
Contents

1	General Summary.	1
1.1	Global Trends in the Natural Gas Industry	1
1.1.1	Abundant Resources, and a Greater Role for Natural Gas in the Future	1
1.1.2	Changes to the Global Trade and Pricing, and a More Interconnected Market	2
1.1.3	Falling Oil Prices and Their Effect on Natural Gas Markets—but no Great in the Price of Imported Gas in China in the Medium to Long Term.	3
1.1.4	China’s Share of the Global Natural Gas Market Is Slowly Growing—China Must Become an Active Player in the International Natural Gas Market.	5
1.2	China’s Natural Gas Supply and Demand and Its Primary Challenges	6
1.2.1	The Chinese Economy’s New Normal	6
1.2.2	Growth Natural Gas Demand in China.	6
1.2.3	Potential to Expand Domestic Natural Gas Supply and Import Capacity in China	7
1.2.4	Key Problems Facing the Development of the Natural Gas Industry	9
1.3	China’s Natural Gas Industry Development Strategy for the Next 15 Years	11
1.3.1	National Strategy and Policy Are Crucial for Natural Gas Industry Development in China.	11
1.3.2	Strategic Objectives of High Efficiency, Safety and Sustainability	13
1.3.3	Clearly Defined Channels and Targets of the Natural Gas Industry	14
1.4	Raising Efficiency and Supporting Improved Policies to Expand Natural Gas Use	16

1.4.1	Strengthen Environmental Regulation, Improve Resource Utilisation Efficiency, Substitute Natural Gas for Coal	17
1.4.2	Improve Planning and Technological Standards, and Promote the Development of Natural Gas Transportation	18
1.4.3	Improve the Pricing Mechanism, Making the Development of Natural Gas Electrical Power Generation Justifiable.	19
1.4.4	Adjust Gas Prices for Residential and Chemical Industry Use, and Reduce Cross-Subsidies for Different Users	21
1.5	Measures to Ensure a Safe and Efficient Gas Supply . . .	22
1.5.1	Attracting New Players to Resource Exploitation to Expand Natural Gas Production	22
1.5.2	Achieving Import Diversification, Safeguarding the Security of Natural Gas Imports.	27
1.5.3	Accelerating the Construction of Pipeline Network, Promoting Network Interconnectivity	29
1.5.4	Accelerate the Construction of Natural Gas Reserve Facilities and Implement Corresponding Institutional Reform	32
1.5.5	Improve Technology Capacity and Strengthen the Long-Term Development Capability.	35
1.6	Constructing a Modern Natural Gas Market Mechanism and Management System	36
1.6.1	Liberalisation of the Upstream Sector and True Import Liberalisation	36
1.6.2	Step-by-Step Natural Gas Price Reform, Accelerated Construction of Natural Gas Trade Hubs	38
1.6.3	Clear Allocation of Functions and Robust Supervision to Support Unbundling and Third-Party Access	40
1.6.4	Strengthen Energy Resource Management, Establish a Regulatory System and Build Regulatory Capacity	42
1.6.5	Support the Development of Professional Services and Technological Companies; Use Market Forces to Promote the Expansion of the Division of Labour.	43
1.7	Deepen the Laws and Regulations System of the Gas Sector, and Establish a Sound Legal System.	44

