



**AUSTRALIA–JAPAN RESEARCH CENTRE**

ANU COLLEGE OF ASIA & THE PACIFIC  
CRAWFORD SCHOOL OF ECONOMICS AND GOVERNMENT

**CHINA AND EAST ASIAN ENERGY: PROSPECTS  
AND ISSUES**

VOLUME II, PART II



**ASIA PACIFIC ECONOMIC PAPERS**  
No. 369, 2008



ASIA PACIFIC ECONOMIC PAPER NO. 369

PART II , 2008

**China and East Asian Energy:  
Prospects and Issues  
Volume II**

Proceedings of the Conference on 10–11 October 2005  
Xindadu Hotel, Beijing

Peter Drysdale, Kejun Jiang and Dominic Meagher (eds)

**AUSTRALIA–JAPAN RESEARCH CENTRE  
CRAWFORD SCHOOL OF ECONOMICS & GOVERNMENT  
ANU COLLEGE OF ASIA AND THE PACIFIC**

© Australia–Japan Research Centre 2008

This work is copyright. Apart from those uses which may be permitted under the *Copyright Act 1968* as amended, no part may be reproduced by any process without written permission.

*Asia Pacific Economic Papers* (formerly *Pacific Economic Papers*) are published under the direction of the Editorial Committee of the Australia–Japan Research Centre (AJRC). Members of the Editorial Committee are:

Professor Jenny Corbett  
Executive Director  
Australia–Japan Research Centre  
The Australian National University, Canberra

Professor Emeritus Peter Drysdale  
Crawford School of Economics and Government  
The Australian National University, Canberra

Professor Christopher Findlay  
Professor of Economics  
University of Adelaide  
Adelaide, South Australia

Professor Stuart Harris  
Department of International Relations  
The Australian National University, Canberra

Dr Kazuki Onji  
Post-Doctoral Fellow  
Australia–Japan Research Centre  
The Australian National University, Canberra

Papers submitted for publication in this working paper series are subject to double-blind external review by two referees. The views expressed in APEPs are those of the individual authors and do not represent the views of the Australia–Japan Research Centre, the Crawford School, or the institutions to which authors are attached.

The Australia–Japan Research Centre is part of the Crawford School of Economics and Government, The Australian National University, Canberra.

ISSN 0 728 8409  
ISBN 0 86413 323 5

Australia–Japan Research Centre  
Crawford School of Economics and Government  
The Australian National University  
Canberra ACT 0200

Telephone: (61 2) 6125 3780  
Facsimile: (61 2) 6125 0767  
E-mail: [ajrc@anu.edu.au](mailto:ajrc@anu.edu.au)  
URL: <http://www.crawford.anu.edu.au>

## CONTENTS

<i>Contributors</i>	iv
<i>Abbreviations</i>	v
6 China's energy procurement strategy <i>Zhao Hongtu</i>	1
7 Korea's experience in securing energy supplies <i>Jinwoo Kim</i>	27
8 Diversification policies in Japanese energy supply <i>Takeo Suzuki</i>	47
9 Development and reform in the power sector of China <i>Zhaoguang Hu</i>	59
10 China power - reform and development in the electric power sector in China <i>Edward A. Cunningham IV</i>	81
11 China coal development and outlook <i>Hu Yuhong</i>	117
12 Reforms and development in the natural gas sector in China <i>Zhu Xingshan and Yang Jianhong</i>	135

## CONTRIBUTORS

Tony Beck, Visiting Fellow in the Crawford School of Economics and Government, Australian National University; Director, Beck Consulting Services Pty Ltd <tbeck@beckconsulting.com.au>

Edward A. Cunningham, Research Fellow, Massachusetts Institute of Technology <eac4@MIT.edu>

Kejun Jiang, Director of Research Management and International Collaboration Division, Energy Research Institute of China <kjiang@eri.org>  
Xiulian Hu, China Energy Research Institute <huxl@eri.org.cn>

Hu Yuhong, Deputy Director-General, China Coal Industry Association <huyh@chinacoal-safety.gov.cn>

Hu Zhaoguang, Vice President, State Power Economic Research Institute, China <huzhaoguang@chinaspec.com.cn>

Kim Jinwoo, Director, Center for Energy Research on Northeast Asia, Korea Energy Economics Institute <kimj@keei.re.kr>

Warwick McKibbin, Executive Director, Centre for Applied Macroeconomic Analysis, The Australian National University. <warwick.mckibbin@anu.edu.au>

Takeo Suzuki, Senior Coordinator, Institute of Energy Economics, Japan <takeo.suzuki@tky.iecej.or.jp>

Yang Jianhong, Senior Engineer, Petrochina Planning and Engineering Institute, China

Zhao Hongtu, Associate Research Professor and Deputy Director, Institute for World Economic Studies, China Institutes of Contemporary International Relations <htzhao12@yahoo.com>

Yong Zhao, Technical Economic Research Institute, China Huaneng Group <zhaoyong@mail.tsinghua.edu.cn>

Zhu Xingshan, Researcher, PetroChina Planning Department, Beijing <zhuxsh@petrochina.com.cn>

## ABBREVIATIONS

**\$ are US dollars unless otherwise specified**

**RMB are Renminbi (Chinese Yuan)**

**Tons always refers to metric tons unless otherwise indicated**

ACC	advanced clean coal
AIM	Alternative Investment Market
ASEAN	Association of South East Asian Nations
AP6	Asia-Pacific Partnership for Clean Development and Climate
APEC	Asia Pacific Economic Cooperation
APP	Asia Pacific Partnership
Bbl	barrel
BOF	Basic Oxygen Furnace
CBM	coal bed methane
CCS	carbon capture and storage
CDM	Clean Development Mechanism
CFB	circulating fluid bed
CMM	Coal mine methane
CNOOC	China National Offshore Oil Company
CO <sub>2</sub>	Carbon Dioxide
CPCNPC	National Congress of the Communist Party of China
DC	Direct Current
DOE	United States Department of Energy
DNAs	Designated National Authorities
E&P	Exploration and Production
ECEDTC	Eastern China Electricity Dispatching and Trading Center
EECPs	Early entrance co-production plants
ERI	Energy Research Institute (of China)
ETS	Emissions Trading Scheme

EU ETS	European Union Emissions Trading Scheme
FBDC	Fluidised Bed Desulphurisation Combustion
FYP	Five Year Plan
GDP	Gross Domestic Product
GHG	Green House Gas
GW	Giga-Watt ( $10^9$ Watts)
ha	Hectare
HC	Hydro Carbons
IEA	International Energy Agency
IGCC	integrated gasification combined cycle
IPAC	Integrated Policy Assessment Model for China
IPCC	International Panel on Climate Change
IPO	Initial Public Offering
KEPCO	Korea Electric Power Corporation
KOGAS	Korea Gas Corporation
KNOC	Korea National Oil Corporation
KW	Kilo-Watt ( $10^3$ Watts)
kV	kilo-Volts
LIFAC Oxide	Limestone Injection into the Furnace and Activation of Calcium Oxide
LNG	liquefied natural gas
LPDME	liquid phase dimethyl ether
LPG	Liquid Petroleum Gas
LPMEOH	liquid phase methanol
m <sup>2</sup>	square metres
m <sup>3</sup>	cubic metres
MHP	Magneto-hydrodynamic
MLTECP	China Medium and Long-Term Energy Conservation Plan
Mt	Million Tons
Mtoe	Million Tons of Oil Equivalent
MW	Mega-Watt ( $10^6$ Watts)
NDRC	National Development and Reform Commission
NEDO	New Energy Development Organisation (in Japan)
NEDTC	Northeast Electricity Dispatching and Trading Center
NERC	Northeast Electricity Regulatory Commission
NDRC	National Development and Reform Commission
NO <sub>x</sub>	Nitrous Oxides



OH	Hydrogen Monoxide
OPEC	Organisatino of Petroleum Exporting Countries
PFBC	Pressurised Fluidised Bed Combustion
PJ	Petajoules
PNG	piped natural gas
R&D	Research and Development
SCEDC	Southern China Electricity Dispatching Center
SCETC	Southern China Electricity Trading Center
SEPA	State Environmental Protection Administration
SERC	State Electricity Regulatory Commission
SO <sub>2</sub>	Sulphur Dioxide
tce	tons of coal equivalent
TOU	time-of-use
TRP	Top-pressure Recovery Turbine
TSP	Total Suspended Particulates
TWh	Terra-Watt Hours
UNFCCC	United Nation's Framework Convention on Climate Change
u tons	micro tons



## 6 CHINA'S ENERGY PROCUREMENT STRATEGY

ZHAO HONGTU

Different observers place different levels of importance on various issues relating to China and energy. To Chinese observers, the most important issue is how to maintain economic growth. To most Western analysts, the more crucial issue is how Chinese energy policies and activities will affect world markets. One point is not in dispute: China's international energy procurement activities are attracting considerable attention.

One of the main areas of contested opinion is whether international acquisitions by China's energy firms represent a national procurement strategy driven by the central government or simple profit maximising behaviour by enterprises in China's energy sector and the implications of either situation for China and the world. Many Chinese analysts tend to believe that no such national procurement strategy exists. They point to several failed Chinese bids for international oil acquisition as evidence of the absence of a governmental strategy for foreign energy procurement. In contrast, most Western analysts not only believe that China has such a strategy but also that the government is diligent in carrying it out.

A number of observers look for evidence of China's energy procurement strategy in analogies with Japan's practice of exploration abroad and the strengthening of relations with oil exporting countries since the 1970s, identifying these practices as a Japanese energy procurement strategy. In this regard, China can be considered to have a similar strategy to the Japanese (as can India, which faces similar energy issues). However, the degree to which this can be considered a major strategy is questionable. China's oil companies sell most of their equity oil and gas in the world market rather than sending it back to China. Any Chinese energy strategy, rather than focusing on international procurement, is multifaceted, focusing on improving energy efficiency, saving energy, developing new and renewable energy sources, furthering the reformation of the energy sector and establishing strategic petroleum reserves. Despite these facts, it is Chinese firms' international activities that draw most of the international concern.

This paper addresses the issues of where, how and why China's oil companies invest overseas and both the international and domestic implications of these investments. The relationship between the government and the oil companies is also discussed. In drawing conclusions, the paper will seek to suggest a range of issues that would push forward the mutual understanding and energy cooperation between China and the rest of the world.

### *'Going abroad' strategy*

The Chinese government first outlined the strategic principles for developing China's oil industry in December 1993. The main principle was to 'make full use of two resources and two markets (domestic and international)'. When former President Jiang met the China National Petroleum Corporation (CNPC) leaders on 14 January 1997, he said: 'We are poor in per capita oil reserves and should work hard to engage the international oil market. The oil industry should walk with two legs: actively engaging and using international oil resources while basing on domestic resources' (Tong et al. 2003: prologue).

In 2000, the 15th Central Committee on the 10th Five Year Plan referred to 'carrying out the "Going abroad" strategy, and working hard to achieve new progress in using two resources and two markets' (Tong et al. 2003: prologue ).

At the same time, foreign exploration and development of energy resources became a hot topic across China, with numerous publications on the issue appearing. The discussion focused both on national oil security issues and business issues for the companies involved. In 1992, An Yupei wrote an article entitled 'Thoughts on China's oil industry to develop overseas business' which suggested going abroad to use overseas resources and markets, and pointed out several strategies for the oil industry to develop overseas business. Since the publication of An Yupei's article, China has become increasingly dependent on imported oil. The number of publications on the issue has increased correspondingly. Professor Han Wenke, deputy director of the Research Institute of the National Development and Reform Commission (NDRC), makes the point as follows: 'what we want is to make China's large companies more competitive. To achieve this goal, one strategy is to invite foreign companies into China. The other is for Chinese companies to go abroad.'

As early as 1991, however (even before foreign oil reserves became an issue of hot discussion), the China National Petroleum Corporation (CNPC) had taken 'go international' as one of three strategies of its development plan. CNPC established its international department in November 1992 to take charge of oil exploration and production cooperation with foreign companies inside or outside China.

China National Offshore Oil Corporation (CNOOC) purchased a 32.5 per cent interest in an oilfield in the Straits of Malacca in 1993. In 1995 it purchased an additional 6.93 per cent interest. However this project did not achieve much progress until 2002, when CNOOC invested \$1.2 billion and acquired three big projects, including Indonesian assets of Repsol-YPF, a 12.5 per cent interest in the Tangguh liquefied natural gas (LNG) project in Indonesia and a 25-year contract worth \$8.5 billion to supply LNG from Tangguh in Papua province to China's Fujian province.

Sinopec signed an exploration contract with Iran in 2000 and established the International Corporation of Oil Exploration and Production in January 2001. China National Chemicals Import and Export Corporation (SINCHEM) expanded their business to explore and produce overseas in May 2002. In the same year, SINCHEM signed two contracts: one with PGS, the other with Ecuador. Additionally there are some companies not in the energy industry, such as CITIC Group and China North Industries Group, which are also interested in investing in overseas oil exploration and production.

The history of Chinese firms' international activities can be divided into three broad periods.

*Initial period (1993–97).* The initial period was characterised by small projects such as searching for oilfields and increasing the capacity for extraction. From 1993 to 1995, CNPC acquired several old oilfield projects such as Talara Block in Peru, Exploration Block in Papua New Guinea and Block-6 in Sudan. The initial period was a crucial time for Chinese companies to become familiar with the international market environment, accumulate experience and train professionals.

*Growth period (1997–2002).* 1997 was a fruitful year for the CNPC with the signing of several large contracts. These included purchasing Block 1/2/4 in Sudan, 60 per cent of Aktobemunaigas Production Association and 51 per cent of the Uzen field in Kazakhstan and Intercampo Norte and the Caracoles Block in Venezuela. From the second half of 2000, CNPC signed a number of new contracts for ventures such as Block 3/7 in Sudan, four blocks in Myanmar, the Garachukhur oilfield in Azerbaijan and Block 5 in Oman. At the same time, CNOOC, SINOPEC and SINCHEM made significant progress in their overseas investments, signing a number of contracts, including in Australia, Indonesia, Iran, and Algeria. This period saw Chinese companies move to a new stage in which their investments began delivering returns.

*New development period (2003–).* Since 2003 Chinese oil companies have invested in oil ventures in over 20 countries with bids for oilfield development contracts, pipeline contracts and refinery projects in Africa, the Middle East, Central Asia, Southeast Asia, Latin America, and North America. Additionally, China has pursued a strategy to achieve similar equity levels of both oil and natural gas. It has done this by importing natural gas through acquiring upstream equity stakes in LNG projects. By late 2007, such ventures are expected to bring LNG to China, particularly from Indonesia.

CNPC foreign investment has expanded to more than 20 countries, involving over 60 projects. In 2004, CNPC foreign production reached over 30 million tons; its equity oil production reached over 16 million tons; and equity gas supplies were about 2.59 billion cubic metres. By comparison, in 2002 the total equity oil production by Chinese oil companies was

just 12 million tons. According to an investigation by the Japan External Trade Organisation, from the beginning of 2005 to January 2006, the investment of three Chinese oil companies in overseas equity oil reached about \$8.5 billion, overtaking the cumulative foreign investment of all previous years. At the same time, the business also expanded to exploration for and production of oil and gas, both on the mainland and offshore.

China also invited state oil companies in key exporting countries to invest in downstream oil and petrochemical projects in China. An example is the joint refining investment in Fujian province with Saudi Aramco and ExxonMobil mentioned above. Sinopec has a 50 per cent equity stake in the joint venture, known as the Fujian Refining Ethylene Joint-Venture Project, while Aramco and ExxonMobil will each own 25 per cent.

Tables 6.1 to 6.4 list a wide range of international Chinese investment and commercial activities. These include, but are not limited to, direct overseas equity investments. Also included are short- and long-term purchase contracts for oil or natural gas, investments in pipeline infrastructure and contracts/agreements for joint ventures and exploration.

## China's energy diplomacy

China's energy diplomacy forms part of its economic diplomacy more generally. The goal is to diversify oil supplies and ensure energy security. Since the 1990s, with the rapid growth of oil demand and dependence on oil imports, China's energy diplomacy has come to attract considerable attention, both domestically and internationally.

Generally, energy diplomacy can be divided into two categories. The first perceives energy as a tool, or a means. An example is the Organisation of the Petroleum Exporting Countries (OPEC) oil embargo in the 1970s. This was a case of using oil to meet diplomatic ends. The second category perceives energy as a goal, or end. For example, oil importers such as the United States, the European Union (EU) and Japan have in the past conducted diplomatic activities to promote energy cooperation and ensure energy supply. China's energy diplomacy is of this type.

Box 6.1 shows some examples of China's energy diplomacy

**Strengthening diplomatic relations with exporting countries.** State visits and high level diplomacy are important parts of China's energy diplomacy. They are also the main focus of criticism from Western countries. During the cold war period, China's diplomats paid more attention to politics and ideology than to other issues. However since the end of the 1970s economics has played an increasingly important role in China's foreign policy making. Energy diplomacy should be considered as an extension of China's economic diplomacy, meaning that energy diplomacy is made to serve economic development. Recently, especially after President Hu came to office, energy cooperation has become an important part of China's

Box 6.1 Examples of China's energy diplomacy

- At the end of January 2004, President Hu Jintao visited four nations, three of which (Egypt, Gabon and Algeria) are oil exporters. After the visit, PetroChina signed petroleum investment agreements with Egypt and Algeria while Sinopec started importing oil from Gabon for the first time.
- In 2004, President Hu Jintao visited Kazakhstan and established a strategic partnership between the two countries through a joint communiqué. Hu's visit directly helped the two countries reach the agreement to build the Kazakhstan–China oil pipeline.
- During the visit of Premier Wen Jiabao to Russia in 2004, a key agenda item was Russia's Far East oil pipelines. In November 2004, he signed a \$19.7 billion investment with Argentina, \$5 billion of which is to be used for oil exploration (Lin 2005).
- In January 2005, China and Canada issued a statement of energy cooperation in the 21st century. The two countries committed to work together to promote cooperation in the oil and gas sector, including Canada's oil sands, as well as in the uranium resources sector. They also agreed to encourage their respective enterprises to expand their commercial partnerships.
- In March 2005, Venezuela's President Hugo Chavez visited Beijing, where he signed an agreement allowing China to drill for oil, establish oil refineries and produce natural gas.
- In April 2005, China and India pledged to cooperate on upstream development in foreign countries, the first such agreement between these two former rivals to be reached in decades.
- In December 2005, the OPEC president, Sheikh Ahmad Fahd al-Sabah, visited China to engage in talks regarding world energy markets and meeting China's future energy needs.

high-level visits to oil and gas rich regions like Central Asia, Africa and Latin America and countries like Russia, Australia and Canada. Additionally, the Chinese government has been actively strengthening relationships with key exporting countries.

**Financial support for energy investments abroad.** In addition to state visits and high-level diplomacy, the Chinese government is promoting bilateral ties by providing soft loans and other types of assistance in countries where China has promoted energy and other investments through state companies. For example, in 2004, China provided the Angolan government

**Table 6.1 Key Chinese investments and commercial ties in exporting countries: Central Asia and Russia**

Country	Date	Company	Description
Azerbaijan	June 2004	Sinopec	Signed a 25-year \$220 million deal to rehabilitate Azerbaijan's Garachukhur oilfield.
Kazakhstan	1997	CNPC	Purchased 60 per cent of Aktobemunaigas Production Association for \$4.3 billion.
Kazakhstan	1997	CNPC	Purchased 51 per cent of Uzen field for \$1.3 billion.
Kazakhstan	Mar. 2003	CNOOC/ Sinopec	British Gas Group announced the sale of its 16.67 per cent Sinopec interest in the Kashagan field to CNOOC and Sinopec. Subsequently, five of the six partners in the Kashagan consortium exercised their preemption rights and blocked the Chinese companies from investing.
Kazakhstan	May 2003	CNPC	Purchased a 25 per cent interest in Aktobemunaigas Corp, increasing its total interest to 85 per cent.
Kazakhstan	Aug. 2003	CNPC	Acquired 35 per cent of the joint venture Texaco North Buzachi Inc. from Nimir Petroleum. In September 2003, CNPC bought out ChevronTexaco interests to become the sole owner of the rights to develop the field. In February 2004, CNPC conveyed a 50 per cent stake in the project to the Canadian company Nelson Resources for \$90 million. The joint venture is now Nelson Buzachi Petroleum B.V.
Kazakhstan	Dec. 2003	Sinopec	Acquired a 50 per cent stake in Big Sky Energy Kazakhstan for \$2.3 million. In 2004, Sinopec withdrew from Big Sky Energy Kazakhstan.
Kazakhstan	Oct. 2004	Sinopec	Purchased \$160 million worth of Kazakh oil assets from First International Oil Company, a small US firm.
Kazakhstan	Oct. 2005	CNOOC/ CNPC	Signed an MOU with KazMunaiGaz to explore the offshore Darkhan field, which is said to hold about 480 tons of fuel equivalent.
Kazakhstan	Oct. 2005	CNPC	A Canadian court dismissed a case brought by Lukoil claiming preemptive rights in CNPC's \$4.18 billion offer for PetroKazakhstan. Kazakhstan's state-owned petroleum monopoly KazMunaiGaz will get a share of the company and joint management over its Shymkent refinery in return for political approval for CNPC's offer.
Kazakhstan	Dec. 2005	CNPC	The 988-kilometre Atasu-Alashankou pipeline is on track for completion. It is the second and easternmost section of a three-phase pipeline that will carry oil from western Kazakhstan to Xinjiang. A 50/50 venture with KazMunaiGaz, but CNPC is responsible for sourcing oil to fill the pipe.
Russia	June 2003	CNPC	Signed a memorandum of understanding with Yukos Oil of Russia for sales of oil via a pipeline from Angarsk to Daqing.
Turkmenistan	July 2005	China*	Signed an agreement on oil and gas cooperation; China extended a low interest loan of \$24 million to Turkmenistan for the development of its oil and gas industry.



Turkmenistan	Recent years	China <sup>a</sup>	China extended three \$12 million low interest loans to Turkmenistan for the purchase of Chinese drill rigs.
Uzbekistan	July 2005	CNPC	Agreed to a \$600 million oil venture to invest in 23 oilfields; a 50/50 partnership with state-owned Uzbekneftegaz.
Uzbekistan	Sept. 2005	CNPC	Signed agreement on the Establishment of the Investors Consortium with Uzbekneftegaz, Lukoil, Petronas, and Korea National Oil Corp. The Consortium plans to negotiate with Uzbekistan for drafting the production sharing agreement for exploration and production of oil and gas fields in the Uzbek part of the Aral Sea. The PSA is planned to be signed in 2006.

*Notes:* a Information was not available on specific Chinese actors, company or otherwise.

*Source:* United States, Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006.

with a 17-year, \$2 billion loan at a low (1.5 per cent) interest rate along with the offer to build hospitals and electronics manufacturing factories. The agreement provides China with crude oil in return for credit, and also opens the door to possible future exploration prospects (Dadwal and Sinha 2005).

In November 2004, China and Cuba signed a memorandum of understanding (MOU) that essentially committed over \$500 million for investment in Cuba. A few months later, Sinopec signed an agreement with Cuba's state run Cubapetroleo (Cupet) to jointly produce oil in Cuba.

China has also supplied direct infrastructure development to many producer countries. Examples are port facilities in Gabon, railways in Nigeria and a metro system in Iran. Other examples can be seen in Sudan, which is among the top five oil exporters to China. Here, Chinese state oil companies have concluded several exploration and production contracts in recent years. Meanwhile, CNPC and other Chinese companies (non-oil) have spent over \$30 million to build schools, hospitals, bridges, and other social/economic infrastructure in exchange for a share in Sudan's energy industry and other parts of the economy.

China has also established strategic partnerships with the governments of several major oil exporting countries. Such partnerships, which are mostly bilateral arrangements, have not focused particularly on energy. Rather, they encompass cooperative arrangements on political, economic and security issues as well as generally broadening relations between the two countries. In a similar vein, China and ASEAN recently established a free trade area (FTA). China is negotiating other FTA arrangements, including with Australia, Burma and the Gulf Cooperation Council (GCC) countries.<sup>1</sup>

**Table 6.2 Key Chinese investments and commercial ties in exporting countries: Middle East and Africa**

Country	Date	Company	Description
Algeria	Dec. 2003	CNPC	Will invest \$31million over three years to prospect for oil and gas.
Algeria	July 2004	CNPC and Sinopec	Granted with 3 exploration blocks.
Angola	Oct. 2004	Sinopec	Secured a 50 per cent interest in Angola's block 18, set to produce 200,000 b/d by 2007.
Angola	Aug. 2005	Sinopec	Secured a 30 percent share in Block 3/5 (formerly block 3/80).
Angola	2004	Sinopec	Signed a memorandum of understanding for joint refinery and offshore prospecting.
Angola	2004	Govt.of China (Chinese EXIM BanK)	Provided \$2 billion line of credit for 10,000 b/d supply.
Congo-B	Mar. 2005	Sinopec	Two oil exploration and production blocks.
Cote voire	Dec. 2004	Sinopec	Became a partner in the San Pedro block.
Egypt	1998	CNPC	Signed an agreement with two Egyptian companies to form a joint-investment company.
Gabon	2004	Sinopec	Exploration of three offshore blocks; two onshore blocks.
Iran	Oct. 2004	Sinopec	Signed a MOU for a 25-year \$70 billion agreement to import LNG in exchange for developing Yadavaran oilfield.
Iraq	1997	CNPC (and consortium of others)	Signed a 22-year production-sharing contract to develop al-Ahdab field for an estimated cost of \$1.3 billion.
Libya	2004	GOC	Signed a \$300 million, 10 million barrel crude purchase.
Madagascar	Undetermined	China	Potential for a joint venture in exploration sometime in the future.
Mali	Oct. 2004	Sinopec	Obtained two exploration blocks.
Mauritania	June 2005	CNPC	Owens a 65 per cent stake in onshore Block 20 for exploration and production; 100 per cent share of Blocks 12, 13, and 21 for exploration.
Niger	Aug. 2004	CNPC	Obtained two exploration blocks.
Nigeria	Dec. 2004	Sinopec	Signed an agreement with Nigeria Petroleum Development Corp. to develop oil production in two blocks in the Niger delta (OML 64 and 66).
Nigeria	2005	PetroChina (CNPC subsidiary)	Secured a one-year supply contact, 30,000 b/d. Four oil exploration blocks reward for stake in Kaduna refinery.
Nigeria	Nov. 2004	Sinopec	Obtained two blocks in Lake Chad Basin.

Nigeria	Jan. 2006	CNOOC	Agreed to pay \$2.3 billion for a 45 per cent working interest in Nigerian Oil Mining License (OML) 130 from South Atlantic Petroleum.
Saudi Arabia	Mar. 2004	Sinopec	Signed a \$300 million gas exploration and production deal with Saudi Aramco.
Sudan	1997	CNPC	Acquired a 40 per cent stake in the Greater Nile Petroleum Operation Company consortium to explore and develop the Heglig and Unity fields.
Sudan	1999	CNPC	Heglig-Port Sudan Pipeline (500,000 bpd) – A pipeline from the fields to the Red Sea.
Sudan	June 2000	CNPC	Khartoum refinery, 70,000 bpd.
Sudan	June 2004	CNPC	Adar/Yale fields, 300,000 b/d by 2006.
Sudan	Sep. 2005	CNPC	Offshore exploration and production of block 15.
Sudan	Dec. 2004	Sinopec	Adar-Port Sudan Pipeline.

---

*Source:* United States, Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006.

Similarly, Beijing has successfully paved the way for oil expansion through trade agreements and financial support. In early 2005, as part of a government-to-government package of financial and political cooperation, Sinopec signed a memorandum of understanding with Pertamina to build a \$2 billion refinery in East Java, Indonesia. Sinopec expects access to upstream hydrocarbon reserves. Aside from leveraging the benefits of government intervention, Chinese national oil companies (NOCs) are exploring alternative options to asset acquisition, such as the consortium approach (CNPC and Sinopec Andes Petroleum) in Ecuador.

In addition to providing China's NOCs with cheap capital, Beijing aids the oil companies through the China Development Bank and the China Export Import Bank, two of the policy banks created in 1994 to manage state-directed lending. China Eximbank is the world's third largest export credit agency. According to Evans and Downs (n.d.), its principal mandate is to 'implement state policies in industry, foreign trade and economy, finance and foreign affairs'. Resource-rich countries in Africa have been the primary beneficiaries. There are three main types of support.

The first type of support is the extension of credit lines to China's NOCs that are not necessarily tied to specific acquisitions. For example, China Eximbank has provided lines of credit of up to \$1.2 billion (all currencies in US dollars) to both the CNPC and PetroChina, intended, in part, for overseas exploration and production.

**Table 6.3 Key Chinese investments and commercial ties in exporting countries: Asia Pacific**

Country	Date	Company	Description
Australia	Aug. 2002	CNOOC	Paid \$348 million for an interest in Australia's North West Shelf LNG project.
Australia	Oct. 2003	CNOOC	Bought a 12.5 per cent (\$8.5 billion) share in Gorgon liquefied natural gas field off the coast of Western Australia.
Australia	Dec. 2004	Guangdong Dapeng LNG	Signed a purchase agreement to buy 3.3 million tons a year for 25-years, total of \$14 billion.
Indonesia	2004	PetroChina	Has a 25 per cent interest in, and operates, Sukawati oilfield.
Indonesia	1993/1995	CNOOC	Purchased 32.5 per cent interest in an oilfield in the Straits of Malacca, and an addition 6.93 per cent in 1995.
Indonesia	Jan-02	CNOOC	Bought Indonesian assets of Repsol-YPF for \$585 million.
Indonesia	2002	CNOOC	Acquired 12.5 per cent interest in the Tangguh LNG project in Indonesia for \$275million.
Indonesia	Sept. 2002	CNOOC	A 25-year to supply of \$8.5 billion worth of LNG from Tangguh in Papua province to China's Fujian province.
Indonesia	2004	CNOOC	Increased share of Tangguh to 17 per cent, purchased additional share for \$100 million from BC Group Plc.
Indonesia	Apr. 2003	PetroChina	Purchased a 45 per cent interest in an operator-ship in an Indonesian field.
Myanmar	2004	Sinopec and CNOOC	Awarded with four exploration blocks.

*Source:* United States Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006.

A second type of support is financing for specific investments. The most controversial case was the ill-fated attempt of CNOOC to purchase Unocal in 2005. The financing CNOOC arranged for its \$18.5 billion bid included a \$4.5 billion subordinated loan at the below-market interest rate of 3.5 per cent and a \$2.5 billion subordinated two-year bridge loan at zero interest, both from its state-owned parent company.

A third type of support is investment in infrastructure. The most prominent example is the \$2 billion soft loan agreement that China Eximbank signed with Angola in 2004 to finance infrastructure projects presented by Chinese companies. A recent example of this type of deal occurred during Hu Jintao's visit to Nigeria in April 2006. Hu signed an MOU for

**Table 6.4 Key Chinese investments and commercial ties in exporting countries: The Americas**

Country	Date	Company	Description
Brazil	Sept. 2004	Sinopec	Deal to build a \$1.3 billion gas pipeline.
Canada	1992–1993	CNPC	Purchased nearly \$11 million worth of Canadian reserves.
Canada	Apr. 2005	CNOOC	Paid \$122 (C\$150 million) for a 16.7 per cent interest in Canadian oil sands company MEG Energy Group.
Canada	May 2005	Sinopec	Agreed to purchase 40 per cent interest in Synenco Energy Inc.'s Northern Lights oil sands project for \$83 million (C\$105 million).
Cuba	Jan. 2005	Sinopec	Signed a joint exploration agreement and production agreement signed with Cubapetroleo Enterprise.
Ecuador	Sep. 2005	CNPC/Andes Petroleum	Paid \$1.42 billion for EnCana oil and pipeline holding.
Peru	1993	Sapet Development Co. (CNPC subsidiary)	Bought the Talara Block for \$25 million.
Venezuela	2005	CNPC	Signed an agreement to exploit the Zumano oilfields in Eastern Venezuela.
Venezuela	1997	CNPC	Bought two marginal fields for \$359 million, purchased a field in the Intercampo Norte for \$188 million and the Caracoles Block for \$241 million.

*Source:* United States Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006.

billions of dollars of investment in infrastructure. The MOU included an arrangement for CNPC to take a stake in the Kaduna refinery in return for the right of first refusal on four oil blocks (Evans and Downs n.d.).

**Pursuing multidimensional international energy cooperation.** It is important to note that China's energy diplomacy is not restricted to oil exporting countries or overseas exploration and production investment. Recently China has been working on improving energy cooperation with Western countries that are large oil importers. There are three main motivations for this policy.

The first motive is to improve cooperation on new and renewable energy. Since October 1978, when US Energy Secretary Schlesinger visited China, the United States and China have signed several agreements and carried out fruitful cooperation in the fields of fossil energy, environmental protection and clean energy.

The second motive is cooperation in exploration. An example is the first phase of the Bozhong 25-1 oilfield project in China's Bohai region, which was co-explored by CNOOC and Chevron Texaco. US and Chinese oil companies have also developed fruitful cooperation in other countries. The most representative example concerns 16 oilfields in Ecuador. SINOCHEM holds 14 per cent of the field's shares while Murphy Switch California owns 20 per cent.

The third motive is to strengthen communication and strategic dialogue with industrial countries in order to avoid misunderstandings and friction. Since 1998 China and the United States have held six forums on oil and natural gas, hosting in turn. On 23 May 2005, when participating in the 9th International Energy Forum in Amsterdam, Zhang Guobao, vice director of the NDRC, and Spencer Abraham, US Energy Secretary, signed an MOU to enhance bilateral dialogue on energy policies, deepen mutual understanding on energy issues and policies and promote information exchanges in the energy field. On 30 June 2005 the first Energy Policy Dialogue was launched in Washington DC. In August 2005 China and the United States launched their first strategic dialogue in which energy cooperation topped the agenda. Such exchanges and dialogues between governments, enterprises and scholars of the two countries have become more and more frequent. In addition, there has been major progress in the China-Japan negotiations on energy disputes in the East China Sea.

### **Dynamics driving China's overseas energy activity**

**China's response to increasing energy challenges.** Over the last two decades or so, China has quadrupled its economy and doubled its energy consumption. The total consumption of petroleum has risen dramatically in recent decades, from approximately 1.87 million barrels per day (b/d) in 1980 to approximately 6.99 million b/d in 2005.<sup>2</sup> Furthermore, a surge in demand for oil and stagnation in domestic oil output has turned China into a net oil importer since 1993. In the past decade, the annual growth rate of Chinese oil consumption has been over 7 per cent, with crude oil imports increasing from 9.9 million tons in 1993 to 127 million tons in 2005. Imports accounted for 6.69 per cent of total oil consumption in 1993 and about 40 per cent in 2005.

At the time of writing, China was the world's second largest energy consumer and the second largest consumer of petroleum products after the United States. It was also the world's third largest oil importer, although on a per capita basis energy consumption and imports are still much lower than those of the United States and other developed countries. With China poised to quadruple its GDP by 2020, the country's consumption of energy is expected to at least double again, assuming further efficiency gains in energy use.

The International Energy Agency (IEA) forecasts that China's oil demand will grow at nearly 3 per cent per annum, with consumption doubling to reach 13.1 million b/d by 2030. This dramatic increase in demand is matched by an equally dramatic decline in domestic oil production, down to an anticipated 2.4 million b/d in 2030, leaving a tremendous shortfall to be made up by imports (Zha 2005). According to some Chinese scholars' predictions, China's oil imports will reach 200–240 million tons per year in 2010 and 320–360 million tons in 2020 respectively, while its oil import dependence will rise to 60 per cent and 70 per cent respectively.

China's rapid economic growth also puts the country's electricity supply under strain. The recent power shortages that struck two-thirds of China's provinces and municipalities have directed considerable public attention to energy supply issues. The new round of oil price hikes greatly affected China. Its national foreign exchange expenditure expanded, and the deficit in oil trade mounted to \$45.03 billion in 2005. As a result, there was significant pressure on inflation and renminbi (RMB) appreciation. It has been estimated that China's GDP growth rate will decrease by about 0.01 per cent for every 1 per cent rise in the world oil price (persistent for 1 year). According to this estimation, China's GDP growth rate lost about 0.4 per cent in 2004 when world oil prices rose by 30.7 per cent.<sup>3</sup>

With two-thirds of its total energy consumption coming from burning coal, China's economic growth is very polluting. Though China is still a developing country, its sulphur oxide emissions are now the largest in the world and its carbon dioxide emissions are second only to those of the United States (at the time of writing). Sixteen of the world's 20 most polluted cities are in China. Pollution damage costs China nearly 8 per cent of its GDP annually (Lampton and Kong 2005).

China is facing many other problems and challenges related to energy, such as the mercerisation of its energy industry, domestic energy price reform, coal accidents, energy disputes with Japan in the East China Sea and South China Sea and severe energy competition overseas. In China, energy is drawing great attention from both the government and the public. Energy issues are no longer considered in isolation: they are now perceived as being intertwined with economic, social and diplomatic issues.

**Internationalisation of China's energy sector.** China's economy has been in the process of transition from a state-controlled economy to one that is more market based. As part of this effort, China has worked hard to internationalise its economy by conducting a policy called 'invite in and go abroad'. 'Invite in' means that the Chinese economy is opened to foreign firms. Since China's entry into the World Trade Organization (WTO) in November 2001, the government has made a number of specific commitments to trade and investment liberalisation. 'Go abroad' means getting involved in the world market and doing business

overseas; more and more Chinese companies have expanded their business in foreign countries.

In the energy sector, the policy will require eliminating or sharply reducing tariffs associated with imports of some classes of capital goods and eventually opening some areas, such as petroleum sales, to foreign competition. All three Chinese oil and gas companies successfully carried out initial public offerings (IPOs) of stock between 2000 and 2002.<sup>4</sup>

All three Chinese oil and gas companies have been working hard to improve their international standing, so as to rate as world-class oil companies. They have put forward a strategy to establish an internationally competitive multinational corporation. Due to the limit of domestic reserves and production, China's companies can achieve scale expansion only through involvement in the world market. Presently, most Chinese oil companies' resources are located inside China. This is in contrast to most international oil companies, with reserves all over the world and up to half of company reserves held outside the parent country. This is a key difference between Chinese companies and foreign oil companies. Only through international expansion (China's 'go international' policy) can Chinese companies find low cost reserves and develop into world-class companies (Tong et al. 2003: 15).

Profit maximisation is another reason for China's oil companies to invest actively overseas. Oil prices have followed a new rising cycle and no decrease is likely in the near future. This has made the oil industry one of the most profitable industries in the world. However, it is hard to cut costs, partly because of increasing wages in China. The cost of going abroad is much lower than domestic oil extraction. Revenues and profits of China's overseas companies are near those of international oil companies (Tong et al. 2003:16).

International exploration and production are also a key strategy for improving the technological, technical and managerial capabilities of China's companies and facilitating the export of Chinese equipment, technologies and labour.

The Chinese government financially supports foreign investment by China's National Oil Company (NOC). It does this for several reasons. First, Chinese officials maintain that NOCs are at a disadvantage in the competition for global oil reserves because of their relatively late arrival in the international oil business. Second, they regard state finance as a tool commonly employed by other governments to benefit their oil companies (Evans and Downs n.d.). Third, the major Western oil companies long ago built relationships with oil-rich governments in the relatively accessible and stable regions of the world, leaving remaining reserves only in less stable, less opening up to China.

**Ensuring China's energy security.** Since China became a net oil importer, ordinary citizens, the government and others have shown increasing concern about energy security (particularly oil supplies). China's sense of energy insecurity arises first because of its deepening



dependence on other countries. The end of the era of energy independence for China also spells the end of the viable application of self-reliance as an ideology guiding energy policymaking.

However, China's sense of energy insecurity is also due to the international doctrine of the 'China energy threat'. This includes countries' repeated failures to engage in international energy cooperation in places such as in the United States, the Caspian Sea and Russia. Apart from needs resulting from economic development, there is a feeling of crisis (Lin 2005). Chinese analysts recognise that China's growing dependence on imported Middle Eastern oil means that it has become increasingly vulnerable to disruptions of its oil supplies. The risk of transportation accidents, the safety of sea lanes (especially at choke points such as the Hormuz and Malacca straits) and the risk of embargos attract serious consideration in contemporary China.

Faced with these risks and uncertainties, China's natural reaction is to secure supply by owning the resource, in this case in the form of equity oil. Around the time China became a net oil importer (in 1993), Chinese energy companies began investing in overseas oil and gas projects (Dirks 2006). Some Chinese analysts within and outside the energy industry<sup>5</sup> consider that it is both possible and desirable for Chinese oil companies to engage in international activities as a strategy to ensure China's energy security.

**Learning from foreign countries.** Many Western countries also view international expansion as an important component of energy security strategies. Western governments encourage their oil firms to look abroad for exploration and production opportunities and support these activities. Since the 1990s, US oil companies have invested more on exploration and production abroad than they have on exploration and production within the United States. In 1991, American investment on exploration and production overseas reached \$33.7 billion, about two times the level of domestic investment. Over half of the oil reserves owned by big oil companies and most of their profits came from overseas investments (Ren 2001).

As for energy diplomacy, Western countries are again both a model and a pioneer. The US government's national energy policy points out that international trade and foreign policy negotiations should give energy security a high priority and emphasises that energy is a diplomatic issue.

Since the 1970s, Western countries have carried out a number of diplomatic activities to ensure their energy security. First, there has been significant anti-cartel multilateral oil diplomacy. The most significant was the formation of the IEA in 1974 to fight against OPEC.

