Lawrence Berkeley National Laboratory

Ernest Orlando Lawrence

Berkeley National Laboratory

China Energy Primer

Chunchun Ni

China Energy Group

Environmental Energy

Technologies Division

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Preface

Based on extensive analysis of the *China Energy Databook Version 7* (October 2008) (here after *Databook v.7.0)*, this *Primer for China's Energy Industry* (here after *Primer*) draws a broad picture of China's energy industry with the two goals of helping users read and interpret the data presented in *Databook v.7.0* and understand the historical evolution of China's energy industry. *Primer* provides comprehensive historical reviews of China's energy industry including its supply and demand, exports and imports, investments, environment, and most importantly, its complicated pricing system, a key element in the analysis of China's energy sector.

Most of the data cited from *Databook v.7.0* and analyzed in this *Primer* was collected between 1980 and 2006; however, in order to provide more accuracy and completeness of coverage, this author has also looked outside the *Databook v.7.0* and obtained hard-to-find information regarding energy pricing in China and the complicated pricing mechanisms used by authorities. Simplified flow charts of pricing mechanisms for each energy source, including renewables, are presented in a clear and, hopefully, readily-useable format for readers keen to analyze China's energy market from their own perspectives. This *Primer* also compares China's domestic energy prices with international energy prices to provide both a window into differences between China's energy prices and those of international markets and an overview of the variations in these market differences.

No attempt has been made to question or rectify any of China's published official data.

Primer aims to provide a wider understanding of China's fluctuating and fast changing energy industry, to allow energy analysts and experts, policymakers and enterprises to play more informed roles in both the Chinese and international energy arenas.

The paper would not have been possible without the support of all the staff at the China Energy Group, LBNL. In particular, the author would like to thank Mark Levine, David Fridley, Lynn Price, Nan Zhou, Nathaniel Aden, Hongyou

Lu, Nina Zheng, Yining Qin, Jing Ke and Sammi Leung.

The author also appreciates the advice and input of energy experts at the Institute of Energy Economics Japan (IEEJ) and the Asia Pacific Energy Research Centre (APERC) including the Director of IEEJ, Tsutomu Toichi and the Senior Manager of APREC, Satoshi Nakanishi. Much of the data regarding China's energy exports and imports, as well as its energy prices, could not have been included here without the support and cooperation of these two organizations. The author would also like to acknowledge organizations and experts in China for their advice, including: the China Cement Association, the China Coal Industry Association, the China Coal Industry Development Center, the China Electricity Council, the Development Research Center of the State Council, the State Electricity Regulatory Commission, the State Grid Corporation of China (SGCC), and the State Power Economic Research Institute of SGCC.

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Chun Chun Ni

Chapter 1 Energy Reserves and Resources

1. Coal

According to the Chinese Ministry of Land and Resources (MOLR), as of the end of 2002, China had 186.6 Gt of proved recoverable coal reserves, approximately 14% of the world's total[1]. Of these reserves, 54.4% were bituminous (including anthracite), 29.4% were sub-bituminous, and 16.2% were lignite.

Coal mines are located across most regions in China. However, the northern part of China, including the west of Inner Mongolia Autonomous Region, Shanxi Province, and Shaanxi Province have an abundance of mines containing high quality coal, while coal mines in the southwest contain higher sulfur and ash content coal.

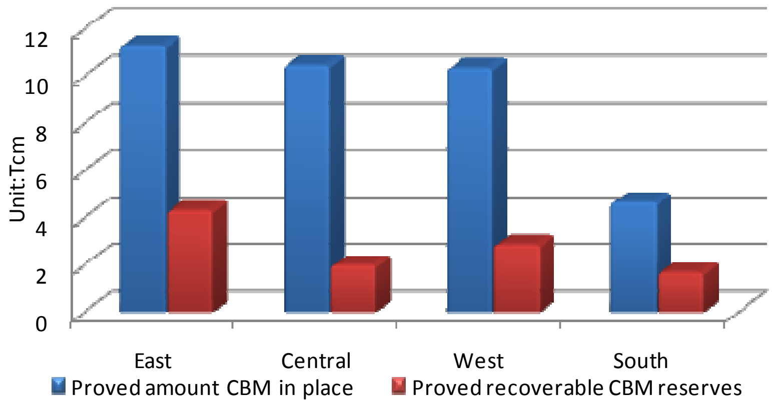
As a relatively large and under-utilized resource, the Chinese government is now paying more attention to coal bed methane (CBM). According to the latest round of China's Petroleum Resources Assessment, carried out by the MOLR (2003-2007), China has 38.6 Tcm of proved CBM resources in place[2]. Major CBM resources are distributed in Eastern, Central, Western, and Southern China, each respectively accounting for 30.8%, 28.4%, 28.1%, and 12.3% of total domestic reserves (Figure 1-1). Though the development of CBM is still in its early stages, the Chinese government plans to increase its annual production from 10 Bcm in 2010 to 40 Bcm by 2020[3]. CBM gas has thus become a supplemental alternative resource to meet China's natural gas needs.

2. Crude Oil

According to British Petroleum (BP), China has 2.1 billion tons of proved recoverable oil reserves as of the end of 2008[4], accounting for just 1.3% of the world's total proved reserves. Though exploration techniques have steadily improved, China's proved oil reserves fell from a ranking of tenth among oil-producing countries in 1995 to fourteenth in 2008 (Figure 1-2). According to MOLR, China's recoverable oil reserves stand at an estimated 21.2 billion tons, of which, 18.3 billion tons are onshore and 2.9 billion tons are offshore[5] (Table

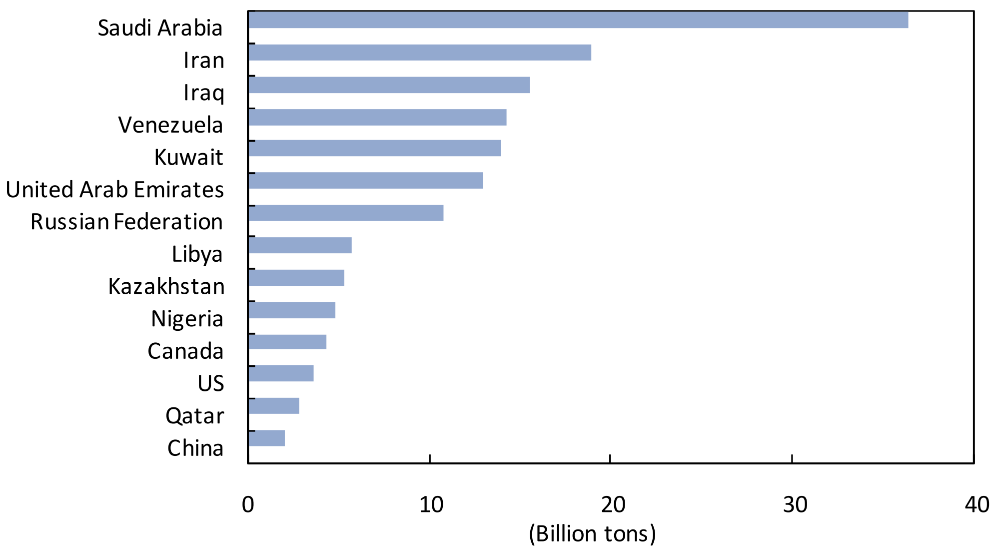
1-1).

Figure 1-1 CBM Resources in Major Regions



Source: MOLR.

Figure 1-2 World Rank of China's Proved Oil Reserves (2008)



Source: *BP Statistical Review of World Energy June 2009*, British Petroleum.

More than 80% of China's oil fields are located onshore (Figure 1-3). The Daqing, Shengli, and Liaohe oil fields together accounted for 44.8% of China's total oil production in 2006, a drop of 22.8% from 1995[6].

Daqing (China's largest oil field) and Liaohe (China's third largest oil field) have matured and production has decreased since 1998 and 1996, respectively. Meanwhile, output at Shengli, China's second largest oil field has been maintained at the same level since 1999.

Table 1-1 China's Recoverable Reserves of Oil and Natural Gas

	Recoverable Oil Reserves (Gt)				Recoverable Natural Gas Reserves (Tcm)			
	95%	50%	5%	Expectated Value	95%	50%	5%	Expectated Value
115 Basins	16.19	21.12	28.71	21.20	15.28	21.55	30.43	22.03
Onshore	14.27	18.25	24.86	18.28	12.68	16.82	22.80	17.08
Offshore	1.92	2.86	3.85	2.93	2.60	4.73	7.63	4.95

Source: MOLR.

Figure 1-3 China's Major Oil Fields

Although the output of older onshore oil fields has peaked, newly found reserves in Bohai Bay seem likely to enhance China's future output. In May 2007, the China National Petroleum Corporation (CNPC), PetroChina's parent company, announced the country's largest discovery in over four decades[7]. The oil field lies in the Nanpu block of the CNPC's Jidong oil field in Caofeidian, Tanshan City, in North China's Hebei Province. It is estimated to contain one billion tons or about 7.35 billion barrels of oil. The Napu block, partly offshore, covers an area of 1,300 to 1,500 square kilometers and is expected to produce light crude.