PART I Analysis of Natural Gas Demand

2	Developments in Global Natural Gas Consumption	49
2.1	Major Factors Affecting Natural Gas Consumption Growth in Other Countries	49
2.1.1	Proportion of Energy Consumption of Natural Gas in Various Countries	49
2.1.2	Breakdown of Natural Gas Consumption Growth in Seven Benchmark Countries	52
2.1.3	The Importance of Fuel Switching in Natural Gas Demand Growth	54
2.2	Primary Factors Motivating Switching from Other Fuels to Natural Gas	56
2.2.1	Various Approaches to Natural Gas Replacement	57
2.2.2	Analysis of Driving Factors in OECD Member Countries Switching to Natural Gas	58
2.2.3	Further Analysis of Motivating Factors for a Country to Switch to Natural Gas	60
2.2.4	Summary	64
2.3	The Influence of Natural Gas Price on Demand	65
2.3.1	The Relationship Between Natural Gas Price Changes and Changes in Demand in OECD Countries Is not Pronounced	65
2.3.2	Limited Effect on Demand of Difference in Price Between Natural Gas and Other Energy Sources	68
2.4	Current State of Natural Gas Use in China and Future Trends	71
2.4.1	Sector Distribution and Total Gas Consumption in China Since 2000	71
2.4.2	Mid- to Long-Term Energy and Natural Gas Development Plans in China	73
2.4.3	Mid- to Long-Term Natural Gas Development Trends for China Based on International Experiences	75
3	Potential for Natural Gas to Act as a Substitute Fuel in China	77
3.1	Power Generation: Cost Comparison of Gas as a Substitute for Coal in Power Generation	77
3.1.1	Direct Cost Comparison Between Gas Generation and Coal Generation	78
3.1.2	Other Factors Influencing the Competitiveness of Gas-Fired Power Generation	79
3.1.3	Conclusions Regarding the Prospects of Gas Replacing Coal in Power Generation	82
3.2	Transport: Analysis of Natural Gas as a Substitute for Diesel	83

3.2.1	Primary Motivators for Natural Gas to Replace Diesel	83
3.2.2	Natural Gas Oil Replacement Price Tolerance in the Urban Transport Sector.	84
3.2.3	Commercial Vehicle Natural Gas Diesel Replacement Price Tolerance	85
3.2.4	Ship Transport Natural Gas Diesel Replacement Price Tolerance.	86
3.2.5	General Factors in the Transportation Market Relating to Gas Replacement of Diesel	87
3.2.6	Potential Prospects for Transportation Market Natural Gas Demand	88
3.3	Urban Use: Assessment of Price Tolerance for Natural Gas to Replace Other Fuels	89
3.3.1	Price Tolerance is Relatively High for Residential Usage of Natural Gas	89
3.3.2	Price Tolerance is also Quite Resilient in Commercial Service Natural Gas Use.	91
3.3.3	Price Tolerance is Weak for Centralised Urban Heating Using Natural Gas	91
3.4	Industrial Use: Cost Comparison of Natural Gas Replacing Other Energy Sources.	92
3.4.1	Price Tolerance is Very Low for Replacement of Fuel Oil by Natural Gas in the Glass Industry.	92
3.4.2	Price Tolerance is Relatively Weak for the Ceramics Industry for Replacement of Coal Gas by Natural Gas	93
3.4.3	Natural Gas Price Tolerance is Relatively Poor for Steam Production as a Replacement for Coal.	93
3.5	Chemicals: Potential for Increased Natural Gas Use in the Production Process	94
3.5.1	Price Tolerance of Natural Gas is Extremely Low for the Manufacture of Synthetic Ammonia.	94
3.5.2	Price Tolerance of Natural Gas is Very Weak for the Manufacture of Methanol	94
3.5.3	Price Tolerance of Natural Gas is Very Strong for the Manufacture of Hydrogen	95
3.6	China's Natural Gas Demand Curve and Ways to Increase Natural Gas Consumption	95
3.6.1	China's Natural Gas Prices in 2013.	95
3.6.2	Natural Gas Demand Curve for China in 2013	96
3.6.3	Implementation Model of Effective Demand and Actual Natural Gas Consumption Based on Natural Gas Price Reform Targets	98