Second, there have been efforts to establish interdependent relations with major oil suppliers by improving trade, investing, providing aid and attracting petrodollars. The United States opened its treasury bond market to Saudi Arabia in the 1980s; Japan has also opened its bond market to oil exporters – and provided them with huge amounts of aid.

Third, Western countries have been heavily involved in the regional and domestic politics of oil-rich areas. In particular, the United States has been heavily involved in the Middle East since the 1970s.

Fourth, Western governments have a variety of institutions which help establish a favourable investment climate for their countries' companies. In the United States there are three important institutions: the Department of Energy represents the government in negotiating with energy rich countries and establishing a favourable environment for American enterprises investing abroad; the United States Agency for International Development (USAID) represents the government in providing aid to developing countries, especially oil-rich countries, and the Overseas Private Investment Corporation (OPIC) provides political protection and guarantees for American companies investing in countries with high political risks.

Japan also provides a model for China's international energy strategies. The Japanese government encourages its companies to explore and produce overseas by providing technological, financial and diplomatic assistance. The Japanese government required equity oil to account for 30 per cent of oil imports in the 1970s. To achieve this, it established the Japan National Oil Corporation (JNOC) to organise and fund overseas exploration and production and to establish a research centre for oil technology in order to provide technological assistance to companies exploring and producing abroad. By 1995, about 177 companies had received technological and financial assistance from the Japanese government.

At the same time, Japan strengthened diplomatic relations with oil exporters, especially in the Middle East. Japan's Middle East policy was quite different from that of the United States. Whereas the United States placed an embargo on oil from Iran, in November 1980, Japan resumed oil imports from Iran and provided it with ¥38.8 billion in official development assistance (ODA). Between 1951 and 1999, Japanese total investments (including direct investments) to 12 Middle East countries reached ¥1,179 billion.<sup>6</sup>

### **Analytical assessment of China's overseas energy strategy**

**Domestic gains and losses.** There are diverse opinions regarding the costs and benefits to China of its international energy strategy. Broadly speaking, there is some consensus that the strategy has been a net positive for China. However many observers are strongly aware that costs are not absent.

Regarding the achievements, most analysts mention that China's energy companies have already expanded their business to over 30 countries and acquired over 50 energy projects. Between the early 1990s and early 2005, the total equity oil—secured mainly by CNPC/PetroChina and, to a lesser extent, CNOOC—was around 400,000 b/d, equivalent

to around 15 per cent of China's total crude imports.<sup>7</sup> According to the president of BP China, the total current equity oil production in China's energy companies is around 30 million tons a year (Dirks 2006). In addition, the international experience gained by China's energy companies has led to considerable improvements in management and training of professionals.

Despite these gains, outward foreign investment is a new game for Chinese companies. In the case of CNPC, both its overseas income and equity oil production account for around just 13 per cent of its total. The extent of internationalisation is still much lower than that of Western oil companies, and Chinese companies have experienced many setbacks, including failed bids on the international stage.

China's strategy of intensified acquisition of equity oil has also been met with considerable suspicion from international oil market analysts. They argue that overseas investments are unlikely to shelter countries from oil market volatility and that equity investments by China in distant producing fields in Africa, Latin America or west Asia are not likely to improve the physical security of its energy supply (Dirks 2006). Minxin Pei (2006) says: 'Ironically, the biggest loser of "locking up" energy supplies would most likely be the Chinese government because the global oil market is so integrated that it really matters little whether one has physical control of the actual barrels of oil when prices shoot through the roof. China, like any other net importing nation, must pay the spot prices'.

It is difficult to judge, but some analysts have said that, in comparison with other international oil companies, Chinese energy investors may overspend just to secure a contract. For example, Dadwal and Sinha (2005) say:

'Chinese companies outspent rival bidders by large margins to win contracts in Venezuela and Kazakhstan in the late 1990s. Many countries are aware that they can derive benefits by forcing Chinese to compete with companies from other countries, such as India. Russia is playing ONGC and CNPC off against each other for a 15-20 per cent interest in the re-nationalised Yuganskneftegaz, a subsidiary of Yukos. CNPC is said to be offering a \$6 billion advance payment on future oil sales, while ONGC proposed a \$2 billion investment and a \$4 billion loan'.

'In their rush to stake claims around the world, Chinese and Indian companies accept terms that would often not be considered commercially viable for the oil majors, who base their investment criteria assuming a long term average price of oil at between \$20-30 per barrel. If oil continues selling for \$50-60 per barrel, the assets may be an advantage, but if prices drop considerably, the results could be quite painful'.

There are risks, of course, particularly when oil prices are very high. The oil industry has seen many boom and bust cycles in oil prices. There is no guarantee against another cycle (Dirks 2006).

Minxin Pei (2006) pointed out that the real beneficiary of China's current strategy is its state-owned oil companies, which work hard to drive the government to support them to go abroad in the name of energy security: 'Given a blank cheque to improve China's energy security, the three giant state-owned oil giants—China Petroleum and Chemical, China National Petroleum and China National Offshore Oil—now have practically unlimited financial resources to make overseas acquisitions, regardless of economic viability or geopolitical risks. If their deals go bad, Beijing will foot the bill. The companies will not be blamed, because they are simply implementing the government's energy security strategy. But if they strike 'black gold', the companies reap the economic benefits. It is a no-lose proposition for China's state-owned oil companies, but a high-risk plan for the Chinese government'.

It is an open secret that Chinese oil companies often import more when the world oil price is higher and less when it goes down. China has paid much more than the United States and Japan for the same amount of oil. The costs and risks of overseas investment are also much higher for Chinese companies than for their Western counterparts, especially in times of high oil prices.

With the global integration of the oil market, oil has become a fungible commodity, and international energy security is much more stable than in the 1970s. Even if national oil companies continue their acquisition strategy, it is very unlikely that they will be successful in satisfying demand or insulating the economy through their acquisitions. Consequently, China will continue to be affected by the world market like other countries.

Furthermore, due to economic considerations, most oil companies which explore and produce overseas do not take their equity oil back to their home country. Rather, they sell it in the world market; at the same time they import what they need from the near market. This is also true for Chinese companies' equity oil, about 90 per cent of which is sold in the world oil markets rather than in China as most people may suppose. China's equity investments in distant producing fields in Africa, Latin America or west Asia are not likely to improve the physical security of its energy supply (Dirks 2006). It is very difficult for China to ensure energy supply security by acquiring equity oil.

**Impacts on global energy markets.** Between the early 1990s and early 2005, China's total equity oil was equivalent to only 6 per cent of its current oil consumption, 2 per cent of current US oil consumption, and less than 0.5 per cent of global oil production. By comparison, US energy analysts estimate that the overseas equity oil levels of the three largest US companies

(Exxon Mobil, Chevron, and Conoco Phillips) were 3.9 million barrels per day (mb/d), 35 per cent of total US imports and 71 per cent of total liquid production for the three companies.<sup>8</sup>

In the United States, and among China's neighbours, there is concern that Chinese actions will remove resources from the world market. According to some, this would have the effect of constricting supply and thereby raising world prices. In fact, transportation and logistical costs prevent most of the oil produced in China's overseas oilfields from entering China. According to industry press reports, most of the oil currently produced by Chinese oil companies abroad is not shipped back to China, but instead is sold on markets closer to production (Dadwal and Sinha 2005). Even if China's equity oil investments remove assets from the global market, in the sense that they are not subsequently available for resale, these actions merely displace what the Chinese would have otherwise bought on the open market. The effects of these purchases should be economically neutral.<sup>9</sup>

Meanwhile, China's overseas investments can help to increase supplies and lower prices, benefiting all consumers. They largely serve the global market and thus contribute to global energy security. China has sought to develop resources in locations, such as Sudan, where most private commercial interests are unwilling to invest. As such investments might otherwise remain outside of the reach of private sector and energy companies, these actions may actually enlarge the total global oil supply.<sup>10</sup>

One effect that China's increasing oil demand will have on global markets is to ensure that the long-term outlook is favourable from the perspective of oil producing countries and firms. The reduced risk of demand shortfalls makes current investments in productive capacity dramatically more attractive. According to Robert Priddle, the former executive director of the IEA, China's increased demand for energy will promote investment of the world energy sectors helping to 'stabilise the energy operation of international markets and make great contributions to the world energy structure as a whole' (Kong 2004). Since many of the international supplies of energy (and especially oil) are owned by large Western energy-consuming countries, China's rising oil demand should be viewed as a source of record profits rather than a competitive threat.

In addition, the overseas investment will no doubt facilitate China's further integration with the world economy. Over two decades of market-oriented reforms in China have resulted in large increases in per capita incomes, significant poverty reduction, a substantial rise in non-state sector activity, and growing integration into the global economy. Furthermore, the internationalisation of state-owned oil companies pushes forward global energy interdependence. Recently, NOCs from China, Russia and Algeria followed companies like Sateoil, Petrobras, Petronas and Saudi Aramco to become internationalised state oil companies (INOCs). Since 2003, over half the upstream bids came from state-owned

companies. This furthers the interdependence between consumers and exporters. Energy interdependence is now firmly a part of the international system. Ongoing discussions need to accept the new international environment for energy markets and focus on managing that international interdependence (Dittrick 2005).

**The impact on international relations.** The worldwide investment practices of China's NOCs have already triggered concerns about China's impact on international oil supplies and prices. Especially in American eyes, China's investments in countries like Uzbekistan, Sudan and Burma pose a series of potential problems for the United States.

As early as the end of the 20th century, people in the United States pointed out that China, when becoming a big oil importer, would alter the political pattern of the Persian Gulf and further pose a threat to the US oil supply in the area. After the George W. Bush administration came to power, it conducted an investigation into the oil trade between China and Iran. In 2002, a US think tank submitted a report to the Congress which claimed that a war for the global energy resources between the United States and China was unavoidable. The US Congress's China Economic and Security Review Commission began to look at how China's huge oil demand would affect the US energy supply. The perception of a 'China energy threat' subsequently gained momentum in the United States as energy demand grew and world oil prices rose. The United States then converted its worries about China's energy strategy into concrete actions by intensifying its efforts to prevent China's oil and gas companies from expanding their overseas markets. In 2004, for instance, the US blocked Sinopec and Iran from cooperating to explore and exploit oil and natural gas fields.

Sino-US energy frictions further escalated in 2005. Following CNOOC's bid for Unocal, the 'China energy threat' thesis became of widespread concern in the United States, further worsening Sino-US relations, which had already been plagued by the textile trade dispute, the problem of RMB appreciation and the EU's decision to lift the arms embargo on China. The US Congress conducted various hearings on issues concerning China. Between June and September 2005, the US Senate Committee on Foreign Relations conducted three hearings on China over energy issues—more hearings than there were on policies toward Iraq. On 26 July 2005, Mikal Herberg, director of the Asian Energy Security Program in the US National Bureau of Asian Research, pointed out that China's increasing energy demand had become a major element of Sino-US relations. Deputy Secretary of State Zoellick, while leading a delegation to attend the first Sino-US strategy dialogue, warned that China must make a decision on the energy issue. Many Americans in the political arena, especially in the Department of Defense and the Congress, consider China's demand for resources to be a new strategic challenge. For instance, although many analysts did not think that CNOOC's bid for Unocal would pose any threat to US national security, the House of

Representatives passed a resolution (with a vote of 398 to 15) assuming that such a move would pose such a threat (Zweig and Jianbai 2005).

Similar bias also exists in China. For example, China thinks that the United States intentionally blocks its access to oil resources and intentionally destroys its oil supply routes and pampers transnational companies in an effort to push it aside. In recent years, the Chinese media have published some reports on China's energy security which show that many people believe that the major threat to China's energy security comes from the United States. The perceived threats focus on issues like marine transport routes, including the Malacca Strait, and US embargos. Some people believe that higher oil prices are the result of conspiracies—for example, that there is an 'oil price plot' and the United States has intentionally increased oil prices to inhibit China's economic development.

China's sense of energy insecurity was increased by the US involvement in successive Middle East conflicts, its launch of the Afghanistan war and the Iraq war, and its expanded military presence in central Asia and the Indian Ocean. Some scholars have pointed out that, as China relies increasingly on shipping lanes controlled by the US navy, it has become more concerned about the prospects of an oil blockade (*Economist* 2005). These concerns arise because the United States has blocked and imposed sanctions on China before and because of fears of a massive US intervention if military conflict breaks out in the Taiwan Strait. People note that in recent years the United States has tried to intervene militarily in the Malacca Strait, prevent China's cooperation with Middle Eastern countries, and blocked a Chinese company's acquisition of an American oil company. All these developments add to China's worries and sense of oil insecurity.

Despite perceptions within China, it is very unlikely that the United States would actually impose blockades on China. The increasing interdependence of the economies of the two countries makes the costs of such actions prohibitive under any but the most extreme circumstances. Even if there were a US embargo, it may not be effective: following US sanctions against Libya and Iran, oil companies from France, Italy and Spain took advantage of the vacuum, consolidating their existence there; and US sanctions against Cuba over several decades have failed to prevent Cuba from getting necessary resources, including oil.

The main threats to China's energy security do not therefore include US sanctions. China's oil consumption model and energy efficiency are more prominent real concerns. And the main threats to energy supply routes are pirates, terrorism, illegal armed raids and transport accidents in peacetime, not potential US sanctions.

**The relationship between state oil companies and the government.** This topic has received increasing attention since the rise in concern over China's foreign investments and energy strategy. A number of Western analysts could not appreciate that the returns from



Chinese companies' overseas investments are much lower than those of their Western counterparts, which are also supported by their respective governments. Western analysts tend to conclude that China's oil companies are being used to carry out the Chinese government's energy procurement strategy and foreign policy. For example, Maria Kielmas (2005) states that China's companies are essentially expected to be an arm of national foreign policy in foreign investment, rather than to create value. 'Foreign investment by the Chinese state companies may be a good way to develop the country's foreign policy. Such investment decisions are made by bureaucrats based on political considerations, rather than being aimed at providing adequate returns.'

Lin (2005) says: 'No country today feels that it has the ability to invade China. China does not set out to save energy, but instead stirs up of a feeling of crisis in various places in order to whip up nationalist sentiment. The goal is to use oil diplomacy to cover up its ambitions for strategic expansion.'

However, the interests of China's oil groups are not always in accordance with those of the government, and in some situations are even in direct contrast. China's transitional processes have created an economy that is increasingly pluralist, with different interest groups playing more and more important roles in China's policymaking. The Chinese state oil companies often choose to follow the government's operational guidelines, as compliance helps to ensure government protection when necessary. However, there have been some recent conflicts as companies have begun to lobby for their commercial interests when they believe that central government guidance will adversely affect their bottom line. The state-owned companies often act in their own interest at times, regardless of government directives. For example, when the government adopted price control policies to keep the price of domestic oil products low and produced huge losses for state refiners in 2005, the state oil companies reacted by constraining crude runs, reducing product imports, and increasing product exports.<sup>11</sup>

Although high-profile oil diplomacy has yielded individual contracts and projects for the state oil companies, these contracts represent only a small portion of the investments made by these companies. In most cases, the state oil companies recognised the opportunities first, initiated negotiations over the prospective investment move, sought government approval of their investment plan and lobbied for financial and diplomatic support if needed.<sup>12</sup>

In developing countries (especially transitional economies), state-owned oil companies often enjoy advantages that promote their success when compared with their international oil company (IOC) counterparts. When the Chinese government offered the Angolan government loans along with the offer to build hospitals and electronics manufacturing factories as part of an effort to help Sinopec's bid to acquire Royal Dutch/Shell's 50 per cent interest in Block 18 offshore Angola in 2004, the Indian government was also prepared to support



ONGC by offering \$200 million to help build a railway (Dadwal and Sinha 2005). In addition, the South Korean government encouraged its companies to go abroad for exploration and production through the establishment of a special fund for overseas exploration and the provision of low rate debt.

## **Conclusion**

Western analysts rarely understand three key factors contributing to China's energy activities abroad: inexperience in the international market, an obvious sense of energy insecurity, and China's incomplete economic and social transition. In the expert's eyes, CNOOC more closely resembles the international majors than the more insular CNPC and Sinopec. But when bidding for Unocal, CNOOC did not play its hand well as it had not undertaken detailed due diligence to articulate a clear rationale for the deal. To some extent CNOOC's approach reflected a cultural difference and corporate inexperience when dealing with alliances and mergers. Many Chinese enterprises have yet to develop a deep understanding and appreciation of the challenges (many cultural) in merging and forming alliances with other companies (Parry et al. 2006). Chinese companies face a steep learning curve, requiring both time and mistakes. However they will need to learn fast.

Solving China's energy problems and improving Chinese companies' international competitiveness will require a more rapid transition to a globally integrated market economy. Western experience shows that the best way to ensure energy security is the development of an effective energy market. The Chinese energy market and price system is undeveloped. Therefore, the most critical task for China is to push forward the liberalisation and diversity of its energy market, to facilitate increased openness, efficiency and competition. A full transition to a market economy will alleviate some of the energy issues that China faces today.

Western countries should welcome China's overseas investment as a part of its peaceful integration into the world economy, not fear it (Anon. 2005). In addition to China's efforts to pursue an energy strategy based on domestic energy conservation and market liberalisation, Western countries need to work to decrease the sense of energy insecurity and mutual misunderstanding. First, they should give China technological assistance and experience to promote energy efficiency and energy conservation and to slow down the growth rate of energy consumption and the dependence on oil imports. Second, they should remove constraints on exporting energy technology to China so that China can reduce its dependence on oil. Third, they should encourage China's energy companies to cooperate with Western companies instead of putting restrictions on them. Fourth, they should establish both multilateral and regional energy cooperation mechanisms, engage in multilateral strategic energy dialogues and establish an IEA-like organisation.

Instead of blaming China for its energy demands or containing China as an energy threat, the industrialised countries may be wise to seize China's vast energy market potential in technologies of energy conservation and efficiency, environmental protection techniques and knowledge, renewable and alternative energy production, and joint efforts in managing global warming.

## Notes

- 1 United States, Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006, pp 33–34.
- 2 *BP Statistical Review of World Energy*, June 2006, p.11.
- 3 See 'World oil conference sending out mixed messages', 30 September 2005; <<http://www.xinhuanet.com>>.
- 4 United States, Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006.
- 5 For examples, see Lei (2002: 316); Amuti and Zhang (2003: 289); Shu and Li (2004); Anon. (2002); and Ren (2001).
- 6 Gao Xinyu and Chen Xinhua, 'Oil "go abroad" strategy: Japanese mistakes and its revelation for China', paper to 226th Academic Salon at Center of China Study of Tsinghua University on 18 November 2005.
- 7 United States, Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006, p. 28.
- 8 Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006, p. 28.
- 9 Ibid.
- 10 Ibid.
- 11 United States, Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006, p. 15.
- 12 United States, Energy Policy Act 2005, Section 1837: *National Security Review of International Energy Requirements*, February 2006, p. 33.

## Bibliography

- Amuti, A. and Zhang, S.W., 2003. *Oil and National Security*, Xinjiang: Xin Jiang Renmin Press.
- Dadwal, S. R. and Sinha, U. K., 2005. 'Equity oil and India's energy security', *Strategic Analysis*, 29(3).
- Dirks, Gary, 2006. 'Energy security: China and the world', paper presented at the International Symposium on Energy Security: China and the World, Beijing, 24–26 May 2006.
- Dittrick, P., 2005. 'Stated-owned oil companies expanding internationally', *COil And Gas Journal*, 19 December.

- Economist, 2005. 'The dragon tucks in', *The Economist*, 2 July 2005:61.
- Evans, P. C. and Downs, E. S., 2006. 'Untangling China's quest for oil through state-backed financial deals'; see <<http://www.brookings.edu.com/policybriefs/pb154.htm>>.
- Gao Xinyu, and Chen Xinhua, 'Oil 'go abroad' strategy: Japanese mistakes and its revelation for China ', paper to 226th Academic Salon at Center of China Study of Tsinghua University on 18 November 2005.
- Kielmas, M., 2005. 'China's foreign energy asset acquisitions: from shopping spree to fire sale', *The China and Eurasia Forum Quarterly*, November.
- Kong, Y.Y., 2004. 'Chinese energy demand is contribution to the world (interview with Robert Priddle, former executive director of International Energy Agency)', *China Petroleum* 3.
- Lampton, D.M. and Kong, B., 2005 'China comes in from the cold'; see <<http://www.sais-jhu.edu/pubaffairs/publications/saisphere/winter05/lampton-kong.html>>.
- Lei, W., 2002. *China's Oil Security*, Beijing: China's Social Science Press.
- Lin, P., 2005. 'China's move toward oil diplomacy ', Association for Asia Research, 2/4/2005.
- Masaki, H., 2006. 'Japan a bigger player on global oil stage'; see <<http://www.atimes.com/atimes/Japan/HD04Dh04.html>>, 4 Apr 2006.
- Parry, P., Splegel, E. and Tse, E., 2006. 'The roaring dragon: Unocal bid just a minor bump in the road'; see <<http://www.boozallen.com>>, February 2006.
- Pei, M.X., 2006. 'China's big energy dilemma', *Straits Times*, 13 April.
- Ren, X.Z., 2001. 'Main measures and components of foreign oil security strategy', see <[http://www.drcnet.com.cn/new\\_product/drcexpert/showdoc.asp?doc\\_id=123264](http://www.drcnet.com.cn/new_product/drcexpert/showdoc.asp?doc_id=123264)>. March 7 2001.
- Shu, X.L., and Li, D.F., 2004. 'China's oil security and oil company's overseas investment ', *World Economics And Politics Forum*, 5.
- Tong, X.G., Dou LR. and Tian, Z.J., 2003. *China's Overseas Oil E&D Strategy in the Early 21st Century*, Beijing: Petroleum Industry Press.
- United States Department of Energy, 2005. Energy Policy Act, Washington DC.
- Zha, D.J., 2005. 'China's energy security and its international relations', *China and Eurasia Forum Quarterly*, November.
- Zweig, D. and Bi, J.B., 2005. 'China's global hunt for energy', *Foreign Affairs*, September/October: 37.



# 7 KOREA'S EXPERIENCE IN SECURING ENERGY SUPPLIES

JINWOO KIM

## Energy situation and prospects in South Korea

**Primary energy.** During South Korea's rapid economic growth in the 1980s, energy demand increased drastically, slowing only after 2000 due to a combination of slower economic growth and continuous improvements in energy efficiency. This is summarised in Table 7.1, which shows that the annual average growth rate of primary energy demand was 8.2 per cent in the 1980s, but dramatically decreased to 3.5 per cent between 2000 and 2005. As of 2005, South Korea was the 10th largest energy-consuming country in the world, using 2.1 per cent of world energy.

**Table 7.1 Major energy and economic indicators**

Indicator	1981	1990	1995	2000	2005	Average annual growth rate (%)		
						1981–90	1981–2005	2000–05
Primary energy consumption (million toe)	45.7	93.2	150.4	192.9	228.6	8.2	7.0	3.5
Per capita energy consumption (toe)	1.18	2.17	3.34	4.10	4.75	7.0	6.0	3.0
Energy/GDP (toe/\$ '000)	0.35	0.33	0.36	0.38	0.36	-0.7	0.1	-1.1
CO <sub>2</sub> emissions (million tons CO <sub>2</sub> )	135.9	239.0	366.9	432.2	482.5 <sup>a</sup>	6.5	5.7 <sup>b</sup>	2.8 <sup>c</sup>
GDP (trillion won)	147.5	320.7	467.1	578.7	721.5	9.0	6.8	4.5
Population (million)	38.7	42.9	45.1	47.0	48.3	1.15	0.93	0.55

*Notes:* CO<sub>2</sub> = carbon dioxide; toe = tons of oil equivalent.

- a As of 2004.
- b 1981–2004.
- c 2000–04.

*Source:* Korea 2006, Energy Info, Energy Economics Institute, Seoul, Korea.

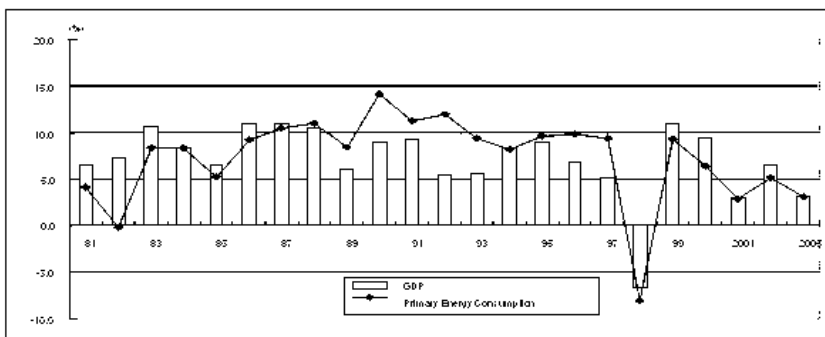
Per capita energy consumption and carbon dioxide (CO<sub>2</sub>) emissions showed almost the same trends as that of primary energy consumption of the country. In terms of energy/GDP measured in tons of oil equivalent (toe)/ \$ '000), energy intensity decreased from 0.38 in 2000 to 0.36 in 2005.

Primary energy consumption in 2005 was five times larger than that in 1981, a growth rate slightly higher than the 4.9 times increase in GDP during the same period. Energy growth was remarkable during 1987–97, showing 10.3 per cent growth per annum (Figure 7.1). The GDP growth rate was 7.7 per cent on average for the same period, hence the elasticity of energy consumption to GDP was as high as 1.34. But for the period 1998–2005, the energy and GDP growth rates decreased to 4.7 per cent and 5.6 per cent per annum respectively, bringing the elasticity of energy to GDP down to 0.84.

Korea's energy consumption is characterised by continuous decrease of oil's share in primary energy, particularly since the late 1990s, and a rapid increase in electric power demand due to the high economic growth of the country. Since the 1970s, consumption of oil increased continuously, up to 62.9 per cent of Korea's total energy consumption in 1994. After 1994, the share of Korea's total energy demand met by oil never rose above 50 per cent, reaching just 44.3 per cent in 2005.

With the increase in electricity demand, Korea's consumption of coal and nuclear power for electricity generation has increased steadily. The demand share of coal, which constantly declined from 1985 to 1995, increased from 18.7 per cent after 1995 due to the increase in imported bituminous coal. Domestic anthracite coal was used for heating in the residential sector, before it was replaced by natural gas. Korean energy resources are limited to low-quality anthracite coals, which accounted for less than 2.1 per cent of the total energy demand

Figure 7.1 Growth in primary energy consumption and GDP



Source: Korea Energy Economics Institute, Yearbook of Energy Statistics, 2006, Seoul.

in 2005. Nuclear power, first introduced in 1978, showed a dramatic increase in consumption since 1982, with a 21.5 per cent average annual growth rate. Nuclear power accounted for 16.1 per cent of Korea's total energy demand in 2005, and all uranium for electricity production was imported.

Since natural gas was introduced in 1986 it has been rapidly replacing oil (with a 16.6 per cent annual average growth rate from 1990 to 2005); it accounted for 13.3 per cent of the total energy demand in 2005. Although renewable energy has only a small share in Korea's total primary energy consumption, it is showing continuous growth.

Table 7.2 presents the quantities of each energy source consumed in South Korea since 1981. The total primary energy consumption is also presented. The general trends can also be seen in Figure 7.2, along with a snapshot of the fuel mix in 2005. The increasing significance of oil can be clearly seen.

### Final energy demand

Final energy demand reached 170.8 million toe in 2005, increasing by 4.4 times from 39.0 million toe in 1981. The industrial sector, which has led growth of final energy-consumption in the past, showed a stable increasing trend with the expansion of low energy consuming industries such as the information and communications industry. The share of the industrial sector in South Korea's final energy consumption was 55.2 per cent in 2005.

While energy demand in the transportation sector experienced a 14.5 per cent decrease in 1998 during the Asian economic crisis, it increased by an average of 8.1 per cent from 1990

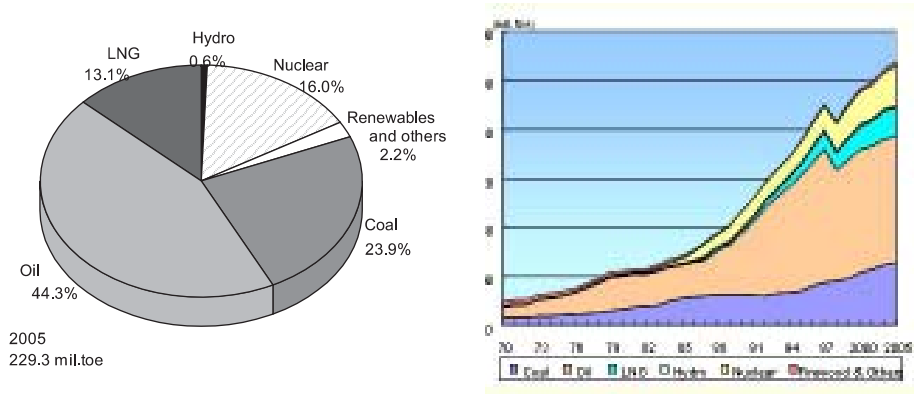
**Table 7.2 Primary energy consumption by source (million toe)**

	1981	1990	1995	2000	2005
Coal	15.2	24.4	28.1	42.9	54.8
Oil	26.6	50.2	94.0	100.3	101.5
LNG	-	3.0	9.2	18.9	30.4
Hydropower	0.7	1.6	1.4	1.4	1.3
Nuclear power	0.7	13.2	16.8	27.2	36.7
Other	2.5	0.8	1.1	2.1	4.0
Primary energy total	45.7	93.2	150.4	192.9	228.6

*Note:* LNG = liquified natural gas; toe = tons of oil equivalent.

*Source:* Korea Energy Economics Institute, Yearbook of Energy Statistics, 1998–2006, Seoul.

**Figure 7.2 Primary energy consumption by source**



Source: Korea Energy Economics Institute, Yearbook of Energy Statistics, 1998–2006, Seoul.

to 2000 and reached a 20.8 per cent share in the country’s total energy consumption in 2005. The consumption share of the sector is still gradually increasing as the number of cars grows.

Energy demand in the residential and commercial sectors and the public and other sectors represent a 21.6 per cent and 2.4 per cent share respectively in total final energy. The substitution of fuels and the decrease of individual income growth since the 1990s have led to more efficient use of energy, so that the growth rate of the final energy demand in those sectors since 1990 was slower.

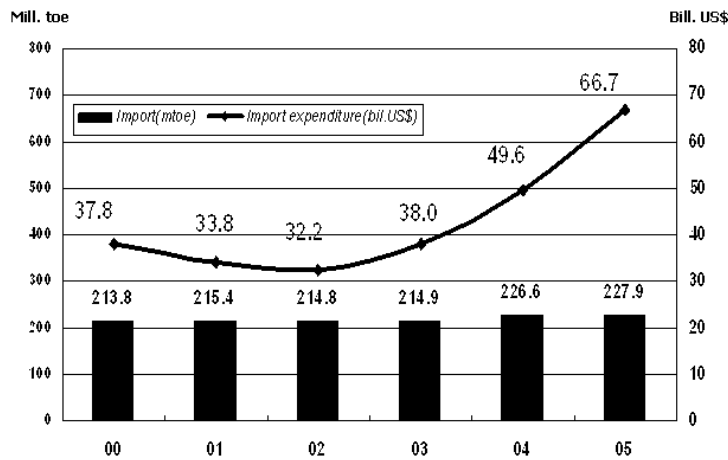
### Energy imports

Given Korea’s limited domestic endowment of resources, it is highly dependent on foreign energy sources. Energy dependence (the share of total energy consumption being met by imported supplies) in South Korea is as much as 97 per cent. Energy imports therefore impose a great burden on the country’s economy. The energy import bill jumped from \$38 billion in 2003 to \$49.6 billion in 2004, and to \$66.7 billion in 2005 (Figure 7.3) due largely to rising energy prices. Korea imported \$50.4 billion worth of petroleum, \$8.6 billion of liquified natural gas (LNG), and \$5.4 billion of coal in 2005. The energy import bill accounted for 25 per cent of South Korea’s total imports.

Since South Korea is highly dependent on the Middle East for oil and gas, it is very vulnerable to a global energy crisis. In 2005, dependence on Middle East oil and gas was 81.8 per cent and 46.8 per cent respectively. Korea imported 843 million barrels of petroleum from Saudi Arabia, the United Arab Emirates, Kuwait, Iran, Qatar and others; 22.0 million tons



Figure 7.3 Energy imports (quantity and expenditure) in South Korea



Source: Korea Energy Economics Institute, Yearbook of Energy Statistics, 2006.

of LNG from Indonesia, Qatar, Oman, Malaysia, Brunei and others; and 73.9 million tons of coal from Australia, China, Indonesia, Russia, Canada and others. The government has formulated policies to lower the country's dependence on oil and is seeking stable supplies of oil and gas by diversifying its import sources to reduce risks due to changes in world oil and gas markets.

### Forecasts of energy demand

At the time of writing, demand for primary energy was expected to increase at an annual average of 2.7 per cent from 2005 to 2010, 2.4 per cent from 2010 to 2020, and 2.1 per cent from 2020 to 2030. Per capita energy demand was also expected to increase, from 4.75 toe in 2005 to 5.31 toe in 2010, 6.62 toe in 2020, and 8.27 toe in 2030 (Table 7.3). Since the expected growth rate of energy demand is lower than the expected economic growth rate, energy intensity is expected to decline to 2030. This is mainly due to better energy efficiency and a shift of economic structure toward less energy-intensive industries.

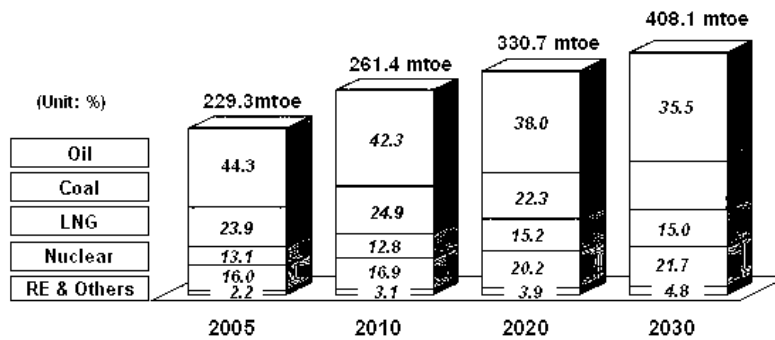
Figure 7.4 shows projections of energy demand by source: shares of oil and coal will decrease, while shares of LNG and nuclear energy are forecast to increase. But oil will remain the dominant fuel until 2030 and beyond. Oil demand is expected to increase until 2030 (though its share in total primary energy will decrease) and dependence on the Middle East for oil is expected to deepen. Therefore stabilising oil imports will continue to remain a key task in South Korea's energy policy.

**Table 7.3 Energy indicator projections, 2005–30**

Indicator	2005	2010	2020	2030	Average annual growth rate (%)			
					2005–10	2010–20	2020–30	2005–30
Primary energy consumption(million toe)	229.3	261.4	330.7	408.1	2.7	2.4	2.1	2.3
Per capita energy consumption (toe)	4.75	5.31	6.62	8.27	3.6	2.2	2.3	2.2

*Note:* toe = tons of oil equivalent.

*Source:* Korea Energy Economics Institute, Seoul.

**Figure 7.4 Projected energy demand by source, 2005–30**

*Note:* LNG = liquefied natural gas; mtoe = million tons of oil equivalent; RE = renewable energy.

*Source:* Korea Energy Economics Institute, Seoul.

Gas supplies are more stable than those of oil since it is deposited widely around the globe and gas reserves are relatively abundant. With the environment becoming an issue of ever-growing social significance, gas is gaining wide recognition as a cleaner fuel than oil. South Korea's domestic consumption of gas is expected to increase continuously. Due to the stable growth of electricity demand, the share of nuclear power in total primary energy is also expected to increase until 2030. The security of the energy supply base for the future has become an important challenge for Korea in the rapidly changing domestic and international energy environments.

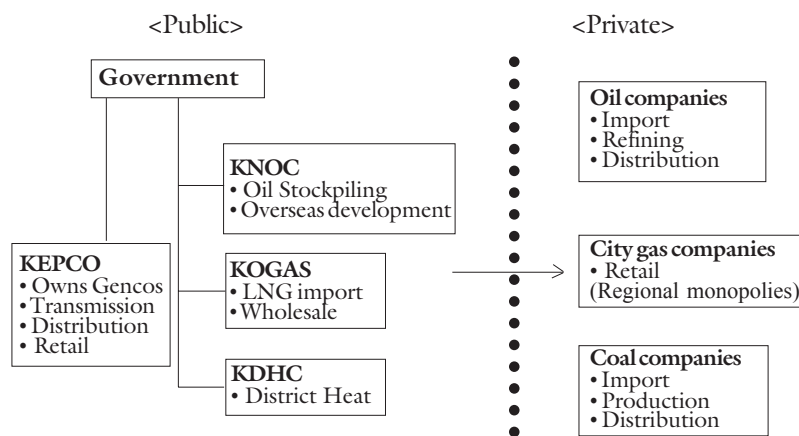
## Energy industry development in South Korea

**Energy industry structure.** The structure of Korea’s energy industry is summarised in Figure 7.5, which clearly separates the public and private sectors. Public corporations have contributed to securing stable energy supply in Korea, and are still playing a great role for energy security. The Korea Electric Power Corporation (KEPCO), a public corporation, is responsible for electric power supply. The Korea National Oil Corporation (KNOC) is playing a leading role in overseas energy development. The task of importing LNG is managed by the Korea Gas Corporation (KOGAS). KOGAS, as a monopolistic wholesaler, supplies natural gas to electricity generation companies and city gas companies.

In South Korea, several privatised oil companies import crude oil and refine and distribute oil products. City gas companies supply gas to households and buildings as regional monopolies.

**Expansion of energy supply capacity.** Korea’s supply facilities were consistently expanded to match the drastic increase in its domestic energy consumption, resulting in a stable energy

Figure 7.5 Structure of the South Korean energy industry



*Note:* KEPCO = Korea Electric Power Corporation; KEPCO = Korea District Heat Corporation; KNOC = Korea National Oil Corporation; KOGAS = Korea Gas Corporation.

*Source:* Compiled by author.

supply. Also, as network-type supply bases for electric power, oil, city gas, and heat energy were expanded, an advanced energy demand and supply system was implemented.

Some of the key indicators of Korea's expanding energy supply capacity are presented in Table 7.4. Crude oil refinery capacity was rapidly expanded in the early 1990s, and reached 2,735,000 barrels by 2005. At the same time, South Korea's natural gas pipeline network extended to 2,511 km, covering most of the major areas around the nation. The number of city gas customers grew sharply during the 1990s and reached more than 11.5 million households in 2005. Power generation capacity also expanded continuously to supply the rapidly increasing power demand in the country. Installed generation capacity was 66.7 gigawatts (GW) as of 2005, with a reserve rate of 12.5 per cent

**Energy industry development.** In the past, the government ensured supply security by maintaining 30 per cent excess refinery facilities compared to domestic oil demand. Based on this policy, domestic oil refinery companies expanded their facilities and came to hold high facility use coefficients. The South Korean oil refinery sector significantly expanded its oil refinery capacity in the mid-1990s. In October 1998, the regulations on the establishment and enlargement of refinery facilities were abolished. Moreover, foreign investments in oil refinery businesses were allowed. The country's crude oil refinery ability was ranked fifth in the world. The South Korean oil refinery industry, despite its relatively short history, is operating very efficiently and is internationally competitive.

**Table 7.4 Energy supply capacity of South Korea**

	Units	1980	1990	2005
Total energy	10 <sup>6</sup> toe	43.9	93.2	229.3
Energy per capita	toe	1.15	2.2	4.8
Crude oil imports	10 <sup>6</sup> bbl	182.9	308.4	843.2
Refinery capacity	10 <sup>3</sup> b/d	640	840	2,735
LNG imports	10 <sup>3</sup> ton	-	2,291	22,304
Trunk pipeline	km	-	224	2,511
Distribution line	km	-	4,295	25,628
City gas customers	10 <sup>3</sup> households	99	1,220	11,543
Power generation	TWh	40.1	118.5	391.5
Generation capacity	GW	10.4	24.1	66.7

*Notes:* b/d = barrels/day; bbl = barrels; GW = gigawatt; km = kilometre; LNG = liquefied natural gas; toe = tons of oil equivalent; TWh = terawatt hours.

*Sources:* Korea Gas Corp., Korea Electric Power Corp., Korea Energy Economics Institute, Seoul.

Natural gas was commercially introduced in 1987, and has grown rapidly since. KOGAS was established in 1983 to promote public service and welfare through the stable supply of natural gas. KOGAS imports natural gas and provides it to big consumers, generators and distribution companies, and constructs and operates production bases and transmission networks.

The reform of the electric power industry was launched in 2001. As KEPCO's generation assets were divided into six generation companies, KEPCO remains an electric power transmission, distribution, and sales company. The five thermal generation subsidiaries were designed to have similar scales and organised to be a suitable combination for generating facilities, considering their geological locations and power sources. The Korea Hydro and Nuclear Power Company Ltd, which is 100 per cent owned by KEPCO, operates nuclear power plants as base load facilities and hydropower plants as peak load facilities. This company is the world's sixth largest nuclear power generation company; as of the end of 2005, it was operating 20 nuclear power plants. As of 2005, nuclear accounted for 40.3 per cent and coal 36.7 per cent of total power production (Table 7.5), supplying the base load of the country's power demand.

