

Sustainable Energy in China The Closing Window of Opportunity

Noureddine Berrah Fei Feng Roland Priddle LeipingWang

Contents

Foreword			xiii
by Qingtai C	Chen		
Foreword			XV.
by David Do	ollar		
Foreword			xvii
by Christian	Delvoie		
Preface	'	,	xix
About	the	Authors	xxiii
Acknowledgme	ents		XXV
Acronyms	and	Abbreviations	xxix
Executive Sum	mary		xxxi
The Problen	ns China Faces		xxxii
Sustainabilit	y: A Challenging bu	ut Feasible Goal	xxxvi
The Path to	Sustainability		xxxix
Sequencing	the Steps to Sustain	nability	xlvii
Chapter 1	Introduction		1
-	An Impressive Fou	undation of Past Achievements	-1
	Growing Concerns	s about China's Energy Future	2
	The Four Pillars of	f Energy Sustainability	5
	The Closing Wind	ow of Opportunity	6
	Structure of the R	eport	7

vi Contents

Chapter 2	China's Energy Future:	
	The Challenge of Recent Trends	' 1 1
	. Sustained Consumption Growth, 1980-2000	13
	High Growth Forecast for 2000 to 2020	19
	Recent Signs of an Unsustainable	
	Energy Growth Path	22
	The Urgency for Policy Action .	30
Chapter 3	Reining in Future Energy Consumption	35
	Achievements in Energy Efficiency	37
	Concerns about Energy Consumption Trends.	
	of the 10th Five-Year Plan •	41
	Bold New Direction's of the 1 lth Five-Year Plan	41
	The Closing Window of Opportunity	Ν
	for Reducing Long-Term Energy Intensity	43
	The Missing Link: An Improved Policy	
	and Institutional Framework	63
		i»
Chapter 4	Greening the Energy Sector	67
	Pollution Levels Still a Major Concern	69
	Environmental Impacts of the Energy Scenarios	72
	The Energy Path to Greener Development	74
Chapter 5	Securing Energy Supply	87
	China's Growing Sense of Insecurity	89
	Options for Securing Oil and Gas Supply	96
	Options for Securing Electricity Supply	115
	Choosing the Right Mix and Amount	
	of Energy Supply Security Measures	119
Chapter 6	Getting the Fundamentals Right	127
	Furthering the Reform Agenda	
	and Developing a Sound Pricing Framework	129
	Energy Pricing in Competitive Markets	131
	Setting Sound Regulated Tariffs '	133
	Taxing Energy Commodities ^	136
	Measures to Mitigate the Environmental	
	Effects of Energy Use	138
	Energy Commodity Price Policy:	
	Status and Necessary Changes	141

Chapter 7	Shaping the Future toward Sustainability	149
	At the Threshold of Change toward	
	Sustainability in Energy Structure and Policy	151
	Characteristics of a Comprehensive Policy	
	for Energy Sustainability	154
	Four Guiding Pillars for Sustainability Policy	156 v
	Building Blocks to Put the Energy Sector	
	on a Sustainable Path	157
	The Sequence of Steps to Sustainability	1 70
. Appendix A	Gross Domestic Product and Energy	
- V	Consumption in China, 1980-2005	181
Appendix B	Biomass Energy Use in China	187
	Summary	187
	Biomass Resources	187
	Current Status of Development	188
	Prospects for Biomass in China's. Energy Balance	188
	Adverse Effects on the.Natural Environment	
	and on Human Health from Biomass Use	189
	Policies Designed to Encourage the Use	
	of Modern Biomass Technologies	1 90
Appendix C	The Chinese System for Energy Statistics:	
	History, Current Situation, and Ways	
	to Improve the System	192
	The Groundwork Established in the 1980s	192
	Retrenchment in the 1990s	193
	The Current Situation and Its Weaknesses	193
	Conclusions and Recommendations	194
Appendix D	Energy Costs as a Proportion of Gross	
	Domestic Product: Estimates for China,	
	Japan, and the United States	198
Appendix E	Feedback from the Dissemination Workshop	201
	Feedback 1: China's Energy Economy Presents	
	Many Challenges	201
	Feedback 2: The Energy Statistical System	
	Needs Revision	202