4	Environmental and Social Value of Natural Gas	101
4.1	Losses Caused by Atmospheric Pollution in China	101
4.1.1	Atmospheric Pollution is a Key Cause of Death in China	101
4.1.2	Losses from Injury to Health Caused by Atmospheric Pollution in China Account for 3–12% of GDP	102
4.2	The Environmental Value of Natural Gas as a Substitute for Coal	104
4.2.1	Environmental Pollution and Economic Losses Incurred During Coal Production	104
4.2.2	Environmental Pollution and Economic Loss During Coal Transportation	105
4.2.3	Estimates of Environmental Pollution and Economic Losses Arising from Coal Use	106
4.2.4	Environmental Value Assessment for Natural Gas Substituting Coal	106
4.3	Social Value of Natural Gas as a Substitute for Coal	106
4.3.1	Social Loss of Coal Production	107
4.3.2	Social Loss of Coal Use	107
4.3.3	Social Value Assessment of Natural Gas as a Substitute for Coal	107
4.4	China's Achievements in Energy Conservation and Emissions Reduction	108
4.4.1	Targets and Main Measures for Sulphur Dioxide Emission Reduction During the Period of the 12th Five-Year Plan	108
4.4.2	Emissions Reduction Results Achieved During the 11th Five-Year Plan Period	109
4.4.3	Enormous Potential for Natural Gas to Substitute for Coal in Industrial Fuel and Residential Heating	109
5	Analysis of Medium- to Long-Term Natural Gas Demand and Supply	113
5.1	The Natural Gas Supply-Demand Model	113
5.1.1	Basic Characteristics of the Model	113
5.1.2	Main Intensifications and Adjustments Made Towards Studies of Natural Gas in This Model	114
5.2	Simulation Scenarios for Analysis Simulations of Natural Gas Demand	116
5.2.1	Key Assumptions of the Standard Scenario	116
5.2.2	Key Assumptions of the Policy-Driven Scenario	117
5.3	Natural Gas Supply and Demand in the Standard Scenario	118
5.3.1	Speed of Economic Growth and International Comparison	118

5.3.2	Mid- to Long-Term Changes in Industrial Structures.	119
5.3.3	Energy Consumption and Structural Change. . .	121
5.3.4	Demand for Natural Gas and Main Increases in Consumption	123
5.4	Natural Gas Supply and Demand in the Policy-Driven Scenario.	126
5.4.1	Total Natural Gas Supply and Demand	126
5.4.2	Effects on Pollutant Discharge of Natural Gas Consumer Demand Growth	127
5.4.3	Main Areas of Natural Gas Demand	128
5.4.4	Demand Curve for Natural Gas in China in 2030	129
6	Analysis of China's Natural Gas Use Policies and Suggested Reforms.	133
6.1	Development of China's Natural Gas Use Policy	133
6.1.1	The Encouraging Consumption Stage	133
6.1.2	Restricted Usage Stage	133
6.1.3	Flexible Restrictions Stage	134
6.2	"Optimisation" of Natural Gas Use Structures and Policies	137
6.2.1	China's Natural Gas Use Structure	137
6.2.2	Worldwide There Is no Such Thing as "Optimised" Gas Use Structure.	137
6.2.3	Market Pricing Adjustments Would Automatically Result in "Optimisation" of Natural Gas Use Structures.	138
6.3	Natural Gas Use and Natural Gas Price Controls.	139
6.3.1	Natural Gas Price Control Policies in China . . .	139
6.3.2	The Effect of Pricing Mechanisms in Keeping Natural Gas Prices Low	140
6.3.3	The Influence of a High Fixed Price for Natural Gas.	142
6.3.4	Removal of Natural Gas Price Restrictions Would See the Disappearance of Natural Gas Use Policies	143
6.4	The Relevance of the 1978 U.S. Natural Gas Policy Act for China	144
6.4.1	Legislative Background	144
6.4.2	Contents of the Legislation.	145
6.4.3	Implementation	146
6.4.4	Lessons for Natural Gas Usage Policy in China.	146
6.5	Policy Recommendations for Encouraging Natural Gas Use.	147
6.5.1	Improve Environmental Supervision, Replacing Dispersed Coal Use with Natural Gas	148

6.5.2	Optimise the Electricity Pricing Scheme, and Increase the Economical Natural Gas Power Generation	148
6.5.3	Strengthen Planned Guidance to Promote Natural Gas in Transportation	149
6.5.4	Reduce Cross-Subsidisation Between Different Users, and Encourage Industrial and Commercial Natural Gas Use	150
6.5.5	Extend Carbon Emission Trading Rights, and Actualise the Environmental Value of Natural Gas	151