With geological oil reserves of 600 million tons, Penglai 19-3, located in the south of Bohai Bay is the largest offshore oil field discovered in China. It is a joint venture between the United States oil company ConocoPhillips (49% share) and China National Offshore Oil Corporation (CNOOC, 51% share)[8]. The project's first phase came into operation at the end of 2002 and its second phase went into production in 2008[9].

3. Natural Gas

Natural gas was not a major fuel in China until the beginning of the 21st century. Historically natural gas, a by-product of oil production, has been used primarily as a feedstock in fertilizer production and as an energy source for oil and gas companies' own use. However, to secure the country's energy supply as well as to achieve the government's goal of "constructing modernized cities", utilization of natural gas has now been given priority placement in the country's energy policy agenda.

Since 2000, China's efforts to boost natural gas output and master advanced drilling technology (2D and 3D seismic technology) have led to several successful discoveries of reserves such as the Ordos Sulige, Sichuan Puguang, and Sichuan Longgang gas fields.

China's main onshore reserves of natural gas are located in Sichuan Basin, Tarim Basin, Ordos Basin, Junggar Basin, and Songliao Basin, while offshore reserves are located in the East China Sea Basin, Yinggehai Basin, and Bohai Bay Basin (Figure 1-4). Recent explorations of natural gas fields have increased the country's proved natural gas reserves significantly above China's gas reserves of the late 1990s. According to Cedigaz, China held 2.63 Tcm of proved natural gas reserves at the end of 2008, two times larger than the level in 1998 (Figure 1-5). MOLR estimates that China's recoverable natural gas reserves stand at 22 Tcm, of which 17 Tcm are onshore, and 5 Tcm are offshore (Table 1-1).

Figure 1-4 China's Major Natural Gas Reserves

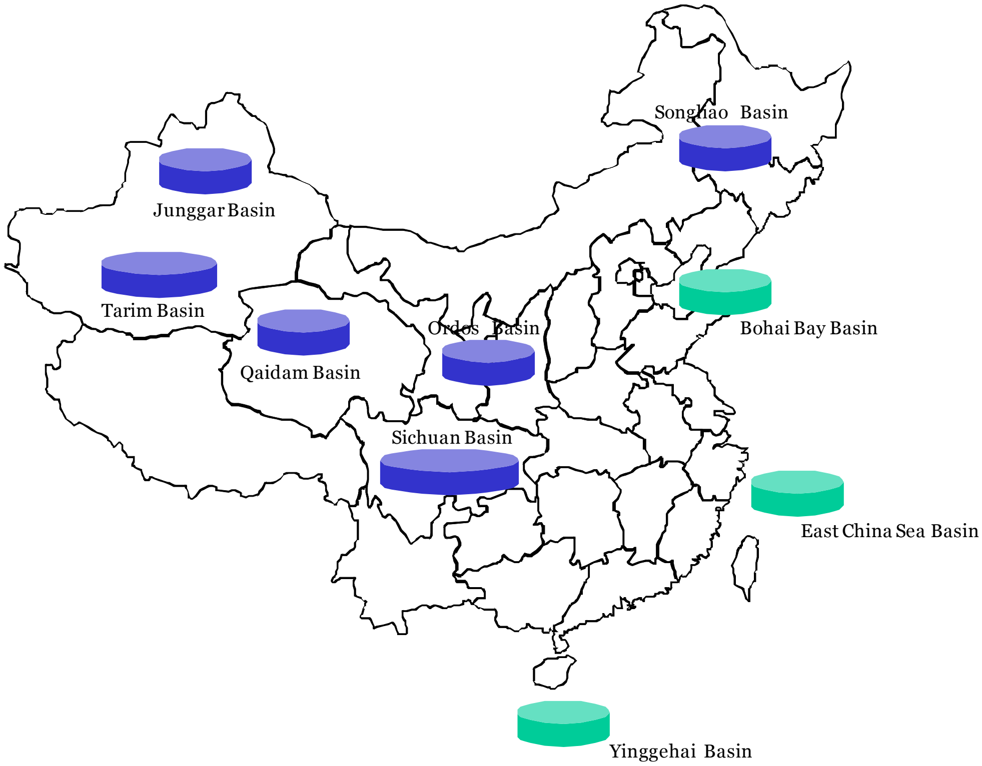
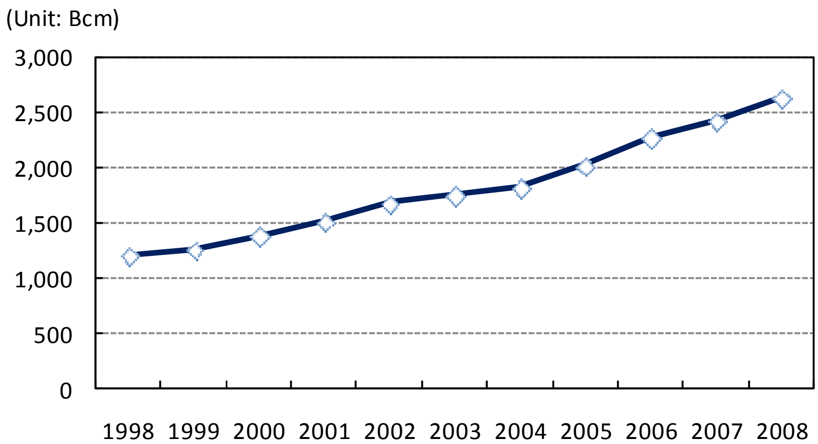


Figure 1-5 China's Proved Natural Gas Reserves (1998 - 2008)



Source: *Natural Gas in the World*, Cedigaz.

4. Uranium

By the end of 2007, China had discovered over 300 uranium deposits with total proved reserves of more than 300,000 tons[10]. The deposits are predominantly medium and small sized and ores are mainly of medium to low grades[11]. China's major uranium resources are located in Jiangxi, Guangdong, Hunan, Guangxi provinces, Xinjiang, and Inner Mongolia regions. In 2008, China National Nuclear Corporation (CNNC) discovered the country's largest uranium deposit in Ordos Basin in the Inner Mongolia Region. It is estimated this basin holds tens of thousands of tons of uranium. Another large deposit was discovered at the same time in Yili Basin in the Xinjiang region, with reserves of over 10,000 tons[12].

Under the Chinese government's plan, the country will have 40 GW to 70 GW of installed nuclear power capacity by 2020. According to the "11th Five-year Plan for the Nuclear Industry" (2006-2010), the country will establish a strategic reserve of natural uranium to ensure that these targets are backed by a stable and reliable fuel supply[13]. The Plan also announced that China will focus on the Yili and Ordos Basins in further exploring domestic uranium resources.

Although China is firmly committed to meeting its uranium demand through 2020 from domestic resources, it is very likely that it will need to further develop uranium resources either domestically or overseas to guarantee meeting long term demand.

5. Hydroelectricity

China's hydroelectric resources are enormous. The country has 378 GW of technically exploitable hydropower reserves capable of producing 1,920 TWh per year and 676 GW of theoretical hydroelectric capacity, which would yield 5,900 TWh per year. Both are the largest such estimated resources in the world[14] (Table 1-2, Table 1-3).

The major hydropower resources are in Southwest China, which includes four provinces and a region: Sichuan, Yunan, Guizhou provinces, and the Tibet region.

As part of its strategy to reduce pollution, the Chinese government has been increasing its investment in hydroelectric projects. According to the power industry's development guideline, the government plans to extend hydropower capacity from 117 GW in 2005 to 190 GW in 2020, an annual growth rate of 10%[15].

Table 1-2 China's Theoretical Hydroelectric Capacity

River Basin	Theoretical capacity (GW)	Annual Generation (TWh)	% of Toal (%)
Changjiang	268	2347.8	39.6
Huanghe	40.5	355.2	6.0
Zhujiang	33.5	293.3	5.0
Hailuanhe	2.9	25.8	0.4
Huaihe	1.4	12.7	0.2
Rivers in Northeast	15.3	134.0	2.3
Rivers in Southeast coastal area	20.7	181.0	3.1
Rivers in Southwest international area	96.9	848.9	14.3
Yaluzangbujiang, Tibet and Other Rivers	159.7	1399.3	23.6
Rivers in North inland and in Xiangjian	37.0	324	5.5
Nation-wide	676.0	5922.1	100.0

Source: State Power Information Network.

Table 1-3 China's Exploitable Hydropower Reserves

River Basin	Exploitable capacity (GW)	Annual Generation (TWh)	% of Toal (%)
Changjiang	197.2	1,027.4	53.4
Huanghe	28	116.9	6.1
Zhujiang	24.9	112.5	5.8
Hailuanhe	2.1	5.2	0.3
Huaihe	0.66	1.9	0.1
Rivers in Northeast	13.7	43.9	2.3
Rivers in Southeast coastal area	13.9	54.7	2.9
Rivers in Southwest international area	37.7	209.9	10.9
Yaluzangbujiang, Tibet and Other Rivers	50.3	296.9	15.4
Rivers in North inland and in Xiangjian	10	53.9	2.8
Nation-wide	378.5	1,923.3	100

Source: same Table 1-2.