	Feedback 3: The Target 20 Percent Energy-Intensity	
	Reduction during the 1 lth Five-Year Plan Will	
	Be Difficult to Achieve	203
	Feedback 4: Economic Well-Being, Energy	
	Consumption, and Environmental Concerns	
	Should Be Addressed	204
	Feedback 5: Energy Technology Leapfrogging	
	Requires Clarification	205
	Feedback 6: International Cooperation	
	and Technology Transfer Are Needed	206
Appendix F	Life-Cycle Costs of Electricity Generation	
	Alternatives with Environmental Costs	
	Factored In	208
Appendix G	International Experience of Insecurity	
	of Energy Supply	212
	Concerns about Oil Imports	212
	Gas Supply Concerns	219
	Concerns about Electricity Supply Failures	224
	Coal Supply, Competitiveness,	
	and Environmental Concerns	226
Appendix H	Strategic Oil Reserves for China	228
	International Practice	228
	Commercial Stocks	229
	Rationale for Stockpiling	229
	Rationale for a Particular Level of Stocks	230
	Decisions to Draw Down Stocks	230
	Costs	230
	A Strategic Oil Reserve for China?	231
	Quality of Estimates ,	232
Appendix I	Predominant Approaches for Setting	
	Regulated Tariffs for Gas and Electricity	
	Transmission and Distribution	233
	Period between ¹ Full Tariff Cases	234
	Three Simple Rules Necessary	
	for Determining Tariffs	234
	Revenue Requirements	235

Rules for Determining Tariffs	238
	-00
	239
Concluding Comments .	239
=	
-	• • •
	241
	243
	243
•	244
	244
	244
Conclusions	246
Gas Price Formation and Gas Subsector Reform	248
Market Pricing Works -^	248
Market Prices Can Work for Gas	248
The Current Gas Pricing System Is Not Tenable	249
The Target: Wholesale Competition	249
Transition Could Be Phased	249
Anticipated Outcomes	254
Pricing System to Support Adequate	
-	256
	258
	258
	258
	259
C C	261
	201
volving Definition of Energy Security	3
	28
· ·	20
÷	54
	21
ergy Sustainability	58
	Lessons from International Experience: Relevant Examples of Losses Derived from Unsound Energy Pricing Crude Oil and Products Natural Gas Electricity Effects on General Economic Performance of Nonmarket Energy Pricing Conclusions Gas Price Formation and Gas Subsector Reform Market Pricing Works -^ Market Prices Can Work for Gas The Current Gas Pricing System Is Not Tenable The Target: Wholesale Competition Transition Could Be Phased Anticipated Outcomes Pricing System to Support Adequate Implementation of State Council Document No. 5 on Power Subsector Reform Bid-Price Pool Environmental Costs Transmission Pricing Final Consumer Pricing volving Definition of Energy Security ' s Coal Production Prospects through 2020 ential Benefits of Technical Retrofitting: ase of the Jinan Iron and Steel Group Corporation ciling Automotive Industrial Policy

Contents ix

x Contents

3.3	Energy Efficiency in Buildings	60
	Key Elements for Environmental Improvement	
i	n the Green Growth Scenario .	73
4.2	China's Clean Development Fund:	
]	Leveraging Carbon Finance for Technology Transfer	82
5.1	Bank Involvement in China's Coal Subsector	94
	Examples of Domestic Energy Development	
]	Incentives in Other Industrial Countries	98
5.3	Repatriating Equity Oil:	
	Is There a Better Way to Provide Security?	102
	e IE As Approach to Short-Term Oil Emergencies	111
	The Shell Group's Latest Energy Security Scenarios	113
5.6	Strengthening China's Energy Security:	
	China's Special Concern	120
7.1	Effective Energy Institutions Involve Significant	
	Staffing and Budgets	152
	ne U.S. Energy Policy Act of 2005 -	160
	Key Elements of a Program for a 20 Percent	
	Improvement in Energy Efficiency .	162
	Creation of a Strong Energy Ministry Reflects	
	International Practice	164
	China and the International Energy Agency	167
	The 2003-06 Oil Price Spike—How Significant Is It	
	in the Security Debate?	216
	auses of the First 21st Century Oil Shock	.217
	Regional and Liquefied Natural Gas Supply Issues	220
	Canadian Views on the Security of Gas Supply	223
	Impacts of Selected Failed Policies	242
	The Present Gas Supply-and-Demand Situation	
	in North America	245
Figure	25	
2.1	Energy Intensity and Energy/GDP Elasticity, 1980-2005	16
2.2	Net Oil Imports, 1990-2005	27
2.3	GDP per Kilogram of Oil Equivalent of Energy Use	31
3.1	China's Per Capita Energy Consumption and GDP	
	Compared with Selected Countries and the World Average	44
3.2	China's Projected Growth Path, of Energy Demand,	
	1980-2020, Compared with That of Other Countries	45