PART II Analysis of Gas Supply for China

7	China's Natural Gas Resource Potential and Production Trends	155
7.1	Natural Gas Resource Potential	155
7.1.1	Resource Potential for Chinese Conventional and Unconventional Natural Gas	155
7.1.2	Changes in Natural Gas Resource Assessments	155
7.2	Proved Natural Gas Reserves	157
7.2.1	Conventional Natural Gas	157
7.2.2	Coalbed Methane	158
7.2.3	Shale Natural Gas	158
7.3	Growth of Natural Gas Production	159
7.3.1	Conventional Natural Gas	159
7.3.2	Coalbed Methane	159
7.3.3	Shale Natural Gas	161
7.4	Conventional and Unconventional Natural Gas Production Forecasts	161
7.4.1	2020 Production Volume Forecast	161
7.4.2	2030 Annual Production Forecast	162
7.5	Accelerating the Development of China's Domestic Natural Gas Resources	163
7.5.1	Clarify Development Paths	163
7.5.2	Adjust Lowest Exploration Commitments	164
7.5.3	Maintain Reasonable Prices	164
7.5.4	Establish Trade Mechanisms and Trade Platforms for Proved Natural Gas Reserves	165
7.5.5	Accelerate Development of Unconventional Natural Gas	165
8	International Natural Gas Supply and Quantities Available to China	197
8.1	Preface	197
8.2	Current and Future Sources of Global Natural Gas Supply	198

8.2.1	Current and Projected Global Natural Gas Resources	198
8.2.2	Global LNG Trade Development.	199
8.2.3	Trends in Global LNG Trade	199
8.2.4	Developments in the Global LNG Export Market.	199
8.2.5	Growing Natural Gas Demand in China, India and Other Emerging Markets	201
8.2.6	The Influence of Oil Price Declines Future Natural Gas Trade.	202
8.3	China's Current Natural Gas Imports and Future Trends.	204
8.3.1	China's Current Natural Gas Imports	204
8.3.2	Potential Source Nations for China's Future LNG Imports	205
8.3.3	Trends in China's Future Natural Gas Imports	208
8.4	China's Natural Gas Trade Policies and Recommendations for Reform	215
8.4.1	China's Current Natural Gas Trade Policies	215
8.4.2	Recommendations for Adjustments to China's Natural Gas Trade Policy.	217
8.5	Conclusions for Chinese Natural Gas Supply and Availability	221
9	Analysis of China's Natural Gas Infrastructure Development Strategy	233
9.1	Current Development of Natural Gas Infrastructure	233
9.1.1	Current State of Infrastructure Development	233
9.1.2	Assessment of Development Levels and Existing Problems	235
9.2	Opportunities and Challenges	237
9.2.1	The Energy Development Strategy Action Plan (2014–2020)	237
9.2.2	Policy Catalyses Rapid Development of the Natural Gas Industry	238
9.2.3	The Atmospheric Pollution Prevention Action Plan	238
9.2.4	Existing Pipeline Network Capabilities Are Insufficient.	238
9.2.5	Peak Shaving Capabilities Are Severely Lacking	238
9.2.6	Increasing Pressure for Safe Operations	239
9.3	Natural Gas Infrastructure Development Strategy	239
9.3.1	Guiding Considerations	239
9.3.2	Development Objectives.	239
9.3.3	Development Strategy	240
9.4	Standardising Infrastructure Planning and Diversifying Investment	244

9.4.1	Infrastructure Construction Planning and Project Progress Oversight	244
9.4.2	Promote Construction of Entities and Investment Diversification	244
9.5	Establishing Fair Third-Party Access to Infrastructure	245
9.5.1	Create the Conditions for Third-Party Access	245
9.5.2	Establish Open and Transparent Oil and Gas Management and Operation Release Platforms	246
10	Analysis of China's Peak Shaving and Natural Gas Storage Systems	247
10.1	Importance of Natural Gas Reserves for Peak Shaving	247
10.2	Issues and Challenges	248
10.2.1	Rapid Increase in Natural Gas Consumption and Peak Period Demand	248
10.2.2	Gas Reserve Peak Shaving Capabilities Insufficient	249
10.3	Key Objectives and Considerations Going Forward	253
10.3.1	Basic Considerations	253
10.3.2	Major Objectives	253
10.4	Recommendations for Developing Natural Reserves for Peak Shaving	254
10.4.1	Accelerate the Formulation of Natural Gas Peak Shaving Emergency Response Plans	254
10.4.2	Emphasise Gas Reserve Facility Legal and Regulatory Construction	254
10.4.3	Accelerate Natural Gas Peak Shaving Emergency Reserve Facility Construction	254
10.4.4	Formulate Proactive Tax and Price Policies	255
10.4.5	Accelerate Gas Reserve Management System Reforms	256
10.4.6	Establish Prompt and Flexible Warning Systems for Emergency Response	256