The power sector faces domestic problems which have to be overcome for sustained development of the industry. There are growing concerns about the problem of finding sites for the construction of generation plants and other power facilities. As for power restructuring, the country has to move to the next step, such as divestiture of the distribution sector and the privatisation of generation subsidiaries. But at the time of writing the process had been suspended until an unidentified future date.

**Table 7.5 Changes in the power generation fuel mix (per cent)**

	1980	1990	2005
Oil	78.7	17.6	5.6
LNG	–	8.9	15.9
Coal	6.7	18.5	36.7
Nuclear	9.3	49.1	40.3
Hydro	5.3	5.9	1.5

*Notes:* – = not available; LNG = liquified natural gas.

## **Korea's energy policy directions**

**Evolution of South Korea's energy policy paradigm.** The targets of Korea's energy policies have been appropriately modified according to internal and external changes in the country's energy conditions. They have ranged from the stable supply of energy to its sustainable development.

In the 1970s, Korea's energy supply policy was formulated to support the country's rapid economic growth. At that time, oil was relatively cheap and easy to purchase. The policy was therefore oriented towards oil as Korea's principal energy source. The two oil crises prompted a change in this focus. Energy policies such as those encouraging the diversification of energy sources and the security of the energy supply infrastructure were actively promoted to establish a stable demand and supply system in the 1980s.

In the beginning of the 1990s, oil prices stabilised and a domestic energy demand and supply system was established. These developments prompted another shift in Korea's energy policies, to focus on the implementation of market functions in the energy industry. Regulations in the market were significantly diminished and the rationalisation of the coal industry was promoted. From the late 1990s, industry restructuring was launched in earnest. The concept of competition began to be introduced in network industries such as electric power and gas, which had been regarded as natural monopoly businesses. Also, as the United Nation's Framework Convention on Climate Change (UNFCCC) made progress, environmental regulations became stricter. As a result, sustainable development, which highlights the '3E's' (energy security, economic growth and environmental protection), was emphasised as the major goal of recent energy policies.

## **Legacies of past energy policy paradigms**

Past energy policy can be characterised as a supply-oriented policy, mainly aimed at supplying energy in a stable manner at low prices. There was a wide range of government intervention in the energy industry. The management of the energy industry depended significantly on central planning rather than free market functioning.

In the early economic development stage, the policy made a lot of achievements in promoting domestic infrastructure for stable energy supply. Korea has well-established domestic networks for oil, gas, electricity and district heating systems.

But the government-driven energy policy produced some negative results as well. It contributed to the country having an energy-intensive industrial and economic structure, induced excessive dependence on the Middle East for energy supplies, and produced environmental concerns and social conflicts.

## Paradigm shift of energy policy

Until recently, energy supply security and energy price stability have been the bases for the development of Korea's energy policies. However, faced with changing internal and external conditions, such as the increasing demand for high-quality energy and the growing interest in the environment, the Korean government has set new energy policy directions. The new directions give full support and consideration to economic growth, the environment, and energy security (the 3 E's). The main subjects of Korea's energy policies, towards the end-goal of sustainable development, are now promoting stable energy supplies, market efficiency through competition and the implementation of an environmentally friendly energy system. Figure 7.6 and Figure 7.7 show these concepts diagrammatically.

## Overseas resource development of Korea

**Recent trends and concerns of world oil development.** Oil resources are more than simply economic assets. They are also highly strategic. A comprehensive energy policy therefore must include resource diplomacy to secure oil reserves. Oil exploration is expanding

Figure 7.6 Harmonised approach to energy policy direction

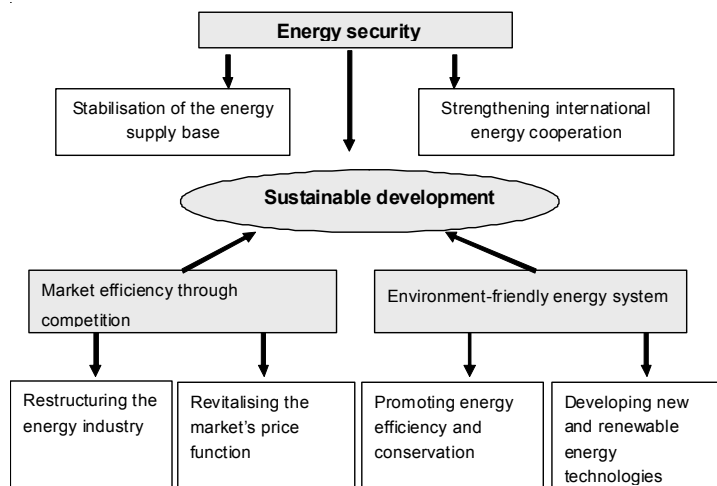
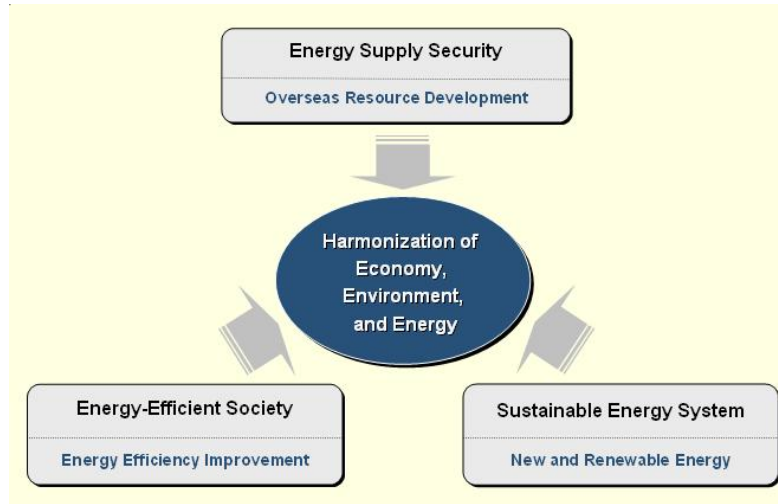


Figure 2.7 Harmonised approach to energy policy directions



in non-OPEC<sup>1</sup> countries such as Russia, Africa, Central Asia, and South East Asia. In an era of high oil prices, we also have higher interests in natural gas and non-conventional oil such as oil sands. Large oil exploration companies, such as Exxon Mobil and CNOOC, have also emerged in order to perform huge resource development projects around the world.

But there are growing concerns about excess competition among growing economies and big oil-consuming countries for overseas energy procurement. The competition is intensified due to recent high oil prices and heightened concerns about energy security. This is a good time to think about international cooperation among those countries to enhance energy supply security as a whole.

People are also concerned about the strategic behaviour of resource-endowed countries. Some countries are taking measures to strengthen government control over energy resources. Their strategies are to enhance political influence in the world by way of energy resources and to gain maximum national benefits by inducing higher competition among oil-importing countries.

**Overview of Korea's overseas resource development.** Korea started its overseas resources development businesses in 1977 and has achieved continuous growth since the Madura project in 1981. But the country suffered rapid withdrawal of overseas investment after the Korean financial crisis in the late 1990s. The number of new projects decreased from 19 in

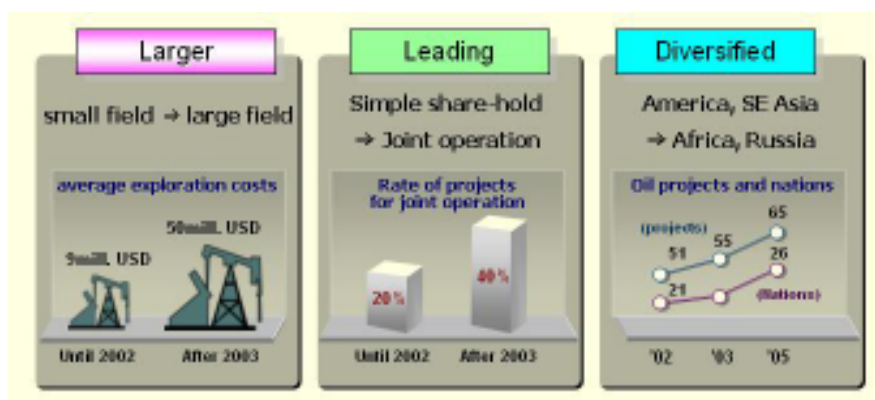


1997 to 5 in 1998, and 26 projects were withdrawn between 1997 and 2002. However, overseas resource development has been reactivated since 2003, with big changes in the quantity and quality of the projects.

The government plans to promote overseas resource development projects. It is focusing on the development of oil and gas fields in Central Asia, particularly along the Caspian Sea; Russia (including Siberia); and South America (including Chile and Peru). A number of successful cases have been reported – for example, the Vietnam 15-1 oil field and the Donghae-1 continental shelf gas field. Korea is planning to continuously develop overseas oil fields and mineral resources, launching the Caspian Sea oil field development projects, and participating in the resources development business. Some of these trends are presented in Figure 7.8. The turning point was 2003, but substantial progress started to be made from 2005.

The government is also intensifying its cooperation with major energy producing and consuming countries. To enhance Korea’s energy supply security and risk management ability, the government is attempting to maintain and further develop multilateral cooperation with various international organisations such as the International Energy Agency (IEA), the Asia Pacific Economic Cooperation (APEC) forum, the Environmental Working Group, ASEAN+3, and International Energy Foundation. In particular, since it joined the IEA in March 2003, it has been involved in the implementation of an emergency response system with other IEA member countries.

Figure 7.8 Changes in overseas resource development projects



**Some successful projects and their reasons.** Recently Korea achieved successful progress in several overseas resource development projects. The sources of the successes are quite different across projects, implying that a differentiated approach is needed taking characteristics of each project into account.

- *Summit diplomacy.* Zhambyl oil projects in Kazakhstan, West Kamchatka oil projects in Russia and the BMC-30/32 offshore exploration shelf in Brazil became possible primarily due to summit diplomacy. Agreement on the protocol for Zhambyl projects was reachable because of agreements between summits of the two countries. The memorandum of understanding for West Kamchatka projects was based on confidence-building between summits.
- *Package projects.* Korea's participation in the Nigerian super-sized abyss exploration shelf was made possible by linking the project with electric power development and gas pipeline construction projects in Nigeria. Korea secured 600 million tons of iron ore for 30 years by linking this venture with Korea's investments in the iron industry in India. This type of cooperation emerges as a new model of overseas resource development.
- *Technological excellence.* The Vietnam 15-1 oil field project was successful backed by excellent exploration technology. The project had been abandoned by a major Western company due to technological problems.
- *Use of purchasing power.* Korea could obtain an additional 6 per cent of the shares of the Marib gas field in Yemen in return for renewal of a long-term purchasing contract of natural gas.

**Bottlenecks to overseas resource development.** In spite of recent achievements, Korea has two substantial bottlenecks or difficulties in promoting overseas resource development.

The first is deficiency in investment. In reality, the amount of investment for overseas resource development is too small compared to that of competing countries or investors. This is mainly due to the drastic withdrawal of investment after financial crisis (1998–2002), and a limited budget for government support. Therefore, overseas projects are making only a small contribution to domestic energy supplies. As shown in Figure 7.9, the level of secured overseas reserves of Korea is extremely low, even comparing to major foreign E&P (Exploration and Production) companies, and the overseas procurement rate of oil and gas was only 4.1 per cent in 2005, which is far below the level of other countries.

The other bottleneck is a deficiency in Korea's overseas exploration capacity in terms of capital, personnel and organisational foundations. The public sector has difficulty in participating in huge exploration projects due to limited capital availability and operational capability. The private sector is highly risk averse and suffers from deficient expertise, with very weak personnel and organisational bases. Private companies have focused more on simple share holding than on big exploration investments.

Figure 7.9 Comparison of Overseas Resource Development Capability



Korea lacks large specialised E&P companies such as CNPC, BP and Exxon Mobil. KNOC is planning to expand its capacity by drastically increasing the capital stock and undertaking organisational reform, but it will take time for the plan to be implemented and begin contributing to practical capacity building.

### Korea's vision for overseas resource development

As part of the government's plan to upgrade the energy security of the country, it has set a target to supply 10 per cent of the domestic demands for oil and gas through overseas resource development by 2008, and to enhance the rate to 15 per cent for oil and 30 per cent for gas by 2013. To achieve the target, several tasks should be fulfilled and harmonised. These include intensive support of the government, concentration of public and private capability, building institutional and financial foundations, and the establishment of human and organisational infrastructure. The framework of the strategies is depicted in Figure 7.10, and government's targets for overseas production of eight strategic mineral resources are shown in Table 7.6.

**Policy directions for overseas resource development.** In order to achieve the above-mentioned targets, relevant policy directions should be well established and effectively implemented. Leadership from the government and cooperation between public and private sectors are critical to successfully meeting the targets. There are four main ways in which Korea can develop policies to promote overseas resource development.

First, it should cooperate with countries of strategic importance. It is of primary importance that Korea should strengthen cooperation with resource-endowed countries. This must include summit diplomacy and tighter economic relationships with South African and Southeast Asian countries. The efficient implementation of agreements reached in summit

Figure 7.10 Vision and strategies for overseas resource development

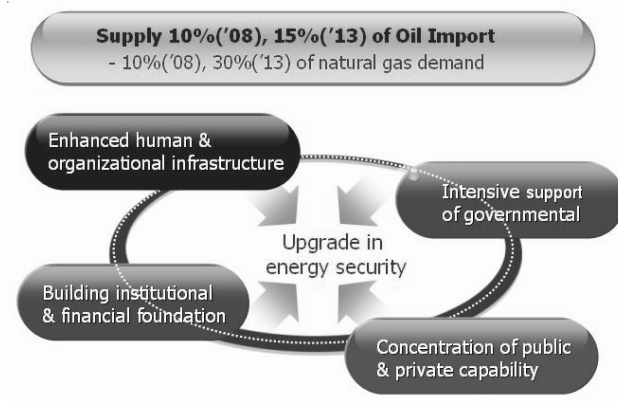


Table 7.6 Overseas production target of eight strategic minerals

Resources	2004		2008		2013	
	Supply rate (%)	Supply quantity	Supply rate (%)	Supply quantity	Supply rate (%)	Supply quantity
Oil (million bbl)	3.8	31.4	10	84.8	15	145.0
Natural gas(million tons)	4.2	0.9	10	2.5	30	8.1
Coal (million tons)	26	18.3	31	26.6	35	31.5
Uranium (u ton)	–	–	5	200	10	550
Copper ('000 tons)	11	107	14	152	20	230
Zinc ('000 tons)	38	304	40	374	40	456
Iron (million tons)	5	2.4	18	8.0	20	8.6
Rare earthelements (tons)	4	225	10	620	10	760

Note: – = not available; bbl = barrels.

Source: Korean Ministry of Commerce, Industry and Energy

talks is more important than having summit meetings themselves, since the confidence built provides the foundation for further economic cooperation with the countries involved. East Siberia, Central Asia and the Caspian countries are areas of strategic importance for Korea. The Korean government is also planning to participate in oil and mineral development projects in South Africa and to establish regular joint committees for resource cooperation with South Africa, Libya and Myanmar.

Second, the Korean government should expand the availability of investment funds. Expansion of investment funds is a crucial factor in the implementation of large overseas resource exploration projects. According to preliminary estimations, \$16 billion will be needed until 2013 to achieve the government-set overseas resource development targets. This requires a drastic increase of governmental budget which should be achieved through increased oil import taxes and other oil-related taxes.

Public corporations will also need to participate more actively. KNOC should re-invest its profits into overseas oil development; this will induce active investment by big energy consumers such as KEPCO. The government should strengthen its support for the private sector by expanding tax and financial assistance to attract active participation in overseas resource development projects. The creation of a consortium of KNOC, KORES and private companies would create a base for the performance of big projects with high uncertainty and risks.

The government plans to introduce the Oil Development Fund in 2006 to raise the money for an overseas business fund from the public; at the time of writing, it was developing institutional arrangements for a public offering of the fund. It is envisaged that overseas resource projects will receive investment from private and public companies, government loans, and the oil fund. The oil fund will pave the way for the participation of the public in overseas oil projects and help to raise the money needed for the large investment fund.

But there still remain some concerns about the fund. Overseas projects bear high risks, and exploration projects have only a 15 per cent average success rate. There is also an intrinsic uncertainty in projects that are long term, particularly because of fluctuating oil prices and the time gap between fundraising and actual investment. Institutional incentives such as guaranteed interest rates and the ability to recover a certain level of the principal will be needed to induce public investment. Tax incentives will be needed, at least in the early stages.

Third, there is a need to intensify organisational capacity. Improved competitiveness in overseas resource exploration businesses requires better organisational capacity. This includes strengthening of diplomatic capability, information collection and analysis with respect to potential countries or areas for resource cooperation. Resource experts need to be dispatched to countries of strategic importance such as Russia and Central Asia. Expanding overseas branches of public corporations such as KNOC, KORES and KOGAS is also a significant step toward improving competitiveness.

KNOC's role should be intensified to make it a specialised Korean E&P company. The government has a plan to foster KNOC as a 'major-class' company by 2013, with a production capacity of 300,000 barrels per day. At the same time, organisational reform of KNOC is required to improve its business capability. There is also a need for other public

energy corporations to participate more broadly and more actively; this will intensify the organisational capacity of the country.

It seems to be essential for the government to strengthen its coordinating and supporting role for overseas resource development. The government plans to establish the National Energy Committee in October 2006; its chair will be the country's president. The committee will ensure that energy security is a top item on the national agenda and will formulate national energy policies and strategies through pan-governmental cooperation and consultation.

The government must reform the regulation and support systems for overseas investment. Above all, administrative procedures for investment need to be simplified. In particular, the Overseas Resource Development Act needs to be amended to facilitate foreign investment and strengthen arrangements for screening government loans to ensure efficiency improvement in the funds.

Fourth, there is a need to develop package projects. This has become a new strategy for overseas resource cooperation. Such projects will increase the range of cooperation on economic issues between countries concerned. Korea has launched resource exploration projects with Iraq, Nigeria, Indonesia and China – projects that link to electric power development projects in those countries.

Some oil and gas projects are linked with development of other industries in the target countries. For example, Korea is participating in a gas field exploration project in Qatar in connection with a construction project of chemical plants in that country. Similarly, oil field development projects in Angola and Libya are linked with LNG plant construction projects of those countries.

## Conclusions

The ultimate goal of Korea's energy policies is the harmonisation of the 3E's (economy, environment and energy), thus achieving sustainable development of the national economy. Like many other countries, Korea considers energy security a top national priority. Due to the recent high oil prices, strategic behaviour of resource-endowed countries and hot competition among energy-importing countries for overseas energy development, particular attention is being given to improving overseas resource developments.

Overseas resource development can be carried out in a manner that will enhance the overall energy security of all countries concerned. Excess competition for energy procurement is not desirable. It will simply result in unreasonably high energy prices and unexpected losses for all countries. Regional cooperation needs to be promoted if energy security is to

be achieved. This is particularly true for East Asian countries. Joint actions or frameworks such as an Asian Energy Agency or an Asian Energy Charter should be developed before it is too late.

## Notes

- 1 Organization of the Petroleum Exporting Countries.





# 8 POLICIES FOR THE DIVERSIFICATION OF THE JAPANESE ENERGY SUPPLY: BRIEF INTRODUCTION TO THE JAPANESE

TAKEO SUZUKI

## Introduction

Japanese energy procurement policy is closely related to its goal of energy diversification. Therefore a discussion of Japan's energy procurement policy requires a consideration of Japan's policy for diversifying the primary energy supply.

This paper considers the changes in Japanese energy policy and the changes in Japanese energy supply and demand. It focuses on the period after the oil shocks of the 1970s. First, I review Japan's energy policies in relation to its energy related circumstances. Then I introduce Japan's latest energy policy, the 'New National Energy Strategy',<sup>1</sup> which was issued in May 2006. Table 8.1 summarises the transition of Japanese energy policies over the post-war period.

**Table 8.1 Changes in Japanese energy policy**

Period	Revival after World War II (mid-1950s)	Economic growth (early 1970s)	1st oil crisis (mid-1970s)	2nd oil crisis (mid-1980s)	Globalisation (current)
Energy policies	Intensive energy input for coal/steel production	Moving from coal to oil	Ensuring supply security for oil	Developing alternatives to oil and energy conservation measures	Focus on supply security, environmental friendliness and market orientation

After the first and second oil shocks Japan placed heavy emphasis on the security of its oil supply, the development of alternative energy sources and the enhancement of energy conservation. At the time, it seemed that Japan's primary objective—to reduce Japan's singular dependence on oil—had been achieved. However, over recent years major global concern has focused on environmental concerns—especially climate change—as well as the enhancement and deregulation of global energy markets. Furthermore, oil supply security has returned as an issue of concern.

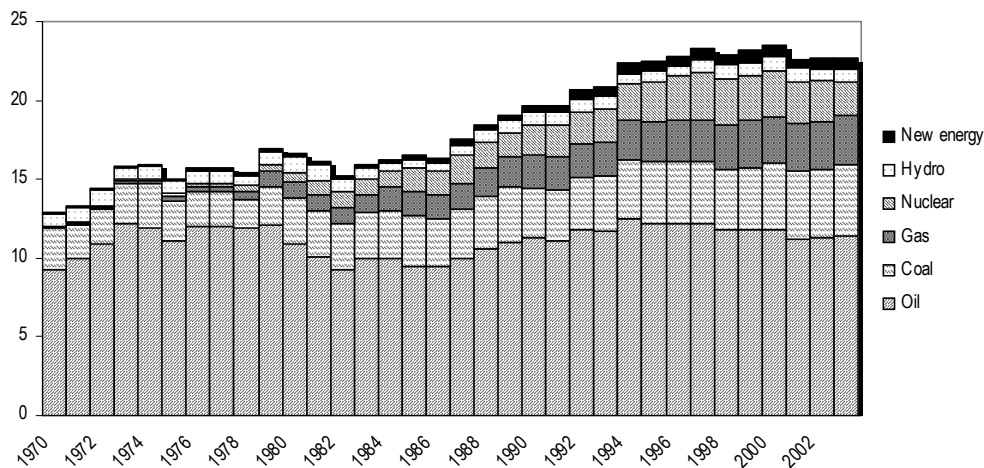
## Transition of Japanese energy supply and demand

### *Primary energy supply*

Japan has scarce domestic energy resources and must depend upon imports for primary energy supply. The oil crises highlighted to Japan the risks associated with its singular dependency upon oil, especially since dependence upon oil also carries with it a dependence upon the Middle East. The oil crises made diversification a very attractive and important issue in Japan.

The process of transition for Japanese primary energy supply is shown in Figure 8.1. In the 30 years since the first oil shock, Japan's reliance on oil for its energy needs decreased from almost 80 per cent of total energy supply to just 50 per cent. Coal, gas and nuclear have been the main substitutes for oil, increasing in the proportion of energy they supply by up to 20 per cent, 14 per cent and 9 per cent respectively. The actual amount of oil did not change significantly over this period; however, the total amount of primary energy supply increased by 60 or 70 per cent.

Figure 8.1 The Japanese primary energy supply, 1970–2004 (by energy type)

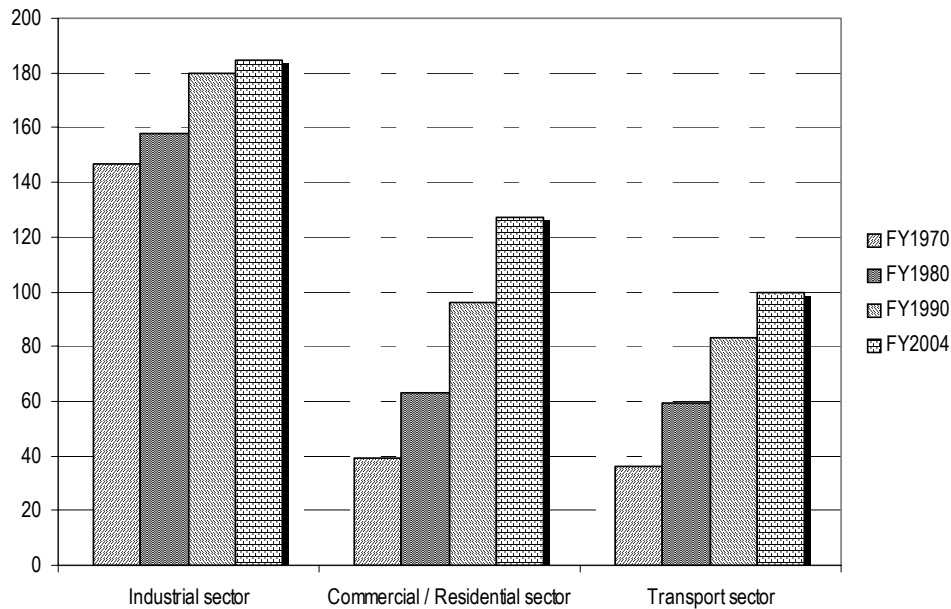


Note: Figures for 2004 are estimated.

Source: Agency for Natural Resources and Energy, *Energy Statistics*, Tokyo.

Figure 8.2 summarises the changes in final energy consumption by sector.

Figure 8.2 Change in final energy consumption by sector, 1970–2004



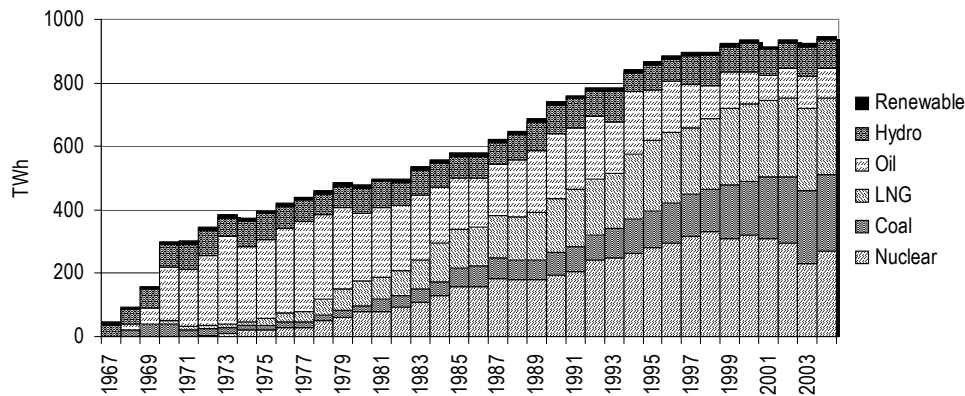
Source: <[http://www.meti.go.jp/english/report/downloadfiles/FY2005EnergyWP\\_outline.pdf](http://www.meti.go.jp/english/report/downloadfiles/FY2005EnergyWP_outline.pdf)>.

The growth rate of energy consumption in the industrial sector is small when compared with that in the commercial/residential and transport sectors. This means better energy conservation in the industrial sector and more efficient energy utilisation, including fuel conversion from oil to other forms. On the other hand, the transport sector is highly dependent on oil: alternative sources for transportation fuel are very limited. Oil-based fuels such as gasoline and diesel still play an important role in this sector.

### *Energy diversification after the oil shocks in the 1970s*

Demand for electric power has steadily increased in Japan, even after the oil crises in the early 1970s (Figure 8.3). However, since that period, the proportion of electricity generated from oil has declined, with oil being substituted largely by liquefied natural gas (LNG), nuclear energy and coal. Nuclear energy and coal were expected to supply base-load power while oil was expected to provide peak-load supply. LNG's main role is now to support the middle-supply load, but it sometimes covers base- or peak-load as well.<sup>2</sup> (See Figure 8.3).

Figure 8.3 History of Japanese power generation source 1967–2004 (incumbent electric power companies)



Source: Agency for Natural Resources and Energy, *Outline of Generation Development*, Tokyo.

As discussed, the two oil shocks in 1973 and 1979 became triggers to promote the introduction of oil alternatives. These price shocks intensified the need to diversify Japan's energy sources. In response to this need, the 'Law concerning the Promotion of Development and the Introduction of non-Oil Energy Sources' (so-called 'Substitute Energy for Oil Law') was enacted in 1980. Also in October 1980, the New Energy Development Organisation (NEDO) was established to promote the large-scale development of energy technologies other than oil.

As a result of these measures, dependency on oil fell from 77 per cent in 1973 to 50 per cent in 2004. This decreased share of energy production was offset by a rise in the relative use of nuclear, LNG and (especially) coal. The share of energy produced from oil thermal power decreased drastically, from 71.4 per cent in 1973 to just 9.5 per cent in fiscal year 2003. These figures suggest that Japan's efforts to diversify its energy sources away from oil have been relatively successful.

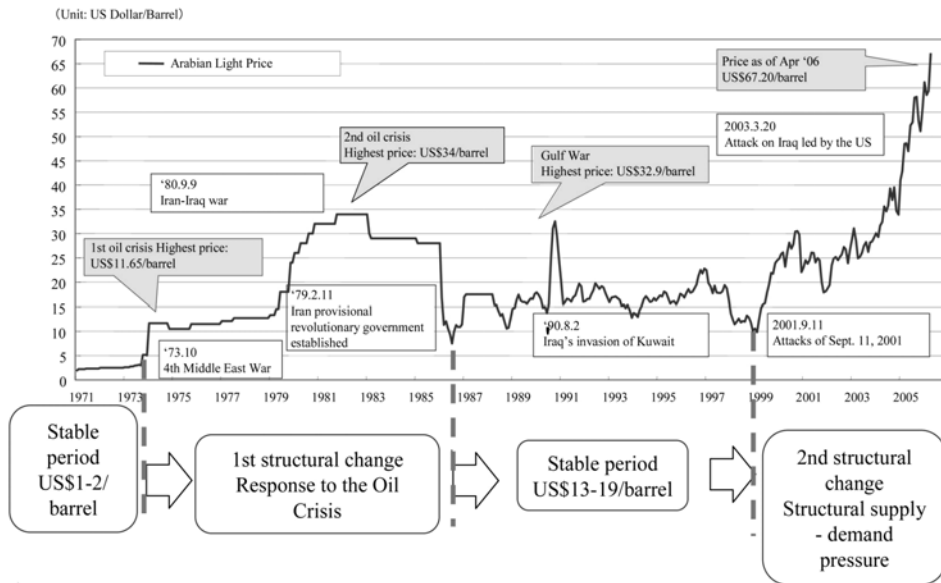
## Current world energy market

### *Change in the structure of supply and demand*

In the 30 years since the oil shocks, the international oil market has shown some fluctuations: the long-term crude oil price is shown in Figure 8.4. The first phase lasted from right after the shocks until the late 1980s, and can be considered a response to the shocks. Oil prices were relatively stable during the 1990s except for a slight jump during the Gulf War.

Since the start of the 21st century, the oil price has been sky-rocketing. This appears to constitute a third phase.

Figure 8.4 Crude oil price transition in the long-term

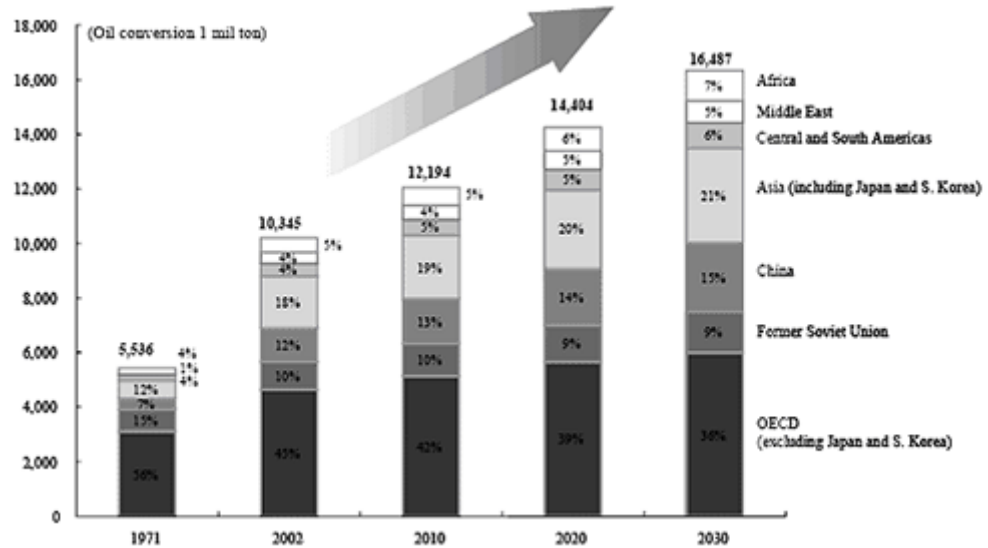


Source: Ministry of Economy, Trade and Industry. This chart shows price fluctuations of Saudi Arabian Arabian Light, of which Japan uses a great deal. However, the price determination method differs by period.

Changes on the demand side are categorised by continuing demand growth worldwide, especially in Asia. The rapid growth in China is particularly significant, as can be seen in Figure 8.5. China, India and other countries have displayed incredible demands for energy resources, and their influence in the international markets has grown proportionately.

While the second period (during the 1990s) saw rapidly rising demand, there seemed to be an investment shortage or mis-allocation of energy supply infrastructure. Despite the general shift away from oil following the shocks of the 1970s, this transformation did not touch the transportation sector. Oil products such as gasoline or diesel still play major roles in the transportation sector. Diversification from oil in this sector is occurring incredibly slowly, a trend that is not likely to change soon.

Figure 8.5 World energy demand, 1971–2030



Source: International Energy Agency, *World Energy Outlook 2004*, Paris.

### *Uncertainties and risks*

The different stages of oil price dynamics discussed above are not the only source of risk and uncertainty in oil markets. Supply variations due to structural change and state control in oil and gas producing countries as well as increasing limitations of foreign capital also caused risk and uncertainty. The period of higher risk in oil markets has eroded the powers of international oil companies. Major structural problems in the Japanese oil market have been revealed, such as a lack of large-scale infrastructure (such as pipelines and spare capacity for refineries), tightening of supplies from non-OPEC<sup>3</sup> countries, and an increasing Middle East dependency. All contribute to uncertainty and insecurity in energy markets.

Issues such as climate change and nuclear non-proliferation affect energy supply and demand structures and are discussed in the international energy framework. Countries must contribute to international cooperation and to establishing an international framework.

Circumstances have also changed for Japan. The Japanese presence in the traded LNG market is decreasing as emerging markets grow. In this situation, it is anticipated that Japan's buying power in the international market will weaken. There is also a concern that the investment required to maintain a substantial supply capacity will not be maintained with the introduction of new regulatory reforms and liberalisation.

Unstable political conditions, accidents, natural disasters and terrorism divert attention, and cause and amplify market disruption, including political uncertainty.

Energy issues are important. Energy consuming (demand-side) countries have started to enforce measures to secure their domestic supply–demand structures and to promote measures to secure resources; energy-producing (supply-side) countries have been focusing on state control of resources.

The New National Energy Strategy sets three objectives. First, it aims to establish energy security measures that people can trust and rely on. The strategy assumes that current trend of soaring oil prices has not yet caused material damage to the overall domestic economy of Japan and that the confusion of previous oil crises has not emerged. However, it recognises that Japan is at high risk, mainly owing to the possibility that the expectation of prolonged supply constraints and high prices will have adverse consequences; anticipated medium- to long-term instability concerning the supply security of oil and natural gas; and increasing sources of risk and uncertainty in energy markets.

Therefore, Japan's energy security measures will focus on the promotion of efforts to establish a state-of-the-art energy supply–demand structure; attempting to avoid increased risk through strategies to address foreign issues; and reinforcing measures to minimise market confusion even in times of emergency.

Second, it establishes a foundation for sustainable development through a comprehensive approach to energy and environmental issues. At the Gleneagles Summit held in the United Kingdom in July 2005, leaders agreed on the significance of a comprehensive and unified approach to address energy issues and climate change issues. They adopted the Gleneagles Plan of Action on Climate Change, Clean Energy and Sustainable Development.<sup>4</sup> As a result, there has been a growing recognition that environmental issues are inextricably linked with energy strategies.

In the course of promoting energy security it is necessary to pay attention to environmental issues (including climate change). A comprehensive solution requires the implementation of medium- or long-term projects to develop advanced technologies (such as decarbonisation technology) that make it possible to reduce dependence on fossil fuels. As one of the world's most environmentally and technologically advanced nations, Japan should take the initiative in building various international frameworks to address the global environmental issues.

Third, there is a need for Japan to make a commitment to assist Asian and world nations in addressing energy problems. The international energy market is interlinked with the overall trend of the world economy. In addition, Japan's industries and economy (especially frontier industries) already depend on Asian-based international specialisation networks.

In these circumstances, Japan must be careful that the implementation of its national energy security measures does not stimulate international competition in the form of a 'race for resources'. The primary objective is to secure a stable supply of energy for Japan through

country-wide efforts to address both domestic and foreign issues. For this reason, Japan should introduce global viewpoints and world-level visions to its New National Energy Strategy. The fundamental policy is to maintain a symbiotic relationship with the Asian and world economies so that Japan's technological strengths and experiences in the field of energy issues can be utilised internationally to assist the nations of the world in addressing various problems and providing a foundation for future development.

### *Basic perspectives of the strategy*

The New National Energy Strategy has three fundamental elements. First, Japan will establish a state-of-the-art structure for dealing with energy supply and demand. Japan has few energy resources but high resource demand. The most effective measure to address the diversified and multi-polarised risk elements affecting energy supply is to establish an energy structure that will allow Japan to improve energy efficiency, diversify and decentralise energy resources, and establish an effective energy reserve. It is especially essential to maintain a certain level of dependence on nuclear energy, which can be produced in a stable manner and which generates no carbon dioxide. In promoting the utilisation of nuclear power, it is important to take all possible measures to ensure safety, focusing on quality assurance.

Second, Japan will strengthen diplomatic efforts, as well as energy and environmental cooperation, in order to overcome the challenges of tight energy markets and reduce or prevent risks to its energy security.

Third, Japan will enhance its emergency response measures. In order to strengthen Japan's energy security drastically, it is essential to examine its emergency response ability.

### *Factors to be taken into account*

In establishing specific contents of the New National Energy Strategy, it is necessary to pay attention to the special characteristics of energy issues. Three points are especially important. The first concerns the need for a medium- or long-term vision with specific numerical targets. In order to improve energy security, it is essential to have a long-term strategy and to clarify the direction in which both public and private organisations should go in coordinating their efforts. Setting specific numerical targets will help to ensure that both government and private organisations move in the right direction.

The second concerns advanced technologies. Government and private organisations need to make concerted efforts to develop and introduce innovative energy technologies, aiming to establish a society based on next generation energy utilisation.

The third concerns strategic collaboration between the government and private organisations and government-wide efforts to make sure the strategy is carried out.



Implementing energy security measures is an important national task that is in the national interest. In the course of establishing specific strategies for implementing the measures, both public and private organisations should make sure they fulfil their own responsibilities, at the same time assisting each other to address foreign relations issues. In addition, all relevant public organisations should have shared objectives if government-wide efforts are to succeed.

### *Establishing numerical targets*

In an effort to establish energy security measures through coordinating public and private organisations toward the same direction, Japan has set five specific targets as long-term goals to be attained jointly by government and private entities.

- *Energy conservation.* Government and private companies are being encouraged to make joint efforts to promote energy conservation. Such efforts began after the oil crises and have resulted in an improvement in energy efficiency of about 37 per cent in the past 30 years, making the Japanese economy one of the most energy efficient in the world. There is a target of a further 30 per cent improvement by 2030.
- *Reducing overall oil dependence.* Japan's oil dependence (the ratio of oil to the entire primary energy supply) has decreased significantly since the first oil shock and is now around 50 per cent. Oil dependence will be reduced to less than 40 per cent by 2030.
- *Reducing the oil dependence of the transport sector.* Currently, dependence on petroleum in the transport sector is almost 100 per cent. The current target is to reduce this to around 80 per cent by 2030.
- *Nuclear power generation.* Nuclear power is now the most important basic energy source in Japan, generating about one-third of all power production. Nuclear power can be regarded as a stable source of energy; it is also regarded as a clean source of energy, because it does not produce any carbon dioxide emissions. The current target is for the ratio of nuclear power to all power production to be maintained or increased to at least 30–40 per cent to at least 2030.
- *Overseas natural resource development.* The ratio of crude oil in which Japanese companies have rights and interests to total imports of crude oil to Japan (the 'oil volume ratio' on exploration and development by Japanese companies) has been gradually increasing from 8 per cent to around 15 per cent at the present time. With intensifying global competition for natural resources, the target is for the ratio to increase to around 40 per cent by 2030.

### *Implementation*

Because Japan has limited resources, it is vital for its energy security that it obtains a stable supply of petroleum and natural gas (the main sources of its energy supply). The government must reinforce its diplomatic efforts to comprehensively strengthen the country's ability to procure resources.

Domestically, the government and the private sector must work together on a medium-to long-term basis to reform the supply–demand structure. This reform should focus on several key areas including the further improvement of energy use efficiency; the diversification and decentralisation of energy sources, for example by promoting nuclear power generation; and the promotion of the effective use of fossil resources, using Japan's superior technical capabilities.

Furthermore, the government must contribute to establishing the basis for the growth of the Asian economy, and consequently the global economy. It can do this by promulgating its expertise and knowledge overseas.

In achieving these goals, the government will undertake four specific programs to strengthen government–private sector efforts at all levels of society.

The first project is to develop a state-of-the-art energy supply–demand structure under a new energy price system—one that is expected to continue in the medium and long term, due to structural tightness in global energy supply and demand. As well as promoting energy conservation, the project will investigate ways to develop a better mix of energy sources. This will include reducing oil dependence through more efficient energy use in the transport sector; introducing new energy sources to a wide range of sectors; and promoting nuclear power generation. The strategy includes four main plans: the Energy Conservation Frontrunner Plan; the Transport Energy for the Next Generation Plan; the New Energy Innovation Plan; and the Nuclear Power Nation Plan.