3.3	China's Energy Intensity and Major Development	
	Periods, 1954-2005 .	46
3.4 •	Tunneling a Less Intensive Energy Path to Higher	
	Per Capita Income	47
3.5	Energy-Intensive Industries to Double Output by 2020	53
3.6	Projected Truck Fleet by 2020	55
3.7	Increase in Vehicle Population	56
4.1	Expected Growth in Global Carbon Dioxide	
	Emissions through 2020	72
4.2	Funding the Technological Leapfrogging	84
5.1	Energy Insecurity: Generic Causes, Effects,	
	and'China's Special Concerns	90
7.1	Designing and Implementing a Coordinated Energy Policy	158
F.I	Levelized Cost Comparison of IGCC and Subcritical	
	600-Megawatt with FGD Units: Capital Cost Ratio	210
F.2	Levelized Cost Comparison of IGCC and Subcritical	
	600-Megawatt with FGD Units: Change of Capital	
	Cost of IGCC , ~"	211
I.I	Three Simple Rules for Determination of Tariffs	235
K.I	The Gas Supply Chain: Structure, Contracting, and	
	Pricing Prior to Introduction of Wholesale Competition	250
K.2	The Gas Supply Chain: Structure, Contracting, and	
	Pricing after the Introduction of Wholesale Competition	255
Tabl	es	
2.1	Primary Energy Production and Consumption,	
	1980-2000 '	14
2.2	Final Energy Consumption by Economic Sector	
	and Fuel, 1980-2000 ^	18
2.3	Key Policy Elements Affecting the Projections	
	of the DRC and ERI's Scenarios for 2020	20
2.4	Projections of China's Primary Energy Consumption,	
	2000-20	21
2.5	Final Energy Consumption by Sector and Fuel, 2000–20	23
2.6	' China's Primary Energy Production	
	and Consumption, 2000-05	24
2.7	China's Oil Consumption and Trade, 1990-2005	26
3.1	Change in China's Energy Intensity by End-Use	
	Sector, 1980-2000	38

xii	Contents
xii	Contents

3.2	Improvements in the Efficiency of Key Energy-Using	/
	Equipment and Comparison with International	
	Standards, 1980-2000 '	39
3.3	Sectoral Composition of China's GDP, 1980-2000	40
3.4	Energy Demand/GDP Elasticities of Major Industrial	
	Countries, 1961-2002	47
3.5	Household Appliances per 100 Households, 1995-2002	62
4.1	Projections of Key Air Pollutants in the Energy Scenarios	
	for 2000^20 and Government Caps	74
5.1	Oil and Gas Reserves in the Middle East	
	and Russian Federation	99
5.2 /	Assessment of Relative Difficulty, Cost, and Degree	
	of Control of Key Measures ¹ for Short-Term Oil	
	Supply Security	104
6.1	Fuel Taxation in Selected Countries	137
6.2	A Classification of Market-Based and	
	Regulatory Instruments	140
7.1	Shaping the Future: The Issues, Guiding Pillars,	
	Building Blocks, and Sequencing Steps to Sustainability	176
B . 1	Development of Biomass Energy in China	189
C.I	Final Energy Consumption by Sector, 1980-2000	195
C.2	Final Energy Consumption by Fuel Type, 1980-2000	196
C.3	Conversion Factors for Tables C.I and C.2	196
D. 1	Total Primary Energy Consumption and Fuel Shares	
	in China, 2005	199
D.2	Total Primary Energy Consumption and Fuel Shares	
	in Japan, 2005 .	199
D,3	Total Primary Energy Consumption and Fuel Shares	
	in the United States, 2005	200
F. 1	Main Technical Indices of IGCC and Subcritical	
	600-Megawatt with FGD Units -	209
G.I	Major Global and Regional Oil Supply Crises since 1950	213
G.2	Some Major Electricity Failures of the Past 40 Years	' 225
K. 1	A Phased Approach to the Introduction	
	of Wholesale Competition	251
L.I	New Tariff Requirements	259