PART III Creation of Natural Gas Market Mechanisms and Reform of Natural Gas Management Systems

11	China's Current Natural Gas Market Mechanisms and Regulatory System	261
11.1	Current State of Natural Gas Market Mechanisms	261
11.1.1	Natural Gas Upstream Market	261
11.1.2	Natural Gas Midstream Market	263
11.1.3	Natural Gas Downstream Market	269
11.2	Current State of China's Natural Gas Regulatory Systems	269

11.2.1	Upstream Market Administrative System	269
11.2.2	Midstream Market Administrative System	275
11.2.3	Downstream Market Administrative System	278
11.3	Challenges Faced by the Current System	280
11.3.1	Over-Centralisation of Mineral Rights and Lack of Exploration	280
11.3.2	Bundling of Infrastructure, Low Utilisation and Blocking Access to Upstream Markets.	281
11.3.3	Irrational Pricing Mechanisms, Which Dampen Incentive to Build Gas Storage	282
11.3.4	Downstream Pipeline Operator Regional Monopolies and Cross-Subsidising Between Different Users	283
11.3.5	Incomplete Supervisory Systems and Insufficient Supervisory Capability	283
12	International Experience of Liberalisation and Evolution of Natural Gas Markets	287
12.1	Incentivising New Entrants and Establishing Competitive Natural Gas Markets	287
12.2	Opening the Upstream Sector to Competition	287
12.3	Orderly and Gradual Implementation of Pipeline Access Policies.	289
12.4	Third-Party Access: The First Step to Infrastructure Reform	291
12.5	Unbundling: An Important Element of Liberalisation of Natural Gas Markets	293
12.6	Natural Gas Pricing Reform as Part of the Market Liberalisation and Development Process.	294
12.7	The Role of Natural Gas Trading Markets	296
12.8	Establishment of an Independent and Legally Protected Regulatory System	299
12.9	A Roadmap for Natural Gas Market Reform	301
13	Regulatory System Reform to Support Natural Gas Market Liberalisation	303
13.1	Direction of Reforms.	303
13.2	Key Pillars of Reform	304
13.2.1	Pillar I: Establish a Diversified, Competitive, Open, Orderly Modern Natural Gas Market System	304
13.2.2	Pillar II: Create a Pricing System that Reflects the Extent of Scarcity of Resources, the Market Relationships of Supply and Demand and Environmental Externality and a Green Financial and Taxation System	305
13.2.3	Pillar III: Establish a Service-Centred Natural Gas Administration with a Legal Basis	306
13.3	Reform Objectives	307

14 Roadmap for Natural Gas Market Liberalisation and Regulatory Reform	309
14.1 Roadmap	309
14.1.1 Upstream Sector Roadmap	309
14.1.2 Midstream Roadmap	310
14.1.3 Downstream Roadmap	311
14.2 Key Measures	312
14.2.1 Creation of Market Systems	313
14.2.2 Completion of a Natural Gas Pricing Mechanisms	315
14.2.3 Removal of Pipeline Transport Bottlenecks . . .	315
14.2.4 Further Regulatory Reform	317
14.2.5 Further Reform of the State-Owned Oil and Gas Companies	320
14.2.6 Establish and Improve the Services Market . . .	321
15 Policy Measures and Safeguards to Support Natural Gas Market Liberalisation and Regulatory Reform	323
15.1 Create and Complete a Natural Gas Legislative Framework	323
15.2 Deepen Reform of Oil and Gas Regulations	324
15.3 Deepen Reform of the Fiscal and Tax Systems	325
15.4 Establish and Complete a Natural Gas Data Management System	327
15.4.1 Data Submission	327
15.4.2 Standardised Data Management	328
15.4.3 Database Development and Information Disclosure	328
15.5 Increase Reform and Technical Innovation in the Natural Gas Sector	328
15.6 Expand International Energy Co-operation	330
PART IV International Experience from the Development of Gas Markets Globally	
16 International Development Trends	335
16.1 Global Natural Gas Markets	335
16.2 International Experiences of Liberalising the Natural Gas Value Chain	336
16.3 Liberalisation of Different Segments of the Natural Gas Value Chain	337
16.4 Natural Gas Energy Security and Social Influence	338
17 The Global Natural Gas Market	345
17.1 An Overview of the Global Energy Market	345
17.2 Factors Driving Demand	348
17.2.1 The Main Factors Driving Demand	348
17.2.2 Natural Gas Price Elasticity and China	349