The second project will comprehensively strengthen resource diplomacy and energy and environmental cooperation. In order to secure a stable supply of petroleum and natural gas, and to promote their effective use, the government will contribute efforts to stabilise the world's energy supply and demand (including those of Asia). It will do this by strengthening the comprehensive strategies to secure resources; reinforcing relations with other countries; and making international contributions of various kinds. These goals can be achieved by utilising the experience and knowledge the Japanese government has accumulated since the first oil shock. Moreover, the government will strive to comprehensively reinforce its strategy for securing the supply of metal resources. Supply and demand in this area have become tighter in recent years and it is feared that the supply of metal resources could become a bottleneck for all industrial activities. Japan will achieve this through the Comprehensive

Strategy for Securing Resources and the Asia Energy and Environment Cooperation Strategy.

The third project is to enhance emergency response measures. The government will strengthen its preparations for unlikely events and critical situations. This will be achieved through the Enhancement of the Emergency Response Plan.

The fourth project addresses several common challenges. The government will develop strong private enterprises to be in charge of energy security through the realisation of the tough demand–supply structure mentioned above. It will also make efforts to develop a strengthened, comprehensive foreign strategy. Most of the technologies required for such efforts (including nuclear power) require sustained long-term efforts and public–private cooperation; the government will therefore concurrently formulate a comprehensive energy technology strategy with a medium- and long-term view: It will do this through the Energy Technology Strategy.

## **Contribution to energy issues in China and East Asia**

### *Energy conservation*

During the 1970s and 1980s Japan experienced a transformation to an energy-efficient economy learned. Such experience will be useful for countries such as China that might wish to accelerate energy conservation under the Clean Development Mechanism or Joint Initiative scheme. For example, so-called ‘pinch technology’, which provides theoretical justification of potential utilisable heat in process industries, will be useful in the industrial sector.

### *Technical cooperation*

Japan has some of the cleanest ambient conditions in urban areas. This has been achieved through substantial reductions in emissions of sulphur oxides (SO<sub>x</sub>) and nitrogen oxides (NO<sub>x</sub>) in combustion flue gas in fuel oil/coal combustion since the 1960s and 1970s. In particular, it has got rid of dust blockages, especially in coal combustion. In the case of fuel oil combustion, facilities to remove sulphur in fuel-oil have been installed in refineries. This has been achieved in facilities with high pressures and high temperatures in a hydrogen atmosphere. Japan has rich experience in and knowledge about the design, construction and operation of such facilities.

### *More flexible LNG trade*

LNG markets are expanding and globalising. The Asia Pacific region is the world's leading recipient of LNG imports; Japan is still the largest LNG importing country in the world. Japan and other countries in the Asia Pacific region therefore have a common interest in LNG imports, concerning issues such as procurement; the design, construction and operation of receiving terminals and gas-using facilities; and transportation and distribution network systems. Japan has over 35 years of experience in these activities. In order to ensure the sound expansion of LNG markets, Japan is ready to cooperate on such matters with both new importing economies and exporting countries.

### *Nuclear energy*

One clear and practical solution to the issues of global warming and energy security for countries in the region is greater utilisation of nuclear energy. Nuclear utilisation is politically sensitive, but Japan can use its experience in increasing nuclear energy utilisation over the last 30 years to contribute to regional cooperation in this area.

### **References**

- International Energy Agency, 2004. *World Energy Outlook*, International Energy Agency, Paris.
- Japan, Agency for Natural Resources and Energy, 2006. *Energy in Japan*, available at: <http://www.enecho.meti.go.jp/english/index.htm>, Ministry of Economy, Trade and Industry, Tokyo.
- Japan, Agency for Natural Resources and Energy, various issues. *Energy Statistics*, Ministry of Economy, Trade and Industry, Tokyo.
- Japan, Agency for Natural Resources and Energy, *Outline of Generation Development*, Ministry of Economy, Trade and Industry, Tokyo.
- Japanese Government, 2006. New national Energy Strategy. Available at: [www.gas.or.jp/english/letter/images/05/pdf/newstrategy.pdf](http://www.gas.or.jp/english/letter/images/05/pdf/newstrategy.pdf)

### **Notes**

- <sup>1</sup> See <<http://www.enecho.meti.go.jp/english/data/newnationalenergystrategy2006.pdf>>.
- <sup>2</sup> Since electric power cannot be stored, meeting the instantaneously changing demand is best achieved through separating the concept of base load and peak load. Base-load is always required through a day or year. Hydro, nuclear, and coal thermal power generation is used as base supply in Japan. Certain times of the day (such as breakfast or dinner times) are subject to large changes in demand. This peak load is met in Japan using oil thermal power generation etc. as 'peak supply power'.
- <sup>3</sup> Organization of the Petroleum Exporting Countries.
- <sup>4</sup> Available at: [www.fco.gov.uk/Files/kfile/PostG8\\_Gleneagles\\_CCChangePlanofAction.pdf](http://www.fco.gov.uk/Files/kfile/PostG8_Gleneagles_CCChangePlanofAction.pdf)

## 9 DEVELOPMENT AND REFORM IN THE POWER SECTOR OF CHINA

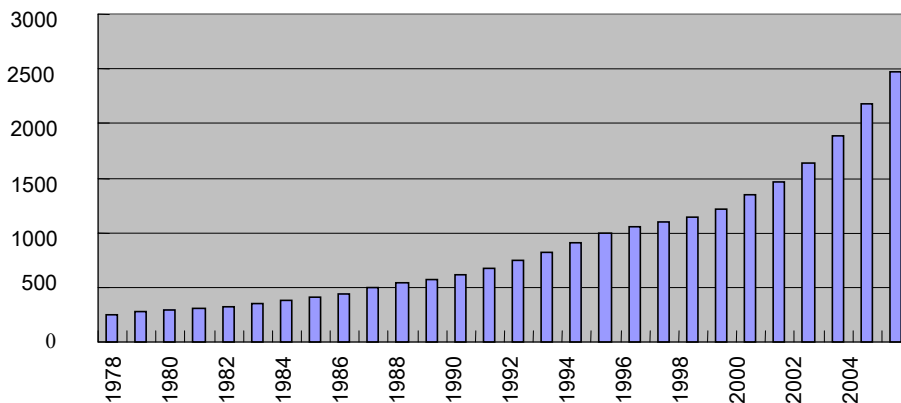
ZHAOGUANG HU

### Electric power sector

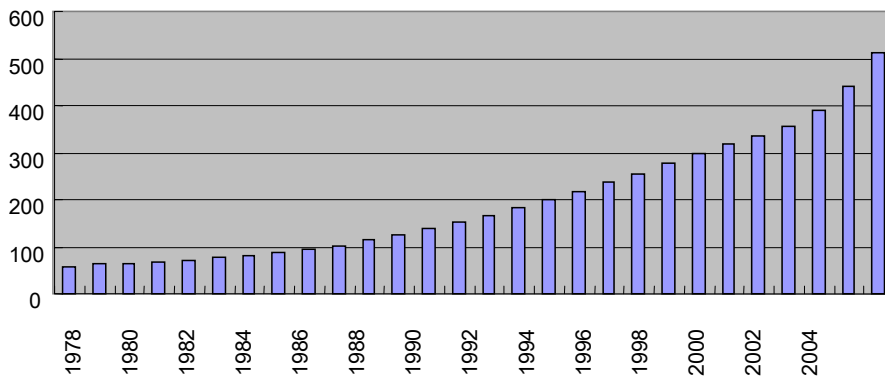
#### *Overview*

Since the implementation of China's market reforms and open-door policy, large-scale investment (particularly foreign investment) has encouraged the rapid development of China's electricity industry. In 1978, China's generation capacity was just 57 gigawatts (GW) and electricity consumption was 249.8 terawatt hours (TWh). By 2005, China's generation capacity had reached 510 GW and electricity consumption 2,474.6 TWh (Figures 9.5 and 9.6). The average generation capacity has grown by an average of 8.45 per cent per year; electricity consumption has grown by 8.86 per cent annually over the past 27 years. Installed generation capacity and consumption of electricity in China have both increased to the point where China's electricity capacity and consumption are second only to those of the United States.

Figure 9.5 Electricity consumption in China, 1978–2005 (TWh)



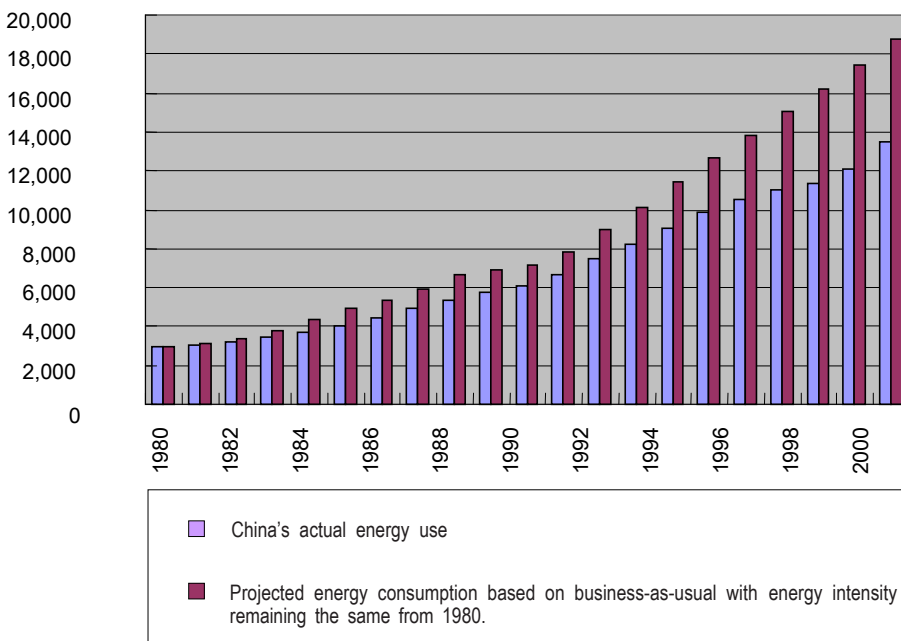
**Figure 9.6** Electric power generation capacity, 1978–2005 (GW)



Sources: *China Energy Statistical Yearbook*, various years, National Bureau of Statistics, Beijing.

During 1980–2000, energy efficiency in the Chinese economy improved considerably. At the beginning of the period China consumed 0.1949 kilowatt hours (kWh) for every renminbi (RMB)1 of economic output. By 2000, this had fallen to 0.1361 kWh/RMB. If the difference is taken as an electricity saving, then considering the total economic output in China over the 20-year period, total electricity savings were 39,995 TWh. The yearly saving is shown in Figure 9.7. Unfortunately this trend has not continued this decade, with energy intensity rising to 0.1587 kWh/RMB in 2005.

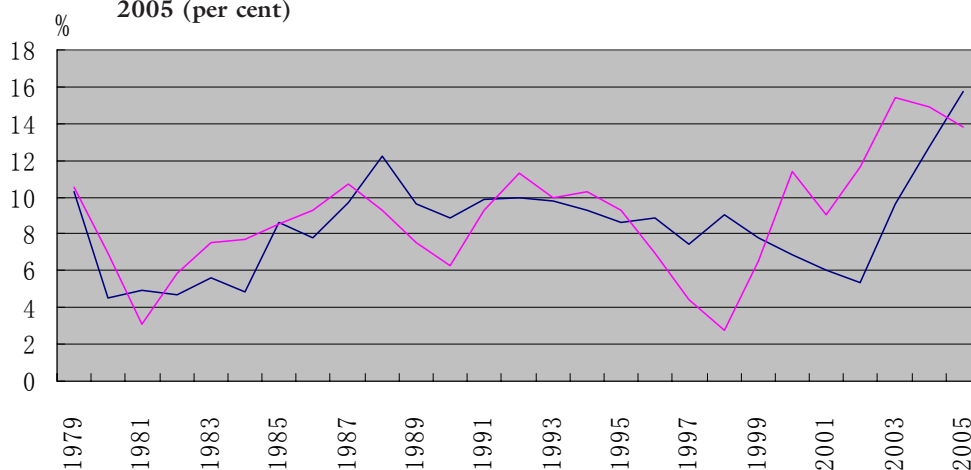
**Figure 9.7** Electricity saving during 1980–2000 (kilowatt hours per year)



Source: *China Energy Statistical Yearbook*, various years, National Bureau of Statistics, Beijing.

Consistent with China's fluctuating economic growth in the period since reform in 1978, increases in energy consumption in China have not been steady. Figure 9.8 shows the growth in both electricity consumption (demand) and generation capacity in China since 1979. The volatility in both consumption and capacity growth is evident from the figure. In 1998 electricity consumption experienced the lowest annual growth rate (2.7 per cent) while in 2003 electricity consumption grew by 15.4 per cent (the highest annual growth during the period). Since meeting electricity demand requires the capacity to produce sufficient electricity, generation capacity will ideally grow at the same rate as demand. This explains the low growth of capacity in 1980 (4.5 per cent) and the high growth in 2005 (15.9 per cent). However the volatility of demand growth is difficult to accurately forecast. It can be seen from Figure 9.8 that changes in capacity tend to lag behind changes in demand. This results in alternating periods of electricity shortage and surplus. This was especially evident after 1999 when rapid growth in electricity consumption outpaced rapid growth in generation capacity, leading to wide-ranging electricity shortages for a number of years.

**Figure 9.8** The growth of generation capacity and electricity consumption, 1979–2005 (per cent)



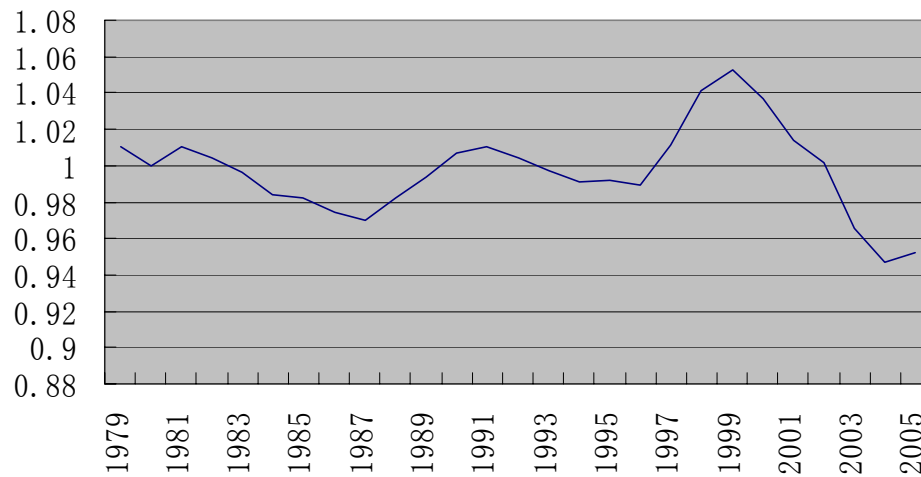
*Note:* Generation capacity is shown in dark, electricity consumption in light.

*Source:* *China Energy Statistical Yearbook* (various years), National Bureau of Statistics, Beijing.

The alternating shortages and surpluses can be expressed as an index: the ratio of supply to demand. A supply–demand index can show if electricity was in shortage or surplus in any given year. A value of 1 in the index would indicate perfect balance between supply and demand. A value greater than 1 indicates that supply exceeds demand and electricity is in surplus; a value less than 1 indicates that demand exceeds supply and there is a shortage of electricity. The further the value is from 1, the more extreme is the market imbalance. Although the index has no theoretical upper limit, it can never fall below 0 (and could only reach 0 if China had no capacity to produce electricity at all). Figure 9.9 shows values for

China's electricity supply–demand index from 1979 to 2005. The striking feature of Figure 9.9 is the degree of imbalance since 1997: there was a prolonged period of considerable surplus from 1997 to 2001 (peaking in 1999 with an index of 1.05), while in 2001 to 2005 there were major electricity shortages (reaching the extreme in 2003 with an index of 0.94). Since 2003 the shortage has abated; however, this has not been uniform across the country.

**Figure 9.9** Electricity supply–demand index, 1979-2005



Source: Author's calculations

At the time of writing (2006), major investments in generation capacity, coupled with dampened electricity demand, were expected to result in a return to electricity surplus by 2007. However the degrees of relief are uneven among regions, with some regions rich in power sources experiencing balance or even surplus and other regions still experiencing damaging electricity shortages. This cycle highlights the importance of accurately forecasting electricity demand, and the difficulty of providing accurate forecasts in a highly volatile environment.

## Electricity supply

### *Electricity generation*

Table 9.1 presents some basic data on electricity supply. China's total electricity generating capacity in 2005 was 511 GW, of which 118 GW was from hydropower, 386 GW from thermal power and just 7 GW from nuclear power. Some 71 GW of China's generating capacity in 2005 was installed since 2004. Of this, 10 GW was in hydropower and 61 GW in thermal power. The growth in China's generating capacity (15.9 per cent in 2005) was



somewhat greater than the growth in actual generation (13.2 per cent), reaching 2,476 TWh. Interestingly, the growth in electricity generation did not come purely from expanded capacity, as evidenced by the different rates of growth in capacity and generation across hydro, thermal and nuclear power sources. While 2005 saw no increase in China's nuclear capacity, electricity produced by nuclear plants increased by 4.39 per cent. Similarly, while hydro capacity increased by 9 per cent, generation from hydro sources increased by 9.54 per cent. However, China's capacity to produce electricity using thermal plants increased by 18.8 per cent, while actual generation increased by only 11.66 per cent. This represents changes in the average number of hours each plant spends generating electricity in a given year.

**Table 9.1 Electricity supply**

	2004	2005	Growth (%) (%)
<b>Total generating capacity (GW)</b>	<b>440.7</b>	<b>511</b>	<b>15.9</b>
Hydro power	108.26	118	9
Thermal power	324.9	386	18.8
Nuclear power	7.0	7.0	0
<b>Total electricity generation (TWh)</b>	<b>2187</b>	<b>2476</b>	<b>13.2</b>
Hydro power	328	359.3	9.54
Thermal power	1807.3	2018	11.66
Nuclear power	50.1	52.3	4.39
<b>Coal used for thermal generation (g/kWh)</b>	<b>375</b>	<b>374</b>	<b>-0.3</b>
<b>Generating hours (h)</b>	<b>5455</b>	<b>5250</b>	<b>-3.75</b>
Hydro	3462	3210	-7.28
Thermal	5991	5760	-3.85
<b>Line loss (%)</b>	<b>7.55</b>	<b>7.4</b>	<b>-1.98</b>

*Source:* Electric Reliability Management Center, *China Electric Reliability Management Annual Report, 2005*.

### *Electricity distribution*

China has six large inter-provincial power networks. These networks are named for the regions they service: Northeast China, North China, Central China, East China, Northwest China and Southern China. The networks are inter-connected by 500-kV lines forming a trunk network across the country. The exceptions are the Northwest power network, which is connected by 330-kV lines, and the connections from Hong Kong and Macao to the Southern network (which use 400-kV and 110-kV lines respectively).

The network connecting each of the six regional networks is sufficient to cope with base-load requirements but is strained under peak load conditions. During the summer peak in particular, all interregional lines operate under their operational limitations. The result is that during extreme peak periods electricity surplus in one region cannot be used to fully satisfy shortages in other regions. To improve the regional distribution of electricity resources, there is a need to improve regional interconnection infrastructure.

## Electricity consumption

Driven by persisting rapid economic growth, electricity consumption in China increased by 13.78 per cent from 2004 to 2005, marking a third consecutive year of rapid electricity consumption growth. The vast majority (74.9 per cent) of that consumption occurred in the secondary industry sector, which consumed 1,855.3 TWh. Some 10.46 per cent (259 TWh) was consumed by the tertiary industry sector, while the primary industry sector consumed just 3.07 per cent (76.04 TWh). The remainder (11.56 per cent) was consumed by residential consumers, using 286.4 TWh of electricity. Table 9.2 presents this breakdown over the six years to 2005.

Table 9.2 shows electricity demand intensity in the secondary and tertiary industry sectors. This is an index that represents the relative growth in demand for each sector to overall growth in electricity demand. Demand intensity greater than 1 represents demand growth in that sector greater than the overall demand growth. The average demand intensity of all sectors (in this case, the primary, secondary and tertiary industry sectors plus the residential sector) must, by construction, equal 1. Therefore it is impossible for all sectors to have a demand intensity greater than 1. In 2000, secondary demand intensity was 0.97 and in 2001 it was 0.98, while tertiary sector demand intensity during 2000–2001 was greater than 1 (approximately 1.2). This relationship reversed during 2002–2003, then reversed back during 2004–2005.

**Table 9.2 Structure of electricity consumption**

	2000	2001	2002	2003	2004	2005
<i>Total</i>						
(TWh)	1350.9	1468.3	1638.6	1889.2	2173.5	2476.6
Growth (%)	11.36	8.69	11.6	15.29	14.9	13.78
<i>Primary industry</i>						
Consumption						
(TWh)	53.395	56.732	58.803	59.362	60.96	76.04
Growth (%)	1.76	6.25	3.65	0.95	2.7	7.31
<i>Secondary industry</i>						
Consumption						
(TWh)	978.6	1062.5	1193.3	1391.9	1620.5	1855.3
Growth (%)	11.13	8.57	12.31	16.65	16.42	13.67
<i>Tertiary industry</i>						
Consumption						
(TWh)	147.43	162.72	183.25	210.34	242.4	259
Growth (%)	14.17	10.37	12.62	14.78	15.24	12.48
Power demand intensity (secondary industry)	0.979754	0.9862	1.0612	1.0889	1.103	0.9978

Power demand intensity (tertiary industry)	1.247359	1.1933	1.0879	0.9666	1.024	0.9109
--	----------	--------	--------	--------	-------	--------

*Note:* Power demand intensity is the ratio the growth rate of electricity consumption in a particular industry against the growth rate of electricity consumption across all industries. If the power demand intensity of a particular industry is greater than 1, the implication is that electricity demand in this industry has grown quicker than in other industries. The sum of all power demand intensities must equal 1.

*Source:* *China Energy Statistical Yearbook*, National Bureau of Statistics (various years)

### *Electricity demand*

Here, I firstly consider three 5-year scenarios for electricity demand, differentiated by energy efficiency. In each scenario, economic growth is assumed to be constant at 7.5 per cent annually. Then, the electricity demand in the future will be discussed.

*Scenario A.* The electricity elasticity of growth is 1.08, implying that China's economy becomes more electricity intensive (consumes more electricity per RMB of GDP). In this scenario, electricity demand will be 3,609 TWh. The total generation capacity will be 810 GW, with 300 GW installed between 2006 and 2010. Total investment in the power sector will be around \$300 billion (\$1 = 8 RMB) over the five years.

*Scenario B.* The electricity elasticity of growth is 1.0, implying that China's economy retains the same electricity intensity. This relies on successful adjustments of the structure of China's economic growth. In this scenario, electricity demand will be 3,500 TWh. The total generation capacity will be 790 GW, with 280 GW installed between 2006 and 2010. Total investment in the power sector will be around \$280 billion over the five years.

*Scenario C.* The electricity elasticity of growth is 0.84, implying that China's economy becomes less electricity intensive. This relies on good results in efforts at sectoral adjustment as well as electricity saving and efficiency programmes. In this scenario, electricity demand will be 3,329 TWh. The total generation capacity will be 760 GW, with 250 GW installed between 2006 and 2010. Total investment in the power sector will be around \$250 billion over the five years.

With the development of electrification, my study by intelligent engineering (Hu 1999) shows that the electricity requirements of implementing industrialisation of a country/region assume that the electricity consumption per-capita should be around 4500 kWh at least, electricity used for resident per-capita should be around 900 kWh at least, the generation capacity per-capita should be around 1 kW at least, the share of electricity used for industry sector should be around 55%, and around 18-20% for commercial and residential sectors. China's electricity consumption per-capita was 1919 kWh, electricity used for resident per-capita was 208 kWh, and the generation capacity per-capita was 0.396 kW, the share of

electricity used for industry sector was 74.9 per cent, and 10.5 per cent 11.56 per cent for commercial and residential sectors in 2005. It is only in the middle period of China's industrialisation process. It is assumed that China will achieve its industrialisation during the 2020s. Then, the electricity demand should be around 6700 TWh and the generation capacity should be around 1500 GW.

### **Electricity sector restructuring**

The management system and organisational structure of the electricity industry have experienced profound changes since 1978 (CEC 2000). In 1979, the State Council replaced the single Ministry of Water Conservation and Electricity with the Ministry of Power Industry and the Ministry of Water Conservation. In 1982, the two ministries were again merged into the Ministry of Water Conservation and Electricity, which was replaced by the Ministry of Energy Resources in 1988. During this period, the industry became more concentrated and unified.

For example, five major regional power administrative bureaus were established one after the other. These were based on China's North, Northeast, Northwest, East, and Central regions. By 1985, a vertical management system had been created in all provinces and autonomous regions except the Guangdong, Inner Mongolia and Tibet autonomous regions. At the top of the system was the Ministry of Water Conservancy and Electricity. The period also saw many investigations into ways to reform the power industry.

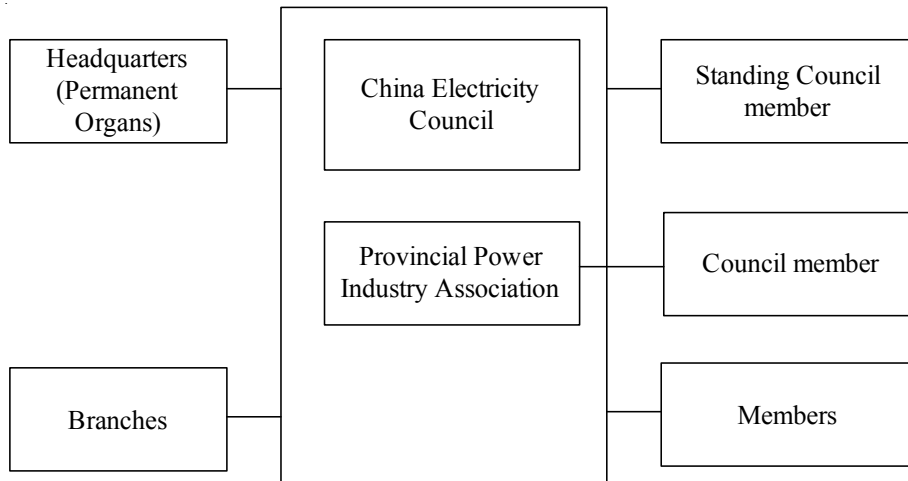
In order to accelerate the development of the electric power industry and alleviate supply shortages, the State Council established the principle of 'separating government functions from enterprise management'. To implement this principle the State Council established the Restructuring Program on the Management of Power Construction. In October 1988, the Ministry of Energy Resources took over this program. The main result of the reform was the privatisation of the provincial power bureaus (the five network bureaus), creating provincial power companies and united power companies under the jurisdiction of the Ministry of Energy Resources. These economic entities assumed sole responsibility for their profits or losses and possessed legal person status. The assets of each power generation and supply unit within the power grid were unaffected.

To resolve supply shortage problems, the state enacted policies encouraging private financing and investment in the electricity sector. Local governments and other enterprises (including foreign firms) invested in new generating plants. The diversification of investment capital ensured the independence of China's electricity generating enterprises.

The China Electricity Council was established in 1988 as a not-for-profit organisation which would provide management support to electric power enterprises and bridge relations

between the government and enterprises. The council operates somewhat like an independent regulatory agency or a management consultant. Figure 9.10 depicts its structure.

**Figure 9.10 The structure of the China Electricity Council**



In accordance with the spirit of the State Council's principles for large enterprise groups, the five united power companies, together with the Huaneng Group, were reorganised into a power group corporation on 11 January 1992. This merger established the first trial unit among large enterprise groups.

In December 1996, the State Council issued a circular on the formation of the State Power Corporation, which was formally established in January 1997. This reform allowed control over state asset operations to be transferred from the Ministry of Power Industry to the State Power Corporation. The transfer marked the complete separation of industry regulation from corporate management in China's electricity industry. Four of the original inter-provincial power groups (excluding the North China power group) then became branches of the State Power Corporation.

In 1998, the State Council approved a pilot program under which grid prices would be determined by market forces. The State Economic and Trade Commission selected Zhejiang, Shandong, Liaoning, Jilin and Heilongjiang provinces and Shanghai Municipality for this program, which provided valuable experience for further reforms in China's power market.

### **Market-oriented reform**

Following the 1998 pilot program and more than one year of in-depth studies, the State Council established the Power Restructuring Program in March 2002. This program defined the guiding ideology, general objective, main content and implementation and coordination

measures for further market-oriented reforms. It includes efforts to break monopoly, raise efficiency, lower costs, perfect the price mechanism for electricity, optimise resource allocation, promote electricity development, propel a nationwide distribution network and establish a power market system with fair competition and sound development, under government supervision.

The assets controlled by the State Power Corporation were divided into generation assets and distribution assets. This allowed electricity generation to be more easily privatised while distribution could retain a higher degree of government regulation and supervision.

In accordance with the objective of breaking monopoly conditions, several independent power generation enterprises have been created. The five power corporations (China Huaneng, China Datang, China Huadian, Guodian Power and China Power Investment), as well as four subsidiaries (China Power Engineering Consultant Group Corp. and Gezhouba Group Corp.), were formally established on 29 December 2002. Authorised by the State Council, these enterprises have duties to keep and increase the value of state assets. They are independent group companies in the state plan.

On the distribution side, the State Power Grid Corporation and the Southern Power Grid Corporation were established. The State Power Grid Corporation established five regional companies in the north (including Shandong Province), northeast (including the eastern part of inner Mongolia), east, central and northwest regions of China. It also manages the power enterprises in Tibet. The Southern Power Grid Corporation covers Yunnan, Guizhou, Guangdong and Hainan provinces as well as Guangxi Zhuang Autonomous Region.

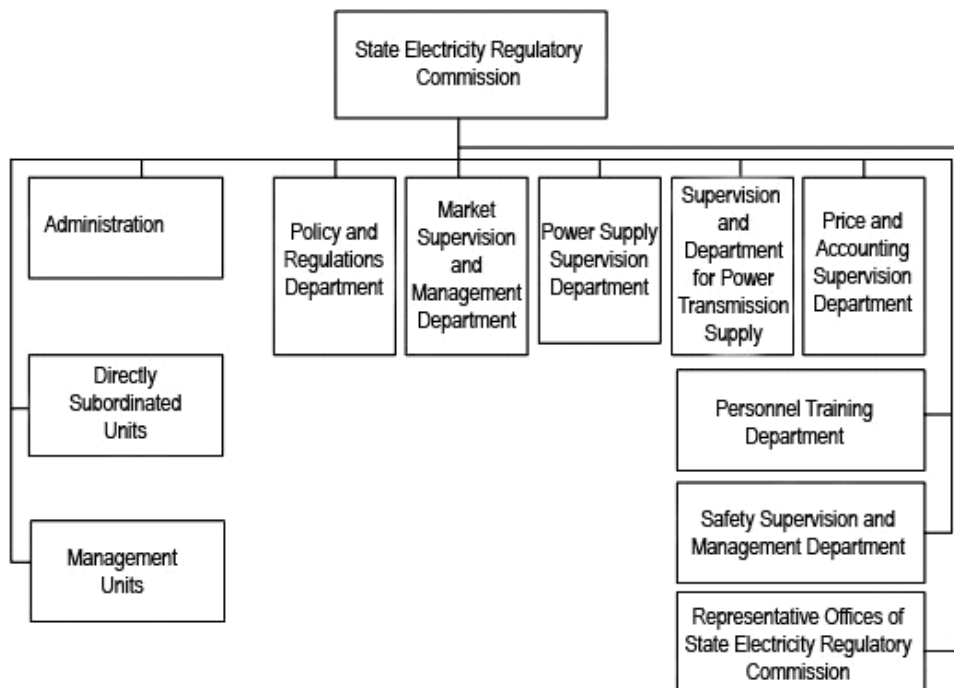
The State Council empowered the State Electricity Regulatory Commission (SERC) to perform administrative and regulatory duties with regard to the national electric power sector in accordance with laws and regulations. Figure 9.11 shows the structure of SERC; Box 9.1 shows its major responsibilities.

**Box 9.1 Functions of the State Electricity Regulatory Commission (SERC)**

1. SERC is responsible for the overall regulation of the national power sector. It is required to establish a coherent regulatory system and exercise direct leadership over its regional branches.
2. SERC is to develop laws, regulations and relevant amendments governing the electricity sector.
3. SERC is to participate in the formation of a development plan for the sector. This participation should include proposing development plans for electricity markets and designs for regional power markets. SERC must also review and confirm the operational structure of the electricity market and the establishment of electricity trading arrangements.

4. SERC is to monitor electricity market operations to ensure orderly and fair competition in the market.
5. SERC must regulate aspects of the electricity industry which are characterised by natural monopoly conditions. This refers to the transmission and distribution of electricity.
6. SERC is to participate in the stipulation and enforcement of safety and technical standards and quantitative and qualitative codes for the electricity industry, issue and maintain business licences, and enforce environmental laws in coordination with relevant environmental protection agencies. This includes investigating any possible violations of laws and regulations by market participants and resolving disputes among them.
7. SERC must propose tariffs and adjustments to the government pricing authority on the basis of market conditions, review tariff levels, and regulate fees and charges for ancillary services.
8. SERC is to supervise the implementation of the universal service provisions policy and propose revisions to that policy.
9. SERC is to provide statistics and information on the electricity market.
10. SERC is to organise the implementation of sector reform programs in accordance with the direction of the State Council, and propose options for further reform
11. SERC is to assume any other duties delegated by the State Council.

Figure 9.11 Structure of the State Electricity Regulatory Commission



## **Power markets in China**

As part of the liberalisation of the electricity market, China has introduced regional trial markets in Northeast and East China. There is also a simulation operation in Southern China and arrangements for Central China and North China regional markets. The regions have accumulated experience in electricity price bidding following a number of government experiments in past years. The simulation exhibits the current situation of China's regional electricity markets and introduces their rules. In this section I describe the characteristics of the Northeastern, Eastern and Southern regional electricity markets.

### *The North eastern regional electricity market*

The first regional electricity market was established in China's north eastern provinces of Liaoning, Jilin and Heilongjiang, also covering Chifeng and Tongliao cities and Hinggan and Hulun Buir leagues in the Inner Mongolia Autonomous Region. It covers a total area of 1.2 million square kilometres encompassing a population of 100 million residents. There are extensive transmission networks in place and there is an electricity supply surplus, creating highly competitive market conditions.

The market began trial operations at the end of October 2003 and formal operations on 15 January 2004, based on a two-part tariff pricing system. There are 25 plants participating, with a total generating capacity of 20,260 MW. The establishment of the regional electricity market is being viewed as a test in China's attempts to create a competitive national electricity market by forcing generators to cut overheads.

The objective of the reform is the transition from a vertically integrated monopoly to free market competition. There are two major stages. In the first stage, the target is to organise and establish a uniform Northeastern regional electricity market. This requires establishing a regional electricity market regulatory system, including a series of related pricing policies. During this stage, trading of generation rights and transactions between generation companies and large consumers are permitted. The second stage involves the establishment of an ancillary service market. As the market matures and the pricing system improves, the regional electricity market will be fully opened to competition in the power generation and retail sectors. The financial market, including futures and options contracts, will expand. At the time of writing, the North eastern regional electricity market was at the initial stage.

The regional electricity market is operated and managed by the Northeast Electricity Dispatching and Trading Center (NEDTC). The NEDTC is responsible for facilitating trading, settlement, information broadcasting, matching generation rights between generators, market registration and emergency market intervention (including suspending trade,



terminating transactions, adjusting trading results and price caps and other necessary measures). The market is supervised by the Northeast Electricity Regulatory Commission (NERC). The NERC mediates disputes, grants licences to market players and enforces market regulations. It is responsible to the SERC.

As of 2006, only those generators with a unit capacity greater than 100 MW<sup>2</sup> are required to participate in competition; however, all plants will be required to participate in competition after a suitable transition period. This aims to avoid sweeping bankruptcies of smaller and more fragile generating companies.

Bidding in the market is based on a two-part tariff system. Capacity price is determined and adjusted by the state government, but the energy price is determined through market competition. The capacity income is measured by the NEDTC according to the capacity price, available operation hours (usually 5,500 hours per year in China) and available operation capacity.

The regional electricity market operates under uniform market rules with centralised dispatch and trading. Generating companies submit bids to sell electricity through a so-called 'power pooling system'. All transactions are conducted through the NEDTC, the only buyer in the market.

The transactions are supported by long-term contracts and spot market transactions. The long-term contracts are the primary form of transaction, with trading occurring annually and monthly. Long-term trading is supplemented by the spot market, which has day-ahead and real-time trading. The vast majority of trading is based on forward bilateral transactions.

Before the day-ahead market was put into practice, 80 per cent of power consumption in Northeast China was sold through the yearly contract and 20 per cent of power consumption was sold through the monthly contract. The yearly contract is carried out by power plants, not single units. Bids can have a maximum of 20 pairs of quantity/prices. All the power plants can amend their bids until the market closes. The yearly bilateral contract is signed between generating plants and the NEDTC 20 days after 1 January.

The monthly bilateral contract market, which must take account of yearly contracts, opens at 10:00 on the 22nd day of every month and closes at 16:30 on the 23rd day of every month. Bids can have a maximum of 20 pairs of energy prices at most. All the power plants can amend their bids until the market closes. The marginal price is taken as the market-clearing price.

The transactions in the day-ahead market cannot exceed 10 per cent of the total power generation in principle. The day-ahead market opens from 10:00 to 14:00 and is settled at 16:00 every day. The NEDTC works out the generation schedule and broadcasts the information to the plants. The bids are submitted for every 15 minutes of the following day.

Bids can have several pairs of energy prices, changing from 1 to 10, and must be monotone increasing sequence. The marginal price is taken as the market-clearing price.

Real-time transactions are settled every 30 minutes, before the period of demand in question. This is the so-called balancing market. It must take account of all kinds of existing contract transactions and day-ahead transactions. The NEDTC buys any difference between the expected electricity load and the actual load. Bids can have several pairs of quantity-prices, changing from 1 to 10, and must be in monotone increasing sequence.

There are price caps and price floors in the long-term transactions, but there is only a price cap in the day-ahead and real-time markets (no price floor). Not all the contract markets open at the same stage: yearly and monthly contract trading occurs first, and the day-ahead and real-time markets follow, in order to balance supply and demand at each moment. The power generation trading is determined orderly so as to minimise financial operating costs, taking into account transmission losses and security constraints. Payments are made every month through local settlement centres in Liaoning, Jilin and Heilongjiang provinces. The NEDTC is in charge of the settlement of capacity payments.

An ancillary services market is not open in the initial stage. All the generation units connecting to the grid have the responsibility to supply the ancillary service to ensure system reliability. The ancillary service is dispatched to match power demand.

### *Eastern China regional electricity market*

The East China regional electricity market came into being in June 2003, covering Shanghai and the provinces of Jiangsu, Zhejiang, Anhui and Fujian. It covers a total area of 0.47 million square kilometres, involving 230 million residents. The simulation operation began on 28 October 2005. Some 59 plants (171 units) have participated in the market, with a total capacity of 43,388 MW, accounting for almost all the installed capacity in the East China network. The market began trial operations on 1 April 2006. Those generators with a unit capacity greater than 100 MW are required to participate in competition; however, they are only required to place 10 per cent their annual generation in the market under free competition. The remainder can be sold at the government-determined price.

The Eastern China market is the biggest in China, covering the most developed regions. However it is far removed from major generating resources. Coupled with the much higher than expected development, this has caused serious shortages of electricity supply in recent years.

There are three major steps involved in developing the Eastern China regional market as it moves from a vertically integrated monopoly to free market competition. In the initial stage, the target is to build a uniform electricity trading platform. Initially not all electricity

will be permitted to be traded in the competitive market. A regional market regulatory system and a series of related pricing policies need to be established in this stage. Transmission and distribution price systems should also be established in this stage.

During the second stage, both the number of participating plants, and the proportion of each plant's generating capacity sold under market conditions should increase. The market will adopt other forms of trade, including bilateral transactions. Ancillary services and the financial market are expected to develop at this stage.

Generating units are divided into two groups, A and B. Group A generating units are required to compete in the market immediately while group B units are not required to operate under competitive market conditions until the market matures. Group A units are coal-fired units with unit capacity greater than 100 MW; group B units include nuclear plants, liquified natural gas (LNG), oil-fired units, renewable units, co-generation and self-supply power units and coal-fired units with a unit capacity less than 100 MW. As the market matures and the pricing system improves, the market will become freely competitive. All generation plants and energy consumers will be required to undertake transactions in the competitive market.

The Eastern China Electricity Dispatching and Trading Center (ECEDTC) operates the Eastern China regional electricity market. It is responsible for trading, settlement, information broadcasting and granting licences to market players.

The regional electricity market has uniform rules with centralised dispatch, planning and management, but local control and cooperation operates between subregions. In the initial stage, electricity quantities and price bids are permitted, but only part of the energy generated is permitted to be traded in the market.

Transactions occur under the yearly and monthly contract markets as well as the day-ahead spot market and real-time balance mechanism. Initially, only monthly and day-ahead transactions are performed competitively, although there are controls over monthly contracts. Price and quantity are both subject to caps for monthly contracts. Additionally, bids can have a maximum of four quantity-price pairs. The price can not be less than zero and should be monotone increasing sequence. The minimum price difference between pairs is 10 RMB/MWh. In contrast, prices for yearly contracts are determined through bilateral negotiations. As the market matures, weekly and quarterly contract transactions should become competitive under market conditions. Electricity consumption covered by yearly contracts will account for 85 per cent of electricity consumption, with 15 per cent of electricity sold under competitive conditions.

