholm School of Economics. He has a Ph.D. degree from the University of Gothenburg (1994), where he held a Senior Researcher position until 1998. His research interests include applied microeconomics, globalization, development strategy, efficiency, productivity, and growth with application to manufacturing and services. In addition to more than 100 scientific journal articles, he has published books on the EU Lisbon Process, global inequality, East Asian manufacturing, the Chinese economy, technology transfer, information technology, water resources, landmines, power generation, development economics, economic growth, and world values.

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Jörn Altmann Jörn Altmann is Professor for Technology Management, Economics, and Policy at the College of Engineering of Seoul National University. Prior to this, he taught at the University of California at Berkeley, worked as a Senior Scientist at Hewlett-Packard Labs, and has been a postdoc at EECS

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Contents

List of Abbreviations

AIC	Akaike information criterion
APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
BIC	Bayesian information criterion
BRICS	Brazil, Russia, India, China, and South Africa
CCGT	Combined cycle gas turbine
CCHP	Combined cooling heat and power
CCMT	Carbon-change-mitigation technology
CDM	Clean development mechanism
CHP	Combined heat and power
CSP	Concentrated solar power plant
CVPP	Commercial virtual power plant
DER	Distributed energy resources
DG	Distributed generation
EEX	European Energy Exchange
EIA	Energy Information Administration
EKC	Environmental Kuznets curve
EMS	Environmental management system
EPBT	Energy payback time
ERGO	Electric recharging grid operator
EROI	Energy return on investment
ETS	Emission trading system
EV	Electric vehicle
EXAA	Energy Exchange Austria
FDI	Foreign direct investment
FE	Fixed-effect
FGLS	Feasible generalized least square
FIT	Feed-in tariff
GDP	Gross domestic product
GHG	Greenhouse gas
GLS	Generalized least square

GNP	Gross national product
GSHP	Ground source heat pump
Gt	Gigatonne
Gtoe	Gigatonnes of oil equivalent
GW	Gigawatt
ICT	Information and communication technology
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
JI	Joint implementation
kWh	Kilowatt hour
LCA	Life cycle analysis
MENA	Middle East and North Africa
MMT	Million tones
Mtoe	Million tones of oil equivalent
MW	Megawatt
NPV	Net present value
OECD	Organisation for Economic Co-operation and Development
PHES	Pumped hydro energy storage
PHEV	Plug-in hybrid electric vehicle
PHS	Pumped hydro storage
PTC	Production tax credit
PURPA	Public Utility Regulatory Policies Act of 1978 (US)
PV	Photovoltaic
RE	Renewable energy
RE	Random effect
RES	Renewable energy sources
RET	Renewable energy technology
RPS	Renewable portfolio standard
RPT	Renewable energy premium tariff
SAPV	Stand-alone solar photovoltaic
SHPP	Small-hydro power plant
SOFC	Solid oxide fuel cell
TJ	Terajoule
TOU	Time-of-use
TWh	Terawatt hour
V2G	Vehicle to grid
VAR	Vector autoregression
VPP	Virtual power plant

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Chapter 1
Introduction

1.1 Background

Industry's electricity consumption will comprise an increasing share of the global energy demand during the next two decades. It is expected that the growth rate of electricity consumption will be more than that of the consumption of other sources of energy (e.g., liquid fuels, natural gas, and coal) (IEA 2012). The increasing prices of fossil fuels such as crude oil and the increasing concerns about the environmental consequences of greenhouse gas emissions have renewed the interest in the development of alternative energy resources. In particular, the Fukushima Daiichi accident was a turning point in the call for alternative energy sources. Renewable energy is now considered a more desirable source of fuel than nuclear power plants because of the absence of fatal risks.

Considering that carbon dioxide is the major greenhouse gas (GHG), there is a global concern about reducing carbon dioxide emissions. Different policies can be applied in this regard (e.g., enhancing renewable energy deployment and encouraging technological innovations). In addition, supporting mechanisms (e.g., feed-in tariffs, renewable portfolio standards, and tax policies) can be employed by governments to increase renewable energy generation and achieve energy efficiency. Many countries have started installing facilities for power generation that can use renewable energy sources. However, the share of a renewable energy supply differs by region and country. Europe is considered at the forefront of using renewable energy technologies.

The research literature on the relationship between energy consumption and economic growth is extensive. Many researchers have studied the effectiveness of conservative energy policies on economic activities. Some researchers (Fthenakis et al. 2008; Crawford 2009; Frick et al. 2010) have measured the amount of carbon saving by using the life-cycle analysis method. Other researchers have analyzed carbon emission saving by enhancing energy efficiency through cogeneration and advanced technology (Shipley et al. 2008; Kiviluoma and Meibom 2010;

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