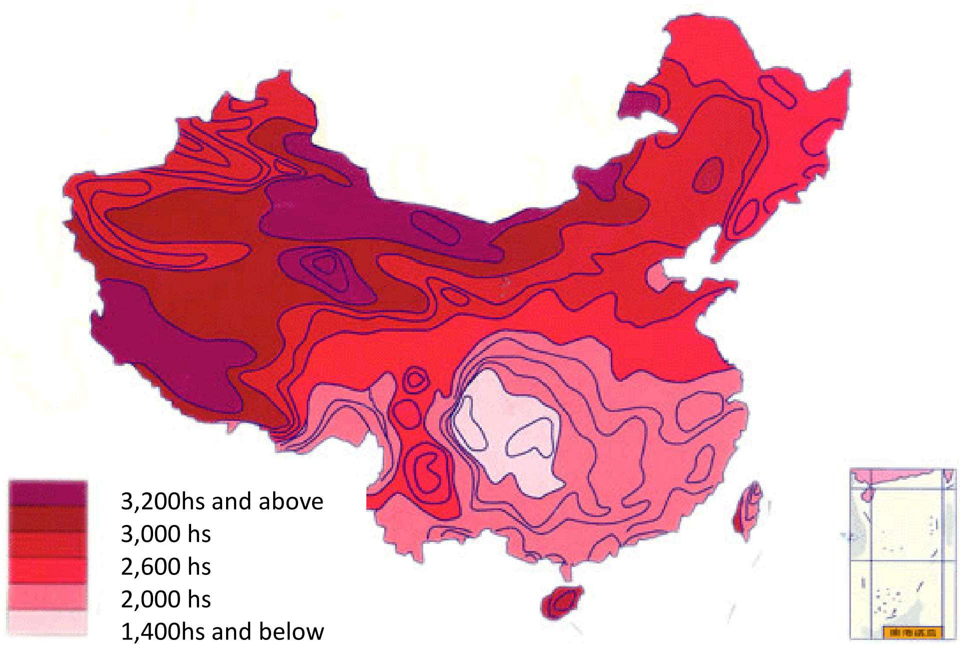
6. Renewable Energy Sources

China's renewable energy sources had not been well integrated into energy planning until the government enacted the *Renewable Energy Law* in February 2005 (the Law took effect on January 1, 2006) amidst a surging demand for energy as well as a growing desire for energy security, pollution reduction, and poverty alleviation.

According to the National Development and Reform Commission (NDRC), China has 300 Mtce of biomass resources[16]. Historically, biogas has been used since 1920 and has been promoted since the late 1970s when the government considered biogas production an effective and rational use of natural resources in rural areas.

China has abundant solar resources that can be utilized to provide electricity and heating. More than two-thirds of China's land area receives an annual total radiation above 5,000 MJ per square meter with more than 2,200 hours of sunshine[17]. Western China, especially Tibet, has the richest solar potential in the country (Figure 1-6).

Figure 1-6 China's Solar Resources

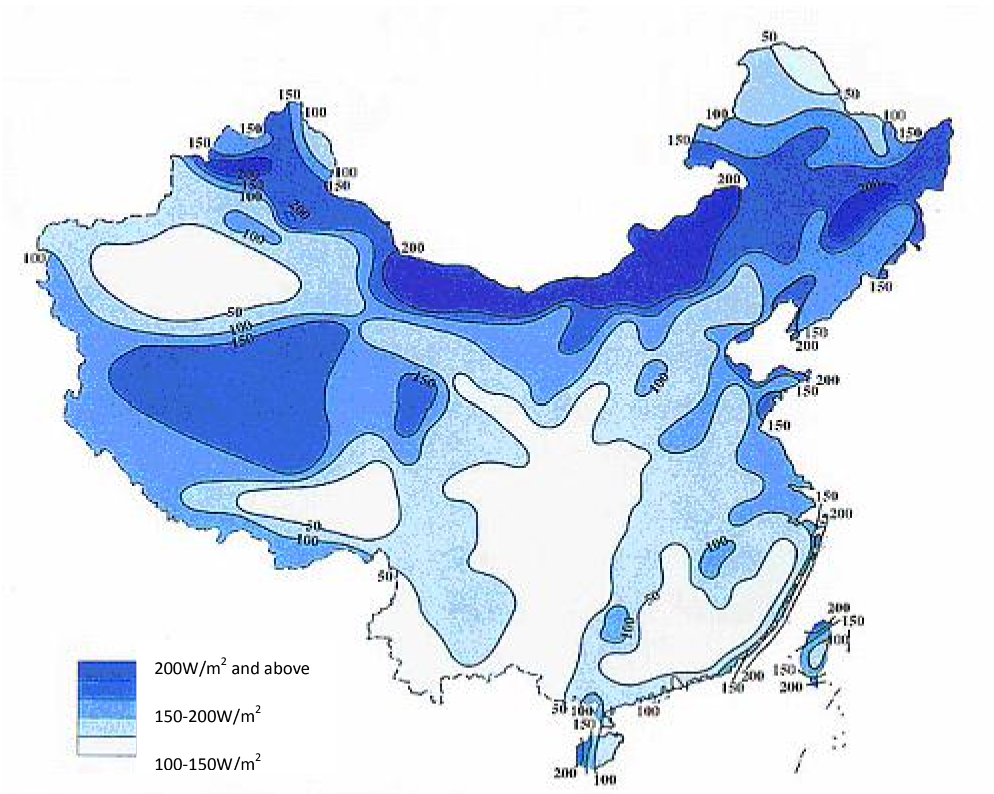


Source: Beijing Diamond Agricultural Science and Technology Development Co., Ltd.

China is also rich in wind power resources. According to the China Meteorological Administration, the theoretical capacity of onshore wind power resources at an altitude of 10 meters is about 3,226 GW. Of this, 253 GW of wind is practical for exploration and utilization. At an altitude of 50 meters, the practical potential resource for exploration and utilization doubles to more than 500 GW. The practical potential offshore wind power resource in coastal waters is 750 GW. As Figure 1-7 shows, wind energy resources are mainly distributed in grasslands or in the Gobi region of Northwest, North and Northeast China, as well as coastal area and inlands in East and Southeast China.

China abounds in exploitable small hydropower resources, scattered in more than 1,500 mountainous counties; economically exploitable resources exceed 90 GW[18], accounting for 22.5% of the country's total economically exploitable hydropower resources. Already many small scale hydropower stations provide much needed electricity for rural areas and villages that are off the power networks.

Figure 1-7 China's Wind Resources



Source: China Meteorological Administration.

High temperature geothermal resources suitable for power generation are mainly concentrated in Tibet, and the western parts of Yunnan and Sichuan provinces. However, all over China's low-to-medium temperature geothermal resources are used extensively for non-electrical direct purposes such as space heating, agriculture, fish farming, and industrial processing.

The utilization of geothermal power generation has been relatively slow compared with hydropower generation. Nonetheless, China is at the top of the list of countries that directly use geothermal energy. The North of China is of particular note here.

Overall, China has abundant renewable energy resources. Establishing a stable and sustainable market demand and creating robust financial incentive policies and mechanism are the most significant factors for the development of China's renewable energy potential.

[1] Tao, Zaipu and M. Li (2007), "What is the limit of Chinese coal supplies—A STELLA model of Hubbert Peak", *Energy Policy*, Vol.35, 2007, pp. 3145–3154; "China's Coal Reserves", China Coal Industry Network, http://www.chinacoal.org.cn/mtzy/254/390.aspx.

[2] "Proved amount in place" refers to the World Energy Conference category, which is defined as "resource remaining in known deposits that has been carefully measured and assessed as exploitable under present and expected local economic conditions with existing available technology."
Assessment Report of Oil, Natural Gas, Coal Bed Methane, Oil Shale, and Oil Sand, Strategic Research Center of Oil and Gas Resources, Ministry of Land and Resources, China, January 19, 2009, http://www.sinooilgas.com/NewsShow.asp?NewsID=10650.

[3] The development progress of CBM in China has been slow. By 2007, the ground production capacity of CBM was only 1 Bcm, and coal mine gas utilization in 2007 was 1.45 Bcm, which are far behind the government target.
Zhang, Guobao, speech at the National Coal Mine Gas Managing Meeting on July 8, 2008, National Development and Reform Commission (NDRC), China, http://zhangguobao.ndrc.gov.cn/zyjh/t20080716_224674.htm.

[4] *BP Statistical Review of World Energy June 2009*, British Petroleum.

[5] *Assessment Report of Oil, Natural Gas, Coal Bed Methane, Oil Shale, and Oil Sand*, Strategic Research Center of Oil and Gas Resources, Ministry of Land and Resources, China, January 19, 2009, http://www.sinooilgas.com/NewsShow.asp?NewsID=10650.

[6] China Energy Group (October 2008), *China Energy Databook v. 7.0.*, Table 2A.1.1, and Table 2B.9, Lawrence Berkeley National Laboratory (LBNL).

[7] "New Oilfield Found in Bohai Bay", *People's Daily*, May 12, 2007.

[8] Takehara, Mika (2003), *Bohai Bay – China's Major Offshore Oil Field*, Japan Oil, Gas and Metal National Corporation.

[9] ConocoPhillips, http://www.conocophillips.com/EN/about/worldwide_ops/country/asia/pages/china.aspx.