Bids are based on a time-of-use (TOU) rate structure. A day is divided into peak and valley periods. The former is from 08:00 to 22:00 (22:00 not included) and the later is from 22:00 to the following 08:00 (08:00 not included). Transactions are performed in peak and valley periods respectively.

A node pricing system is adopted; this is confirmed by ECEDTC taking into account the security constrained to minimise the total purchase cost. There is a regional reference node in the East China network and some provincial reference nodes (in subregion networks). Grid-loss factor refers to the transmission loss of generating plant to provincial reference nodes. In monthly and day-ahead transaction, bids must be converted according to the grid-loss factor.

In the day-ahead market, transactions are performed every 15 minutes, creating 96 trading points in a day. Trading begins at 00:00. Bids from generating plants are submitted before 14:00 and prices must be positive, but less than the price cap. The generation schedule is determined at 16:30 by the ECEDTC.

### *Southern China regional electricity market*

The Southern China regional electricity market is the third regional market in China. It covers the provinces of Guangdong, Guizhou, Yunnan, Hainan and Guangxi Municipality, a total area of 1 million square kilometres involving 220 million residents. A simulation operation began on 1 November 2005. Some 39 plants are required to operate in the competitive market with a total generating capacity of 13,540 MW (accounting for 19 per cent of the total installed capacity in the Southern China regional network in 2003).

The Southern China regional electricity market is highly diverse. The eastern region is more developed and consumes more electricity than the west, while most of the energy resources (such as hydro) are located in the west. It is therefore necessary to optimise the resource allocation across sub-regions. The power supply structure and load-bearing characteristics are also different across the provinces. The price of electricity from coal-fired units is almost double those of hydropower units. The price difference between Guangdong and other western provinces is large. Furthermore, because the regional electricity market covers some western provinces—such as Guangxi Municipality, Guizhou and Yunnan—west to east electricity transmission must be taken into account in electricity dispatch. At present (2006), the provinces of Guizhou, Guangxi, Guangdong and Yunan suffer from power shortages. It is anticipated that electricity supply and demand balance in some sub-regions will remain tight in the near future. The Southern China regional electricity market leads the way to establish a regional market in some complicated regions.

There are three major steps involved in developing the Southern China regional market as it moves from a vertically integrated monopoly to free market competition. The objective of the initial stage is to establish competitive market conditions over part of the electricity traded in the region. The objective of the second stage is to open the day-ahead market and long-term contract transactions, as well as develop the financial market, transmission rights

and ancillary services. In the long term, as the market matures, all generating plants and all electricity consumers should be required to participate in competition. Electricity should be sold to provincial power generating groups and buyers in the regional market through the regional electricity trading platform. The electricity price of west–east electricity transmission project is also determined through competition.

The Southern China Electricity Trading Center (SCETC) operates the market and is responsible for yearly and monthly transactions and information dissemination. The Southern China Electricity Dispatching Center (SCEDC) has the responsibility to dispatch, perform trading results and maintain system balance in real time. It must also intervene in the market in emergency situations (including suspending trading, terminating a trade, adjusting trading results and the price cap and other necessary measures).

Bidding in the Southern regional market is based on the electricity quantity price system. The separated generation, transmission and distribution and retail prices are established clearly. Only the generation price is determined through competition. Transmission and distribution prices are based on cost plus income. Bids have uniform limits that are subject to a price cap when submitted by suppliers and to a price floor when submitted by consumers.

In the initial stage, transactions are supported by yearly and monthly contracts. The electricity quantity sold under competitive market conditions will account for 15 per cent of electricity generation. Of electricity sold competitively, 30 per cent will require yearly contracts while 70 per cent will require monthly contracts. Bids in the Southern regional market are based on a more detailed TOU rate structure than bids in the East or Northeast regional markets. The Southern market TOU rate structure consists of peak, flat and valley prices. Bids are subject to price floors and a maximum of four quantity-price pairs.

Contracts under the west–east electricity transmission project are not competitive in the initial stage since quantities are determined by China's central planning authority. As the market matures, the electricity quantity will be fully open to market competition.

The ancillary service market is divided into basic and paid service markets with centralised dispatch. All generation units connected to the grid have the responsibility to supply ancillary services to ensure system reliability and maintain system balance. The basic ancillary services are provided by grid companies and generation companies without payment. The paid ancillary service market is not open in the initial stage. All of the ancillary services are dispatched according to power demand.

### *National electricity market*

China faces a major policy challenge regarding the urgent need to improve the management and coordination of energy demand and supply throughout the country. Sustained rapid economic growth has occurred primarily in the eastern parts of China. Therefore, the majority of the increase in energy demand has also occurred in these areas. This has created an imbalance since the majority of China's energy resources such as hydro, wind and coal are located in the mid and western parts of China, where economic growth, and subsequently energy demand, are considerably lower.

Responding to this issue will make the development of western China and the transmission of electricity from west to east important strategies for China over the next few decades. Plans exist to develop an additional 140–150 GW of hydro power generating capacity over the next 15 years. Ensuring that this new capacity is able to meet electricity demand where it is most needed will require greater integration of China's main regional electricity networks. Establishing a fully unified electricity market across China, based on a nationwide transmission network, will have incredible social, economic and environmental dividends. Although a unified national electricity market is still a long way off, studies are under way as to how it can be achieved.

However this is not China's only energy-related policy challenge. China needs to formulate a coherent energy policy to provide the basis for the effective management of the energy sector and its environmental consequences. China has plans to import electricity from Russia, Mongolia and other neighbouring countries. Responding to environmental sustainability constraints requires China to place a high priority on clean and renewable energy. Policies and methods to reduce the cost of hydro electricity and other renewables will all be studied in the context of China's national electricity market.

### **Challenges**

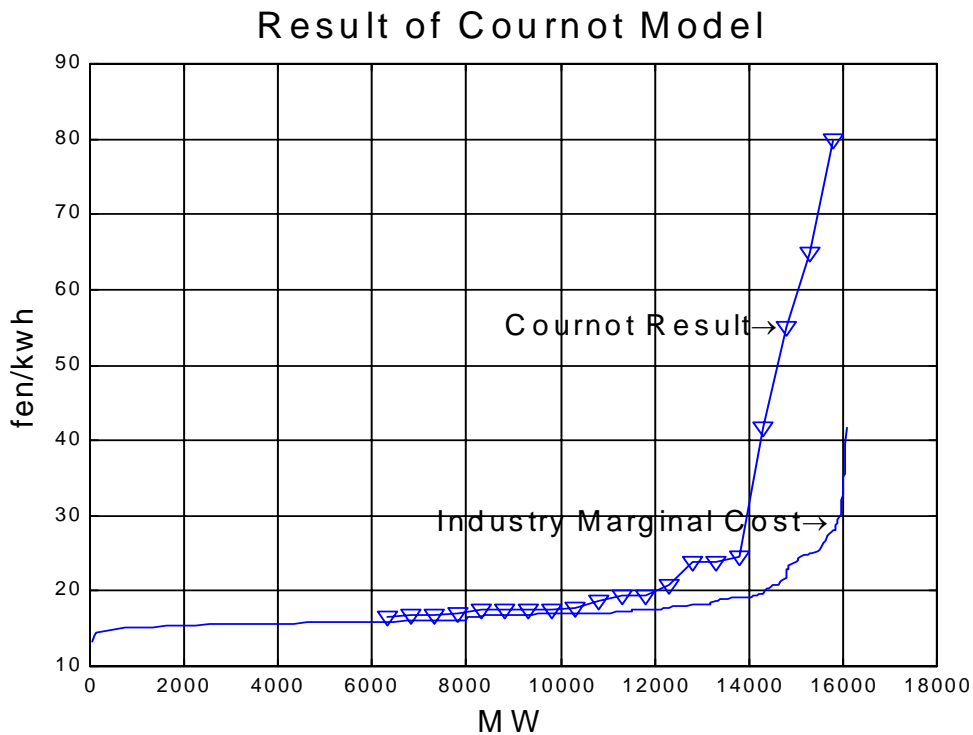
China urgently needs to improve the economic efficiency of its generation, transmission and distribution of electricity. The principal method of achieving this objective is through the establishment of competitive market conditions in the electricity industry. There are three conditions necessary for achieving this transition:

- the electricity generating capacity must be higher than the electricity demand;
- electricity grids must be sufficiently robust to meet transmission requirements at all times and in all locations; and
- there must be a comprehensive legal system under which the market operates (Hu 2001).

The first condition is derived from Cournot simulations of electricity markets (Tong et al. 2002). The simulations show that in a system with a 16-GW generating capacity, the difference between marginal cost and bid price is acceptable when the load demand is less than 14 GW. The results of this model are presented in Figure 9.12. This implies that supply capacity must be at least 10 per cent higher than demand. If this is the case, then the first of the three conditions mentioned above is satisfied.

This will present a challenge for China, given the continuation of China's sustained and rapid, but volatile economic growth. Volatility in China's economic growth creates an alternating cycle of electricity shortages and surpluses. China's growth pattern since the reform period has been characterised by a cycle of above average growth for about 4 years, followed by about 4 years of below average growth (although below average growth in China is still rapid by international standards). If this continues, the cycle of electricity shortages and surpluses will also continue. Power shortages place upward pressure on spot prices, resulting in short-term gains for electricity generators; however, electricity surpluses place downward pressure on spot prices, resulting in short-term losses for generators. The ultimate result, however, is that generating capacity cannot reliably be expected to exceed demand, without meeting the first condition.

Figure 9.12 Results of Cournot model



Source: Author's calculations

The second of the three stated conditions also presents a challenge for China. The power grids for transmission and distribution are weak throughout the country. It is very difficult to provide options for power suppliers and customers. In order to strengthen the grid, it is endowed with monopoly buying rights, so that electricity producers cannot sell directly to consumers.

A final major challenge for China is the conflict between economic efficiency and energy efficiency. Rapid economic growth creates considerable upward demand pressure for electricity. To ensure that China's growth is sustainable, the first priority must be to strengthen demand-side management to reduce the consumption of electricity. China considers energy efficiency and conservation to be greater priorities than energy supply. However, it is also necessary to ensure that generation capacity remains greater than demand.

Energy efficiency is, and will remain, a very important international issue. It is relative to energy security, energy price, environment, health, climate change and sustainable development. The electricity deregulation must promote energy efficiency in both power supply and demand. The challenge is how to ensure that deregulation increases China's energy efficiency. It is clear that low electricity prices will be the main source of inefficiency on the demand side. With low prices, it is very difficult to provide the incentives for people to save energy. This influence may be countered if the bid prices received by electricity generating firms are greater for more efficient generators. Unfortunately, under the current pricing system, energy efficiency is in conflict with price. Smaller units that are quicker to cover their investment costs are able to charge lower prices despite being less efficient. For example, a 50-MW coal-fired unit that has paid back its investment will make lower bids than a 600-MW unit. This is despite the 50-MW unit operating at 30 per cent efficiency and the 600-MW unit operating at 40 per cent efficiency. Around 60 GW of China's electricity is produced from small-scale units such as the 50-MW example. If competition was based on energy efficiency, more than 70 million tons of coal equivalent will be saved each year, mitigating many million tones of CO<sub>2</sub> and other emissions.

## Conclusion

China's economic growth pattern has exhibited a cyclical pattern since the reform period. It is characterised by a 9-year cycle of alternating rapid and moderate growth. This economic growth cycle has particular significance for electricity demand in China since demand for electricity follows economic growth very closely. The electricity requirements of implementing industrialisation for a country/region assume that the electricity consumption per-capita should be around 4500kWh at least, the electricity used for resident per-capita should be around 900kWh at least, the generation capacity should be around 1kW at least,



the shares for industrial, commercial and residential sectors are around 55 per cent, 18 per cent and 20 per cent respectively. China is only in the middle way of her industrialisation process. Further, predicting fluctuations in electricity demand has major implications for energy efficiency, the first priority in China's energy strategy.

Reform in China's electricity sector has progressed steadily over the past 27 years and will continue in the future. However, major challenges remain, including establishing a competitive market for generation, improving energy efficiency and promoting renewable energy. Although there are lessons China can learn from the experiences of other countries, much of the needed reform will occur through experimentation and China's own studies. In particular, studies in theory and market design are needed to promote energy efficiency and improve China's market institutions to establish a competitive, efficient industry.

## References

- Arthur, W.B., Durlauf, S.N. and Lane, D.A. (eds), 1997. 'The economy as an evolving complex system II', Proceedings Volume XXVII, Santa Fe Institute Studies in the Science of Complexity, Reading MA: Addison-Wesley, 1997.
- Blair, A. R., Nachtmann, R., Saaty, T.L., and Whitaker, R., 2002. 'Forecasting the resurgence of the US economy in 2001: an expert judgment approach', *Socio-Economic Planning Sciences*, 36: 77–91.
- China Electric Reliability Management Center, 2005. *China Electric Reliability Management Annual Report, 2005*, China Electric Reliability Management Center, Beijing.
- China Electricity Council, 2000. *The Chinese Power Industry Today*, Foreign Languages Press, Beijing.
- China, National Bureau of Statistics, (various years). *China Energy Statistical Yearbook*, National Bureau of Statistics, Beijing.
- Fildes, R. and Stekler, H., 2002. 'The state of macroeconomic forecasting', *Journal of Macroeconomics*, 24: 435–468.
- Hicks, J.R., 1950. *A Contribution to the Theory of the Trade Cycle*, Oxford: Oxford University Press.
- Hu, Z.G., 1999. *Intelligent Space*, IEEE-Fuzz99, South Korea.
- , 2001a. 'China takes a giant step: China's initiative combines technology and pricing options to impact consumer behavior', *Transmission & Distribution*, December: 34–40.
- , 2001b. 'China's sustainable electrification through competition in the power sector' 18<sup>th</sup> World Energy Congress, pp18, Argentina.
- , 2004. 'Studying on the baseline space of sustainable power development', *Electric Power* (in Chinese), 37(4): 1–4.
- , 2004b. 'Demand side management: strategic option for sustainable development in China's power sector', 19th World Energy Congress, Australia, 5–9 September 2004.
- , 2005. 'Power windows: analysis of effects of macro regulation', *Macroeconomics*, 7: 43–46.
- and Fang, Y.P., 2000. 'Analysis on prospect of economic development and power demand in China', *Electric Power (China)*, 33(8): 6–9.
- et al, 2003. 'Policy study of demand side management in China, Working Paper.
- et al, 2004. 'Demand side management in China's restructured power industry, Working Paper.

## Asia Pacific Economic Papers

- Klir, G. J., 1991. *Fuzzy Sets, Uncertainty and Information*, Prentice Hall, New York.
- Kandel, A. and Langholz, G., 1992. *Hybrid Architectures for Intelligent Systems*, CRC Press, Scottsdale, Arizona.
- Kosko, B., 1992. *Neural Networks and Fuzzy Systems*, Prentice-Hall, New York.
- Langton, C.G., 1989. 'Artificial life', SFI studies in the science of complexity', pp. 1–47 in Langton, C.G. (ed.), *Artificial Life*, Vol. IV of *SFI Studies in the Sciences of Complexity*, Addison-Wesley, Redwood City CA.
- Li X., and Dai R.W., 1998. 'System science and complexity', *Acta Automatic Sinica*, 24(2): 200–208.
- Luger, G. F., 1992. *Artificial Intelligence*, Thomson Scientific, New York.
- Mills, T.C., 1993. *The Econometric Modelling of Financial Time Series*, Cambridge University Press, Cambridge.
- Priestley, M.B., 1981. *Spectral Analysis and Time Series*, Vols 1 and 2, Academic Press, Burlington, MA.
- Shi, F.Q., 2000. 'The positive research on China's economic cycle', *Statistics Research (Chinese)*, 2000(7): 59–62.
- Tong, F., Wu, Z.X., and Hu, Z.G., 2002. Market power analysis in the whole-sale market', *Journal of Quantitative & Technical Economics*, 19(1): 109–111.
- Wasserman, P.D., 1989. 'Neural computing theory and practice', ANZA Research Inc.
- , 1993. *Advanced Methods in Neural Computing*, Van Nostrand Reinhold, New York.
- Young, P., 1990. 'Special issue on state-space forecasting and seasonal adjustment', *Journal of Forecasting*, March–April.
- Zhai, Z.C., 2001. 'The theory of economic cycle and the development tendency of macro-economy in today's China', *Economist (Chinese)*, 2001(2): 14–18.

## Notes

- 1 All RMB are in 2000 prices in this paper.
- 2 Not including co-generating units, renewable units or self-supply power units.

# 10 CHINESE POWER: REFORM AND DEVELOPMENT IN CHINA'S ELECTRICITY INDUSTRY

EDWARD A. CUNNINGHAM IV

## Introduction

The oil and gas aspects of China's energy rise have garnered much attention in recent years, distracting observers from the larger driver of resource consumption in China: electricity generation. Electricity powers China's national economy and is significant both in terms of the scope and scale of natural resources consumed and the externalities produced (domestic as well as international). More importantly, the power generation phase of the electricity industry has undergone significant reform in recent years and therefore serves as a useful case study of the larger development and governance challenges that shape China's energy decisions. Electricity in China is in many ways a success story, proving that formal decentralisation and top-down corporatisation, mixed with *de facto* liberalisation, can produce rapid growth in output and slow diversification into progressive fuels. The industry also reveals a darker side to such growth: expansion at the expense of much needed ownership reform, negligible environmental enforcement capacity, and a lack of corporate activity oversight by central regulatory authorities. This paper seeks to make three central points: (a) at the national level, energy governance in China is fragmented, incoherent and dominated by *de facto* decisions at the local level;<sup>1</sup> (b) at the industry level, dramatic capacity expansion has taken place and greatly diversified ownership rights; and (c) at the firm level of power production, hybrid corporate energy actors are emerging, born from partnerships between traditional electricity firms and nuclear, non-traditional, and upstream resource firms seeking to hedge against rising fuel costs and to 'diversify around' disjointed central price controls.

The unwieldy web of interests shaping China's energy signature is, in form, nothing new—centre and locality tugging at one another for resources and authority—but in substance is a departure from the past. Long-term investment decisions in fuel choice and technology, which will remain in place for decades, are now being made at an unprecedented pace and scale by an array of local actors and regulated by a fractured and diminished central bureaucracy. For example, Chinese government sources estimate that approximately 120,000 megawatts (MW) of electric capacity currently in the process of installation has not received approval from Beijing and is therefore illegal—capacity greater than that of Germany's national grid, the largest in the European Union (NDRC 2006; Merrill Lynch 2005). Such estimates are corroborated by provincial level evidence. Similarly, even after the

current wave of flue gas desulphurisation equipment is fully installed in China's power plants, only 5.4 per cent of total thermal capacity will have been treated (NBS 2005: 102). How does one make sense of such figures and what are the governance implications? The current policy challenges evident in China's electricity industry are most clearly understood in the context of larger institutional changes within the energy sector itself.

### **National level: splintered institutions**

Energy policy in China today is a battleground of negotiation among powerful actors with conflicting interests. Within the central government itself, regulatory bodies such as the State Electricity Regulatory Commission (SERC) and the pricing bureau of the National Development Reform Commission (NDRC) seek to strengthen competition by maintaining high numbers of energy firms in industries such as power generation. In contrast, other central agencies, such as the State-owned Assets Supervision and Administration Commission (SASAC), aim to maximise returns on assets by encouraging the consolidation of existing firms. Conflicts of interest between central and local governments are perhaps more obvious. Sub-national government leaders, eager to maintain or increase economic output and thus advance their political careers, often aid in the financing and under-reporting of power production capacity expressly forbidden by the central government. Interests between local government actors diverge as well, with more efficient, large-scale networked power production often stymied by dispatch discrimination among grids, local governments building protected smaller plants for higher tax revenue, and an unwillingness to depend on other localities for sources of energy.

The electricity landscape in particular has changed dramatically in the past five decades, reflecting an ongoing struggle both within Beijing and between core 'lifeline' (命脉) state-owned enterprises (SOEs), the central government, and sub-national governments. On the success side of the reform ledger, the nation's power monopoly has been disbanded. The generation assets of the State Power Corporation (SPCC) have been redistributed into several partially competing corporations while its transmission assets have achieved an unprecedented level of consolidation into two major grid corporations. A regulatory body—SERC—has been established and in May 2006 was strengthened through legislation detailing its rights and powers.<sup>2</sup> However, challenges remain. The process of separating ownership of state energy assets from operational authority remains incomplete, regional wholesale market reforms stymied, pricing regimes either preferential or entirely opaque due to local manipulation, and separation of transmission and distribution networks deferred. Moreover, newly established and proliferating corporate actors are now governed by understaffed, under-funded and conflicting regulatory entities, rendering a consensus on reforms elusive. These challenges

weigh heavily on the minds of the corporate actors that are the main investors in the industry. A recent survey of energy executives in China revealed that 88 per cent of respondents believed that ‘full-functioning wholesale price competition’ will not be a reality until after 2009, while 62 per cent predicted that unbundling transmission and distribution assets would take longer (Capgemini 2006: 6).

The resulting institutional evolution of energy oversight in China is an alphabet soup of line ministries built and destroyed, firms merged and torn apart, and supra-institutions effectively stillborn. Current institutional dynamics are greatly shaped by two core aspects of this evolution. The first aspect has been the persistently abbreviated nature of attempts to centralise energy supervision, resulting in poorly delineated responsibilities and control rights between multiple regulatory entities and between such entities and corporate actors. Second, this dispersed and localised governance system has encouraged the rise of a new form of organisation—the energy corporation—an innovation that enjoyed the support of the central government yet has also complicated further reform efforts in the context of weak regulatory enforcement. As a result, the central government’s capacity to monitor, regulate and guide long-term investment and output has weakened over time, while local actors have proliferated and now engage in critical infrastructure decisions.

### **Centralisation as myth**

Energy institutions have followed a tortuous path in China, characterised by overlapping jurisdictions and inconsistent waves of authority centralisation and decentralisation. While an exhaustive historical review of China’s energy policy is beyond the scope of this paper, a brief institutional discussion of the four key centralisation initiatives conveys the splintered nature of such governance.<sup>3</sup> Tellingly, Beijing’s first attempt to centralise energy oversight proved short-lived. Between 1953 and 1955, the recently established central government created the Ministry of Fossil Fuels (MFF) to combine the coal, electricity and petroleum industries into one organ for energy policymaking, allocation, planning and development. By 1955, the need for specialisation and the growth of energy demand quickly led to the abolition of the MFF and the formation of separate ministries for electric power, coal and petroleum.

A consolidation trend then ensued during the early phases of the Great Leap Forward (GLF), with the rapid expansion of small-scale hydropower capacity, growing impressively from 400 units in 1957 to over 9,000 in 1960 (Xu 2002: 85). By 1961, the disastrous economic results of the GLF and declining hydropower output effectively curtailed the centralisation movement. Consolidation strengthened again, however, through the Cultural Revolution, and in 1970 the Ministry of Electric Power and the Ministry of Water Resources Utilisation were combined to form the Ministry of Water Resources and Electric Power.<sup>4</sup> In

1980 a second attempt at comprehensive administrative centralisation created the State Energy Commission, which never received dedicated staff, an independent base of operations, or funding, and whose creation qualified ‘as one of the major non-events of 1980’ (Fingar 1987: 207). Previously existing agencies continued to operate as before, and the commission dissolved two years later amid a proven inability to raise the capital necessary to support sufficient power generation for the burgeoning national economy.

The need for capital financing and advanced technology acquisition for power generation encouraged the proliferation of local energy actors during the mid- to late 1980s, discussed below. Such a trend necessitated, in the eyes of many conservatives, a movement to reassert Beijing’s authority, and by June 1988 the third centralisation phase moved to abolish the ministries of Petroleum, Water Conservancy and Power, and Coal Industries, and to form the Ministry of Energy (MOE). This new ‘super-ministry’ soon followed in the footsteps of its predecessors, suffered from internal competition and dissension, and was disbanded less than five years later, in March 1993. By the mid-1990s the central administration of the energy sector—and the power industry in particular—was performed by disparate entities, including, but not limited to, the State Development and Planning Commission (SDPC), the State Economic and Trade Commission (SETC), the Ministry of Geology and Mineral Resources, the Ministry of Electric Power, and the Ministry of Coal Industry. In 1998, as part of a government-wide restructuring of industrial policy in the ‘pillar industries’ of energy, transportation, and telecommunications, the Ministry of Coal Industry and Ministry of Electric Power Industry (MEPI) were abolished and the State Administration of Coal Industry (SACI) was formed under the SETC, granting provincial governments operational management over coal mining enterprises and power projects of larger scale.

Significantly, central government capacity in the form of personnel, dedicated funding and institutional structure contracted considerably during this critical reform period. In 1998 the 40 ministries overseeing China’s growth were reduced to 29, with many employees transferred to SOEs, research institutes, quasi-private firms, or simply laid off. The reforms affected over 33,000 central government personnel and in total laid off more than four million government employees (Luo 1998; Li 2000: 122). Power struggles between the SDPC and the SETC ensued, and by February 2001 the SACI and coal, power, and other administrations under the SETC were closed, as were most of their provincial, prefectural, and county counterparts. In March 2003, the SETC itself was abolished and the majority of its functions transferred to the SDPC, then renamed the National Development and Reform Commission (NDRC). Immediately prior to this major realignment, the nation’s first independent regulator for the power industry was established: the State Electricity Regulatory Commission (SERC). The emergence of this unprecedented, arm’s-length body heralded what many

scholars have termed a new era of the ‘regulatory state’ in China and the launch of the fourth great centralisation drive.<sup>5</sup> Indeed, one such scholar has recently argued that ‘the most recent round of bureaucratic restructuring in March 2003 strengthened the state’s efforts to maintain authority over strategic assets’ (Pearson 2005:304–305).

Despite the seeming victory of final consolidation, however, parallel energy structures have proliferated. At the central level, the recently established State-Owned Assets Supervision and Administration Commission (SASAC) claims nominal ownership rights over, and bears responsibility for, the management and disposal of certain state-owned assets (including merger and acquisition approval and other energy asset restructuring). The commission also has input into personnel movements concerning individuals of vice-ministerial rank and below. Energy policy research currently falls under the auspices of the Energy Bureau, part of the newly created umbrella organisation named the State Energy Administration (SEA), while energy pricing authority is exercised by the Pricing Bureau; both were established within the reconstituted strategic and long-term economic planning agency, the NDRC. The State Environmental Protection Agency (SEPA) enforces environmental standards and compliance by energy firms, while resource extraction rights, operation management, and conflict resolution responsibilities are largely shared by the Ministry of Land and Resources (MLR), the Ministry of Water Resources (MWR), and the State Administration of Coal Mine Safety (SACMS). In the spring of 2005, a National Energy Leading Group (NELG) and State Energy Office (SEO) were established, with the SEO technically housed within the NDRC but, surprisingly, separate from the State Energy Administration. The group was established to provide direct leadership guidance related to national energy security policy and strategy, while the office was designed to execute such strategy through the management of the disparate energy institutions distributed throughout the government apparatus.

To complicate matters further, institutions that are now defunct at the central level, such as the SETC itself, the Ministry of Coal Industry and the Ministry of Electric Power, still play critical, yet conflicting and inconsistent roles, at the local level. The sub-national offices of these institutions are present in some provinces, such as coal-rich Shanxi, yet absent in others. Local economic and trade commissions and coal/power industry management bureaus are responsible for a range of duties, including local implementation of industry policy; power plant construction approval; coal industry planning; reviewing, approving, and issuing coal production licences; and the issuing and reviewing of mine directors’ certification (UNDP and World Bank 2004:5). Power plants, coal mines and other energy actors are often bewildered by the constant churn of bureaucracy and labels, and at times even local government officials are unaware of new offices to which they supposedly must report on a regular basis.<sup>6</sup>



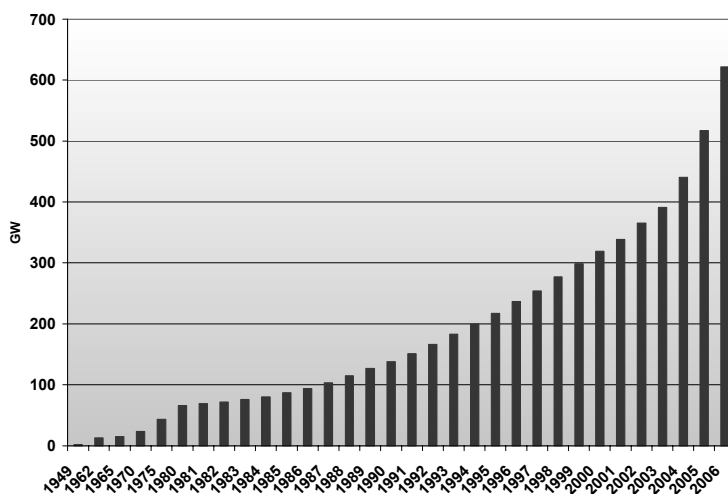
## Rise of the corporation

As described above, while several waves of separation and merger affected the sector throughout the 1970s, the 1980s provided an opportunity for the new, reform-oriented leadership to begin the process of removing government from enterprise work and the business of controlling energy production. The energy corporation initially served as a vehicle to resolve increasingly blurred rights and claims between central and local control over energy assets, and also to attract foreign technology and financing to develop domestic resources under tight credit market conditions. As Figure 10.1 shows, rapid increases in electricity capacity began in the late 1980s, after expansionary economic reforms, and averaged a respectable 15,000 MW of annual additional capacity through the 1990s.<sup>7</sup>

More recently, total generating capacity increased by nearly a third between 2003 and 2005 and is expected to double between 2002 and 2007.<sup>8</sup> While such capacity increase is laudable, the growth and creativity of such firms have also proven to be a source of friction in the governance of the sector.

In 1985, the China Huaneng Group (CHG) was formed to import foreign electricity generation technology, increase electricity generation investment, and promote international trade. Huaneng's first chairman and president were both former vice-ministers and the corporation initially operated under the State Council's Finance Office (Xu 2002:101). In

Figure 10.1 Installed capacity increase, 1949–2006



Source: Pu et al. (2004: 12–13); Xu (2002): 37; <www.drcnet.com.cn>, accessed July 27, 2006.



addition, the Ministry of Nuclear Industry transferred its formal administrative capacity to the new China National Nuclear Industry Corporation. The corporate reforms were strengthened through deregulatory legislation, such as the crucial ‘Provisional Regulations on Encouraging Fund Raising for Power Construction and Introducing Multi-Rate Power Tariff’ in the same year (Zhang 2003:9). This regulation diversified sources of finance for power generation, opening access to private and foreign firms, as well as sub-national government enterprises.

Before this reform in 1985, there was no cumulative foreign investment in China’s power industry. Huaneng Power International, Incorporated (HPI) was established in June 1994 and in October of the same year listed on the New York Stock Exchange, issuing \$1.25 billion in American Depositary Receipts.<sup>9</sup> By 1995, over 40 power investment companies had begun operation, forming what has been characterised by some scholars as ‘a group of independent power producers (IPPs)’ (Xu 2002:127). In January 1998, HPI was listed on the Hong Kong Stock Exchange and in November 2001 the company successfully issued A-shares in the domestic market. By 2002, 13 per cent of the total investment in the Chinese power industry was foreign (Pei 2005: 11).

The rise of these corporations marked an important break from past governance patterns, and represented a new model of both interacting with the rapidly evolving global energy market outside China’s borders and also attracting the financing and technology necessary to harness the energy potential within the country. This need was articulated in a 1994 Ministry of Electric Power plan: ‘China can fulfil about three-quarters of the new business [which includes rehabilitation programs for existing plants] internally, leaving \$25 billion for foreign suppliers; such help will be welcomed, provided it is accompanied by foreign finance’ (Huang 2003, cited at p.13 of Woo 2005). The emergence of corporations also marked a critical step in the ‘marketisation’ of China’s infrastructure—a sector that had until that point remained one of the prominent bastions of state control. As one scholar has noted, corporate involvement ‘fundamentally changed expectations about electricity—power was now regarded as a commodity to be bought and sold on the market, rather than allocated by government’ (Xu 2002:126).

Corporations such as Huaneng (in the electricity industry) and China National Offshore Oil Corp. (in the petroleum industry) proved quite effective at building partnerships with foreign financial institutions and creating the financial foundation for rapid expansion in China’s energy capacity. The prominence of electricity firms in this crucial stage of policy and economic reform is reflected in the fact that six of the original 22 SOEs approved by the State Council to issue shares in overseas stock markets hailed from the power industry.<sup>10</sup> Three years later, in March 1997, another power firm—Beijing Datang Power Generation Corporation—became the first Chinese firm to list in the London Stock Exchange. By

December 1996 the State Power Corporation had been established, and by March 1997 MEPI had been transformed into the Department of Electric Power within the SETC, with a staff reduced to fewer than 20 people. This reorganisation served to separate production, including both generation and distribution, from regulatory functions. In 1999 the China National Nuclear Corporation (CNNC), which managed the country's nuclear power sector, was also split into two separate firms. One firm focuses on resource extraction, nuclear processing for civilian and military use, waste treatment and safety, while the other remains responsible for the construction and execution of nuclear power plants.

In addition, the corporation emerged in part as a means of organising productive assets and property rights. The proliferating and diffused government entities discussed above claimed ownership over financial stakes in SOEs that overlapped and that were often illegitimate and at odds with one another. The logic of corporatisation stemmed from 'its ability to specify ownership rights and to legally separate enterprise from state administration' (Xu 2002:100). The 'Company Law', which was passed on 29 December 1993, served as the primary legal framework to identify claims over liabilities and assets of the rapidly diversifying economy, and to regulate formal decision-making powers at the firm level in an effort to make firms more independent of political influence. In fact, Articles 3 and 4 clearly state that the liability and rights of shareholders of a firm are in proportion to their capital contribution to the firm. Moreover, Article 7 explicitly states that SOEs under reorganisation to corporation status must 'identify and verify' the firm's assets and 'determine the respective owners of the property rights therein, and settle its creditor's rights and liabilities'.<sup>11</sup> The law therefore provided an opportunity both to re-evaluate the nest of outstanding claims against many SOEs in the energy sector and to begin the process of removing party political actors from the daily management of firms.

Electricity generation in particular witnessed significant restructuring. In 1998, after two years of operation, the SPCC had earned a mere RMB7.01 billion in profits, based on sales revenue of RMB260.64 billion (Miller 2000: 10). As a result of such poor performance, in 2003 the SPCC, which controlled 49.5 per cent of installed capacity, was broken up into five major generation companies. Additionally, 6,470 MW of installed capacity was transferred to the State Power Grid Company for eventual sale in an effort to finance power grid development, and 9,200 MW was assigned to another firm to cover non-core business expenses (Woo 2005: 9). These five parent companies are what Barry Naughton describes as a 'middle layer' between the fully corporatised, usually listed companies, and the national government. These firms, he argued, are quite autonomous:

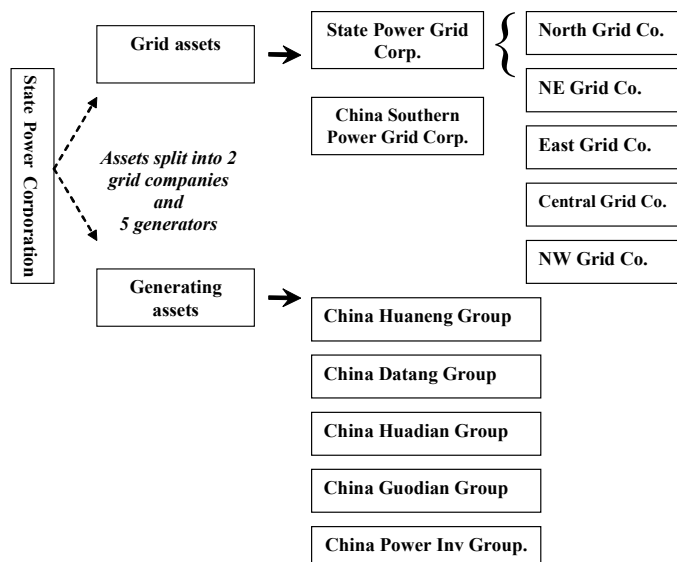
Dividends are paid up to this middle layer, which currently has the authority to control and reinvest these funds...since the middle-level firm still controls both the profitable and

unprofitable firms, the middle-level firms often operate with enormous discretion. These firms were carved out of the ministries during early rounds of reform [and therefore] have strong networks of cooperating bureaucrats and officials.<sup>12</sup>

The mobilisation of corporate resources also heralded a massive reduction in the state’s capacity to monitor the activities of these new actors. Moreover, the state did not redeploy its resources to guide energy investments at the firm level. Philip Andrews-Speed (2005:17) captures this process well, observing:

‘[i]n the past, the leaders of the major state-owned energy companies were able to play a major role in determining the policies and plans for their individual industries. Progressive corporatisation of these companies has reduced the power of these executives to influence national policy to a great extent, but the capacity of government to lead has not been enhanced in a commensurate way. Indeed, with more players in the sector, the government’s ability to manage the energy sector has actually diminished.’

Figure 10.2 Power sector assets after reform of 29 December 2002



Source: Author’s compilation.

Naughton (2006:4) also recognised the migration of energy decisions to the firm level, writing:

‘Particularly following the revival of state sector profitability, some of these organisations are extremely rich and powerful. The state companies under central SASAC’s purview include, for example, the State Electricity Grid and the big electric power-generation companies, some of the biggest and least transparent companies in China, and military-linked companies like Baoli and the Nuclear Industry Corporation... This middle layer of the state economy is the least transparent... part of the state economy... a ‘middle layer’ of companies and organizations in between the fully corporatised and often listed companies, and the national government.’

Such diffusion of activities and levels of actors in the energy field spread rapidly, indeed so rapidly that it has elicited a raft of reactions from Beijing—characteristically piecemeal reactions, however. One of the clearest responses was institutional. SASAC was created in 2003 in an effort to centralise Beijing’s ownership rights over 196 SOEs involved in sectors considered critical to the national economy such as energy, telecommunications, and natural resources. SASAC was granted status equivalent to that of a ministry, revealing the political capital the central government has invested in the effort. Such institutions have also taken action. Recently, Li Rongrong, Chairman and Party Secretary of SASAC, has led an aggressive series of initiatives to expand the authority of the commission. Today SASAC is seeking to reform its scope officially and to exercise partial rights to firm profits and direct personnel management. Total profit for these firms increased by approximately 40 per cent annually in the period 2003–06, and in 2005 SASAC’s portfolio of firms earned RMB628 billion, equalling 3.4 per cent of China’s GDP Naughton (2006: 2). Clearly discontented with the erosion of central authority over nominally state-owned firms, on 14 April 2005—less than two years after its inception—SASAC issued a temporary but comprehensive regulation prohibiting management buyouts (MBOs) within state-owned enterprises.<sup>13</sup> The legislation was passed as a stopgap measure of sorts, mostly to prevent the further quasi-privatisation and opaque diversification of ownership over such vast and productive assets that have proven central to the economy’s growth.

### *Industry level: investment diversification and capacity drives*

The fragmentation of energy governance and the emergence of energy corporations have been accompanied, at the power industry level, by gradualist policies that have transferred

resources and decision-making powers to sub-national actors. Such a process has unleashed considerable growth, as documented below, and has also (a) weakened sources of central regulatory authority (loans, financial penalties, inspection oversight); (b) blurred lines of ownership and responsibility of firm assets; and (c) produced an uncoordinated liberalisation of upstream and downstream prices in the power industry, creating a largely market-responsive coal sub-industry and a rigid wholesale, transmission, distribution, and retail electricity market.

While central energy institutions continue to rise and fall in Beijing, corporate and sub-national actors on the ground build capacity at a frenzied pace. The output in electricity exceeded even the high-end scenarios of international energy experts as well, as evidenced in Figure 10.4. Chinese coal production doubled between 1990 and 2005, and grew by 17 per cent in 2004 (Zhongguo 2004:64). Firm-level coal statistics reflect similar expansion. The number of non-contract coal firms increased by over 18 per cent between 1999 and 2004, while those firms operating with a deficit declined dramatically, from 885 in 1999 to 363 in 2004 (Zhongguo 2004: 79). Downstream, China generated approximately 1,106 TWh of incremental electricity in the past five years alone, nearly equal to the total world increase in 2003 and 2004 combined (IEA 2004:193). Electricity generation grew at a rate of 15.2 per cent in 2003, 14.8 per cent in 2004, 12.3 per cent in 2005, and 11.8 per cent in the first quarter of 2006.<sup>14</sup> In 2005, about 70,000 MW of new generating capacity was brought on line, producing a total of 2,469 TWh of electricity.<sup>15</sup> At this rate, China is adding well over one 1,000-MW plant a week and the equivalent of nearly the entire Spanish national power grid annually. At the time of writing, the current pace and scale of building was on track to add

**Figure 10.3 China's coal-fired power plant construction, 2000–05**

Year	Units commissioned	Capacity (MW)
2000	39	13,685
2001	47	11,775
2002	22	6,550
2003	91	31,110
2004	144	36,700
(2005)	(Legally under construction)	87,150

*Source:* NDRC (2006); APERC (2004). 'Energy in China – Transportation, Electric Power and Fuel Markets', Institute of Energy Economics, Japan, 2004 p.57, ([http://www.ieej.or.jp/aperc/pdf/China\\_COMBINED\\_DRAFT.pdf](http://www.ieej.or.jp/aperc/pdf/China_COMBINED_DRAFT.pdf)).

