

Yiming Wei  
Lancui Liu  
Gang Wu  
Lele Zou

# Energy Economics: CO<sub>2</sub> Emissions in China

With 134 figures

 Science Press  
Beijing

 Springer

# Contents

<b>Chapter 1 Energy Use and Carbon Dioxide Emissions</b> .....	1
1.1 Characteristics of world energy use.....	2
1.1.1 Energy is an important driver of socio-economic development.....	2
1.1.2 World energy intensity decreases continually with great difference from country to country.....	4
1.1.3 Differences of energy consumption distribution among sectors in different development phases.....	5
1.1.4 Fossil energy dominates world energy consumption structure.....	6
1.1.5 Uneven energy consumption.....	8
1.2 Fossil energy use and climate change.....	9
1.2.1 Global warming directly threatens the human environment.....	9
1.2.2 Industrial production is the major cause of global climate change.....	11
1.2.3 CO <sub>2</sub> emissions caused by fossil fuels combustion are the main sources of greenhouse gases.....	13
1.3 Basic characteristics of world CO <sub>2</sub> emissions.....	14
1.3.1 CO <sub>2</sub> emissions increase continually.....	14
1.3.2 Electricity, industry and transportation sectors account for 60%—70% emissions of total CO <sub>2</sub> emissions.....	15
1.3.3 Industrialized countries account for 80% of world accumulated CO <sub>2</sub> emissions.....	15
1.4 CO <sub>2</sub> emissions mitigation and sustainable development.....	18
1.4.1 CO <sub>2</sub> emissions and socio-economic development.....	18
1.4.2 CO <sub>2</sub> emissions mitigation has become one of the new elements of sustainable development.....	22
1.4.3 Challenges and opportunities of CO <sub>2</sub> emission abatement for China.....	24
References.....	25
<b>Chapter 2 Analysis of Energy Consumption and CO<sub>2</sub>                 Emissions in China</b> .....	27
2.1 Characteristics of energy consumption in China.....	28
2.1.1 Huge energy consumption with high growth rate.....	28
2.1.2 Low carbon energy grows fast in recent years while small in	

proportion .....	30
2.1.3 Big difference in energy structure with certain potential .....	31
2.1.4 Low energy efficiency and big differences among regions .....	34
2.2 Overview of CO <sub>2</sub> emissions in China .....	40
2.2.1 CO <sub>2</sub> emissions grow fast while accumulated emission is lower than that of major developed countries .....	40
2.2.2 CO <sub>2</sub> emissions per capita is lower than the level in developed countries and worldwide average .....	45
2.2.3 CO <sub>2</sub> emission intensity is higher than world average while decreases fast .....	47
2.3 Study on characteristics of CO <sub>2</sub> emissions from primary energy consumption in China .....	48
2.3.1 CO <sub>2</sub> emissions and its intensity during 1980—2005 .....	48
2.3.2 Method for studying CO <sub>2</sub> emission change .....	51
2.3.3 Structure decomposition analysis on CO <sub>2</sub> emission intensity ..	52
2.3.4 Structure decomposition analysis on CO <sub>2</sub> emissions .....	54
2.4 Conclusion .....	57
References .....	58
<b>Chapter 3 Study on Impact Factors of CO<sub>2</sub> Emissions under   Different Economic Development Levels .....</b>	<b>61</b>
3.1 Population, economy, technology and CO <sub>2</sub> emissions .....	62
3.1.1 Change of CO <sub>2</sub> emissions .....	62
3.1.2 Change of population .....	63
3.1.3 Change of GDP per capita .....	64
3.1.4 Change of energy intensity .....	64
3.2 Method for analysis .....	66
3.2.1 STIRPAT Model .....	66
3.2.2 Data sources .....	67
3.3 Impact analysis of population, economy and technology on CO <sub>2</sub> emissions .....	68
3.4 Conclusion .....	76
References .....	77
<b>Chapter 4 Evolution Characteristics of CO<sub>2</sub> Emissions in   Carbon-intensive Sectors in China .....</b>	<b>81</b>
4.1 Study on characteristics of CO <sub>2</sub> emissions change in electricity sector .....	82
4.1.1 Current status of CO <sub>2</sub> emissions in electricity sector .....	82
4.1.2 Method for analyzing CO <sub>2</sub> emission change in electricity	