[10] "China Looks to Foreign Uranium to Meet Future Demand", *Interfax-China*, June 17, 2008.

[11] Cui, Minxuan (ed.) (2008), *Annual Report on China's Energy Development*, Beijing: Social Sciences Academic Press.

[12] "China Uncovers Country's Biggest Uranium Deposit", *People's Daily*, February 25, 2008.

[13] "11th Five-Year Plan for the Nuclear Industry", August 2006, Commission of Science Technology and Industry for National Defense, China.

[14] "Summary of China's Hydroelectricity Reserves", Sate Power Information Network, http://www.sp.com.cn/zgsd/zgsygk/snygk/200805/t20080515_104298.htm.

[15] Zhao, Xiaoping, "11th Five-year Development Guideline for the Electricity Industry", January 30, 2007, http://www.chinapower.com.cn/article/1063/art1063907.asp.

[16] Biomass means, in general a substantial amount of bio-origin resources which can be utilized in the form of energy and materials. It includes wood, grass, marine product, micro algae, agricultural wastes, forestry wastes, and municipal wastes. Energy crops are one of the most promising biomasses, which could make energy plantation possible on a large scale, though it has some issues that need to be resolved such as "food vs. fuel", and "environment vs. fuel".
Wu, Guihui, presentation paper: *Renewable Energy in China*, September 5, 2007 in Tokyo, Japan.

[17] Wu, Guihui.

[18] Wu, Guihui.

Chapter 2 Energy Production

1. Energy Production Policy

1.1. Coal

Coal is a primary energy source for China, accounting for 75.8% of the country's primary energy production in 2006[1]. In the 11th Five-year Plan, the Chinese government established a basic strategy of "taking coal as the base while seeking diversified energy resources", thus reinforcing a foundation upon which the coal industry could continue to prosper.

China's coal industry has undertaken structural reform and strategy transformation since the late 1990s; however, the "11th Five-year Plan for Development of Coal Industry" (2006-2010) has guided the coal industry's development policies. According to the Plan, the government committed to fully support the development of large coal mines with higher productivity, and will work to strengthen mine safety and environment protections, develop clean coal technology (CCT), as well as reorganize and improve small coal mines.

The development objectives for the coal industry are summarized as follows:

- **Coal supply**: By 2010, coal production will reach 2,600 million tons, of which 1,450 million tons of coal will be sourced from large coal mine producers (56% of total production) and 450 million tons of coal will be produced by medium size coal mine producers (17% of total production). The number of small mines will be limited to around 10,000 sites and production will be less than 700 million tons, which accounts for 27% of total production. Meanwhile, 1,300 million tons or 50% of total raw coal produced will be washed coal.
- **Construction of coal mines**: During the 11th Five-year Plan period, the industry will transform small mines into medium or large coal mines through mergers and consolidation. This is expected to increase total yield by 200 million tons over the five years. The capacity of new commercial coal mines (a figure which includes the reconstruction and improvement of small mines) will reach 450 million tons, providing 200 million tons coal for production. The industry will also focus on the construction of 10 modernized open cast coal pits with an annual output of 10 million tons

each and 10 high-efficiency modernized underground coal mines with the same output level each. Exploration of coal resources will also be enhanced and 150 billion tons of coal reserves is expected to be evaluated during this period.

- **Developing large enterprise groups**: To develop and diversify coal mine companies' business strategies, 6 to 8 gigantic coal conglomerations, each with 100 million tons of annual output, and 8 to 10 super large coal enterprises each with 50 million tons of annual output, will be established during this period. Output from these large coal enterprises will account for more than 50% of national production.
- **Improving technology**: The industry has set for itself the goal of strengthening and improving its level of mining automation. Large coal mines' automation level will reach above 98%, medium size coal mines' will reach above 89%, and small scale coal mines' automation and semi-automation level will reach 40% within the next few years. By 2010, the country will have a total of 380 secured, high-efficiency coal mines, comprising 45% of domestic coal production.
- **Improving coal mine safety**: The fatality rate for industry employees per million tons of coal should decline to less than 2.0% by the end of 2010.
- **Protecting the environment**: In order to improve the quality of coal and decrease environmental pollution, 70% of coal wastes and coal mine water will be reutilized. All coal mine water discharge will meet 100% of the government's water quality standards for such effluent. The amount of coal washing water to be recycled and the proportion of coal refuse fire extinguishment will reach 80% and 95%, respectively. The rate of land recovery will be over 40%.
- **Others**: During the 11th Five-year Plan period, the industry will save energy resources equivalent to 60 million tons of standard coal. The industry will also utilize 10 billion cubic meters CBM gas.

To accomplish the above targets, the industry has also set for itself the following concrete development tasks:

- Optimizing the geologic distribution of coal resources
- Adjusting coal production (Table 2-1)
- Building 13 large scale coal mine bases

- Encouraging gigantic coal-based conglomerates
- Restructuring and upgrading small-to-medium size coal mines (Table 2-2)
- Innovating in sciences and technology

Table 2-1 Coal Production Plan by Province (2005-2010)

(Unit: Mt)

Region	2005	2010
1. Jing-Jin-Ji Region	95.4	88
Beijing	9.0	3
Hebei	86.4	85
2. Jin-Shan-Meng-Ning Region	989.0	1,315
Shanxi	554.3	680
Shaanxi	152.5	200
Inner Mongolia	256.1	380
Ningxia	26.1	55
3. Northeast China Region	95.4	88
Liaoning	64.0	61
Jilin	27.2	30
Helongjiang	95.0	100
4. East China Region	297.7	332
Jiangsu	28.2	25
Zhejiang	0.4	-
Anhui	84.9	120
Fujian	18.2	16
Jiangxi	25.7	21
Shandong	140.3	150
5. Central-South China Region	265.8	255
Henan	187.6	185
Hubei	10.1	10
Hunan	57.3	52
Guangdong	3.8	-
Guangxi	7.0	8
Hainan	-	-
6. Southwest China Region	290.1	316
Chongqing	36.2	32
Sichuan	81.3	81
Guizhou	108.0	125
Yunnan	64.6	78
7. Xin-Gan-Qing Region	80.8	103
Gansu	36.2	44
Qinghai	6.0	9
Xinjiang	38.6	50
Total	**2,205**	**2,600**

Source: The "11th Five-year Plan for Development of Coal Industry", January 1, 2007, NDRC.

- Enhancing coal mine safety at work
- Constructing new mines which incorporate energy efficiency and environmental protection features

Table 2-2 Output Control Target for Small Coal Mines (2005-2010)

	2005		2010	
	Total amount of coal mines	Output (1,000 t)	Total amount of coal mines	Output (1,000 t)
1. Jing-Jin-Ji Region	652	31,800	300	15,000
Beijing	52	5,500	0	-
Hebei	600	26,300	300	15,000
2. Jin-Shan-Meng-Ning Region	4,592	381,810	1,620	241,000
Shanxi	3,124	184,000	1,100	115,000
Shaanxi	769	69,900	250	50,000
Inner Mongolia	602	126,510	200	75,000
Ningxia	97	1,400	70	1,000
3. Northeast China Region	2,639	69,120	1,100	53,000
Liaoning	939	16,850	300	11,000
Jilin	370	9,650	200	8,000
Helongjiang	1,330	42,620	600	34,000
4. East China Region	1,639	75,440	918	53,000
Jiangsu	18	3,610	18	2,000
Zhejiang	4	500	0	-
Anhui	265	9,700	100	6,000
Fujian	397	17,500	300	15,000
Jiangxi	767	19,870	400	15,000
Shandong	188	24,260	100	15,000
5. Central-South China Region	3,108	179,690	1,830	125,000
Henan	698	108,000	500	65,000
Hubei	691	6,000	200	6,000
Hunan	1,646	56,190	1,100	50,000
Guangdong	18	4,000	0	-
Guangxi	55	5,500	30	4,000
6. Southwest China Region	7,211	224,230	3,757	177,000
Chongqing	1,287	28,480	700	22,000
Sichuan	1,975	64,400	1,300	60,000
Guizhou	2,143	86,300	1,000	60,000
Yunnan	1,806	45,050	757	35,000
7. Xin-Gan-Qing Region	781	43,380	475	36,000
Gansu	340	8,830	200	7,000
Qinghai	29	1,400	25	1,000
Xinjiang	412	33,150	250	28,000
Total	**20,622**	**1,005,470**	**10,000**	**700,000**

Source: Same as Table 2-1.

1.2. Oil and Natural Gas

China became a net importer of oil in 1993, prior to which the country not only produced most of the oil it needed but exported some oil as well. However, since oil output from the three main oil producing zones peaked in the middle of 1990s, policies for the oil and natural gas industry have increasingly focused on more strategic and security considerations. During the last few years, several guidelines and plans have begun to show that these are the dominant concerns being addressed by the central government's oil and gas strategy.