**Figure 10.4** Sample projections of electricity generating capacity (GW)

Year	High estimate	Mid-range estimate	Low estimate
2003	436	356	312
2004	470	376	326
2005	507	398	340
<b>2006</b>	<b>547 (actual: 508.4)</b>	<b>422</b>	<b>355</b>
2007	590	447	370
2008	636	473	386
2009	686	501	402
2010	739	530	420

*Source:* Li, Binsheng and James Dorian (1995) 'Change in China's power sector', *Energy Policy*, 23 (7): 621.

another 75,000 MW by the end of 2006 and maintain a 70–80,000-MW annual increase through 2008. Beijing had already approved 141,000 MW of planned construction for 2006, 67,000 MW for 2007, and was well on its way to accounting for over a quarter of global capacity increase through 2030 (NDRC 2006).

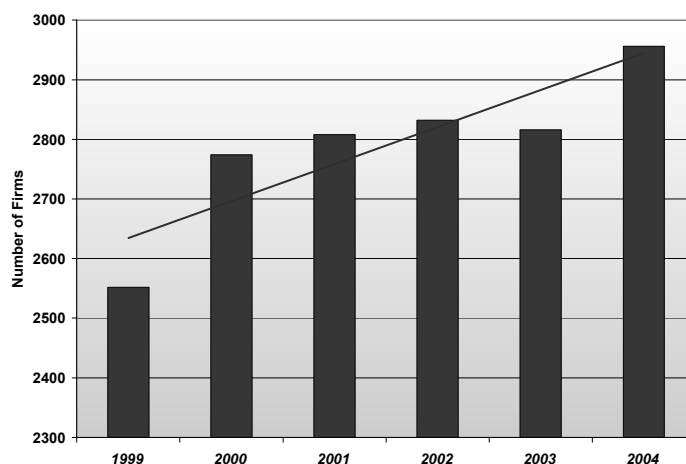
### Electricity reform

Formal financial reform of the power industry began in 1981 with the passing of legislation that transformed direct state funding of power plant construction into loans from state banks. Price reform deepened considerably by 1985, and was highlighted by the promulgation of the 'Provisional Regulations on the Encouragement of Fundraising for Power Construction Investment and Implementation of the Multi-Rate Power Tariff'. This battery of reforms increased wholesale prices and diversified sources of finance by permitting sub-national government entities to invest, in an effort to encourage investment through three main mechanisms. To attract new investors, the reforms raised the wholesale tariffs paid to the power producers and introduced a pool purchase price (PPP) to a 'cost plus' formula that guaranteed a 12–15 per cent rate of return for newly invested plants. In addition, an RMB0.02 fee was added to the end-user retail prices nationwide to raise capital for the newly established electricity construction fund. Lastly, a wide range of special fees and charges, such as the 'fuel and transportation surcharge', were also allowed by 1986; they were collected by the state and local governments to finance various projects such as the Three Gorges hydro project and the coal for oil substitution project (Zhang 2003: 9). Such reforms therefore diversified ownership, diluting the central government's monopoly hold on generation assets, and also

introduced sufficient sub-national funding to increase generation capacity and largely solve the power shortages of the 1980s and early 1990s.

The year 1996 witnessed a raft of new laws that brought legal, if not regulatory, clarity to the power industry. The Electricity Law was passed and allowed non-state entities to participate in the generating sector, while also furthering the separation of regulatory and ownership functions of power producers. Between 1998 and 2002 subsequent legislation revised and clarified regulatory changes designed to separate generation and transmission assets formally, split generation and transmission pricing, launch small-scale market power pooling trials and elaborate future reform objectives.<sup>16</sup> These objectives included (a) the formal separation of generation from transmission in terms of ownership and regulation; (b) the establishment of new pricing mechanisms to internalise environmental costs more effectively; (c) the creation of competitive regional markets for the dispatching of generators; and (d) the development of market-oriented pricing mechanisms throughout the power value chain, from generation to transmission, distribution, and retail pricing (Steinfeld 2004). Such liberalisation on the generation side of the ledger has clearly resulted in a growing number of market entrants, as reflected in Figure 10.5. Cross-subsidisation through price discrimination still plagued the sector however. For example, in 2002 the average rural price for electricity was RMB0.66/kWh, compared to an urban average of RMB0.44/kWh. The largest differential between regions reached RMB0.264/kWh.<sup>17</sup>

**Figure 10.5 Growth in number of power producers**



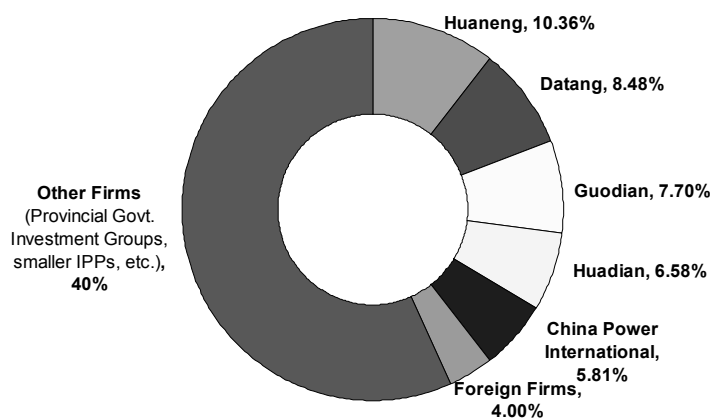
Source: Capgemini (2006) 'Investment in China's demanding and deregulating power market', Energy, Chemicals and Utilities Unit: 21.

These reforms have diversified the structure of ownership between different levels of government. As reflected Figure 10.6, the term ‘state-owned’ is much more ambiguous than in the past. In fact, the ‘Big Five’ power producers own less than one-half of power generated in China. A dense constellation of local and regional government actors extends deep into the power generation sector, including provincial government investment funds, local government SOEs, grid and subsidy groups, and nuclear power firms. Many have considered the rapid increase in power production capacity particularly remarkable because such growth has occurred through the investment decisions of state-owned entities, often considered slow-moving and inefficient. Indeed, the presence of private and foreign-invested plants peaked in 1997 at 14.5 per cent of total installed capacity and has now dropped to 3 to 4 per cent, with the rest falling into the hands of government entities at various levels (Capgemini 2006: 21). However, this statistic masks the amount of diversification that has taken place in the generation industry.

### Ownership diversification

The proliferation of power firms mirrors the diversification of ownership that resulted from such reform, as financing and construction authority continued to decentralise and weaken central levers of oversight. The great expansion of power that began in the mid-1980s through

Figure 10.6 Ownership structure of generation production (kWh), 2005



Source: Author's estimates and Zhongguo (Zhongguo jingji jingqi jiance zhongxin) (ed.) (2006) *China's Industrial Map: Energy*. Beijing: Social Sciences Academic Press (Zhongguo chanye ditu – nengyuan 2004-5, Beijing: Shehui kexue wenxian chubanshe), 2006, p. 134.



the reforms discussed above also heralded the relative decline of central funding for such expansion. For example, between 1980 and 1994, 'the annual growth rates of both power generation and installed capacity averaged more than 8 per cent, while between 1980 and 1992, the share of central government investment in total power sector investment decreased from 91 per cent to 30 per cent' (Li and Dorian 1995: 625). The central government provided nearly half of power industry investment during 1985–90. In the following five years, however, between 1991 and 1995, only one-third of investment funds flowed from the central government. Financial levers of influence have clearly narrowed. In the same period, local sources accounted for 42.9 per cent of the total. The third largest category of investment was foreign, equalling 9.9 per cent. Moreover, the variation across regions was considerable, from central funds dominating provinces remote areas such as Tibet (at 98.7 per cent) to contributing insignificantly to the powerhouse Guangdong market (at 3.5 per cent). (Xu 2002:173) Statistics for the Southern Grid reveal both the progressive efforts of local government to meet rising power demands and the necessary freedom from central guidance that the region enjoyed in order to succeed. Foreign investment shares were highest in Guangdong and Hainan (23.2 per cent and 21.7 per cent respectively), as were local government investments (54.1 per cent and 41.7 per cent) (Xu 2002:173).

Expansion strategies and recent comments of firm executives reflect this growth of firm-level financial autonomy. China Datang Group's Vice-Chairman, Zhang Yi, remarked in 2003 that he remained unconcerned about rumours that bank lending would tighten after Beijing removed RMB150 billion from the money supply by directing commercial lenders to keep more of their deposits with the People's Bank of China. He reasoned: 'All in all, we have some 100 billion yuan of facilities. While more than 20 billion yuan would be needed to fulfil the firm's 2006 production goal ... [we] would need to invest only about RMB13 billion, as many projects were owned along with multiple partners' (Ng 2003: 1). Similarly, China Power Investment Group is currently pursuing an internally financed 'Three, Three, Three' development plan whereby generation capacity is planned to triple by 2009. The firm hopes to acquire about 3,000 MW of plants from its parent in the next year or two and build more than 3,000 MW of new plants by 2009.

In addition, penalty enforcement and construction oversight have suffered dramatically. Illegal power generation capacity has become a major concern for regulators, particularly those responsible for grid safety, environmental protection, and market supervision. On 18 January 2005, SEPA Deputy Director Pan Yue announced a crackdown against illegal plants covering 13 provinces, citing the safety, health and legal implications of rapid power growth. At 120,000 MW, the sheer size of capacity lacking central government approval is staggering, but the composition of 2004 illegal construction is more revealing. First, while most observers blame small-scale operators for the vast majority of off-plan

capacity, close to one-half of the plants were built by the big five SOEs, with Datang and Guodian producing the majority. Second, the distribution of such activity is surprisingly concentrated; over one-fourth fell in Sichuan province. The other areas of lesser concentration were the coastal areas of Jiangsu, Shandong, and the Jing-Jin-Tang northeast corridor. Third, approximately one-third of the illegal capacity took the form of plants that came on line ahead of schedule. These were plants that had received permission to produce at a future date and choose to generate regardless NDRC (2006). In Zhejiang province alone, it is estimated that 11,000 MW, equalling the national electricity capacity of Greece, Israel or Chile, is completely off-grid.<sup>18</sup> The central government publicly estimates that Guangdong is home to more than 9,000 MW of small-scale diesel power plants, a figure cited by NDRC Vice-Minister Zhang Guobao in August 2005 (Ng 2005: 4).

Widespread diversification at the local level has also in part led to the proliferation of small-scale generation capacity. Of the legal thermal capacity, 24 per cent is under 100 MW, while the number of 300-MW plants is slowly on the increase, having reached 43 per cent in 2005. Similarly, in 2005 16,880 MW (4.4 per cent) of thermal capacity utilised supercritical technology, compared to Russia, Japan, and the United States, where such technology enjoys rates of over 50 per cent (NDRC 2006). As CapGemini and others have highlighted, in comparative terms China's dispersed ownership structure is anomalous. After 10 years of electricity industry reform, the United Kingdom consolidated its power generators by 2000, with the largest three firms providing close to 50 per cent of supply. In Germany the corresponding figure is 90 per cent. Northern Europe's seven largest firms control 55 per cent of the market while the 10 largest enjoy approximately 50 per cent of the US market (CapGemini 2006:22). In China, perhaps best described as an attempt at 'competition by fiat', no one generator may enjoy more than 20 per cent of any provincial energy market, by legislation. While this reform was designed to weaken the former power monopoly, it has failed to create mature competition, as ownership separation between grid companies and generators has not progressed fully.

### **Blurred rights**

Identification of property rights and control over asset management at the local level have become incredibly complex and contested through this process of decentralisation. A blurring of lines between commercial and governmental has proven to be both widespread and often a direct obstacle to further development of the sector. In 2002, the Ministry of Finance launched an investigation into the mergers and acquisitions of various power-related assets in Chongqing, Shandong and Anhui, as the Sichuan provincial government had failed to spend over 85 per cent of a six-year, RMB8.6 billion power project, mostly due to confusion

over which level of government would be able to claim financial stakes on the final asset. The ultimate report cited ‘uncertainty over ownership’ as a primary cause for such inefficiency (O’Neill 2003:3). Similarly, the investigation revealed that over 113 power firms owned by county governments had been sold in Sichuan and that Tai Yue Real Estate had been able to acquire RMB36.98 million shares, or 21.2 per cent, of San Xia Hydropower. The resulting report went on to explicate how in one county a power company with assets of RMB110 million was sold for a mere RMB6 million (O’Neill 2003:3). By December 2002 the hydroelectric bureau had sent a report to the provincial government requiring the suspension of all such sales.

Another particularly illuminating example of the dangers of decentralised governance and blurred lines of ownership and control is the continued ownership of electricity generation assets by grid companies. In the most recent wave of reform since 2002, intended to ‘separate government from enterprise’ (‘政企分开’) and ownership from operation, grid companies have been ordered to relinquish ownership and sell off all generation capacity. Many, however, have refused to comply fully, in an effort to maintain preferential pricing from ‘in-house’ power plants that they already own. Perhaps the clearest and most egregious example of partial reform was the ‘Ertan incident’. The Ertan hydroelectric power plant, with annual generation of 17 TWh, was jointly invested in by the State Development Investment Company, Sichuan Provincial Power Investment Company and Sichuan Provincial Power Company, with equity contribution of 48 per cent, 48 per cent and 4 per cent respectively. The dam was designed to generate 17 billion KWh of electricity annually—equivalent to about one-third of the province’s annual power supply. The majority of the dam’s output was to be delivered via high-voltage transmission lines to Chengdu, the capital of Sichuan province, and burgeoning Chongqing, a municipality of 30 million people at the upper end of the Three Gorges dam reservoir. Nine additional provinces would receive the remainder. According to the power purchase agreements between Sichuan Provincial Power Company and Chongqing Municipal Power Company, signed in 1998, the contracted offtake amount in 1998, 1999 and 2000 equalled 0.98 TWh, 6.63 TWh and 9.31 TWh respectively.

However, when Ertan began generating power, two important variables had shifted since the start of construction in 1991. On the economic side, the chronic power shortages of the 1980s and early to mid-1990s ended with the onset of the Asian financial crisis and a slowdown of Chinese economic growth. Chongqing, the largest planned customer for Ertan’s power, had agreed to purchase 32 per cent of the output, yet was now less desperate for power (Kynge 2000). The municipality had reduced economic demand, like many other contracted Ertan customers, but also had begun constructing municipally-owned power plants within the city. On the political side of the equation, Chongqing had, during Ertan’s construction, been elevated to provincial status in 1997. This shift not only enabled

Chongqing to refuse political pressure from the Sichuan provincial government to purchase power from Ertan, but also allowed the city to increase utilisation of its own plants—and therefore its own tax sources.

The actual quantity of power purchased in 1998 and 1999 fell far below the contracted amount, registering at 0.75 TWh and 4.984 TWh respectively.<sup>19</sup> Between 1998 and 2000 the dam was producing at 41 per cent capacity, resulting in a loss of RMB1 billion in 1999, and surpassing that figure in 2000 (Hu 2000). According to economist Hu Angang's calculations, the dam lost RMB3.51 billion to RMB6.83 billion in potential revenue. While the Asian financial crisis had adversely affected national economic growth, more importantly Ertan's two largest contracted customers had transformed into its competitors. In the decade it took to build the giant dam, Sichuan province and Chongqing had financed and built their own sizeable coal-fired plants (ranging from 50 to 700 MW) that were able to produce power for less than that produced by Ertan. By 2003, the plant was unable to service its debt, and the \$2.2 billion project was subsequently forced to turn to the Bank of China for a \$396 million loan to repay a portion of World Bank debt and commercial investors.

The Ertan incident serves as a useful example of diminished governance in a network industry such as power generation. The Sichuan provincial government, as well as Beijing, had chosen to rely on political pressure to force a subordinate unit (Chongqing) to honour purchase contracts, rather than regulate small-scale capacity expansion in the region and rely on more market-responsive behaviour. Decentralised generation capacity grew over time, largely through the localised and off-plan investments of the regional grid and municipality, and when market dynamics and political dynamics shifted, the traditional 'governance through fiat' levers no longer functioned and efficiency losses were substantial.

### **Uncoordinated liberalisation: coal market**

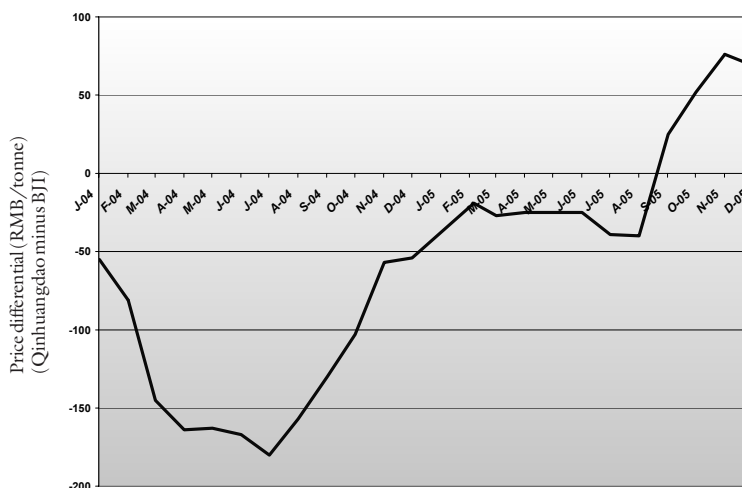
Similar twin processes of decentralisation and diversification have penetrated more extensively upstream, in the coal market. Coal dominates the power production process, and has even increased such dominance in recent years, from 81 per cent of generation in 1999 to 82 per cent in 2004 (Zhongguo 2004:26). Coal prices were partially liberalised in 1984, and were loosened again in the mid-1990s and more fully in June of 2004, yet still remain governed by a *de facto* 'contract' and 'market' dual track pricing system. While initially the contract price was reserved for power plants, reforms in the 1990s allowed progressive marketisation through the organisation of annual price-setting conferences/bargaining sessions between mines and power plants ('订货会'). This price-setting conference arrangement was formally abolished in 2004 but has continued in various forms nonetheless, although contract coal, on average, supplies only about one-quarter of the fuel that plants consume in a given year.<sup>20</sup>

In 2004, the price of Qinhuangdao coal, China’s widely referenced thermal coal benchmark, had aligned rather closely with rising international prices, and by 2005 had begun to exceed Australia’s Barlow Junker index price (see Figure 10.7). Thermal coal prices on the spot market rose 25–30 per cent year-on-year by mid-2004, while contracted prices had increased by less than 10 per cent. However, plant managers interviewed all observed that since 2003 mines have continually renegotiated their prices and failed to deliver coal at the contract price. The domestic media has reported openly about the extent of the problem.<sup>21</sup>

Despite the small volume of ‘contract coal’ that remains as a vestige of the planned economy, mines are expanding and currently taking advantage of the electricity shortage by delivering low grade coal, delaying shipments, and renegotiating contracts with power plants on a regular basis. As illustrated in Figure 10.8, the differential between coal’s cost of production and wholesale price has increased dramatically—expressing the bargaining power of mines in recent years.

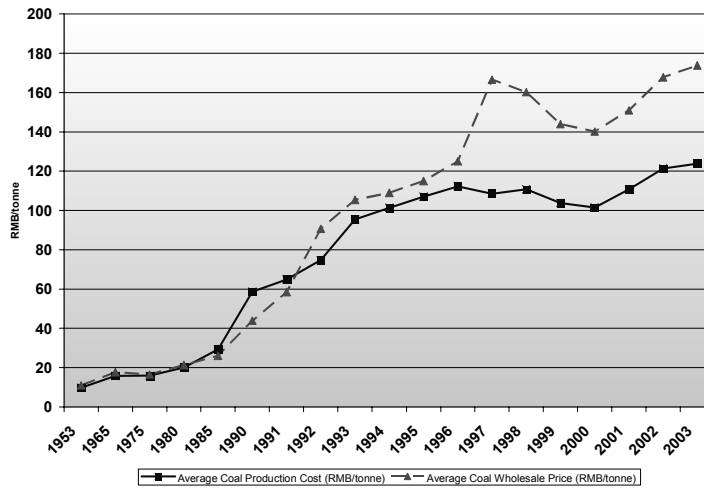
Such trends are reflected in recent profit figures. For example, Yanzhou Coal Mining Company, Ltd, Shanxi Xian Coal Company, Ltd, and Inner Mongolia Coal Company, Ltd all enjoyed total profit increases of 69 per cent, 301 per cent, and 524 per cent between 2002 and 2004 (Zhongguo 2004: 83–87). A fuel procurement executive of one of the largest electricity producers in Taiyuan, capital city of China’s largest coal producing province,

Figure 10.7 2004-2005 thermal coal prices (China ‘Qinhuangdao’ vs Australia ‘BJI’)



Sources: Zhongguo (Zhongguo jingji jingqi jiance zhongxin) (ed.) (2004) *China’s Industrial Map: Energy*, Beijing: Social Sciences Academic Press:74; 2006 edition: 90)

Figure 10.8 Average coal production cost and wholesale price, 1953–2003



Source: *China Electric Power and Coal*, Beijing: Coal Industry Press: 243 (2004).

complained bitterly of his plant's lack of leverage vis-à-vis coal supply. He explained how coal prices fluctuated by 20 per cent or more throughout 2005, despite concluded contracts, making them far more volatile than the underlying market dictated. While all plants are required to maintain a fuel reserve of preferably 2–3 weeks, his plant has at times operated with fewer than five days of coal reserve.<sup>22</sup> In the early months of 2006, such widespread alleged 'price gouging' by mine concerns led to an unprecedented level of bargaining solidarity among their clients—power producers. The major power firms refused to conclude contracts at the higher prices, and contracts signed at the 10-day coal procurement conference in early January 2006 amounted to a mere 8 per cent of projected total coal requirements.<sup>23</sup> This producer 'united front' (统一战线), as some labelled it, created considerable tension in the industry, as full price negotiations endured long past the 28 February deadline set by the NDRC. The NDRC was clear that it would not interfere in the process, and some contracts were not concluded until well into April. The coalition of producers has proven to be just one of many strategies power firms have adopted to navigate the disjointed reform landscape.

### Firm level: four strategies of diversification

At the firm level, power producers are faced with considerable sources of uncertainty created by such reforms. Most importantly, they are grappling with the results of partial reform: the

rising input costs of a largely deregulated coal market and the stable output prices of a largely regulated power retail market. Electricity generation demands a little over half of all coal consumed in China, having risen from 22 per cent of total consumption in 1988 to over 53 per cent in 2002 (Pu et al. 2004:309). Coal currently accounts for about 80 per cent of China's electricity generation, more than 50 per cent of industrial fuels and about 60 per cent of chemical feedstocks, and demands over 45 per cent of national railway capacity.<sup>24</sup> Such a situation is not likely to change dramatically. The largest contributor to future growth in China's demand for coal will be the electric power sector. In 2004, average power coal prices rose 41.7 per cent for contract coal and 100–150 per cent for new orders, while the price of on-grid electricity rose by an average of merely 4.5 per cent (Capgemini 2000:7).

Such cross-pressures have quickly registered on the accounting books of the major power generators. In 2005 a 19.7 per cent rise in coal cost per unit of power generated was largely to blame for Datang's meagre 2.6 per cent increase in net profit despite a 27.1 per cent jump in generation volume.<sup>25</sup> Similarly, for Huaneng, coal costs accounted for about 56 per cent of the firm's total operating costs in 2005. With Huadian Power's unit coal cost up 25.7 per cent last year, net profit rose only 2.0 per cent despite a 25.5 per cent increase in generation volume. Coal accounted for over 64 per cent of the firm's operating expense. These pressures, created by the collision of deregulated fuel markets and regulated power markets, were of sufficient scale to concern the central leadership. On 1 May 2005 Beijing announced a mechanism allowing, in theory, power producers to pass on 70 per cent of cost increases when coal prices jumped more than 5 per cent in a given six-month period. The pass-through did not occur, revealing Beijing's unwillingness to expose retail prices to market conditions, and the NDRC delayed such a review indefinitely when it came due in November 2005, despite further coal price rises. Under such circumstances, coal producers have reaped considerable rewards, with China Shenhua Corporation posting a 75 per cent jump in net earnings to RMB15.63 billion in 2005, on the back of a 13 per cent growth in coal sales volume and a 24 per cent increase in average price (Ng 2006:2).

### *Upstream integration*

So how are power firms negotiating this complex environment of weakened central oversight, supply risk, rising fuel costs, multiplying commercial/government actors, and proliferating local actors? Producers are pursuing a range of equity strategies, as the playing field remains uneven in terms of geography, terms of and access to loans, and distance to market and fuel source. Such inconsistency becomes all the more evident when one considers recent cost estimates. Datang Power reported that its unit coal cost had fallen 1.59 per cent year on year in the first half of 2006. This compared with Huaneng Power International's 26 per cent rise



in unit fuel cost in the first half of the year and a 13 per cent rise at Huadian Power International (Ng 2004: 3). As a result, power producers are engaging in an intriguing patchwork of equity strategies in an effort to diversify their exposure to rising fuel costs and an uncertain regulatory environment. These strategies can be classified into four central categories of investment: (a) upstream integration, through the purchasing of stakes in resource suppliers; (b) creation of new resource firms and hybrid suppliers through merger or acquisition; (c) use of outward foreign direct investment to control foreign sources of fuel; and (d) diversification of plant fuel through acquisition of existing and greenfield power plants utilising renewable, non-traditional, and new technology fuel sources. All strategies have altered dramatically the role of traditional energy supplier and are beginning to integrate comprehensively the energy value chain.

Higher wholesale prices, and, perhaps more importantly, volatility of supply and quality of fuel, have led power producers to enter the power industry upstream through equity stakes in large coal mines, uranium mines, and water access rights. One industry executive explained the upstream strategy through a simple analogy, stating that negotiating prices with China's coal mines in recent years resembled the process of taking a car into the repair shop: 'the mechanic can pretty much tell you anything, and hand you a bill for whatever amount he so chooses. Purchasing upstream assets allows us to open up the 'hood' and understand the underlying dynamics of the mining business'.<sup>26</sup> While this explanation reveals one reason for integrating upstream—addressing information asymmetry between the power producer and the mine—the strategy also affords an opportunity to internalise security of supply risk and to mask cost and profit structure from local and central authorities through internal accounting innovations.

Datang has proven to be the most aggressive in integrating the upstream value chain, largely through equity ownership. Indeed, the firm has included a self-described 'transformation' strategy into its most recent annual report. The Chairman writes:

'The transformation of the Company's business structure from purely power generation business to the development of integrated power [allows the firm] to (1) lock the upstream and downstream resources, secure the sustainable development of power generation business, (2) reduce sector risks by integrating resources and forming business chain and (3) support the Company's development by creating new profit base for the Company.'<sup>27</sup>

To this end, in 2005 Datang executives announced a goal of sourcing half of total coal requirements from Datang-invested coal mines, and earmarked 10 per cent of its 12.39 billion



capital expenditure for 2006 and 2007 to be dedicated to coal mine development in an effort to hedge its coal cost exposure. In 2004, the company formed a venture with Datong Coal Mine Group and other parties to develop jointly the Ta Shan coal mine in Shanxi province. Datang took a 28 per cent stake in the project, which required a RMB2.5 billion investment. In addition, the firm has increased the percentage of mine mouth power plants in use, from 21 per cent in 2003 to 37 per cent in 2005.<sup>28</sup> Datang has already invested in two coal railways (Daqin and Qiancao Railway Corporations) and four coal mines, one of which will start production in 2006 while the other three are in the exploration stage. The mines have an estimated combined capacity of 65 million tons a year (Ng 2006:2). Also in 2005, Datang approved the development of its first wholly-owned mine—No. 2 Shengli open-air mine in Xilinhaote, Inner Mongolia. The mine's total annual production capacity is estimated to reach 30 million tonnes.<sup>29</sup> Similarly, China Huaneng Group announced in January 2006 that the firm plans to secure 30 million tonnes of coal through the acquisition of stakes in coal mines by the end of the year, further increasing that figure to 80 million tonnes by 2010. In 2005, Huaneng consumed about 100 million tonnes of coal to fire its 75 power plants across 23 provinces and regions. In addition, the domestic media noted that 'Huaneng's move to secure long-term coal supplies follows price disputes between coal suppliers and users'.<sup>30</sup>

China Power Investment has also joined in this integration strategy, and signed a framework agreement with the local government in the northern province of Jilin to develop jointly oil shale resources. Recent reports estimate that 317 million tonnes of Jilin's 546 million tonnes of total proven oil shale reserves can be commercially developed.<sup>31</sup> By the end of 2004, China Power Investment controlled power generation facilities with a total capacity of 27,959 MW and, like many other power producers, remained heavily reliant on coal: coal-fired plants accounted for 67 per cent, hydro plants accounted for 28 per cent and nuclear plants accounted for the final five per cent.<sup>32</sup>

The second equity strategy is to partner with traditional infrastructure suppliers to create hybrid firms and directly provide public energy services (i.e. port infrastructure) and private energy services (i.e. coastal shipping, railways). Rather than simply acquire upstream stakes, Huadian Corporation followed a modified upstream strategy of hedging price and supply risk, and established a subsidiary expressly for fuel exploration and provision. Huadian Coal, created in August 2005, has already invested in five coal projects in Guizhou and Shanxi with a combined annual capacity of 11.25 million tonnes. It is in the early stages of feasibility studies in Xinjiang, Inner Mongolia, Anhui and Shanxi. The firm is seeking a controlling stake in a 500 million-tonne per year coal producer, giving it a production capacity of 20 million tonnes. By the end of the decade, it should control 100 million tonnes of coal resources and be able to produce 40 million tonnes per year, rising to 80 million tonnes by 2015.<sup>33</sup> Short-

term plans include the raising of its registered capital from RMB500 million to RMB1.35 billion.

Perhaps the best example of partnerships between these newly emerging hybrid firms and local government is a major infrastructure project in Fujian being established without any central government funding. On 30 May 2006 in Fuzhou City, Huadian Coal and the Fujian Provincial Communication and Transportation (shareholding) Co., Ltd broke ground on a RMB1.5 billion coal transfer port station. The station will boast a two 50,000-tonne berth or 20 million tonnes annual coal transfer capacity.<sup>34</sup> Moreover, one month later, Huadian Coal announced the creation of a new coal shipping firm, together with Shanghai Huadian Electric, Far East United Shipping Co and Hebei Energy Group; the firms will hold stakes of 36, 34, 15 and 15 per cent respectively.<sup>35</sup> To date, despite the start of work, there has been little discussion of how such a complex will integrate with the national waterways transportation system, and negotiations with the Ministry of Railways for rail capacity allocation are ongoing.

Third, Chinese firms have sought to import technological and managerial know-how through foreign acquisitions and operations, much like the mining integration discussed above. China Huaneng Group has proven a leader in foreign power/fuel acquisitions, and in late November of 2003 signed a strategic cooperation framework agreement to buy coal from Australian mining giant BHP Billiton. A few days later, Huaneng Power International, the group's publicly listed arm, outbid Malaysian conglomerate Sime Darby, Australia's Origin Energy and other firms to buy US-based global energy firm InterGen's 54 per cent stake in a \$1.09 billion, 840-MW Millmerran power plant utilising supercritical boiler technology (Ng 2003:3). In July 2005, the group also agreed to pay \$173.5 million to buy into its first overseas coal mine as part of China's bid to secure offshore raw material supplies, acquiring a 25.5 per cent stake in the Monto coal project in Queensland, Australia, from Brisbane-based Macarthur Coal.<sup>36</sup>

The motivations driving such foreign acquisitions are many. The purchase of advanced drilling and burning technologies are clear advantages, termed 'hard technology acquisition', but industry executives often deemed 'soft technology acquisition' to be more important. Foreign acquisitions offer the unique opportunity to 'buy into' the international frontier of modern enterprise management, supply chain management and risk management techniques through sophisticated financial strategies. As Huaneng executives cited, high-quality foreign assets also offer leverage when bargaining with domestic mines for supply contracts, as many firms import the coal produced abroad.<sup>37</sup> In addition, as the regional coal market is quite mature and standardised, power producers can improve the security of supply for high-grade coal through such acquisitions. Often, reserves will consist of imported coal as a conservative means of ensuring median-grade fuel through various in-house treatments. Lastly, some scholars have argued that large-scale foreign acquisitions also serve as a vehicle for major

SOEs to ship capital abroad. China's under-funded pensions and impending reform are indeed often contemplated by these firms, and foreign acquisition could serve as a long-term attempt to shield such assets from SASAC and other central government entities that might begin to target these firms as sources of liquidity.<sup>38</sup>

Fourth, diversification of fuel choice in power production has strengthened in recent years. In under a decade, China's supply of natural gas for electric power, gas and water production rose from 0.172 Tcm to 1.15 Tcm (NBS 2004: 130). In 2003 alone nuclear power capacity grew 38.5 per cent, from 4,468 MWh to 6,186 MW (NBS 2004: 666). China's total hydropower capacity more than doubled in 5 years, increasing from 53,000 MW in 1999 to 105,000 MW in 2004, while the global hydropower growth rate registered at a mere 2 per cent (Martinot forthcoming:62). By 2004, China surpassed Canada to become the world's largest installed capacity hydropower producer, with 74,000 MW (Martinot forthcoming:12). Similarly, five of China's largest electrical, aerospace, and power generation equipment companies began to develop wind turbine technology in 2004. Four firms signed technology-transfer contracts with foreign companies and in 2005 began to produce their first prototype turbines (Martinot forthcoming: 26). China's Renewable Energy Law, passed in January 2006, established a target of 15 per cent of total power capacity by 2020, including 10 per cent of primary energy and 12.5 per cent of power capacity, 270 million square meters of solar hot water, and 20,000 MW each of wind and biomass power (Martinot forthcoming: 29). This would place 2020 hydropower capacity at 290,000 MW, wind power at 30,000 MW, and nuclear at approximately 40,000 MW.

Datang, for example, is already pursuing its goal to generate 30 per cent of its capacity from renewable sources of energy such as wind, nuclear and hydropower by 2010, in a bid to 'reduce the impact of soaring coal costs'.<sup>39</sup> The firm has partnered with Gantou Hydropower in a joint venture to invest RMB22.5 billion in two hydropower projects in Sichuan province (Dueck 2006:4). In early 2006 Datang also struck an agreement with Guangdong Nuclear Power Investment to set up Ningde Nuclear Power, in which Datang will hold 49 per cent. The project will consist of two 1,000-MW generating units, both located in Fujian province.<sup>40</sup> Such rapid diversification and high rates of acquisition are beginning to affect adversely credit ratings of firms like Datang. In June 2006, Standard and Poor's (S&P) reduced its corporate credit rating to the lowest level and reduced its senior unsecured debt rating on Datang from BBB to BBB-minus. An S&P credit analyst reasoned: 'Our downgrade reflects Datang Power's weakened financial profile and the possibility that this profile will deteriorate over the intermediate term as the company continues to expand aggressively, largely funded by debt' (Ng 2006: 4).

In addition, hybrid electricity suppliers are emerging, mirroring developments in the upstream resource exploitation industry, in an effort to diversity exposure to variable retail

pricing through extended reach into different markets. In what has been described as ‘an unprecedented challenge to the century-old duopoly of CLP Power and Hong Kong Electric’, China Hong Kong Power Development Company Limited applied in July 2006 to lay power cables in Hong Kong. This new firm is a joint venture between China Power Investment Group’s China Power International Holding Limited (‘CPI’), Vertex Group and China Southern Power Grid Co. Ltd. (‘CSG’) for the supply of electricity to Hong Kong. The joint venture is 50 per cent owned by CPI, 15 per cent owned by Vertex, and 35 per cent owned by CSG. China Hong Kong Power engages in the generation, transmission and supply of electricity to Hong Kong.<sup>41</sup> While Hong Kong’s electricity market is not governed by any franchises, CLP and Hong Kong Electric have been operating as virtual monopolies—the former supplying exclusively to Kowloon and the New Territories, the latter to Hong Kong Island, Lamma Island and Cheung Chau.

### *Major consumers: the off-grid strategy*

Major energy consumers, as well as producers, have pursued energy agendas at times independent of the national infrastructure, choosing to mitigate price and supply risk by investing in costly diesel powered generators that grant a degree of energy freedom. In 2000, approximately 25 per cent of Guangdong’s total electric capacity was fuelled by diesel fuel (Xu 2002:178). When electricity shortages proved to be particularly severe in 2003, 2004 and, to a lesser extent, 2005, the combined actions of these consumers gained considerable scale and registered in national account figures. In 2003, diesel imports surged to 1.116 million tonnes, double those of 2001, mainly driving diesel generators for manufacturing activities.<sup>42</sup> Net diesel trade reveals similar trends, growing from net exports of 16,000 barrels per day (bpd) in 2002 to imports of 50,000 bpd by the second quarter of 2004 (IEA 2004:14). As MIT’s Richard Eckhaus argues (Eckhaus 2004:6), Chinese statistics reveal that between January and September 2004, the production of ‘electric power generating equipment’ increased by 102 percent, compared to the same period in 2003. In the past four years, China has become the world’s largest market for industrial diesel generators. Major US diesel manufacturers estimated that 11–12 per cent of China’s total electric power consumption is produced by such off-grid generators.<sup>43</sup> Similarly, one of the world’s largest generator manufacturers, FG Wilson, lists China Telecom as its largest customer by a large margin, having sold over 700 units to the utility.<sup>44</sup>

One of the largest US manufacturers in China has followed a similar path. A cosmetics, consumer goods and nutrition giant, the firm houses its national production capacity, R&D facility, materials sourcing and purchasing and national warehouse in Guangdong. The main categories of product are home white goods (detergents, etc.), personal care (shampoo, gel,

etc.), cosmetics (make-up, skin care), and nutrition (vitamins). Following the regional power shortages that began in 2003, the firm was forced to reduce its electricity load frequently, particularly during the summer months when daily shedding orders equalled approximately 30 per cent of total power load. In order to avoid this productivity loss, the firm shifted weekend labour, giving workers Monday and Tuesday off and asking them to work on Saturday and Sunday. Three eight-hour shifts operated 24 hours a day. In early 2005, the firm decided to contact FG Wilson and purchase dual Perkins generators at 1,800 KW each for a total of 3,600 KW.<sup>45</sup>

Another off-grid strategy pursued by major energy consumers is the construction of factory-dedicated power plants that are on site and off grid. One of Hong Kong's largest apparel manufacturers decided to pursue this strategy in 2000, when business activities were expanding rapidly, firm energy demand was soaring, and the fuel economics were clear. The initial incentives were largely economic, while the current benefits are largely related to security of supply. In early 2000, the head of energy management for the firm calculated that power produced by the dedicated power plant would equal 0.25–0.35 RMB/kWh, while public electricity at the time was selling at around 0.76 RMB/kWh and had not changed appreciably in several years.<sup>46</sup> It was estimated that the project would save the company about RMB 200,000 per day if implemented. In addition, the power plant would provide more than sufficient steam for the factory and obviate the need for expensive heavy oil burning industrial burners. At the time heavy oil was selling for about RMB 1,200/ton and now is at approximately RMB 3,000/ton. Aside from the considerable cost saving and steam provision aspects of a dedicated power plant, the firm appreciated the supply security such a configuration afforded.

The feasibility study for the power plant began in 2001 and construction began in the autumn of 2002. The plant has a capacity of 30 MW and has been operational since spring of 2004. The approval process required 1.5 years. Significantly, the plant was up and operating 6 months before the approvals were finalised. As the scale of the plant was under 100 MW, approvals were needed at the provincial level only. The executive assistant to the general manager explained that the approval was obtained largely through the lobbying efforts of the provincial State Economic and Trade Commission by the district government, in an effort to maintain the firm's productivity as a major district-level tax revenue contributor. At the time of writing, recent increases in coal price had clearly reduced the economic attractiveness of the dedicated plant. The coal cost paid by the company had risen from 330 RMB/ton to 520 RMB/ton, rendering the plant electricity cost for 1 kWh of electricity only several cents cheaper than grid electricity. However, worsening supply reliability and quality control issues rendered the plant invaluable for the profitability of the firm's performance.

## Looking to the future

‘不能走市场，应该找市长’ (‘If you cannot follow the market, just seek out the mayor’)

Decentralisation and partial deregulation have opened much of the fuel and generation aspects of the power industry to sub-national participants and investors. Such reforms also led to the creation of a new class of legally independent corporate actors able to pursue a range of choices regarding power provision—many of which are unknown and unguided by central regulators. This process has unleashed an unprecedented growth in power capacity that will continue to thrive in an institutional context ill-equipped to enable regulators to understand, let alone predict and influence, these activities. These firm strategies, discussed above, are indeed integrating China’s power market, creating economies of scale and slowly increasing the diversity of fuels and energy contributing to China’s growth. However, such a process has by default proven rather piecemeal and beyond the purview of central oversight. In the generation industry, diversification has indeed occurred but not comprehensively. Guangdong suffers from what many term a quasi-monopoly, as Guangdong Yudean (‘*yuedian*’) Group Co. Ltd controls the majority of the generation market (Zeng et al. 2004). Similarly, disjointed ownership and deregulatory reform has created a largely marketised coal industry with responsive, flexible coal prices that stand in stark contrast to the rigid retail and non-

**Figure 10.9 China’s power mix in 2020 (per cent): estimates of four research teams (per cent)**

Fuel category	ERI (conservative scenario)	ERI (mid-range scenario)	ERI (diversified scenario)	APERC scenario	Capgemini	Tsinghua scenario
Coal fired	72.4	67.0	57.1	59.5	64.9	55.2
Gas-fired	2.2	4.2	6.0	8.7	6.9	20.8
Oil fired	0.3	0.3	0.3	1.5	0.0	0.1
Hydropower	18.6	21.6	26.6	25.1	21.7	21.8
Nuclear	5.6	5.7	7.6	4.6	3.3	1.9
Other renewable	0.8	1.1	2.4	0.6	3.3	0.1
Total	100	100	100	100	100	100

*Notes:* APERC = Asia Pacific Energy Research Centre; ERI = NDRC’s Energy Research Institute.