sector .....	84
4.1.3 Structure decomposition analysis of CO <sub>2</sub> emissions coefficient in electricity production .....	85
4.1.4 Structure decomposition analysis of CO <sub>2</sub> emissions coefficient in electricity consumption .....	88
4.2 Study on characteristics of CO <sub>2</sub> emission change from final energy use .....	93
4.2.1 Method for analysis .....	95
4.2.2 CO <sub>2</sub> emission intensity in material production sector .....	96
4.2.3 CO <sub>2</sub> emissions in material production sector .....	99
4.3 Study on characteristics of CO <sub>2</sub> emissions change from final energy use in industry sector .....	102
4.3.1 Current status of CO <sub>2</sub> emissions in industry sector .....	102
4.3.2 Method for analysis .....	104
4.3.3 Analysis of CO <sub>2</sub> emissions change in industry sector .....	105
4.4 Conclusion .....	111
References .....	114
<b>Chapter 5 Impacts of Household Consumption and Export Trade on CO<sub>2</sub> Emissions .....</b>	<b>117</b>
5.1 Impact of household consumption on CO <sub>2</sub> emissions .....	118
5.1.1 Current household consumption in urban and rural areas .....	119
5.1.2 Methodology: Input-Output Model .....	123
5.1.3 CO <sub>2</sub> emissions of household consumption .....	125
5.1.4 Impact factors of household CO <sub>2</sub> emissions .....	131
5.1.5 Urban and rural household CO <sub>2</sub> emissions under different income levels .....	133
5.2 Impact of export trade on CO <sub>2</sub> emissions .....	136
5.2.1 Current export trade status of China .....	137
5.2.2 CO <sub>2</sub> emissions embodied in exports .....	138
5.2.3 Impact factors of CO <sub>2</sub> emissions embodied in export trade .....	141
5.3 Conclusion .....	143
References .....	144
<b>Chapter 6 Study on Regional CO<sub>2</sub> Emissions Change in China .....</b>	<b>147</b>
6.1 Comparison analysis of regional CO <sub>2</sub> emissions .....	147
6.1.1 Comparison analysis of regional total CO <sub>2</sub> emissions .....	147
6.1.2 Comparison analysis of regional per capita CO <sub>2</sub> emissions .....	148
6.1.3 Comparison analysis of regional CO <sub>2</sub> emission intensity .....	149

6.1.4	Regional electrical CO <sub>2</sub> emission coefficient analysis	150
6.2	Method for analysis of regional CO <sub>2</sub> emissions variation	151
6.3	Analysis of regional CO <sub>2</sub> emissions during 1997—2005	153
6.3.1	Impact from economic growth on regional CO <sub>2</sub> emissions	155
6.3.2	Impact from industrial structure on regional CO <sub>2</sub> emissions	156
6.3.3	Impact from energy intensity on regional CO <sub>2</sub> emissions	157
6.3.4	Impact from CO <sub>2</sub> emission coefficient on regional CO <sub>2</sub> emissions	158
6.4	Conclusion	159
	References	160
<b>Chapter 7 CO<sub>2</sub> Emission Abatement Technology and Impact Analysis</b>		
	<b>Analysis</b>	161
7.1	Major CO <sub>2</sub> emission abatement technologies	162
7.1.1	Renewable energy technology	163
7.1.2	Advanced power generation technologies	168
7.1.3	Carbon capture and storage technology	171
7.1.4	Energy conservation technologies	178
7.2	Analysis of CO <sub>2</sub> emission abatement capability of technologies	181
7.2.1	Renewable energy could mitigate CO <sub>2</sub> emissions effectively with long term abatement potential	181
7.2.2	IGCC and NGCC now are in commercial demonstration and may accomplish the overall optimization of energy conservation and emission reduction	182
7.2.3	CCS may reach near zero emission	184
7.3	Socio-economic impact analysis of renewable electricity	186
7.3.1	China Energy and Environmental Policy Analysis Model (CEEPA)	186
7.3.2	Analysis of socio-economic impact of renewable electricity	188
7.4	Conclusion	192
	References	193
<b>Chapter 8 Simulations of CO<sub>2</sub> Mitigation Policies</b>		
8.1	Major mitigation policies	198
8.2	Study on carbon taxation policy	200
8.2.1	Setting of carbon tax schemes	200
8.2.2	Analysis the effects of carbon tax policy	201