In its 10th Five-year Plan (2000-2005), the government planned to start a state strategic oil reserve base program in three phases over 15 years as a way to offset oil supply risks and reduce the impact of worldwide fluctuating energy prices on China's domestic market for refined oil. Based on this plan, the country decided to establish its first four strategic oil reserve bases in Dalian, Qiangdao, Ninbo, and Zhoushan (Table 2-3). They are designed to maintain 30-day strategic oil reserves of an equivalent to about 10 million to 13 million tons by 2010. Construction of the first four oil reserves began in 2004. The earliest to begin operations was the Zhenhai Reserve in Ninbo City, Zhejiang Province, which was completed in 2006. By the end of 2008, the other three had started operations as well. Sites for the 8 oil reserves of phase two with a total of 28 million tons stock capacity were also decided by the National People's Congress Meeting in March 2009.

To better administer the country's national oil reserve system, in December 2007 the government set up the Oil Reserve Center. The Oil Reserve Center takes responsibility for building and administering the country's strategic oil reserves as well as keeping an eye on the movement of demand and supply in both domestic and international oil markets[2].

Table 2-3 China's Current Strategic Oil Reserve Bases

Base	Province	Operator	Tank Capacity (1,000 kl)
Zhenhai	Ninbo, Zhejiang	Sinopec	5,200
Huangdao	Qingdao, Shandong	Sinopec	3,000
Daishan	Zhoushan, Zhejiang	Sinochem	5,000
Dalian	Liaoning	PetroChina	3,000
Total			**16,200**

Source: Takehara, Mika, *China: Soon Will Start Its State Oil Reserve*, JOGMEC, February 4, 2005.

In both the 11th Five-year Plan and the "11th Five-year Plan for Development of Energy" (2006-2010), the Chinese government advocated accelerating the development of the oil and gas industry. Major objectives highlighted by the government are as follows:[3]

- Expand and improve the exploration and development of oil and natural gas resources. Strengthen the exploration and evaluation of oil and natural gas resources. Expand the area of exploration and intensively exploit offshore areas, major oil and gas basins and new onshore oil and gas areas. Promote the exploration and research of coal bed methane gas, oil shale, oil sands, as well as methane hydrate and other non-conventional types of oil and gas-related energy resources and promote the diversification of exploration and development companies.
- Stabilize the increase in crude oil production and implement approaches to increasing the production of natural gas at the same time. Carry out maintenance and modification of aging oil fields to attain stable production and slow down the rate of production decreases. Advance oil and gas development rates in areas such as the deep sea, Tarim, Junggar, Ordos, Qaidam, and Sichuan basins. Widen exploitation and cooperation in overseas oil and gas areas. Firmly maintain equal cooperation and mutual benefits and profits, and establish LNG importation projects along the coast in a timely manner. Domestic oil production will reach 192 million tons in 2009, 196 million tons in 2010, and 198 million tons in

2011, respectively. Meanwhile, domestic natural gas production will reach 86 Bcm, 105 Bcm and 120 Bcm, respectively[4].

- Advance the planning and construction of main oil and gas pipelines and complete a national oil and gas pipeline network. Construct the West-East petroleum and gas pipelines that deliver oil and gas from the West to the East, and the Northeast-South petroleum and gas pipelines that transport oil and gas from the Northeast to the South. Strengthen the construction of trunk oil and gas pipelines and increase the branch pipelines and inter-connecters.
- Implement oil conservation and accelerate the development of oil substitute projects such as ethanol, hydrogen, oil from coal, methane, and biodiesel.
- Restructure the distribution of the refinery industry based on the location of refinery bases, refinery capacities and industrial unification. In areas where consumption of petroleum products is concentrated, expand refinery capability at an appropriate pace, focussing on the expansion of refining capacities. In areas where there are no oil refineries but high consumption of petroleum products, plan the construction of new refineries in a rational manner. In areas where petroleum refinery capacity is relatively redundant, constrain the size of refining activities and close less efficient smaller refineries.
- Promote oil and gas pricing reform.
- Accelerate the construction of state strategic oil reserve bases and encourage development of commercial oil reserves.
- Diversify oil importation, exploration and development investments. Strengthen international energy cooperation with "win-win" policies.

1.3. Electricity

China's power sector, unlike its oil and gas industry which has attracted tremendous attention from international society, has a greater impact on the country's domestic energy supply, economic stability, and environmental sustainability. Power shortages have been a chronic issue since the middle of the 1980s because of the government's inconsistent electricity sector development policies. Significant under-investment through the late 1970s and early 1980s and under-estimating the demand for power during the Asian financial crisis that started in 1997 caused serious power outages from the mid-1980s well into the mid-2000s. Therefore, alleviating electricity supply shortages has been made a long term priority for China's electric power sector.

To meet the country's electricity needs, thermal power plants of 100 MW and less were the focus of major investment in the early years of the new millennium. Such plants were relatively inexpensive and required a construction lead-time of only two to three years. However, to cope with the deteriorating air pollution situation that was caused principally by coal-fired power plants, the government decided to encourage the installation of large-scale, high-efficiency thermal power plants. In doing so, the government aimed to promote hydropower development and to improve the quality of power grid network. Central electricity development policy shifted from small-size to large-size advanced thermal power plants, from thermal power to hydropower, nuclear power and renewable energy sources, and from generation capacity development to power grid construction. These shifts have been reflected in both the "10th Five-year and 11th Five-year Plan for Development of the Electric Power Industry" as well as the "11th Five-year Plan for Development of Energy".

Major polices of the power sector from 2000 are as follows.

- **Promote market and electricity pricing reform**: Continually promote competition in the generation sector. Introduce Time-of-Use (TOU), Seasonal, and Peak and Off-peak pricing schemes; implement Demand-Side-Management (DSM), and establish preferential pricing policies for renewable and clean energy sources; and implement a bilateral power purchase pilot program. Gradually establish generation, transmission and distribution pricing mechanism.
- **Strengthen the construction of the Electric Grid Network**: Construct three electricity transmission routes that transport power from the West to the East of the country and construct cross-region power transportation and distribution networks. Continue to promote the development of West-East, North-South and nation-wide power grids. Strengthen the construction of regional and provincial power networks through the development of transportation and distribution networks. Enhance the construction and reform of the power networks in both urban

and rural areas, and improve local distribution networks in urban and rural areas. Extend the power supply territory and enhance the reliability of the power supply.

- **Aggressive development of hydropower**: Construct hydropower bases on the Jinsha, Yalong, Lancang and upper Yellow rivers, and establish large-scale hydropower stations in Xiluodu and Xiangjiaba, while also developing a number of pumped storage hydropower plants.
- **Optimize the development of thermal power generation**: Optimize the development of thermal power generation through the development of high efficiency and environmentally friendly large-scale electric power plants. Install large-scale ultra-super critical power plants as well as air-cooled power plants. Promote clean coal technology, construct 600 MW (per unit) circulating fluidized bed (CFB) power plants, and launch gas-based combined cycle electric generation projects. Encourage the development of coal-mine power stations and the construction of large-scale coal based thermal power generation bases. Speed up the closure of outdated small-scale thermal power plants.
- **Aggressive development of nuclear power**: Aggressively promote nuclear power generation through the construction of 1 GW class reactors and through the domestic design, manufacture, construction, and operation of advanced pressurized water reactor (APWR) nuclear power plants. Install 10 GW of nuclear power capacity by 2010 and 40 GW by 2020. Strengthen exploration, mining and processing technologies for uranium resources and enhance training and education of human resources in the nuclear energy field.
- **Proper development of gas-fired thermal power**: Properly introduce gas-fired combined cycle power plants into coastal regions and mega cities, depending on the development of domestic natural gas supplies, the construction of the West-East pipeline, and the price movement of international gas market (a total of 36 GW gas-fired power plants are planned by 2010[5]). Promote the utilization of domestic natural gas resources and increase peak shaving within power grids. Accelerate the reform of gas pricing mechanisms.
- **Accelerate the development of renewable energy sources**: Encourage renewable energy production and consumption through favourable financial, and investment policies and enforce a mandatory

market share policy for renewable energy generation. Increase the percentage of renewable energy in primary energy consumption. Greatly develop wind power by constructing thirty 100 MW wind farms and four GW class wind farms in the Inner Mongolia region, Hebei, Jiangsu, and Gansu provinces. Accelerate development of biomass energy and support the development of biomass power generation by burning municipal solid waste and agricultural wastes. Expand the production of solid biomass fuel, bio-ethanol, and bio-diesel. By 2010, on-grid wind power generation capacity will reach 5 GW and biomass generation capacity will reach to 5.5 GW. In addition, the power industry will actively develop and utilize solar energy, geothermal, and ocean energy (for more details, please also see the energy production policy for Renewable Energy Sources - 1.4.).

- **Protect ecological environment**: By 2010, the power industry will reduce SO2 emissions from coal-fired thermal power plants to 2.7g/kWh and limit total annual SO2 emissions to under 10 million tons. Increase the capacity of generation from fuel gas desulfurization (FGD) systems to 300 GW. Reduce soot emission to less than 12g/kWh and annual emissions to under 3 million tons. Waste-water discharges will meet 100% of the government's standard level. Encourage generators to control NOx emission.
- **Enhance energy efficiency**: The power industry will encourage the adoption of advanced efficiency technologies and will install high efficiency power plants and transmission and distribution network systems. Improve dispatching order policies and promote DSM. Shut down small-scale, inefficient power plants and decrepit transmission and distribution facilities. Install a total of 45GW of highly efficient and environmentally friendly co-generation units mainly in areas with concentrated heat loads or that have relatively bigger development potential. Greatly develop clean coal technology including constructing IGCC CFB pilot projects.