*Sources:* CapGemini, ‘Investment in China’s Demanding and Deregulating Power Market’, Energy, Chemicals and Utilities Unit, 2006, p.18; APERC, ‘Energy in China – Transportation, Electric Power and Fuel Markets’, p.77, 2004.

transparent transmission prices of electricity. The grid system reveals firms that in some cases suffer from 80 per cent debt loads yet maintain generation capacity ownership to sustain operating income and therefore discriminate against newer, more efficient generators not owned by the grid itself. Resulting losses in efficiency and disincentives to invest are most clearly expressed by the fact that line losses actually increased between 2001 and 2004, from 7.55 to 7.71 per cent.<sup>47</sup> In the mid-1990s, the ratio of investment in generation, transmission and distribution in China equalled 1:0.21:0.12, compared to values of 1:0.43:0.7 in the United States, 1:0.45:0.78 in the United Kingdom and 1:0.47:0.68 in Japan (Xu 2004: 74). Lastly, 120 GW of power remains off grid, unapproved, not inspected or generating ahead of schedule and threatening grid stability.

It is clear that, moving forward, coal will continue to dominate the power fuel mix. In fact, most recent independent estimates concluded that in the short term the nation's energy mix will be characterised by a slightly higher coal fired power percentage than official Chinese predictions (Capgemini 2000:7). Great environmental hope has been placed on the development of renewable energy, most importantly nuclear capacity, and government estimates predict renewable energy to contribute between one-quarter and one-third of electric power by 2020. Hydropower will provide the bulk of this supply, with estimates ranging between 19 per cent and 27 per cent, depending on efficiency and economic growth scenarios (Chen et al. 2004: 182). However hydroelectric capacity requires long lead times, considerable capital and, as the Ertan incident reveals, coordination with local networks so that supply will meet demand and future revenues are able to finance the debt used to construct such mega projects. In the case of nuclear power, technology selection, development of indigenous capabilities, safety management and access licence distribution will continue to present serious challenges to rapid deployment.

In the long term, *de facto* industry consolidation will most likely prevail, as upstream and downstream integration of firms continues to mature and new entrants and infrastructure investments in transportation create a national energy market. Moreover, China's current market share configuration is unstable—less the result of competitive, transparent market forces than the result of highly political, opaque 'horse trading' that in turn has created an inefficient distribution of assets across the country. Huaneng's recent acquisition of North United Power, the upstream integration of producer and resource exploitation firms, the creation of hybrid full value chain energy actors and the mergers and acquisitions among existing firms discussed earlier all serve as prominent examples of the consolidation forces gaining momentum in China.

Perhaps the most troublesome and far-reaching challenge remains electricity pricing. The current regime is plagued by inefficiency and non-transparency at two critical market junctures. The first is between power producers and grid companies; the second is between



the grid company and the consumer. In the first instance, rigid wholesale electricity prices that do not respond to supply and demand are slowly squeezing the profitability of power producers that are facing ever higher fuel costs. On the regulatory side, unbundling or the separation of grid and generation assets (‘厂网分开’) has faltered, with grids maintaining ownership of profitable generation assets, resulting in protectionism by grids, which often grant access only to the plants they own, further depressing efficiency. In the second instance, electricity consumer tariffs remain divorced from any systematic linking of price to volume, time of use, and underlying cost structure. Moreover, opaque cross-subsidisations of mainly urban households occur through the high prices paid by industry and the forgone profits of generators themselves.

China’s energy portfolio has now passed from Zhang Guobao to Chen Deming, recently appointed Vice-Chairman of the NDRC and an individual known for his experience in navigating the sub-national level of government and negotiating with sophisticated foreign corporate interests.<sup>48</sup> Despite such a promising professional background, Chen will be attempting to execute far-reaching energy reforms with, at most, a mere 750 individuals within the central government whose responsibilities in some way relate to energy policy.<sup>49</sup> The vast majority of these people devote only a small fraction of their attention to energy issues. In fact, most observers estimate that only 55–60 central government officials are full-time energy specialists. In contrast, the US Energy Information Agency alone—an organisation dedicated mainly to data gathering, analysis, and education—employed 620 people in fiscal year 2004. The US Department of Energy employed 14,713 individuals in the same period.<sup>50</sup> While one may debate how many employees are involved in part-time energy work at these institutions, the disparity in personnel is striking, particularly in the context of the processes of decentralisation, ownership diversification, corporatisation and rapid capacity expansion that characterise China’s current energy market.

While many are already predicting the emergence of power surplus in China, the fact remains that rapid economic development has changed both the industrial structure and the lifestyles and energy needs of hundreds of millions of Chinese citizens, as reflected in recent consumption statistics. For example, between 1990 and 2004 the number of refrigerators and colour television sets per 100 households have both more than doubled (NBS 2005:100). Electricity consumption per capita in China, about 1,680 KWh per year in 2004, is only about one-fifth the level of consumption in advanced economies. Historically, on the demand side of the equation, Beijing pursued policies that aided conservation efforts, particularly in the mid-1980s, and still provided economic growth. However, Beijing is now governing a domestic energy market vastly more complex, independent, and exposed to the global market than ever before. It is not clear that these past policies can be used to predict future energy governance capacity. On the supply side, firms have successfully expanded and diversified



sources and forms of investment in the electricity industry, with a continued reliance on coal as the primary form of fuel. In any case, the majority of the capacity needed to power China's economic growth through electrical power does not yet exist, but it is clearly being built, and built quickly. While accusations of neo-mercantilism dominate discussions of Chinese energy policy, it is Beijing's lack of authority in this critical sector that should be most concerning to careful observers of China's long-term energy governance.

## Notes

The author would like to thank the US Fulbright Program, the Total Corporation, as well as MIT's Industrial Performance Center, Laboratory for Energy and the Environment, and Center for International Studies for their generous support of this research.

- 1 For additional views on this topic, please see Deutch et. al. (2007), Chapter 5; Magee (2006); and Oakes (2004). For counter-arguments supporting a more top-down view of governance, see Yang (2004); Zweig and Bi (2005); and various Heritage Foundation Briefing Papers by John Tkacik.
- 2 Legislation included 'Regulation on Power Market Supervision' and 'Interim Administration Directive' relating to pool purchase pricing, transmission and distribution pricing, and retail pricing.
- 3 For a more detailed institutional review of power reform, refer to van Sambeek (2001).
- 4 Similarly, in the fuel industries, the Ministry of Petroleum Industry merged with the Coal and Chemical Ministries to form the Ministry of Fuels and Chemicals.
- 5 For representative works supporting this perspective, see Yang (2004); Pearson (2005); and Wang (2004).
- 6 Interviews, Taiyuan, 19–20 October 2005; Guangzhou, 27 February 2006; Beijing, 17 May 2006.
- 7 See Wei et al. (2006: 12); NBS (2004: 671); Energy Bureau (2005).
- 8 Investor Communication company document, 'In pursuit of world class corporate governance and IR'; see <[www.fal00index.com/images/PDF/huanengpower.pdf](http://www.fal00index.com/images/PDF/huanengpower.pdf)>.
- 9 The six firms are Huaneng International Joint Stock Company, Shandong Huaneng Electricity Joint Stock Company, Shandong International Power Development Company, China Harbin Power Plant Equipment Group, Northeast Electric Transmission and Transformation Equipment Corp, Datang Power Company. The listings occurred in 1994.
- 10 See <[www.cclaw.net/download/companylaw.asp](http://www.cclaw.net/download/companylaw.asp)>.
- 11 Naughton (2006: 4); see <[www.media.hoover.org/documents/clm18\\_bn.pdf](http://www.media.hoover.org/documents/clm18_bn.pdf)>.
- 12 Naughton (2005: 2); see <[www.media.hoover.org/documents/clm14\\_bn.pdf](http://www.media.hoover.org/documents/clm14_bn.pdf)>.
- 13 See Wei, Yiming, Han Zhiyong, Fan Ying and Wu Gang (eds) (2006) 'Zhongguo Nengyuan Baogao: Zhanlue yu zhengce yanjiu (2006) [China Energy Report (2006)]', Beijing: Kexue Chubanshe [Science Press], p. 12; NBS (2004: 671); Energy Bureau (2005).
- 14 Huadian Annual Report 2005, State Council Information Office, 8 June 2006; see <[http://www.gov.cn/xwfb/2006-06/08/content\\_303550.htm](http://www.gov.cn/xwfb/2006-06/08/content_303550.htm)>.

## Asia Pacific Economic Papers

- 15 Prominent examples of such legislation were State Council Documents 146, 5 and 2704 of 2002; and later 2 of 2003 and 432 of 2005.
- 16 State Council Office of Economic Restructuring, 'Zhongguo dianli jianguan jigou jianshe yanjiu baogao', November 2004, p. 150.
- 17 Interview, Beijing, 26 October 2005.
- 18 See <<http://www.threegorgesprobe.org/TgP/print.cfm?ContentID=1331>>.
- 19 Multiple plant interviews in 2005 and 2006; 'Favorable coal prices to be abolished', *China Daily*, 23 July 2004.
- 20 'Favorable coal prices to be abolished', *China Daily*, 23 July 2004.
- 21 Interview, Taiyuan, 19 October 2005.
- 22 Interview, Beijing, 21 April 2006.
- 23 See NBS (2005: 99); UNDP and World Bank (2004: 4).
- 24 State Power Information Network 2006. See also Ng (2006: 2).
- 25 Interview, 26 September 2005.
- 26 Datang Annual Report, 2005, p. 26.
- 27 See <[http://www.dtpower.com/en/operation/cost\\_manage\\_fuel.jsp](http://www.dtpower.com/en/operation/cost_manage_fuel.jsp)>.
- 28 See Datang Annual Report, 2005.
- 29 'Huaneng signs deal to build coal mine', *People's Daily*, 26 January 2006.
- 30 'China Power moves to develop oil shale; tapping wind also', *China Daily*, 28 December 2005.
- 31 CPI Annual Report, 2004.
- 32 Huadian company website and 2005 Annual Report; see <[http://www.hdpi.com.cn/est/TZ/NBXZ/nbxz\\_disp.aspx?ID=200641226160](http://www.hdpi.com.cn/est/TZ/NBXZ/nbxz_disp.aspx?ID=200641226160)>.
- 33 'Fujian to build huge coal transfer base', Financial Times Information, 30 May 2006.
- 34 'China Huadian Group units form shipping company with 2 other companies', *Xinhua*, 23 June 2006.
- 35 Macarthur Coal Press Release, 28 July 2005. See also, 'China's power producer acquires interest of Australian coal project', *People's Daily*, 29 July 2005.
- 36 Interview, 22 September 2005.
- 37 Steven Lewis is one scholar pursuing work in this area.
- 38 Interview, 22 September 2005.
- 39 'China's Datang to invest in \$2.9 billion nuclear project', Reuter News Service, 27 January 2006; see <<http://www.planetark.org/dailynewsstory.cfm/newsid/34700/newsDate/27-Jan-2006/story.htm>>.
- 40 Vertex Group company website: <[http://www.vctg.com/power\\_gb.php](http://www.vctg.com/power_gb.php)>.
- 41 NBS (2004: 89). For more details on the final use of diesel imports, see a draft paper by Eckhaus (2004).
- 42 Interview, Beijing, 29 July 2005.
- 43 Company website: see <[http://www.fgwilson.com/fgw/cda/articleDisplay/1,4163,7\\_2017\\_23705-23706-23708\\_70\\_\\_\\_\\_7\\_10013106\\_\\_,00.html](http://www.fgwilson.com/fgw/cda/articleDisplay/1,4163,7_2017_23705-23706-23708_70____7_10013106__,00.html)>.

- 44 Interview, Guangzhou, 29 September 2005.
- 45 Interview, Gaoming, 28 September 2005.
- 46 NDRC 2006; State Power Information Network.
- 47 Chen was born in Shanghai and was Mayor of Suzhou; Vice-Governor and Governor of Shaanxi; and Vice Chairman of NDRC.
- 48 Interview, Beijing, 21 July 2006.
- 49 Email communication with US EIA staff, 20 December 2005; US DOE website.

## References

- Andrews-Speed, P., 2005. 'China's energy woes: running on empty', *Far Eastern Economic Review*, June.
- Advanced Power & Electricity Research Center (APEREC) 2004. 'Energy in China – Transportation, Electric Power and Fuel Markets', Institute of Energy Economics, Japan, 2004. ([http://www.ieej.or.jp/aperc/pdf/CHINA\\_COMBINED\\_DRAFT.pdf](http://www.ieej.or.jp/aperc/pdf/CHINA_COMBINED_DRAFT.pdf)).
- Capgemini, 2006. 'Investment in China's demanding and deregulating power market', Energy, Chemicals and Utilities Unit.
- Chen, Q.T., et al., 2004. 'Zhongguo nengyuan fazhan zhanlue yu zhengce yanjiu' (Research on Chinese Energy Strategy and Policy). Beijing: Jingji kexue chubanshe, November, 2004, p.182.
- China, Energy Bureau, 2005. 'Shijie yu Zhongguo de nengyuan shuju bijiao [A comparison of world and Chinese energy statistics]', Energy Bureau, National Development and Reform Commission, 28 November; see <[http://nyj.ndrc.gov.cn/sj/t20051128\\_51344.htm](http://nyj.ndrc.gov.cn/sj/t20051128_51344.htm)>.
- China, National Bureau of Statistics (NBS), 2004a. *China Electric Power Yearbook*, Beijing: China Electric Power Press.
- , 2004b. *China Energy Statistical Yearbook*, Beijing: China Statistics Press.
- , 2005. *China's Economy and Trade Yearbook*. Beijing: China Economy and Trade Yearbook Press.
- , 2005. *China Electric Power Yearbook*, Beijing: China Electric Power Press.
- China, State Council Development Research Center, 2006. Statistical Database, [www.drcnet.com.cn](http://www.drcnet.com.cn)
- China, State Council Office of Economic Restructuring, 2004. 'Zhongguo dianli jianguan jigou jianshe yanjiu baogao', (Research Report on the Creation of China's Electricity Supervisory Structure) November.
- Dueck, C., 2006. 'Datang's hydropower alliance', *South China Morning Post*, 14 June, p. 4.
- Eckhaus, R., 2004. 'Unraveling the Chinese oil puzzle', unpublished paper for MIT, 29 December.
- Fingar, T., 1987. 'Implementing energy policy: the rise and demise of the State Energy Commission', in David M. Lampton (ed.), *Policy Implementation in Post-Mao China*, University of California Press, Berkeley :219–220.
- Hu, A.G., 2000. 'Ertan shuidian xiangmu yanzhong kuisun de yanjiu baogao [A research report on Ertan's severe deficits]', *Zhongguo guoqing fenxi yanjiu baogao*, 27.
- Huang, Y.S., 2003. *Selling China*, Cambridge: Cambridge University Press (cited in Woo, p. 13).
- International Energy Agency (IEA), 2004a, *Oil Market Report*, Paris: IEA, 10 November.
- , 2004b. *World Energy Outlook 2004*, Paris: IEA.
- Kynge, J., 2000. 'New doubts over Chinese plant', *Financial Times*, 10 March.

Asia Pacific Economic Papers

- Li, B.S. and J. Dorian, 1995. 'Change in China's power sector', *Energy Policy*, 23 (7): 619–626.
- Li, C., 2000. 'China in 1999: seeking common ground at a time of tension and conflict', *Asian Survey*, 40 (1): 112–129.
- Luo, G., 1998. 'Explanation of plan for institutional restructuring of the State Council', Ta Kung Pao, 7 March 1998 (FBIS, DR/CHI, 10 March, 98-068).
- Magee, D., 2006. 'Powershed politics: Yunnan hydropower under Great Western Development', *China Quarterly*, 185: 23–41.
- Martinot, E., (forthcoming). *Renewables 2005: Global Status Report*, Worldwatch Institute.
- Massachusetts Institute of Technology, 2007. *The Future of Coal: Options for a Carbon-Constrained World*, an inter-disciplinary study. 'Coal Consumption in China and India', MIT Press, Boston.
- Merrill Lynch, 2005. 'Beijing to get tough on illegal power supply', 14 February.
- Miller, M., 2000. 'Beijing's power sector feels wind of change', *South China Morning Post*, 13 January.
- Naughton, B., 2005. 'SASAC rising', *China Leadership Monitor*, 14 (Spring).
- , 2006. 'Claiming profit for the state: SASAC and the capital management budget', *China Leadership Monitor*, 18 (Spring).
- Ng, E., 2003a. 'Beijing Datang to spend \$12b in expansion drive', *South China Morning Post*, 25 August.
- , 2003b. 'Huaneng signs deal for coal with BHP', *South China Morning Post*, 11 December.
- , 2004. 'Cheap coal fuels Datang Power's earnings', *South China Morning Post*, 24 August.
- , 2005. 'Guangdong diesel plants ordered to shut down', *South China Morning Post*, 11 August.
- , 2006a. 'Datang counts on green sources', *South China Morning Post*, 30 March.
- , 2006b. 'Datang Power credit rating cut to lowest grade', *South China Morning Post*, 8 June.
- , 2006c. 'Shenhua contracts signal end to deadlock', *South China Morning Post*, 14 March.
- O'Neill, M., 2003. 'Finance ministry acts to stop power raids', *South China Morning Post*, 7 April, p. 3.
- Oakes, T., 2004. 'Building a southern dynamo: Guizhou and state power', *China Quarterly*, 178:167–187.
- Pearson, M., 2005. 'The business of governing business in China: institutions and norms of the emerging regulatory state', *World Politics*, 57 (January): 296–322.
- Pei, Y. W., 2005. 'China's electric power market: the rise and fall of IPPs', Programme on Energy and Sustainable Development Working Paper No. 45.
- Pu, H.J., Lu, Y.C., Lu, Y.H. and Zhou, X.Z. (eds), 2004. *China Electric Power and Coal*, Beijing: Coal Industry Press.
- Steinfeld, E., 2004. 'Energy policy: charting a path for China's future', World Bank China Note, June.
- United Nations Development Programme (UNDP) and World Bank, 2004. 'Toward a sustainable coal sector in China', UNDP and World Bank Energy Sector Management Assistance Programme (ESMAP) June.
- van Sambeek, E.J.W., 2001. 'Institutional framework of the Chinese power sector', Energy Research Centre of the Netherlands, ECN-C—01-071 (October).
- Wang, S.G., 2004. 'Regulating death at coalmines: changing mode of governance in China', 9 May 9 (draft).
- Wei, Y.M., Han, Z.Y, Fan, Y. and Wu, G. (eds) 2006. 'Zhongguo Nengyuan Baogao: Zhanlue yu zhengce yanjiu (2006) [China Energy Report (2006)]', Beijing: Kexue Chubanshe [Science Press].

- Xu, Y.C., 2002. *Powering China: Reforming the Electric Power Industry in China*, Aldershot: Ashgate Publishing Ltd.
- , 2004. *Electricity Reform in China, India and Russia*, Cheltenham: Edward Elgar.
- Yang, D. L., 2004. *Remaking the Chinese Leviathan: Market Transition and the Politics of Governance in China*, Stanford CA: Stanford University Press.
- Zeng, L.M., Zhang C., Chen L.J., and Xiang, X.M., 2004. 'Guangdong electric power market reform: options and impact', Programme on Energy and Sustainable Development Paper 43, November.
- Zhang, C., 2003. 'Reform of Chinese electric power market: economics and institutions', Programme on Energy and Sustainable Development draft paper, Stanford University, 31 January.
- Zhongguo (Zhongguo jingji jingqi jiance zhongxin), (ed.) 2004. *China's Industrial Map: Energy*, Beijing: Social Sciences Academic Press (Zhongguo chanye ditu – nengyuan 2004-5, Beijing: Shehui kexue wenxian chubanshe), 2004, p.64.
- (ed.), 2006. *China's Industrial Map: Energy*, Beijing: Social Sciences Academic Press (Zhongguo chanye ditu – nengyuan 2004-5, Beijing: Shehui kexue wenxian chubanshe), 2006.
- Zweig, D. and Bi, J.H., 2005. 'China's global hunt for energy', *Foreign Affairs*, 84 (5): 25–38.



# 11 CHINA'S COAL DEVELOPMENT AND OUTLOOK

HU YUHONG

## **Introduction**

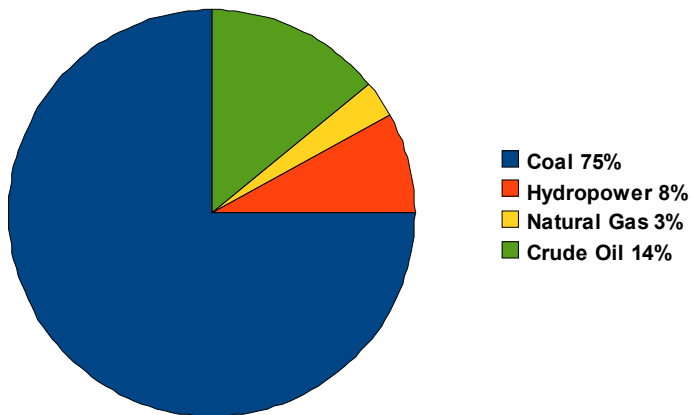
As the dominant domestic source of energy, coal is integral to China's economy. In recent years, strong domestic demand and rising coal prices have stimulated major increases in mining investment and coal output. However concerns regarding efficiency, the ballooning number of illegal mines and, especially, safety in coal mines have stimulated China's government to enact new regulations covering coal mines. Thirteen major coal bases in China have been identified for further development. Consolidation of small coal mines within these major coal bases is a key part of the government's strategy to reduce illegal mining and mining-related deaths, as well as improving the efficiency of China's coal mining industry. The stated objective of the government is to 'promote the healthy development of the coal industry'.

This paper begins by discussing the role of coal in China's energy sector, and then looks in detail at the state of China's coal reserves, considering separately each of the 13 major coal bases set for future development. It then provides an analysis of China's coal market, considering the rising demand for coal in China and the supply side response as well as the impacts on China's international trade in coal. The paper concludes with a brief outlook of the prospects for China's coal industry.

## **The roles of coal in China's energy sector**

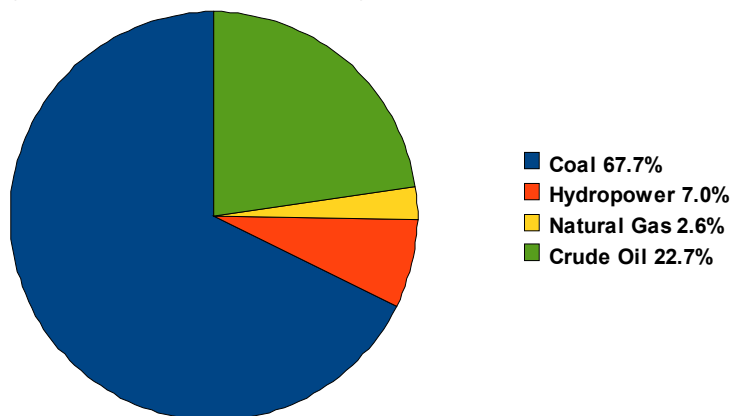
Coal is the most abundant source of energy in China. It is integral to many production processes as a raw material. Coal is therefore strategically important in the national economy and will remain so for the foreseeable future (Figures 11.1 and 11.2). In light of this reality, the Chinese government has pursued a coal-based energy development strategy, attaching great importance to the efficient and effective production and consumption of domestically available coal.

Figure 11.1 China primary energy supply by type (2004)



Source: National Statistics Bureau, *Statistical Yearbook of China*, various

Figure 11.2 China primary energy consumption structure in 2004



Source: National Statistics Bureau, *Statistical Yearbook of China*, various

## Coal resources and large coal base construction

### *Coal resources*

The Ministry of Land and Resources reports that China's proved coal resources (at end 2003) were 1,020.2 billion tons. Economically recoverable reserves were 189.268 billion tons. The National Development and Reform Commission (NDRC) plans to develop 13 coal bases with coal reserves exceeding 850 billion tons. These bases, distributed across 14 provinces, account for 70 per cent of the total national reserves. In 2005 total output from the 13 coal bases reached 1.8 billion tons.



China's 11th Five Year Plan (FYP) refocuses coal exploitation in China. The top priority is restructuring and consolidating coal mines – not constructing new mines. The coal industry is entering a new stage of development.

Figure 11.3 Geological distribution of China's 13 coal bases



Source:

### Prospects for the construction of coal bases

The document 'State Council Decisions Promoting the Healthy Development of the Coal Industry' was promulgated in June 2005. In consideration of the large reserves and great development potential in the 13 large coal bases, especially given support from large state-owned coal enterprises, development of these bases is to be accelerated. The goal of this accelerated development is to establish stability and reliability in the commercial coal chain, from supply to processing and exports. State-owned banks and share-holding commercial banks are required to provide their active financial support while complying with national industrial policies. Qualified coal enterprises should be encouraged to seek private capital by listing on the stock market. Provision of state bonds can also raise funds to accelerate construction and development.

To meet projected national energy demands, there is a preliminary schedule calling for the development of the 13 key, large coal bases before 2020. Details about these bases follows.

## Summary of Facts about China's Thirteen Large Coal Bases

### *a. Shaanxi and Inner Mongolia coal base*

Shendong base is a trans-provincial coal complex with extensive coal resources. It includes several mining areas in the provinces of Inner Mongolia and Shaanxi. Proven coal reserves in the Shendong base are approximately 136 billion tons with additional prospective reserves. The majority of coal in the Shendong base is ranked as long-flame coal and non-coking coal. The coal is high-quality steam coal suitable for chemical engineering and metallurgy. Wuhai mining area has some fat coal and 1/3 coking coal reserve while Fugu mining area has some gas coal reserves.

The main rail transport links to other provinces are the Jing-Bao, Bao-Lan, and Baotou-Shenmu lines, which connect Baotou to Beijing, Lanzhou and Shenmu respectively, as well as the Shenmu-Shuozhou, Shuozhou-Huanghua, and Datong-Zhunge'er lines. The connection between the Shenmu-Yan'an and Xi'an-Yan'an lines will further improve traffic in this area.

The Huanghua coal wharf entered its first phase in 2002, with a capacity of 30 million tons. Stage 2 of the project, commissioned in 2006, will expand the wharf's capacity by an additional 30 million tons. This shipping link will assist coal exports and the shipping of coal to southern China.

Coal quality and geological and mining conditions in the Shendong base are generally favourable and the coal field has been well explored. The base will combine production of high-quality steam coal for domestic and export use with coal-chemical utilisation including coal liquefaction and coal water mixture. The Shenhua Group currently has majority interests in this coal base and is the major party responsible for its development.

### *b. North Shaanxi coal base*

The northern Shaanxi coal base lies mainly in the Yulin and Yan'an areas in the north of Shaanxi province. Proven reserves in the area amount to 59.7 billion tons. The base has long-flame and non-coking grades of coal, suitable for use as superior steam coal, chemical industry applications and pulverised coal injection).<sup>1</sup>

Two main railway lines service the northern Shaanxi base. The line from Xi'an to Baotou runs through the base, and the planned line between Yinchuan and Taiyuan will cross the base from east to west.

The northern Shaanxi base has favourable coal quality and mining conditions. Further development prospects include a plan for developing Yusheng mining area which

has already been approved by the state. Additionally, local miners have begun extraction in part of the Zichang mine area.

*c. Coal base on the boundary of Shaanxi and Gansu Provinces*

This coal base is located on the boundary of Shaanxi and Gansu provinces. There are 22.1 billion tons of available coal reserves in the area. Future efforts will be directed at extracting gas coal and weakly coking coal in Huangling and Binchang mine areas, and long-flame coal and non-coking coal in Huanting mine area.

Three major mining areas of the Shaanxi/Gansu coal base are in good proximity to rail lines. The Huangling mining area is linked to the Xi'an-Yan'an line, which connects with the Xi'an-Ankang line (which has recently been completed). The planned railway from Xi'an to Pingliang will run through Binchang mine area while the Baoji-Zhongwei railway passes through the middle of the Huating mining area. A railway from Xi'an to Nanjing, now under construction, will carry coal directly from China's western region to the east, thus creating favourable inland transport conditions.

Coal resources in this area offer favourable conditions for development. The coal is of good quality and can be transported either eastward to eastern China and the central south regions, or to Sichuan province and Chongqing municipality. It is an important base for the coal and coal chemical industry. The government views it as economically strategic in its role in connecting the different regions of China, contributing to the creation of a national coal market.

*d. Jinbei coal base in Shanxi province*

The Jinbei coal base is located in the northern part of Shanxi province, with proven coal reserves of 75.3 billion tons including weakly caking coal, gas coal, 1/3 coking coal and lean coal.

The North Tong-Pu railway, Jing-Bao, Da-Qin, and Shen-Shuo lines run through the area offering convenient transport solutions. The area mainly produces steam coal and has good prospects for expansion into a super-large coal producing complex.

*e. Jinzhong coal base in Shanxi province*

Jinzhong coal base is situated in central western Shanxi province. The notable Hedong coal field located east of the Yellow River and west of the Liuliangshan mountains is an area identified for large-scale exploitation. This area is abundant in coal resources, with over 52 billion tons of proven coal resources. The coal is of good quality, comprising

mainly high-grade coking coal in the central and southern parts. It is an important, strategic coking coal producing area.

Railways in the existing mining areas connect with Shi-Tai, and the southern Tong-Pu lines. The Xiaoxi-Liuzhou railway intersects the southern Tong-Pu line at Jiexiu station. Coal from the Xiangning mining area is dispatched to the outside cities via Hejin station on the Houma-Xi'an railway. Prospects for further development include the establishment of a production base for both superior coking coal and steam coal. The Liliu mining area is now under construction and Xiangning mine area will be developed soon.

*f. Jindong coal base in Shanxi province*

Jindong coal base is located in the southeastern part of Shanxi province with proven coal resources of about 76.6 billion tons. The coal is mainly anthracite, but also includes meagre coal with small amounts of coking coal. The Shi-Tai, Tai-Jiao, Houyue, Han-Chang and Yang-She railways serve the area.

The area produces mainly anthracite, meagre coal and lean coal. The coal is of good quality and conditions are considered favourable for development. Subject to further improvements in rail transport links, the area has the potential to be developed into a super-large base of superior anthracite and steam coal.

*g. Luxi coal base in Shandong province*

The Luxi coal base, located in Shandong province, has proven reserves of 22.6 billion tons. This includes the Juye mining area, with 5.7 billion tons. The prime area is scheduled for further development. The coal in the Luxi base is mainly graded for gas coal, fat coal and 1/3 coking coal. The Jin-Pu, Xin-He-Yan, Jing-Jiu, and Yanzhou-Shijiusuo railways all pass this area.

This area is abundant in coal resources with a favourable geographical position and transport facilities. Coal may be transported directly to east and south China and can be exported by sea. This area is destined to become a major coal base.

*h. Lianghuai coal base*

Lianghuai coal base is a trans-provincial base straddling the northern part of Anhui province and the eastern part of Henan province. The proven coal resources in this base are 29.6 billion tons with 1/3 coking coal, gas coal, fat coal and anthracite. Coal is of good quality. The railway network in this base is well developed. Three main railway lines—Jing-Hu, Jing-Jiu and Long-Hai, with two additional lines, Huainan and Qing-Fu—surround the coal field. All the mines in the mining area are connected with dedicated railways.

The coal base is endowed with abundant coal resources. Its geographical position and transport facilities are superior, and thus it has the potential for development into a large coal base.

*i. Jishong coal base in Hebei province*

Jishong coal base has proven reserves of about 14.7 billion tons, 1.4 billion of which are in Weixian. The base has well-developed traffic facilities. All the large mine areas are connected with railway lines. Servicing the Weixian mining area is the recently completed Sha-Wei branch line which connects to the Feng-Sha-Da line.

The base has a favourable geographical position and a variety of coal types. Some development of the Weixian mining area is taking place. The coal resources in Xingtai, Fengfeng and the deep part of Kailuan mining areas can be further exploited.

*j. Yuxi coal base*

The Yuxi coal base is located in the middle of Henan province and west of Jing-Guang (Beijing- Guangzhou) railway with proven reserves of about 20 billion tons. It offers a wide range of coal ranks, including coking coal, gas coal, fat coal, lean coal, meagre coal, anthracite and long-flame coal. The Jing-Guang, Long-Hai, Jiao-Zhi, Xin-Jiao, Xin-He, Tai-Jiao and Hou-Yue railways serve this area.

The area has rich coal resources and has a superior geographical position. Yuxi base has the potential to be built into a large coal complex.

*k. Southwest coal base*

The Southwest coal base is an inter-provincial base, extending across western Guishou and eastern Yunnan. The base is rich in coal resources with proven coal reserves of about 46 billion tons. A wide range of coal grades are represented, including gas-fat coal, meagre coal, anthracite, coking coal and lean coal. The Shui-Zhu, Gui-Kun, Shui-Bai, Nei-Kun and Nan-Kun railway lines serve the area.

This is a key, western coal mining area. Although developed in some parts, there are still virgin coal fields remaining to be explored and developed in northwest Guishou, south of Panxian, and in east of Yunnan. It has some promise as a prospective large coal-producing complex. It is considered an important electricity and coal base for the southern route of the 'West-East Electricity Transmission' project.

### *l. Northeast coal base*

The northeast coal base includes all the major mining areas in the provinces of Liaoning, Jilin and Heilongjiang, and also some mining areas in four cities or leagues<sup>2</sup> in eastern Inner Mongolia.

The three provinces in the northeast were of former importance as an industrial base. Now many of the existing mining areas, including Fushun, Fuxin, Liaoyuan, and Tonghua, are depleted due to intensive coal extraction over many years. Only Tiefa, Shenyang, Hegang, Shuangyashan and Qitaihe mining areas have a medium- to long-term future. The area is served by Ye-chi, Jing-Tong, Bin-Zhou, Tong-He railway lines.

Four leagues and cities in the eastern part of Inner Mongolia have abundant lignite resources. The calorific value of the lignite is low and therefore long-distance transportation is not warranted. The plan is therefore to construct an integrated coal and electricity complex to satisfy energy demand mainly in the northeast region.

### *m. Ningdong coal base in Ningxia*

Ningdong coal base is situated in the eastern part of Ningxia Hui Autonomous Region with proven coal reserves of about 27.2 billion tons. The coal is mainly of gas coal, non-caking coal and part of coking coal grades. In the area Da-Gu branch line (from Daba to Guyaozi) intersects Bao-Lan line (from Baotou to Lanzhou) at Daba station. The planned railway from Yinchuan to Taiyuan runs through the mine area.

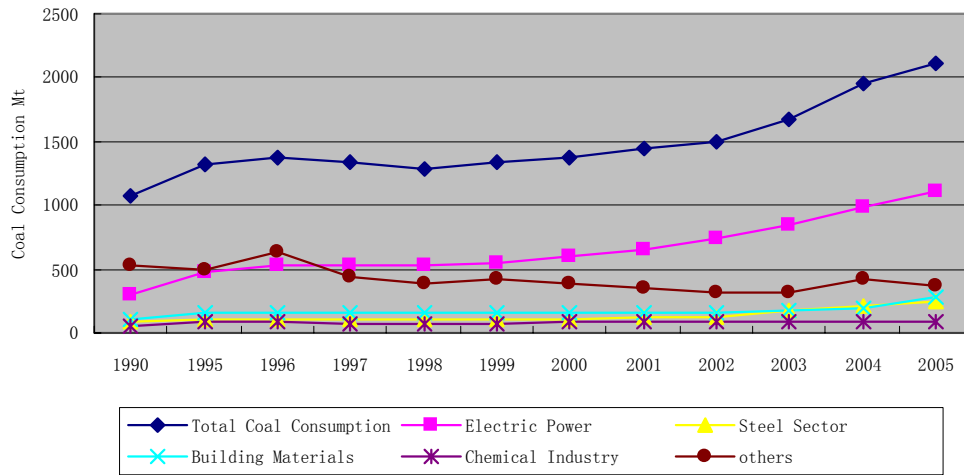
This area possesses abundant coal resources with good-quality coal. It has a bright prospect for development as major production base for steam coal and coal for the chemistry industry. It may also be built into a large power plant group 'bundled' with hydropower plants in the upstream part of the Yellow River in the northwest regions. It will become one of the major power sources in the northern route of the 'West-East Electricity Transmission' line.

## **Coal market**

### *The growth of coal demand*

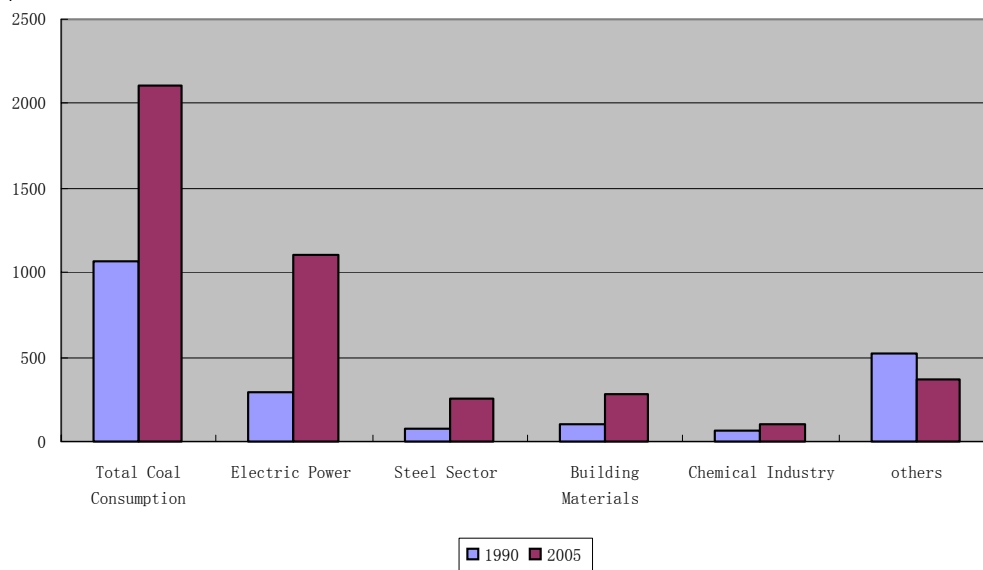
In the early 1990s the Chinese government initiated a two-step deregulation of coal prices signalling the beginning of market-oriented reforms in China's coal industry. The rapid development of the Chinese economy has led to increased demands for coal for electricity production. While coal consumption for civilian and other uses has decreased, it has in no way offset the overall rise in demand (Figures 11.4 and 11.5).

Figure 11.4 Trend of coal consumption structure in China, 1990–2005



Source: China Coal Information Institute, *Yearbook of Coal Industry*, Beijing

Figure 11.5 China’s coal consumption by sector, 1990–2005



Source: China Coal Information Institute, *Yearbook of Coal Industry*, Beijing

### *The increase in the coal price*

The average coal price of state-owned coal enterprises reached 270.2 yuan /ton in 2005, up 119.2 yuan/ton from 2001, a gain of 78.9 per cent. The price of coal for electricity generation reached 212.75 yuan/ton, up 88.81 yuan/ton over the same period, a gain of 71.65 per cent.

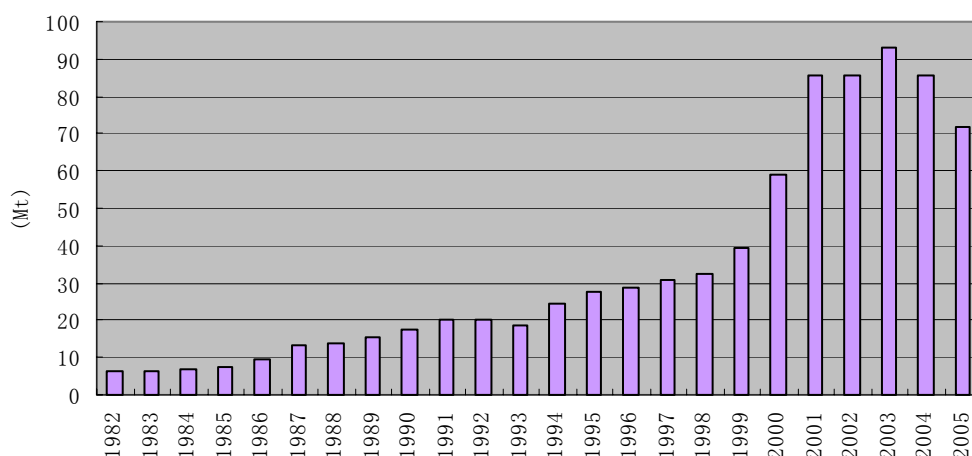
During the period of the 10th Five Year Plan (FYP) profits in China's coal industry increased gradually, eventually moving from an aggregate loss to an overall gain. In 2005, the profit of coal enterprises above a designated size exceeded 55 billion yuan, which increased 78 per cent over the previous year, setting a new historical record. Significantly, the salary of coal miners also began to rise during this period.

### Coal imports and exports

In 2004, total global coal trade reached 1.317 billion tons. China is not only the largest coal producer and consumer in the world, but also an important coal exporter (Figure 11.6). However, under pressure from surging domestic demand, China's coal exports decreased from 90.13 million tons in 2001 to 71.72 million tons in 2005, down 18.40 million tons. Over the same period imports increased rapidly, from 2.66 million tons in 2001 to 26.07 million tons in 2005.