8.2.3	Discussion of carbon tax policy	212
8.3	Study on carbon pricing mechanism based on bilateral trading model	216
8.3.1	Bilateral trading model	217
8.3.2	Trading scenarios	221
8.3.3	Comparison and analysis of carbon pricing mechanism	221
8.4	Conclusion	227
	References	228
<b>Chapter 9</b>	<b>International Carbon Market and Its Impacts on CO<sub>2</sub> Emission Abatement</b>	<b>231</b>
9.1	International carbon market	232
9.1.1	Overview of quota based market	235
9.1.2	Overview of project based market	237
9.2	Relationship between EU carbon market and energy price	250
9.2.1	Relationship between carbon prices and energy prices	251
9.2.2	Model of cointegrating relationship test between carbon prices and energy prices	253
9.2.3	Analysis of interactions between carbon prices and energy prices	256
9.3	Liquidity analysis of EU carbon market	270
9.3.1	Models for market liquidity study	271
9.3.2	Data sources and definitions	272
9.3.3	Empirical results and discussions	273
9.4	Socio-economic impacts analysis of CDM projects in China	279
9.4.1	CEEPA model with CERs prices	283
9.4.2	Macro impacts of renewable electricity CDM project	283
9.4.3	Impacts of renewable electricity CDM project on energy intensive sectors and energy sectors	286
9.4.4	Regional impacts of CDM projects	288
9.5	Challenges of international carbon market development	290
9.5.1	Uncertainty of long-term development of international carbon market	290
9.5.2	Challenges of the development of EU carbon market	291
9.5.3	Challenges of the development of CDM market	292
9.6	Conclusion	294
	References	296

<b>Chapter 10</b>	<b>Outlook of CO<sub>2</sub> Abatement in China</b>	301
10.1	Main driving forces of CO <sub>2</sub> emissions in the procedure of urbanization and industrialization in China	302
10.1.1	Economic growth	303
10.1.2	Population growth	304
10.1.3	Urbanization level	304
10.1.4	Technology advance	305
10.2	China's future CO <sub>2</sub> emissions	305
10.2.1	Total emissions continue growing	306
10.2.2	Per capita CO <sub>2</sub> emission will continually increase while still lower than the current level of developed countries	307
10.2.3	CO <sub>2</sub> emissions in Central China occupies the largest share	308
10.2.4	Obvious difference existing among CO <sub>2</sub> emission intensities	308
10.2.5	Huge shifting emission among regions	310
10.3	Pathway of CO <sub>2</sub> abatement in China	312
10.3.1	Optimizing economic structure and energy structure as the long-term strategy of CO <sub>2</sub> abatement	312
10.3.2	Guiding household consumption style to reduce CO <sub>2</sub> emissions	313
10.3.3	Improving structure of international trade to lower embedded CO <sub>2</sub> emissions	314
10.3.4	Strengthening self-innovation of technology to mitigate CO <sub>2</sub> emissions effectively	315
10.3.5	Balancing positive and negative impacts of carbon tax	316
10.3.6	Participating and improving international carbon market actively	317
10.4	Policy implications	318
10.4.1	Guiding GHG mitigation in the national energy strategy	318
10.4.2	Accelerating the R&D of low carbon technologies	319
10.4.3	Optimizing the industrial structure and energy consumption structure	319
10.4.4	Accelerating the import of advanced energy technologies through international mechanism	320
10.4.5	Strengthening socio-economic impacts analysis of	

mitigation policies .....	320
10.4.6 Enhancing the propaganda of the efforts on GHG	
mitigation .....	321
References .....	321