Table 2-4 FGD Conversion Plan for Existing Coal-fired Power Plants (2006-2010)

Year	The 11th Five-year period	2006	2007	2008	2009	2010
Target of FGD capacity (GW)	136.6	57.6	37.5	28.7	12.8	0.0
% of total target (%)	100.0	42.2	27.4	21	9.4	0

Source: The "11th Five-year Plan for SO_2 Pollution Control of Existing Coal-fired Power Plants", March 2007, NDRC and Ministry of Environmental Protection.

Table 2-5 FGD Conversion Plan by Unit Capacity (2006-2010)

Unit capacity	Under 100 MW	100 MW - 200 MW	200 MW - 300 MW	300 MW - 600 MW	Above 600 MW
Capacity of FGD power plants (GW)	0.2	16.9	24.4	71.0	24.1
% of total FGD power plants (%)	0.2	12.3	17.9	52.0	17.6

Source: Same as Table 2-4.

Table 2-6 FGD Conversion Plan by Power Company (2006-2010)

	The 11th Five-year period (GW)	2006 (GW)	2007 (GW)	2008 (GW)	2009 (GW)	2010 (GW)
State Grid Corporation	7.4	2.2	1.8	2.5	0.8	0
Huaneng Group	17.6	7.8	3.1	5.0	1.7	0
Datang Corporation	18.1	9.8	4.3	2.5	1.5	0
Huadian Corporation	9.3	5.6	1.0	1.8	1.0	0
Guodian Corporation	13.6	5.2	3.1	1.7	3.6	0
China Power Investment Corporation	10.3	4.8	3.0	1.5	1.0	0
Local power companies, etc.	60.3	22.3	21.1	13.8	3.1	0
Total	**136.6**	**57.6**	**37.5**	**28.7**	**12.8**	**0**

Source: Same as Table 2-4.

Table 2-7 Energy Efficiency Target for Power Industry (2006-2010)

Year	Coal consumption per unit of electricity (g/kWh)	Internal use of electricity over total generation (%)	Power transmission loss rate (%)
2005	370	5.9	7.18
2010	355	4.5	7.0

Source: The "11th Five-year Plan for Development of Energy", April 2007, NDRC.

China's desire for the development of nuclear power increased significantly after 1976, however, economic retrenchment and the Three Mile Island incident in the United States abruptly halted the country's nuclear program. Following three years of "investigation and demonstration" in the mid-1980s, China decided to proceed with nuclear power development. China's first commercial plant, Qinshan, a 300 MW domestically-designed nuclear plant went online in 1991. Subsequently nuclear power was developed gradually and discreetly. However, because of the severe power shortages from 2002 onwards and the country's deteriorating air quality, the strategy for the nuclear power industry in China has been altered to one of vigorous development. In the "11th Five-year Plan for Development of the Nuclear Power Industry" (2006-2010) and the "Middle and Long Term Development Plan for Nuclear Power" (2005-2020), China committed to enlarging its nuclear generating capacity to 10 GW by 2010 and to 40 GW by 2020[6].

The key elements of the nuclear energy policy set by the central government are as follows[7]:

- Make pressurized water reactors (PWRs) the principal but not the sole reactor type.
- Maximize domestic manufacturing of plant and equipment with self-reliance in design and project management.
- Continue the "Closed Nuclear Fuel Cycle" policy and supply nuclear fuel by using indigenous uranium resources as well as internationally acquired resources[8].
- Construct middle and low level radiation waste repositories and construct an underground research laboratory for a high-level waste repository before 2020.
- Encourage international cooperation.

Table 2-8 China's Development Plan for Nuclear Power (2005-2020)

(Unit: GW)

Five-year period	Newly installed capacity during the Five-year period	New commerical capacity during the Five-year period	Total commerical capacity by the end of Five-year period
Before 2000			2.3
2000-2005	3.5	4.7	6.9
2006-2010	12.4	5.6	12.5
2011-2015	20.0	12.4	25.0
2016-2020	18.0	20.0	45.0

Note: The NDRC recently revised its nuclear target from 4% to 5% of total installed electric Power capacity by 2020 (approximately 80 GW).
Source: The "Middle and Long Term Development Plan for Nuclear Power", October 2007, NDRC.

1.4. Renewable Energy Sources

The Chinese government has recognized the importance of developing renewable energy for use in off-grid rural and remote areas and therefore has supported the development of small hydropower, biogas, and small wind turbines to provide energy and electricity to isolated populations since the 1970s. However, China's early efforts to promote renewable energy through governmental policies have had limited impact on the utilization of its renewable energy resources[9]. Aiming to increase the proportion of renewable energy in China's overall energy mix, in February 2005 the Chinese government passed landmark legislation, the *China Renewable Energy Law*, which went into effect in January 2006. This law provides financial incentives for some technologies and establishes grid purchase requirements and standard purchasing procedures. The law also establishes cost-sharing mechanisms among utility consumers and creates government renewable energy subsidies and financial support for the use of renewable energy in rural areas. The law also provides for a long term development plan, research, geographic resource surveys, technology standards, and building codes for integrating solar hot water into new construction[10]. To implement specific sectoral developments called for in the law, a series of regulations and directions were formulated afterwards, as shown in Table 2-10. In addition, other national standards for resources surveying, as well as technology and financial policies, are being drafted.

Table 2-9 Middle and Long Term Development Plan for Renewable Energy (2005-2020)

	2005	2010	2020
Hydropower (GW)	117	190	300
Wind power (GW)	1.26	10	30
Biomass power (GW)	2	5.5	30
Biogas (Gm3)	8.5	19	44
PV (MW)	70	300	1800
Solar water heater (Mm2)	80	150	300
Bio-ethanol (Mt)	1.02	2	10
Total renewable energy (Mtce)	166	300	530
% of total energy consumption (%)	7.5	10	15

Note: Figures for 2005 and 2010 are cited from the "11th Five-year Plan for Development of Renewable Energy", while Figures for 2020 are extracted from the "Middle and Long Term Development Plan for Renewable Energy".
Although the government's official target for wind power is 30 GW by 2020, the wind power industry plans to reach a target of 150 GW by 2020.
Source: The "11th Five-year Plan for Development of Renewable Energy", March 2008, NDRC; "Middle and Long Term Development Plan for Renewable Energy", August 2007, NDRC.

Table 2-10 Regulations Issued under the Renewable Energy Law (As of March 2009)

Regulation/Direction	Date	Issued by
Regulation on the Administration of Power Generation from Renewable Energy	Jan. 2006	NDRC
Provisional Administrative Measures on Pricing and Cost Sharing for Renewable Energy Power Generation	Jan. 2006	NDRC
Guiding Catalogue for Development of the Renewable Energy Industry	Jan. 2006	NDRC
Regulation Governing the Use of the Renewable Energy Development Fund to Promote Renewable Energy Integration in Buildings	Apr. 2006	Ministry of Finance, Ministry of Housing and Urban-Rural Development
Provisional Administrative Measures on the Renewable Energy Development Fund	May 2006	Ministry of Finance
Renewable Energy Surcharge Level Regulation	July 2006	NDRC
Regulation on the Management of Bio-ethanol Projects	Dec. 2006	NDRC
Regulation on Promoting Wind Power Industry	Dec. 2006	NDRC
Provisional Regulation on Renewable Energy Surcharge Balancing	Feb.2007	NDRC
Middle and Long Term Plan for Development of Renewable Energy	Aug. 2007	NDRC

Source: Shi, Jingli, *Overview of China's Renewable Energy Policy Framework: China's Renewable Energy Law and Regulations*, Center for Renewable Energy Development, Energy Research Institute, NDRC, Presentation paper on September 5, 2007 in Tokyo.