China's coke and coking coal exports play a significant role in international markets. In 2003, China's coke output reached 178 million tons and Chinese exports exceeded 50 per cent of the international market. China is also the biggest coking coal producer and exporter in the world, providing the majority of imported coking coal for countries such South Korea and Japan. Shanxi province accounts for 42 per cent of China's total coke production and 80 per cent of national coke exports, 48 per cent of the global coke trade.

Figure 11.6 Coal exports by China, 1982–2005



Source: China Coal Information Institute, *Study Report on Coal Industry* (various years)

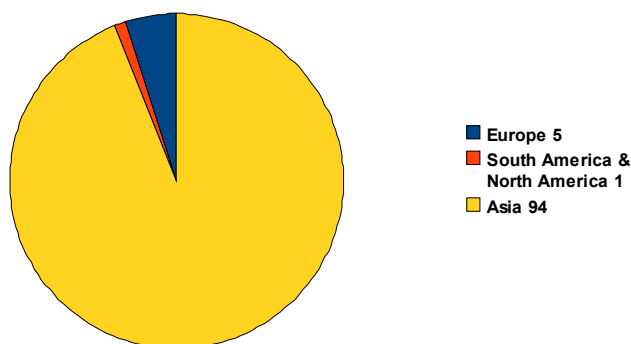


Despite the often remarked upon success of China's 'opening up policy', at the time of writing (September 2006) the Chinese government maintained national control of coal exports. There are four major companies with coal export licences: China National Coal Group, Shanxi Coal Import & Export Group, Shenhua Group, and China Minmetals Corporation. The main market for Chinese coal exports is Asia; Europe is the second market, followed by South and North America. In Asia, China's main coal exporting destinations are Japan, South Korea and Taiwan (Table 11.1 and Figure 11.7).

**Table 11.1 Coal export volumes of four coal export companies, 2002–04**

	2002		2003		2004	
	Million tons	per cent	Million tons	per cent	Million tons	per cent
China National Coal Group	47.6	55.50	44.7	48.05	42.2	49.12
Shenhua Group	20.0	23.32	27.6	29.75	27.5	32.08
Shanxi Coal Import & Export Group	15.0	17.53	16.1	17.35	12.4	14.43
China Minmetals Corporation	3.12	3.64	4.52	4.86	3.77	4.39

**Figure 11.7 Market shares of Chinese coal in Europe and Asia**



Sources: China Coal Information Institute, *Outlook of Coal Development in the World*

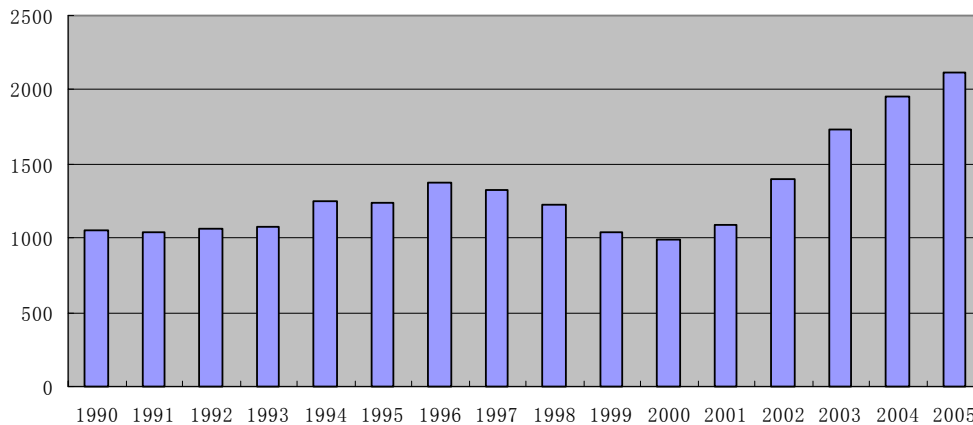
## Coal production

In recent years coal production has increased at approximately the same pace as China's national economic growth. The fast growth of the national economy and subsequent rapid increase in coal demand has pushed up coal prices, encouraging producers to expand

activities. In 2001 China produced 0.9 billions tons of coal. By 2005 China was producing 2.19 billion tons—an increase of almost a billion tons, or 69.23 per cent over 5 years (an average annual growth rate of 11 per cent).

A significant proportion of this growth came from the accelerated development of large-scale state-owned coal enterprises. In 2005, 31 coal enterprises with annual output over 10 million tons accounted for 42.3 per cent of the total national output, producing 900 million tons of coal. The market share of the top 10 coal producers increased 5 per cent, from 18.69 per cent in 2000 to 23.69 per cent in 2005. The annual output of Shenhua Group alone was 150 million tons, while the outputs of China National Coal Group, Shanxi Coking Coal Group and Datong Coal Group exceeded 50 million tons.

**Figure 11.8** China's Coal output (1990–2005)



Source: China Coal Information Institute, *Yearbook of Coal Industry*, Beijing

### *The regulation of coal production*

In April, 2006, 11 departments, including the State Administration of Work Safety (SAWS), the National Development and Reform Commission (NDRC) and the Ministry of Finance (MOF), jointly issued the document ‘Decisions on Strengthening Coal Mine Safety and Restructuring Coal Mines’.

This document regulates the problems arising from the current restructuring of coal mines. It also proffers the government’s goals for small coal mines: (a) enforcement of laws requiring the closure of illegal coal mines with unqualified safety conditions; (b) the elimination of laggard production facilities (all coal mines with an annual output below 30,000 tons will be shut down by the end of 2007); (c) improved coal mine work safety conditions; (d) reduction in the number of small coal mines through consolidation, enhancing the

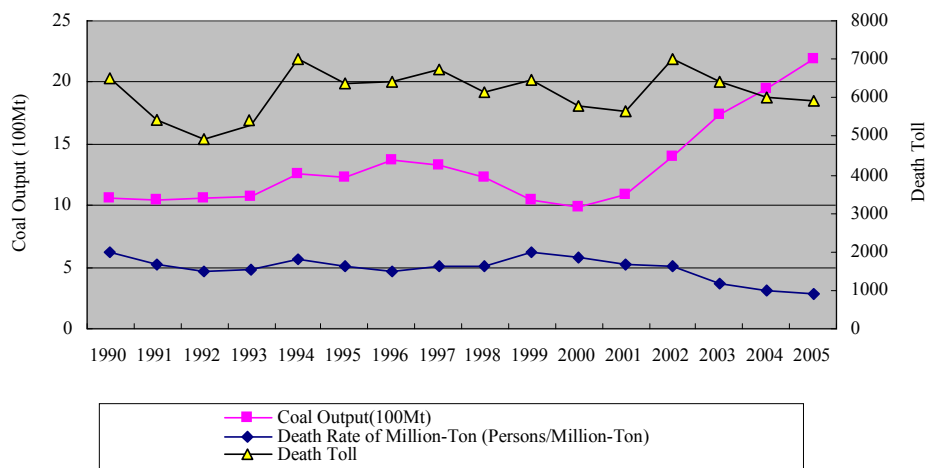
production scale of a single mine;<sup>3</sup> and (e) rational development of coal resources (coal extraction should accord with the approved overall plan of mining area and the mining rights permission scheme and the recovery rate should be in accordance with the relevant regulations).

The mine restructuring and consolidation in Henan province has made gradual achievements. By merging and integrating proximate small coal mines, the number of large modern mines in seven of Henan's leading coal enterprises increased from 58 in 2003 to 82 in 2006, while the annual coal output in the province increased from 69.81 million tons to 86.62 million tons over the same period. Coal production in Henan is expected to reach around 100 million tons per year after the completion of the restructuring program. Shanxi, Inner Mongolia and Shaanxi have also initiated programs for restructuring and consolidating small mines.

### **Coal mine safety**

During the 10th FYP, coal mine accidents leading to death and the death rate per million tons of coal both declined on average in China. Deaths from coal mine accidents decreased from 6,995 in 2001 to 5,938 in 2005, down 1,057. Deaths per million tons of coal decreased from 5.128 in 2001 to 2.811 in 2005, down 45.18 per cent (Figure 11.9). The most significant reduction in the death rate occurred in township coal mines, with deaths per million tons declining 64.85 per cent. The rate fell by 54.39 per cent in state-owned local coal mines, and by 30 per cent in state-owned 'key' coal mines.

While these are encouraging trends, serious accidents continue to happen frequently in China's coal mines, arousing particular social concern. From 2001 to the end of 2005, there were 362 serious coal mine accidents around China, each of which reported a death toll greater than 10 people. The year 2005 saw four exceptionally serious accidents, with the death toll for each over 100. Improving China's coal mine safety is a long-term and arduous task, but it is a critical one.

**Figure 11.9** Coal output, death toll and death rate per million tons of coal, 1990–2005

Source: China Coal Information Institute, *Yearbook of Coal Industry*, Beijing

In recent years, the Chinese government has formulated a series of coal mine safety supervision systems and strengthened the regulations on coal mine safety. The document ‘Decisions of the State Council on Further Strengthening Mine Safety’, issued in 2004, clearly defines three policies for coal mining: reserve safety funds, increasing compensation for accidents and ‘safety risk mortgage’. In February 2005, the Standing Committee of the State Council decided to take seven measures to tackle gas problems, to strengthen gas control in 45 major collieries with serious gas accidents. Coal mine safety experts have been selected nationwide to conduct the safety evaluation on those mines with serious gas problems and help establish concrete preventative measures. All mines with high gas are required to install remote digital gas supervision systems and set up gas draining and monitoring systems.

## Coal investment

### *Analysis of current investment situation*

In the second half of 2000, growth in energy demand accelerated, bringing investment in infrastructure construction along with it. The total investment in fixed assets in the coal industry in 2003 increased 52.3 per cent from the previous year, reaching 70.2 billion yuan by 2004—an annual growth of 60.8 per cent. The investment in the first half of 2005 alone reached 34.5 billion yuan, an annual growth of 85.1 per cent. From 2001 to 2005 the total

investment in the fixed assets for coal mining and dressing in China amounted to 248.9 billion yuan.

The investment structure changed greatly during this time. During the period from the 1st FYP to the 5th FYP, investment from the Chinese government accounted for 85 to 97 per cent of total investment in the infrastructure of the coal industry. In the 9th FYP, this investment proportion decreased to 13 per cent. Currently, fixed asset investments in the coal industry are mainly from enterprises' self-raised funds.

### *Major projects and investment opportunities*

The coal liquefaction project of the Shenhua Group is a key national construction project, with total investment of 25 billion yuan. Its designed annual production capacity is 5 million tons of refined oil product and 180,000 tons of by-products. It can achieve the conversion of 15 million tons of coal each year. With the construction of the coal and power generation base in Huainan, west-to-east electricity transportation within east China will be made possible. Huainan plans to reach an annual coal output of 30 million tons and to install coal-fired power generation units with a total installed capacity of 10,000 MW by 2010. The long-term goal is to reach an annual coal output of 60 million tons and to build a set of coal-fired power generation units with an installed capacity of 20,000 MW.

In September 2004, Yongcheng Coal & Electricity Group, Baoshan Steel Group, Baoshan Steel International and Brazilian CVRD met in Shanghai, where they signed a memorandum of cooperation agreeing to invest jointly to restructure Yongcheng Coal & Electricity Group. In March 2005, two private enterprises of Zhejiang Province signed the letter of intent with Pinglu District of Shuozhou City, Shanxi Province to extract local resources and meet the demand from Zhejiang Province. Zhejiang Zhonghuanneng Investment Management Company will invest 12 billion yuan to construct a pit-head power station.

### *Investment from foreign countries*

By the end of 2004, the coal industry had obtained about \$5 billion of foreign investment (including loans from foreign governments and international financial organisations), among which the loan from Japan for energy resources accounted for 76.8 per cent (about \$3.84 billion) and foreign direct investment (FDI) accounted for 20 per cent (about \$1 billion).

Shanxi Asian American Daning Energy Company is a Sino-foreign joint venture in China's coal industry with a designed annual production capacity of 4 million tons. Its registered capital is \$53.6 million, among which the Continent Coal Company (United

States) holds a 56 per cent share. It began operations in August 2005. Coal output is expected to reach about 1 million tons in 2005, 4.5 million tons in 2006 and 5 million tons in 2007.

## Coal industry policies

On 19 July 2004, the State Council in China promulgated 'Decisions on Investment System Reform'. These decisions focus on transferring governmental management functions to private enterprise and establishing the primacy of the private sector in investment. The key components of the document include reform of the project approval system, safeguarding the right of enterprises to make investment related decisions, standardising the government approval system, improving the investment recording system, encouraging investment from non-governmental financial sources, expanding the channels through which enterprises can obtain capital for investment projects, and regulating the investment activities of enterprises.

The main points can be summarised as follows:

- With the deregulation of prices in the coal market and rising coal prices, profitability in the generation of electric power from coal has been squeezed. To protect electricity generators the NDRC promulgated the 'Coal and electricity prices linkage mechanism' on 15 December 2004. The mechanism went into effect on 1 May 2005.

- In February 2005, the Standing Committee of the State Council studied coal mine safety issues, advanced seven measures on coal mine gas control and announced a 3 billion yuan commitment to develop and deploy safety technology in major state-owned coal mines.

- On 1 June 2005, the State Council announced the 'State Council Decisions Promoting the Healthy Development of the Coal Industry'. This document placed mining safety as the top priority and called for the establishment of large-scale coal bases and the development of large-scale coal enterprises.

- In March 2005, the 'Coal Law' amendment procedure was initiated. The focus of the amendment is to strengthen resource management, to standardise China's coal markets, and to improve mine safety conditions.

## Prospects

In the first quarter of 2006, the implementation of national macroeconomic control policies led to a cooling in the growth of coal output, although coal prices remained stable. Prospects for domestic coal demands and international trade are particularly important.

The overall coal demand will keep increasing, but the increase will be moderate. Major coal consuming industries are maturing, with sustainable and steady, but slower growth horizons. In 2006, the demand for coal for electricity generation was expected to increase by

around 100 million tons, while growth in crude steel production was expected to drop 10 per cent. There is no obvious demand growth for coal from the concrete and chemical industries.

As for international trade, since the second half of 2005 the international coal market has been moved from a situation of under-supply to an essentially balanced market. Due to lower prices and delays with coal orders by the electricity sector, January-February coal imports to China increased 62 per cent year on year from 2005 to 2006. Imports were expected to continue to grow substantially throughout 2006. Affected by the short supply of coal in last several years, the adjustment of the national coal import and export policy and international market price fluctuations, the enthusiasm of China's coal exporting enterprises has declined. China's coal exports in the first quarter of 2006 were 18 per cent lower than in the same period of the previous year. At the time of writing, it was expected that a downturn in exports would continue throughout 2006.

The Chinese government attaches great importance to mine safety and has formulated a series of important laws and regulations. The Standing Committee of the National People's Congress passed a law focusing on coal mine safety in 2005, and it has put forward goals such as 'substantially reducing fatal gas explosions within two years' and 'solving the problem of small coal mines within 3 years'. Since the beginning of 2006, the gas control and rectification of coal mines has been intensified, and operators of coal mines will be unable to begin activities unless they meet certain work safety.

The sustainable development of the coal industry depends on the proper exploitation and utilisation of coal resources, the establishment of a complete legal system, and improved coal mine safety.

## Notes

- 1 Primarily used in metal production
- 2 The league is an administrative unit in Inner Mongolia at the prefecture level in the Chinese administrative hierarchy.
- 3 After restructuring and consolidation of small mines, coal mines must exceed the following annual production thresholds: 300,000 tons in Shanxi, Inner Mongolia and Shaanxi; 150,000 tons in Xinjiang, Gansu, Qinghai, Ningxia, Beijing, Hebei, Northeast China and East China; and 90,000 tons in Southwest China and Central South China.

## References

- Huang Shengchu et al, *China Coal Outlook 2004-2005*, China Coal Industry Publishing House, Beijing
- Proceedings of China Coaltrans, 2002-2005 at <http://www.coaltransinternational.com/places/asia/china.htm>
- China Energy Website <http://www.chinaenergy.com.sg/>





# 12 REFORMS AND DEVELOPMENT IN THE NATURAL GAS SECTOR IN CHINA

ZHU XINGSHAN AND YANG JIANHONG

## **Introduction**

The gas industry in China has grown out of the infant industry stage, and should now be considered a developing industry. The commercial operation of the West-to-East Gas Pipeline Project on 30 December 2004 was emblematic of this transition. Since then, natural gas has become an important part of China's energy mix, with demand increasing significantly. With the operation of the Guangdong LNG Project, Chinese natural gas markets became linked to international gas markets.

This chapter introduces China's production capacities and the state of installed and planned gas distribution infrastructure. It then describes developments in the demand and consumption of gas in China. The chapter then analyses the structure of China's gas industry, and how gas contributes to China's national energy strategy. Recent reforms to the regulatory framework of the gas industry are discussed, focusing on the pricing mechanism. Finally, consideration is paid to the relationship between China's gas industry and the global industry.

## **Current status of China's natural gas sector**

### *Natural gas reserves and production*

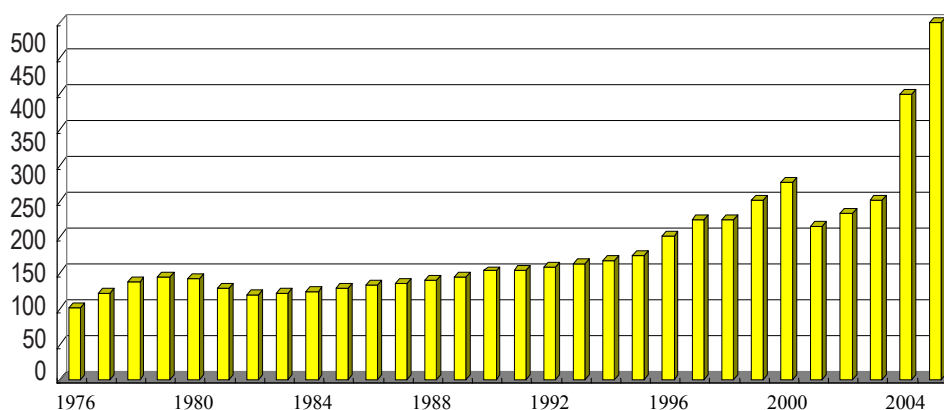
Natural gas resources mainly exist in the central and western regions of China. Key basins for gas resources include the Tarim Basin, Qaidam Basin, Erdos Basin and Sichuan Basin. These four basins account for about half of the known gas reserves in China. Offshore gas fields, mainly located in the East China Sea and South China Sea, are also significant sources of gas.

Since 1995, proven gas reserves in China have increased significantly. During the 9th Five Year Plan (FYP) (1995-2000), newly increased proven reserves were equal to the entire cumulative proven reserves discovered during the preceding 40 years (1955-95). Due to continued investment in gas exploration, this new trend continued through the 10th FYP, with newly increased proven reserves in the 2000-05 period equalling the total cumulative proven

reserves prior to 2000. Six large gas-producing bases were formed during the 10th FYP: Sichuan-Chongqing, Tarim, Changqing, Qinghai, Yingqiong and the East China Sea.

During the 10th FYP, gas production in China rose rapidly (Figure 12.1), with an average annual growth rate of 13 per cent. In 2005, gas production in China grew by 9.1 billion m<sup>3</sup>, reaching 50 billion m<sup>3</sup>, a growth rate of about 22 per cent. PetroChina accounted for about 73.4 per cent of that amount, producing 36.67 billion m<sup>3</sup>.

Figure 12.1 Gas production in China by year (10<sup>8</sup>m<sup>3</sup>)



Source: PetroChina Planning & Engineering Institute. Available at: <http://www.petrochina.com.cn/english/gsj/sjyyj.htm>, Beijing.

**Infrastructure construction** Regional pipeline networks in Sichuan-Chongqing and the Bohai Rim regions provide support for the development of the local gas industry. By the end of 2005, the total length of installed gas pipelines in China was 28,000 km. China’s gas infrastructure is most developed in the Sichuan-Chongqing region, with more than 6,500 km of existing gas pipelines, accounting for 25 per cent of the national total. The first regional gas pipeline network was formed in this region in 1989, improving gas distribution and reducing safety and reliability concerns.

The Bohai Rim region is one of China’s economic and cultural centres and also one of the major gas consuming regions in China. With the opening of the Shaanxi-Beijing gas pipeline in 1997 and the successive construction of associated gas storage facilities, gas consumption in the Bohai Rim region is increasing significantly. At present, a gas supply network system has formed, with the Shaanxi-Beijing gas pipeline and associated gas storage facilities being key components of the gas infrastructure in the Bohai Rim Region.

Pipelines that can transmit high volumes of gas require large diameters, high pressure, and highly-automated control mechanisms. Their construction over long distances presents significant technical engineering and construction challenges. The West-to-East Gas Pipeline is the first high-volume gas pipeline in China to stretch over such a long distance. Construction

was completed in October 2004 and commercial operations began on 30 December 2004. The pipeline crosses nine provinces and autonomous regions, from Lunnan (in Xinjiang province) to Shanghai. Its construction, together with the construction of the Shaanxi-Beijing, Sebei-Xining-Lanzhou, Yacheng-Hongkong and Zhongxian-Wuhan gas pipelines, is treated as symbolic of China's 'catch up' to the forefront of gas and energy infrastructure.

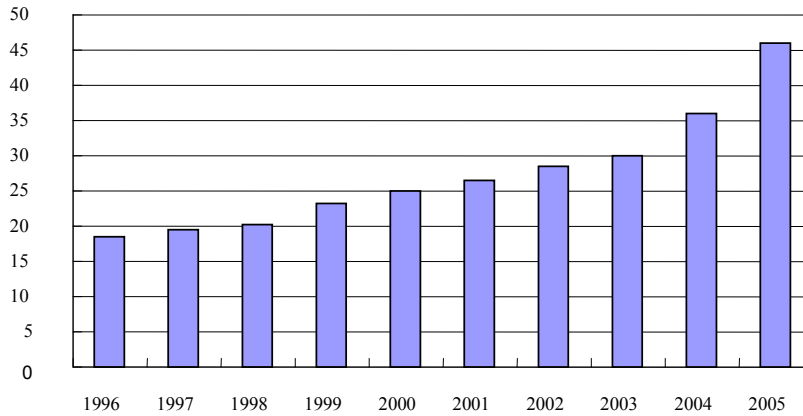
After completion of the West-to-East Gas Pipeline, the next step is the construction of a trunk pipeline network throughout China. The West-to-East pipeline will form the trunk of this network, connecting with three other major pipelines. They are the Shaanxi-Beijing 2 gas pipeline, the Zhongxian-Wuhan pipeline and the Hebei-Xining-Lanzhou pipeline. Connection lines will be constructed between the West-to-East pipeline and each of these other three major pipelines, forming a trunk gas pipeline network throughout the country. Such a network will foster the development of a unified national gas market, and facilitate the transmission of gas from major reserve locations to major consumption areas and international ports. By the end of 2005, the total capacity of trunk gas pipelines in China reached 45 billion m<sup>3</sup> per annum—enough to export gas from four onshore gas producing bases.

In addition to China's piped natural gas (PNG) projects, there are two LNG projects in Guangdong and Fujian. The Guangdong LNG Project is a landmark project in the LNG sector in China, to be constructed in two phases. Following the completion of phase 1 in May 2006, the pipeline went into operation with a capacity of 3.7 million tons per annum. It is planned that its capacity will be increased to 7 million tons per annum in phase 2.

The Fujian LNG Project will also be constructed in two phases. Phase 1 is expected to be completed in 2007, with an estimated capacity of 2.6 million tons per annum. This capacity is expected to increase to 5 million tons per annum in phase 2.

### *Gas consumption*

The operation of long-distance pipelines (such as the West-to-East Gas Pipeline) has resulted in the rapid growth of gas consumption in China (Figure 12.2). Gas consumption in China reached 45.9 billion m<sup>3</sup> in 2005, accounting for 2.8 per cent of primary energy consumption. This was an increase of 80 per cent from 2000 levels. During the 10th FYP, gas consumption in China doubled, with an average annual growth rate of 13 per cent.

**Figure 12.2 Gas consumption in China (1996–2005) (billion m<sup>3</sup>)**

Source: PetroChina Planning & Engineering Institute. Available at: <http://www.petrochina.com.cn/english/gsjy/jyj.htm>, Beijing.

Ten years ago, half of the gas produced in China was used in the chemical industry. In recent years, with the progress of urbanisation and stringent environmental regulations, natural gas (being a relatively clean and high-efficiency energy source) has been adopted for use in urban centres and as an industrial fuel. Gas has come to have a wide market of consumers, rather than the narrow niche of chemical industry uses it used to rely on. In 2005, 32.4 per cent of gas was consumed in urban centres, 30.0 per cent in chemical feedstock, 25.5 per cent for industrial fuel, and 12.1 per cent for power industry use (PetroChina Planning & Engineering Institute).

Prior to the 9th FYP, gas was mainly consumed in areas in close proximity to oil and gas fields. At this time, gas consumption in Sichuan/Chongqing accounted for more than 40 per cent of the national consumption. By 2006, due to the expanded gas distribution infrastructure, gas from six production bases could be transported to markets in the central and eastern regions of China. The operations of the West-to-East Gas Pipeline, the Shaanxi-Beijing 2 gas pipeline and the Zhongxian-Wuhan gas pipeline, have been especially significant in driving the expansion of China's gas market. More and more cities are beginning to use gas, from the Yangtze River delta, to Hunan, Hubei and other provinces along those trunk gas pipelines. By the end of 2005, China's gas market covered 28 provinces, direct jurisdiction cities or autonomous regions, 11 of which consume more than 1 billion m<sup>3</sup> of gas a year.

### *Organisational structure of China's gas industry*

In 1998 the Chinese gas industry underwent a major restructuring process. This was the most important event in the development of the oil and gas industries in China in recent years and forms the current framework in which these industries operate.

At the time of writing (2006), only a limited number of licences to work on conventional gas exploration, production and processing had been issued in China. In addition to the three large, state-owned oil companies (PetroChina, Sinopec and CNOOC<sup>1</sup>), one other company, the Shanghai Oil and Gas Company, possesses such a licence.

Exploration and production of coal-bed methane (CBM) is a more open market, with ChinaCBM, local government and other companies, including coal mine owners and some professional CBM companies, currently engaged in CBM exploration and production.

PetroChina, the largest producer and supplier of gas in China, produces gas mainly in China's northern and western regions. It owns about 70 per cent of China's proven gas reserves and pipelines. Sinopec produces gas in the eastern and southern regions of China as well as the East China Sea. CNOOC operates in the South China Sea, East China Sea and Bohai Bay regions. The Shanghai Oil and Gas Company is responsible only for the Pinghu gas project in the East China Sea near Shanghai.

PetroChina owns and operates most of China's onshore gas pipelines, while Sinopec, CNOOC and other regional companies own and operate the remainder. CNOOC and its partner own and operate all offshore gas pipelines.

Gas distribution throughout China is carried out by regional companies and their partners, usually owned or controlled by local governments; however many foreign companies, as well as private domestic companies, have engaged in gas distribution activities. The three major state-owned oil companies are responsible for the import of pipeline gas and LNG from abroad.

### **The role of gas in China's energy strategy**

There are six guiding principles for the development of China's energy sector, developed during the 10th FYP. They are to prioritise conservation; to strengthen China's energy independence by relying primarily on domestic resources; to recognise that coal should be a major source of China's energy; to promote the diversification of energy sources; to optimise both the production and consumption of energy; and to establish a stable, inexpensive, clean and safe energy supply system.

Although the third guiding principle states that coal should be a major source of China's energy, a principle that is unchanging in the long term, the dominance of coal in China's energy mix is expected to decline. The principal drivers of this change are the practical necessity to improve efficiency and critical environmental requirements. Furthermore, as China's economy continues to develop coal will play less of a role as a consumer good, with most domestic uses of coal being met more cheaply, conveniently and cleanly by other forms of energy including electricity and gas.

Gas has a very significant role to play in optimising the energy mix, improving energy efficiency, alleviating shortages in the domestic oil supply, improving the atmospheric environment, reducing greenhouse gas emissions and improving living standards in China. If current trends continue and follow existing policies, the energy demand in China will reach 3.62 billion tons of coal equivalent (tce) by 2020. Such a high level of demand is beyond the limits of sustainability. Constraints in the available energy supply will present serious challenges, as will environmental capacity. Certain measures must be adopted to reduce China's total energy demand. Restricting the growth of energy consumption to 2020 to 2.8–2.9 billion tce is essential for the sustainable development of China.

Realising the above goal will require a full range of efforts and strategies across all sectors and industries in China. One of those strategies is to increase the share of gas in China's energy mix.

### *Gas price and pricing mechanism*

The gas price and gas pricing mechanism in China are changing gradually, reflecting changes in the gas industry and public perceptions of gas in China. In the past, under China's planned economy, the Chinese government maintained strict control of most industries, including gas. The government determined the production, consumption and price of gas. With nearly 30 years of reform, that system has almost been abandoned. However, gas is one of the few industries in which prices are still under the control of the government.

#### *Existing gas price*

Gas prices include the field price, the tariff and the end-use price. On 26 December 2005, the State Council approved a proposal to reform the pricing mechanism for the field gas price and increased the field gas price accordingly. The new pricing mechanism determined the field gas price in China to be 0.52–0.92 RMB per cubic metre. Tariffs differ between pipelines and there is no common tariff for price by distance and volume. China has adopted the international practice that end-use prices differ from one sector to others.

#### *Gas pricing mechanisms*

The gas price in China is determined by the Chinese government. The National Development and Reform Commission (NDRC) plays an important role in gas pricing. It determines the field gas price and the tariff; the local government price bureau is responsible for determining the price of gas provided by local gas distribution companies.

*Traditional gas pricing mechanism for old projects* China has maintained a low gas price for a long time. In the early stage of the industry's development, the low prices helped establish market share. However, low prices also restricted the profitability of the industry, dampening the enthusiasm of gas producers. To encourage gas production, the Chinese government has adjusted gas prices several times since 1987.

In 1987 the government initiated a two-tier price system: one price would be determined by the government and the other price would be unregulated. At the same time, the government increased the price of gas sold under the regulated prices. In 1992, gas prices were increased again, but different prices were established for different sectors. Gas prices were increased significantly in 1994, and again in 1997. The prices which local gas distribution companies are allowed to charge for distribution services are determined at the local government level.

*Gas pricing mechanism for new projects* The most important feature of the price policy reform in 1997 was the introduction of a new gas-pricing mechanism: new prices for new pipelines. The new mechanism could be used for all gas projects after 1995, including new gas fields and new pipelines. The new gas-pricing mechanism considers three factors: the actual cost of a project, reasonable profitability based on economic evaluations, and the cancellation of the quota plan.

*Latest reforms of the pricing mechanism* The objectives of the reform to China's gas price mechanism, carried out on 26 December 2005 were to rationalise gas prices, promote gas conservation, optimise the gas consumption structure, accelerate the sustainable and healthy development of the gas industry and ensure the domestic gas supply. This most recent reform program is expected to further standardise gas pricing controls, leading to a gradual increase in prices and a clearer relationship with alternative energy sources. This should reduce the uncertainty and risk involved in investing in China's energy markets. Eventually, a fully competitive market for gas should be developed.

The government has set out several guiding principles for the gas market. The first is to promote the development and utilisation of gas by highlighting the requirements of market rule. Market-oriented mechanisms should be introduced gradually, allowing the creation of a fair and competitive environment. Reform should also facilitate efficient use of gas.

*Proposed reforms of the gas pricing mechanism* Further reforms to the gas-pricing mechanism are expected following the establishment of China's national pipeline network and international trade infrastructure. The further clarification of the gas pricing principle will be a principal component of this reform, with market-driven pricing forming the fundamental principle. This will include the abandonment of the dual-price mechanism and the determination of a timetable for realising the full 'marketisation' of gas prices. There is also some discussion about a methodology for pricing based on heat/value rather than volume.

## **Supervision and reform of the gas sector in China**

The existing supervision system of the gas sector in China needs to respond to the rapid development of the sector and the continuous improvement in market conditions in order to satisfy the development requirements of the gas industry. The Chinese government is reforming the supervision system to improve the management of the industry, intensify competition and introduce modern supervision mechanisms focusing on the promotion of competition where possible and government supervision when required (for example, when natural monopolies exist).

The supervision mechanisms for the gas sector in China were established in the 1950s, based on those of the Soviet Union. They were appropriate for a planned economy, with gas production and prices controlled by the government. In the early 1980s, gas companies were required to provide a certain volume of commercial gas at a government nominated price. This system was reformed in the 1990s with the introduction of the dual-pricing mechanism, whereby a certain amount of gas was required to be produced at the nominated price, and additional gas could be produced at a market price. In recent years the government has moved to increase the marketisation of the gas sector, allowing the market to determine supply and demand as well as price for all new pipelines and consumers.

However, there are still some areas in which further reform is needed in the supervision of the gas sector in China. The most important issue is that there are no specific gas laws. Most supervising activities are conducted according to regulations or government documents instead of law. The Oil and Gas Pipeline Protection Rule is the only regulation related to the gas industry. It was formulated to guarantee safe operations of oil and gas pipelines (including CBM) and their associated facilities and public safety. This allows a degree of arbitrariness not conducive to efficient market operations.

Secondly, there is a considerable moral dilemma in China's gas sector: the supervision and policymaking roles of government are mixed with its role as owner and manager of state-owned enterprises. State-owned enterprises operating in the gas industry have retained some of their earlier supervision functions. This has created a situation of relatively weak supervision.

The two immediate objectives for China's gas sector are to create a supervision mechanism which operates under the rule of law, so as to create a fair, stable, and comprehensive supervision regime, and to ensure that there is a competitive structure, in order to facilitate efficient investments and use of resources, and the free and fair trade of gas.



## **The role of the Chinese gas industry in the world**

The role the Chinese gas industry plays in the world has three main characteristics. First, participation in world trade is an inevitable choice in the development of the industry. China's domestic gas reserves are not sufficient to satisfy the forecast growth in domestic demand. Both domestic and international gas resources will be required. PetroChina, Sinopec and CNOOC are the main Chinese players in the international gas market. They import gas via two approaches: either directly through trade or by investing in foreign exploration and development activities, then returning the gas to China.

Second, China is a small country in the international gas market. In 2005, gas consumption in China reached 45.9 billion cubic metres, accounting for less than 2 per cent of the world total, with China ranking 11th in the world in terms of gas consumption. Gas accounts for only about 3 per cent of the total primary energy consumption in China, while it provides 24 per cent of global primary energy consumption.

Third, Chinese entry to international gas markets is a positive sum game. For China, importing gas is a critical requirement for meeting domestic energy demands. For exporting countries, China is an ideal gas market: its domestic demand for gas is expected to increase significantly, allowing exporters to expand their markets rapidly and promote gas development.

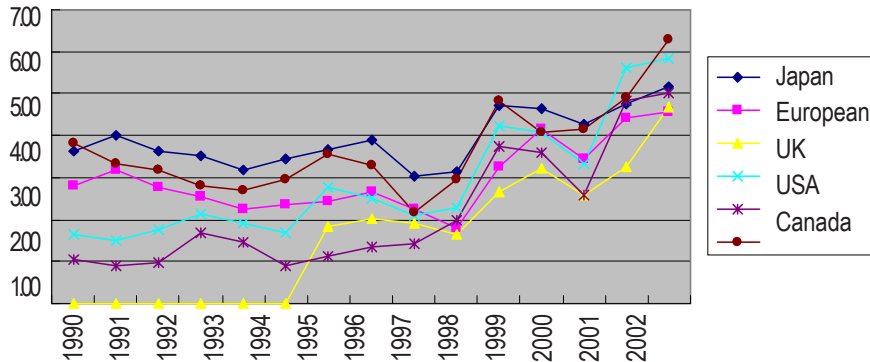
## **The impact of developments in the international gas market on China**

At present, gas is the third global energy source after petroleum and coal. Global gas consumption in 2005 reached 2,750 billion m<sup>3</sup>, accounting for 24 per cent of primary energy consumption. In the 21st century, gas not only is the energy source with the most rapid growth, but also is already a major energy source. It is estimated that the annual average growth rate of gas consumption will remain stable at 3 per cent for 20 to 50 years (World Petroleum Council 2000). Due to the uneven distribution of gas resources and increasing number of consuming countries, it is inevitable that the trade volume of gas, especial LNG, will grow rapidly. About 700 billion m<sup>3</sup> of gas was sold in the international market in 2005, accounting for 26 per cent of total volume of gas sold (BP 2006).

The increasing globalisation of gas markets provides conditions favourable for China's entry to the international gas market. Expansion of LNG trade in particular, gives China greater choices for obtaining gas resources.

The recent dramatic increase in oil prices in the world market has led to a rapid rise in gas prices, too. This trend was exacerbated by the rapid growth of LNG demand.

Figure 12.3 International gas prices (1990–2004)



Source: BP Statistical Review of World Energy, 2005

The rising international price of gas provides significant challenges for China. Having only recently entered the international gas market, Chinese gas consumers are ill-prepared for such high prices. This has reduced demand for gas in China, retarding imports as Chinese consumers switch to alternative energy sources, such as coal. The high prices are a positive sign for domestic suppliers of gas, however, stimulating the further development of domestic gas fields.

## Conclusion

China's gas industry is entering an era of rapid development. Huge demand is pushing forward gas exploration and development, construction of infrastructure and gas imports. At present, China's gas-pricing mechanism and supervision system are not perfect. Continuing reforms in the gas industry are required in order to improve market mechanisms. China has become an important part of the global gas market, involved in sharing gas resources and global gas trade. The further involvement of China will promote the healthy development of the international gas market, however high international prices for gas will restrain Chinese demand.

## References

- British Petroleum, 2006. *Statistical Review of World Energy*, British Petroleum, London.
- Petrochina Planning and Engineering Institute, (no date). *Operating Statistics*, <http://www.petrochina.com.cn/english/gsj/sj/jyyj.htm>, Beijing.
- World Petroleum Council, 2000. Proceedings of 10<sup>th</sup> World Petroleum Congress, London.

## Note

- 1 China National Offshore Oil Corporation

## Previous *Asia Pacific Economic Papers*

- 368 Measuring Trade and Trade Potential: A Survey  
*Shiro Armstrong, 2007*
- 367 APEC and infectious disease: meeting the challenge  
*Joel Gilbourd, 2007*
- 366 The flow of funds through a government – A case study on Japan  
*Jun Ikeda, 2007*
- 365 The puzzle of small farming in Japan  
*Yoshihisa Godo, 2007*
- 364 How should one evaluate fiscal conditions? A study based on the comparison between Japan and Australia  
*Jun Ikeda, 2007*
- 363 Political institutions and distributive politics in Japan: getting along with the opposition  
*Yusaku Horiuchi, 2007*
- 362 Negotiating the Australia–Japan basic treaty of friendship and cooperation: reflections and afterthoughts  
*Garry Woodard, Moreen Dee and Max Suich, 2007*
- 361 China and East Asian energy: prospects and issues Vol. 1  
*Peter Drysdale, Kejun Jiang and Dominic Meagher, 2007*
- 360 Agriculture and political reform in Japan: the Koizumi legacy  
*Aurelia George Mulgan, 2006*
- 359 Nothing new in the (north) east? Interpreting the rhetoric and reality of Japanese corporate governance  
*Luke Nottage, 2006*
- 358 Multinational corporations and Pacific regionalism  
*Philippa Dee, 2006*
- 357 Reliability of structural shocks estimates from a bivariate SVAR model: the case of Southeast Asian countries  
*Arief Ramayandi, 2006*
- 356 RMB exchange rate and local currency price stability: the case of China and ASEAN+3  
*Xiao Bing Feng, 2006*
- 355 Technical efficiency and its determinants in Gansu, West China  
*Sizhong Sun, 2006*
- 354 The making of Asia's first bilateral FTA: Origins and regional implications of the Japan–Singapore economic partnership agreement  
*Takashi Terada, 2006*
- 353 US and EU trade policies and East Asia  
*Peter Drysdale and Christopher Findlay, 2006*

- 352 The Japan–Australia partnership in the era of the East Asian community: can they advance together?  
*Takashi Terada*, 2005
- 351 Trade policy at the crossroads  
*Bill Carmichael*, 2005
- 350 East Asian economic integration and its impact on future growth  
*Philippa Dee*, 2005
- 349 ASEAN monetary cooperation: Issues and prospects  
*Arief Ramayandi*, 2005
- 348 Growth and reform in the Korean economy  
Volume edited by *Jong–Soon Kang and Jung Soo Seo*, 2005
- 347 Trade policy at the crossroads – The Indonesian story  
*David Vanzetti et al*, 2005
- 346 Fiscal rules and targets and public expenditure management: Enthusiasm in the 1990s and its aftermath  
*Hideaki Tanaka*, 2005
- 345 The Australia–US Free Trade Agreement: An assessment  
*Philippa Dee*, 2005

**Annual subscription rate for twelve issues:**

Individuals A\$65.00 (includes GST) A\$60 (overseas)  
Institutions A\$110.00 (includes GST) A\$100 (overseas)

**Cost for single issues:**

A\$16.50 (includes GST) A\$15.00 (overseas)  
A\$10.00 (Students)

*No postage required within Australia*

**Available from:** Publications Department  
Australia–Japan Research Centre  
Crawford School of Economics and Management  
ANU College of Asia and the Pacific  
The Australian National University  
Canberra ACT 0200, Australia  
Facsimile: (61 2) 6125 0767  
Telephone: (61 2) 6125 3780  
Email: [ajrc@anu.edu.au](mailto:ajrc@anu.edu.au)  
URL: <http://www.crawford.anu.edu.au>