

Preface

Energy and carbon emissions have become major strategic issues influencing the development pattern of human society and the global political economy.

China is a major player in the production and consumption of energy. With a large population, China is undergoing rapid industrialization and urbanization. Its per capita energy consumption, especially clean energy consumption, is far below that of developed countries; in the future, the total energy demand will continue growing rapidly, and there are uncertainties over the growth rate. China's per capita energy resources, especially quality reserves, are far below the world average; further, with the current level of domestic reserves, it is increasingly difficult to meet the country's economic and social development needs. Energy dependency, especially oil and gas dependency, will continue to climb. Constrained by its development stage and its resource endowments of coal, China's energy development and utilization have caused serious environmental pollution and ecological destruction, negatively influencing human health.

Besides promoting economic development and social progress, China also needs to tackle the new challenges of global climate change and global climate policy. Carbon dioxide emissions are caused by burning fossil fuels; hence, China's energy development faces the difficulty of reducing such emissions, which developed countries have not experienced during their industrialization phase.

The objective of an energy policy is to safeguard supply, protect the environment, and aid in economic growth. Energy conservation and energy efficiency improvement are important and effective ways of responding to these energy challenges.

Energy efficiency is not merely a development issue concerning the natural sciences, engineering, and economic, social, and environmental aspects; it also poses comprehensive, dynamic, and systemic problems in the complex system. This book focuses on research on China's energy efficiency and applies theories and methods in management science and economic science. We hope to be able to enhance the domestic and international energy policy debates and scholarly exchanges about energy economics, as well as provide a reference for China's energy policy and for science and technology professionals in the energy

and climate policy fields. Energy and energy efficiency involve several disciplines. With energy economics as the focal point, this book focuses on ten key issues, which are discussed below.

(1) A comprehensive summary and analysis of the world's and China's energy development

Financial crisis, energy prices, climate change, and low-carbon economy are the keywords in global development in the past two years. The year 2010 is the last year for China to complete the "Eleventh Five-Year Plan." It is also the first year when China clarifies its 2020 carbon intensity target. With this background, this book highlights and analyzes the characteristics of global and China's economic development and the energy supply and demand. In particular, it treats the imbalance in energy consumption worldwide, the evolution of energy structure in major countries, the recent changes in global economic and energy development since 2008, progress in the energy conservation and emission reduction in the "Eleventh Five-Year Plan," and major challenges in energy development in China.

(2) The meaning and measure of energy efficiency

For energy efficiency, there exists some misunderstanding or conceptual deviation. From the perspective of energy as a factor of production, this book, in theory, analyzes the relation between energy efficiency and economic systems and the connotation of energy efficiency. From the perspective of factor substitution and structure heterogeneity, this book gives indicators and measurement of energy efficiency, including energy macro-efficiency, physical efficiency, thermodynamics efficiency, value efficiency, allocative efficiency, utilization efficiency, and economic efficiency. This is done using national economic accounting and microeconomics to analyze basic theory, assumed conditions, correlations, advantages and disadvantages, and the effective range of every indication.

(3) Impacts of structural changes in the economy on energy macro-efficiency

Economic structure is an important topic in all governmental conferences it also occupies an important position in China's short-term policies and long-term planning. National and regional energy macro-efficiency levels are quite different; these differences are caused by factors such as the economic structure, technical equipment, energy structure, resource endowments, climate conditions, geographic location, and so on. However, among these factors, the most important is the economic structure. This book uses layered analysis, from endogenous factors to exogenous factors, to study the impacts of industrial structure, consumer structure, and disposition of income structure on China's energy macro-efficiency. Doing so, it examines the direct and indirect effects of urbanization on energy consumption of households.

(4) Analysis of urban, rural, and regional characteristics of residential energy consumption

Since the beginning of the twenty-first century, China's urban and rural residents' living standards have substantially increased, with an increasing demand for energy

quantity and quality. Nevertheless, the per capita energy consumption is less than 20 % of that of developed countries, and the per capita electricity consumption accounts for 12 % of that of the developed countries. With the continued progress of a well-off society, China's residential energy consumption will continue to grow rapidly. This book analyzes the residential energy consumption characteristics of major countries and differences between urban and rural residential energy consumption and quantitatively analyzes the impact factors of residential energy consumption.

(5) Energy efficiency of key energy-consuming sectors

Energy consumption in the transportation, construction, and power sectors is more than that in other sectors, and the growth rate is fast. This book analyzes the energy consumption characteristics of China's transportation sector, compared with the transportation sectors in the United States, the European Union, and Japan and analyzes domestic and foreign policy relating to energy consumption in the transportation sector. The book also analyzes China's energy consumption in the transportation sector and energy efficiency in the power sector in terms of the transmission and distribution aspects and other issues.