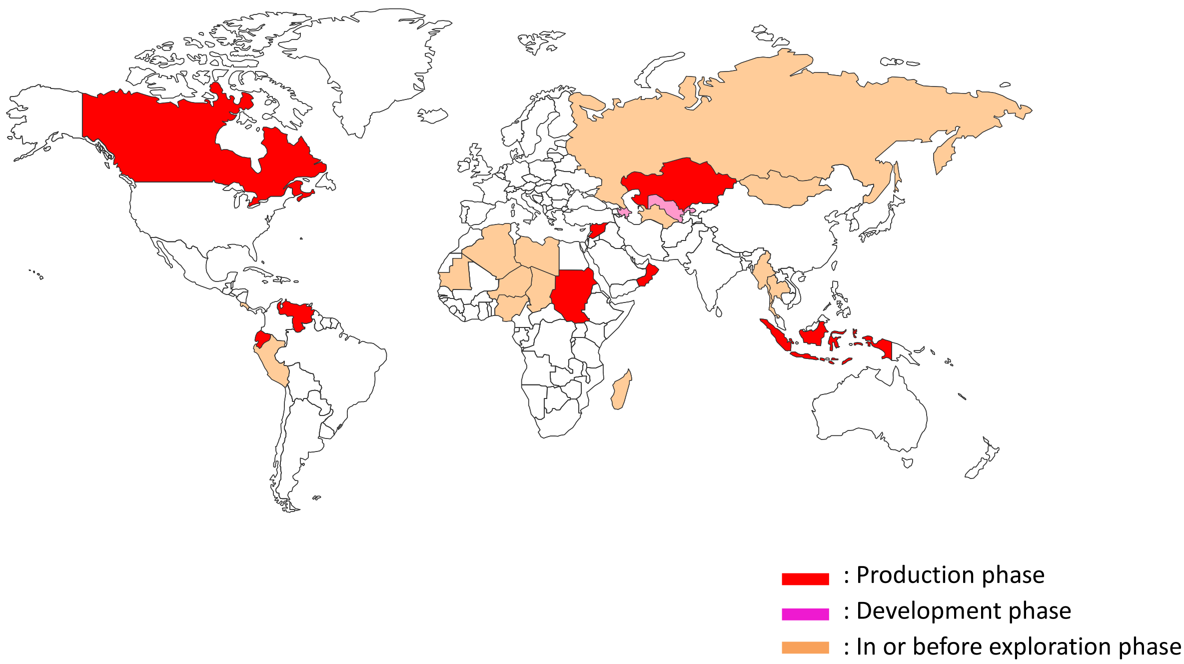
1.5. Energy Diplomacy

Since the beginning of the 21st century, China's energy diplomacy has attracted much international attention, due mainly to China's growing economic potential and the demand increase this growth causes in the international market. Faced with the concerns and suspicions of the outside world, the Chinese government has continued its soft power approach on energy security, while also announcing that the country will be a defender of world peace and be a responsible stakeholder on the international stage. China relies on oil supplies from a number of countries disfavored by the developed West, such as Sudan, Venezuela, Nigeria, and Iran. Beyond this, however, China has also taken the initiative to establish the Shanghai Cooperation Organization, together with Russia and Central Asian countries, to protect China's energy-related and other national interests.

During the past decade, China has developed much closer relationships with countries that had relatively limited interactions with China in the past. From the 1990s onwards, Chinese national oil companies began to turn their attention to central Asia, Africa, Latin American, Canada, and Australia as potential new sources for oil. They have become more aggressive in those regions by making energy-related asset investments and equity-financed oil purchases since the early 2000s (Figure 2-1). In addition to attaining oil resources, China's energy diplomacy efforts across the world also reflect its other diverse needs, as summarized in Table 2-11.

After the dramatic fall in oil prices since the Summer of 2008 and the world-wide economic recession, the Chinese government has adapted the trajectory of its diplomatic momentum in a new round of energy diplomacy, for instance the "loans for oil" proposals. In the beginning of 2009, China signed oil supply deals with Russia, Brazil, and Venezuela, totaling more than US $41 billion. The deal with Russia was finally concluded after nearly 15 years of negotiations between the two countries to extend a key oil pipeline from Siberia to Northeastern China. The agreement provides Russia's oil giant Rosneft and its oil pipeline company Transneft with a $25 billion loan in exchange for 15 million tons of oil a year for 20 years[11]. At the same time, the National Energy Administration has agreed to establish a special fund – to be used for programs such as low-interest loans or direct capital injections – by using a portion of its foreign-exchange reserves to support China's state-owned oil companies acquisition of overseas energy resources[12]. However, importantly this may provoke cautionary reactions from other countries, as exemplified in 2005 when CNOOC was forced to withdraw its offer to purchase the American oil company Unocal due to political pressure from the U.S. Congress.

Figure 2-1 China's Overseas Oil and Natural Gas Development



Source: Kobayashi, Yoshikazu, *Chinese NOC's Corporate Strategies*, presentation paper on September 17, 2008, at The Institute of Energy Economics, Japan (IEEJ), Tokyo.

Table 2-11 China's Energy Diplomacy in Different Regions and Countries

Region/Country	Major Focus
Middle East	• Oil and LNG supply • Regional stability such as Iran's nuclear weapon program
Central Asia	• Oil and natural gas supply • Geopolitics such as Russia vs. Central Asia over energy resources
South Asia	• Supply of natural resources such as LNG and coal, etc. • Geopolitics i.e. safety of Malacca Strait
East Asia	• Supply of oil, natural gas, and coal

Africa	• Oil supply • Taiwan issue • Political influence
Latin America	• Supply of natural resources such as oil, mineral, etc.
Europe	• Clean Development Mechanism (CDM) • Energy related advanced equipment and high technology, such as nuclear power reactor (EPR).
Australia	• Supply of natural resources such as LNG, mineral, etc.
Japan	• Energy efficiency • Clean coal technology • CO_2 Capture and Storage (CCS) at Daqing oil field • Joint natural gas development in East China Sea
US	• Energy Efficiency • Energy related advanced equipment and high technology, such as nuclear power reactor (AP-1000)

2. Energy Regulation

China's energy administration has operated in a highly dynamic regulatory environment since 1949 and hence the industry has witnessed the development of a series of regulatory institutions that generally lack the authority, autonomy, resources, and tools to sufficiently govern the energy sector (Table 2-12). The splintering of energy sector regulatory authority into multiple institutions, some of which are understaffed, underfunded, and politically weak, has impeded coordination across industries and ministries, frustrating the formulation, implementation, and enforcement of energy policies. Consequently, regulating China's energy administration system has been the subject of intense debate in recent years as the country grappled with an unexpected surge in energy demand, growing dependence on energy imports, rising global energy prices, and periodic domestic energy shortages.

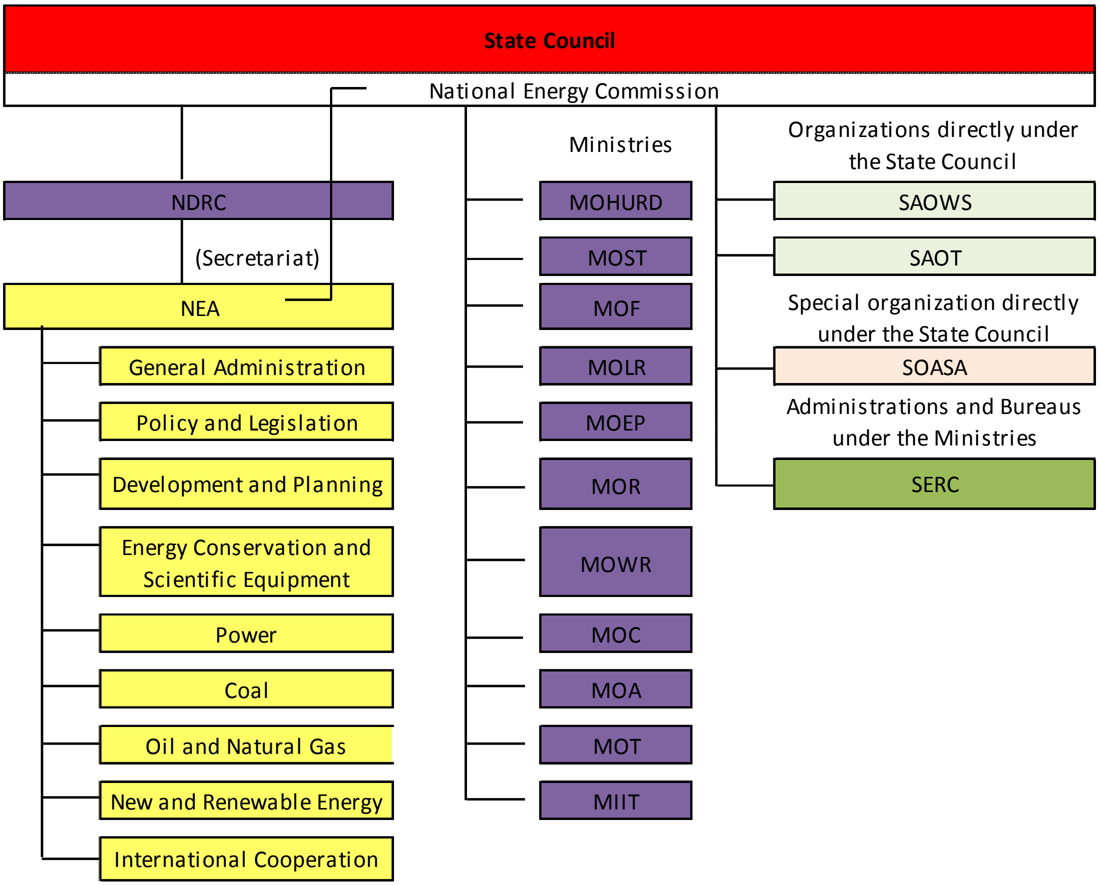
Authority over China's energy sector at the national level is segmented among more than a dozen government agencies, the most important of which is NDRC (Figure 2-2)[13]. Even within NDRC, responsibility for energy policy development and implementation is similarly scattered among multiple departments. Prior to the March 2008 restructuring, NDRC's Bureau of Energy had a broad mandate to manage the energy sector but lacked the authority, tools, and staff to fulfill it. In 2005, China set up the National Energy Leading Group as an advisory and coordinating body directly under the State Council, headed by Premier Wen Jiabao. The establishment of the Leading Group reflected China's recognition of the need to strengthen energy sector governance.