17.3	Supply and Demand Imbalances	350
17.3.1	Summary of Global Resources	350
17.3.2	Regional Imbalances	353
17.3.3	Inter-regional Natural Gas Trade	355
17.3.4	Unconventional Natural Gas Resources	360
17.4	Pricing.	361
17.4.1	Current Pricing Regulations	362
17.4.2	The Relationship Between the Price of Natural Gas and the Price of Oil	366
17.4.3	Chinese Pricing Mechanisms	369
17.4.4	The Influence of Chinese Demand on the World Market.	370
18	An Overview of International Regulatory Experience	379
18.1	Regulatory Reform	381
18.1.1	The Reasons for Regulation	381
18.1.2	The Process of Market Liberalisation Across the Natural Gas Value Chain	382
18.2	Market Liberalisation.	384
18.2.1	Core Initiatives for Liberalisation	384
18.2.2	Political and Economic Factors of Market Liberalisation	390
18.2.3	The Impact of Market Liberalisation on Domestic Mining	391
18.2.4	Market Liberalisation and Ancillary Policies.	392
18.3	Case Studies of Natural Gas Market Liberalisation	393
18.3.1	Case Study 1: United States	393
18.3.2	Case Study 2: Europe	401
18.3.3	Case Study 3: United Kingdom.	408
18.3.4	Case Study 4: Japan	413
18.3.5	Case Study 5: South Korea	419
19	A Close Look at the Natural Gas Industry Chain.	425
19.1	The Upstream Segment: Fiscal Policies and Licensing Systems.	425
19.1.1	International Taxation and Licensing Systems Regulating Upstream Production	426
19.1.2	Case Study 1: The United States—Leasing, Taxation and Development of Information Sharing	426
19.1.3	Case Study 2: Australia—Licensing, Finance and Taxation, and Third-Party Access	428
19.1.4	Case Study 3: Argentina—The Special Licensing System and Encouraging Investment	430
19.1.5	Case Study 4: Mexico—Reopening the Market and Round Zero Tender.	431

19.2	The Midstream Segment: Building Infrastructure and Managing Access	434
19.2.1	Balancing Third-Party Access and Investment Incentives.	437
19.2.2	International Experience of Managing Midstream Asset Access	438
19.2.3	Case Study 1: The UK North Sea—The Framework for Negotiated Third-Party Access.	441
19.2.4	Case Study 2: Japan and Singapore LNG—National Power and the Influence of Oligopoly.	444
19.2.5	Case Study 3: The United States—Master Limited Partnerships	449
19.3	Unbundling Midstream Infrastructure.	451
19.3.1	Models of Unbundling.	453
19.3.2	Key Insights from the Case Studies.	453
19.3.3	Case Study 1: The UK—The Long and Difficult Road to Spinoff	457
19.3.4	Case Study 2: Europe—The Step-by-Step Progression Towards Spinoff and the Multitude of Choices	458
19.3.5	Case Study 3: Japan—Market Characteristics Restricting Unbundling	460
19.3.6	Unbundling LNG Terminals and Gas Storage Facilities	461
19.4	The Downstream Segment: Natural Gas Trading Hubs and the Liberalisation of Wholesale Natural Gas Markets.	462
19.4.1	Pros and Cons of Natural Gas Hubs	463
19.4.2	The Important Inspiration of International Experience in the Development of Natural Gas Trading Hubs.	465
19.4.3	Case Study 1: The United States—Regional Price Balances and Short-Term Pricing	466
19.4.4	Case Study 2: Continental Europe—Market Conditions for Natural Gas Hub Development	466
19.4.5	Case Study 3: The UK—Two Natural Gas Market Reform Bills	467
19.4.6	Establishing Natural Gas Hubs in China.	468
	Bibliography	473
	Further Reading	475

<http://www.springer.com/978-3-319-59733-1>

China's Gas Development Strategies

; (Eds.)

2017, XLVIII, 477 p. 184 illus., 181 illus. in color.,

Hardcover

ISBN: 978-3-319-59733-1