(6) In-depth analysis of the impact of prices on oil demand

With China's recent rapid economic growth, demand for oil is at record highs. From the early twenty-first century to the global financial crisis in 2008, the international price of oil has increased significantly; thus, although not technically accurate, it was believed that a higher oil price would lead to an increasing demand for oil and that rising oil prices did not have any effect on energy conservation. This book quantitatively studies the impact of oil prices on the demand for crude oil.

(7) Comparison of China's regional energy efficiency

China's regional development is uneven, and energy efficiency among its regions varies. Coordinating its regional development is an important aspect of its current and future development policies. At the beginning of the "Eleventh Five-Year Plan", the target was to decrease energy consumption per unit of GDP by 20 % compared with 2005, and then the target is decomposed into regions. At present, China is working to develop the "Twelfth Five-Year Plan", and, the energy conservation and carbon reduction plans on both the national and local district levels by 2020. Comprehensively understanding the differences and changes in the direction and speed of differences of energy efficiency and distinguishing between the subjective and objective reasons for these differences are the preconditions for developing a national and regional energy-saving, emission reduction plan. It is also the precondition for a scientific evaluation of energy-saving performance. In this context, this book empirically analyzes regional energy efficiency.

(8) A comprehensive analysis of energy efficiency policies in developed countries and its implications for China

Since the first oil crisis of the 1970s, developed countries have accumulated more experience and established near-perfect energy efficiency policies. In the 35-year

period (1974–2009), the IEA member countries have experienced overall economic growth of 144 % while energy intensity decreased by 41 %, especially caused by the change in national energy efficiency. This book compares the energy efficiency policies of Japan, the European Union, and the United States, including relevant laws and regulatory, fiscal, taxation, and technology policies, and then it analyzes the implications for China.

(9) Simulation and policy analysis of end-use energy efficiency policies

Investment in improving energy efficiency can reduce the source cost of services. In the absence of additional energy and environmental policy constraints, the efficiency of energy use will be accompanied by a rebound effect that must be at least partially offset by the initial energy savings. This book examines the end-use energy efficiency and the country's economic growth, energy use, and carbon dioxide emissions, focusing on the rebound effect and the various energy and environmental policies in place.

(10) Analyses of the energy efficiency opportunities in China

As the rate of China's energy consumption shows an exponential growth, energy efficiency has never been so urgent and important. China's future energy efficiency direction—whether energy consumption per unit of GDP will maintain its downward trend or whether the emission reduction target, that is, the carbon emission per unit of GDP falling by 40–45 % in 2020 compared with 2005, will be achieved—urgently needs to be explored. This book analyzes the historic opportunities for China's energy, improvement, and judgments on its energy macro-efficiency trend as based on an international comparison.

To be better able to contribute to scientific research, personnel training, and international communication of energy and environmental policy, in 2006, I coordinated with Prof. Yongfa Xu and Keyu Liu to establish the Center for Energy and Environmental Policy Research (CEEP), and I took charge as the first chief. In 2009, the Beijing Institute of Technology President, Haiyan Hu, and the party secretary of Prof. Dacheng Guo invited me and core members of my team to join the Beijing Institute of Technology. The Beijing Institute of Technology's President Office approved the establishment of CEEP in Beijing Institute of Technology, anchored at the School of Management and Economics.

The overall deployment of this project was conducted under the leadership of Prof. Yi-Ming Wei. Further, Hua Liao, Qiao-Mei Liang, Wen-Jing Yi, Zhen-Hua Feng, Jing-Li Fan, Zhong-Yuan Ren, Bin Ouyang, Hai-Bo Wang, Gang Wu, Li Liu, and Jian-Lei Mo participated and completed the relevant sections of this book. Le-Le Zou, Xiao-Wei Ma, Yue-Jun Zhang, Zhi-Yong Han, Jiu-Tian Zhang, Xu-Mei Chen, Jiao-Ling Jiao, Bin Fang, Jie Guo, Kang Li, Zhi-Fu Mi, Kai Wang, Liang-Qiong Xiong, Rui-Guang Yang, Yun-Fei Yao, Ying Yuan, Rong-Gang Cong, Mei-Ning Duan, Lu-Tao Zhao, etc., participated in the study, discussions, and proofreading of sections of this book. The book is the collective wisdom of CEEP. During the process of publication of this book, we have sought to update the relevant data. Although some studies were completed 2 or 3 years ago and some

data are not complete, the conclusions of the study and judgment have proved to be correct and have stood the test of time and practice.

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Due to our limited knowledge of the style and norms of academic-level publications, the book may inevitably be flawed and inadequate in some instances (even wrong), and we are open to criticism and correction!

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