Table 2-12 History of China's Energy Governance Structure

Year	Energy Related Department	Economy System
1949	Ministry of Fuel Industry	
1954	Ministry of Coal, Ministry of Electric Power, Ministry of Oil	Planned economy
1970	Ministry of Fuel and Chemical Industry	
1975	Ministry of Coal, Ministry of Oil and Chemistry, Ministry of Water Resources and Electric Power	
1978	Ministry of Coal, Ministry of Oil, Ministry of Chemical Industry, Ministry of Water Resources and Electric Power,	
1979	Ministry of Coal, Ministry of Oil, Ministry of Chemical Industry, Ministry of Water Resource, Ministry of Electric Power	Reform and Open-door policy
1982	Ministry of Coal, Ministry of Oil, Ministry of Chemical Industry, Ministry of Water Resources and Electric Power	
1988	Ministry of Energy	
1993	Ministry of Coal, Ministry of Electric Power, Bureau of Oil and Chemical Industry	
1998	Bureau of Coal Industry, Bureau of Oil and Chemical Industry	
2002	The State Electricity Regulatory Commission	Social market economy
2003	Bureau of Energy	
2005	Office of National Energy Leading Group	
2008	National Energy Administration	

To further improve energy governance, in March 2008, the National People's Congress (NPC) approved a plan to establish the National Energy Administration (NEA) and the National Energy Commission (NEC). NEA, which replaced NDRC's Bureau of Energy, handles NEC's daily affairs. NEA also absorbed other energy offices from NDRC, the office of National Energy Leading Group, and the office of Nuclear Power Administration of the Commission of Science, Technology, and Industry for National Defense. The NEA now consists of nine departments with 112 staff. Its main responsibilities include drafting energy development strategies, managing the country's energy industries, proposing and advising reforms, putting forward policies of exploring new energy resources and technologies and carrying out international cooperation among others[14].

Figure 2-2 Organization of China's Energy Administration



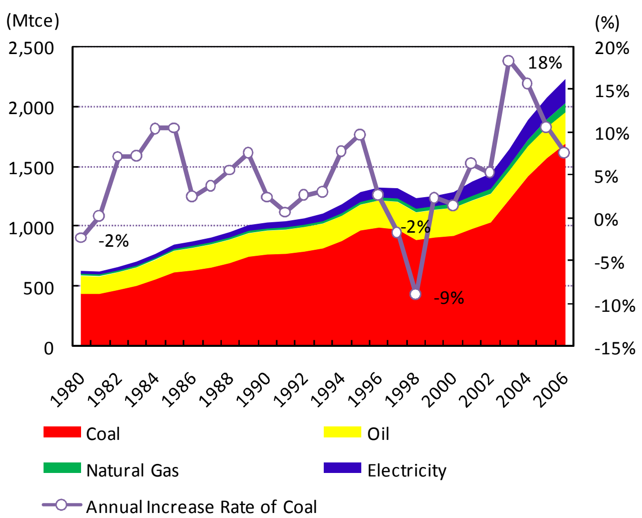
MOHURD: Ministry of Housing and Urban-Rural Development; MOST: Ministry of Science and Technology; MOF: Ministry of Finance; MOLR: Ministry of Land of Resources; MOEP: Ministry of Environmental Protection; MOR: Ministry of Railway; MOWR: Ministry of Water Resources; MOC: Ministry of Commerce; MOA: Ministry of Agriculture; MOT: Ministry of Transportation; MIIT: Ministry of Industry and Information Technology; SAOWS: State Administration of Work Safety; SAOT: State Administration of Taxation; SOASA: State-owned Assets Supervision and Administration; SERC: State Electricity Regulatory Commission.

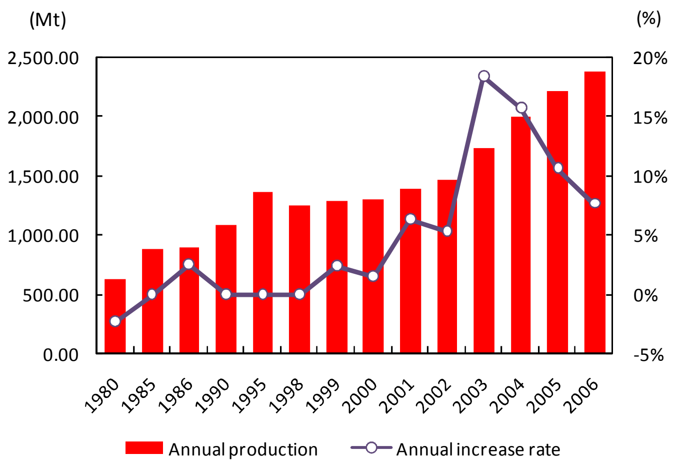
3. Energy Production

3.1. Coal

Over the past 50 years, coal has accounted for 70 percent or more of China's energy production despite government efforts to promote cleaner or renewable alternatives. It is likely that until at least 2050 coal will continue to make up at least half of the nation's energy mix (Figure 2-3).

Figure 2-3 Primary Energy Production - Coal (1980-2006)



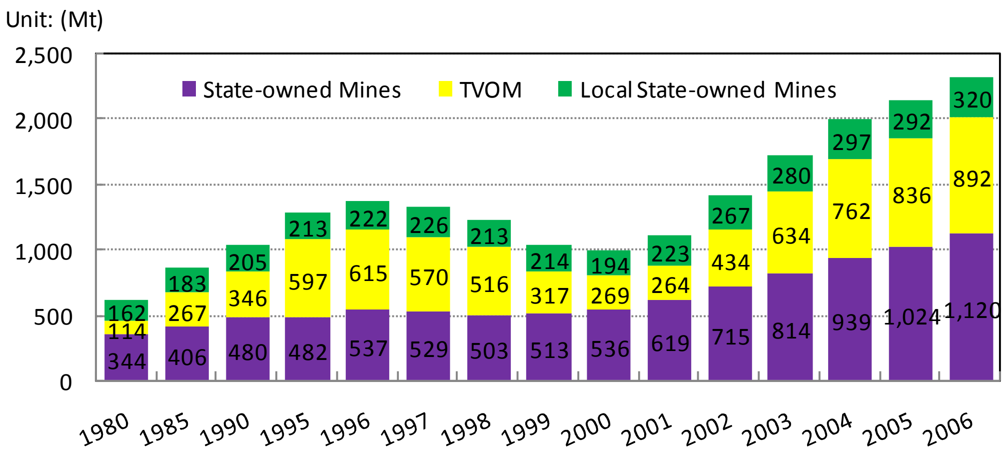


Source: *China Energy Databook*, V.7.0., Table 2A.1.2., and Table 2A.1.4, LBNL.

Since the 1980s, China's coal production has grown rapidly and continuously. Coal production increased from 620 Mt in 1980 to 2,373 Mt in 2006 with an annual average increase of 67.4 Mt or an annual average growth rate of 5.3%. In 1989, China's coal production exceeded 1,000 Mt and since then it has led the world in coal production. Production was cut back following the drop in coal demand during the domestic economic recession of 1997 and 1998. Coal production began to recover slowly on the back of renewed coal-fired power generation in 1999 and 2000 and the rise in export demand in 2000 and 2001. In 2003, production increased rapidly from 1,454 Mt to 1,722 Mt, a record high growth rate of 18% from the previous year. Since then, its upward momentum has shown no signs of slowing down (Figure 2-3).

China's coal mines can be categorized into three types by ownership: centrally state-owned mines, locally state-owned mines, and township and village owned mines (TVOM). The production share of centrally state-owned mines peaked in 2001 and has been gradually declining (Figure 2-4, Table 2-13). In 2006, production of the top ten centrally state-own mines accounted for 28.1% of the total (Table 2-14). To date, TVOMs have played a significant role in China's coal industry. Production from TVOMs between 1995 and 1998 accounted for more than 40% of the nation's total coal production during that same time period (Table 2-13). TVOMs were forced to shut down or limit their production due to the country's coal oversupply from 1999 to 2001. They have recently increased outputs again in response to strong domestic energy demand. Production growth since 2003 has depended on two factors. First, centrally state-owned mines have expanded their designed capacities to increase their outputs. The second factor is that many TVOMs, including those once-closed mines, have restarted operations and increased outputs. Both of these current moves to increase production were the direct effects of the decline in investment in the industry that followed the recession of the late of 1990s.

Figure 2-4 Coal Production by Producer Type (1980-2006)



Source: *China Energy Databook*, V.7.0., Table 2B.1..

Table 2-13 Coal Production Share by Producer Type (1980-2006)

		1980	1985	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
State-owned Mines	% of Total	55.5%	47.5%	46.3%	37.2%	39.1%	39.9%	40.9%	49.1%	53.6%	56.0%	50.5%	47.1%	47.0%	47.6%	48.0%
	Annual growth rate (%)	-3.7%	2.9%	4.8%	0.6%	11.4%	-1.5%	-4.9%	1.8%	4.5%	15.5%	15.5%	13.9%	15.3%	9.1%	9.3%
Local State-owned Mines	% of Total	26.1%	21.4%	19.8%	16.5%	16.2%	17.0%	17.3%	20.5%	19.4%	20.2%	18.9%	16.2%	14.9%	13.6%	13.7%
	Annual growth rate (%)	-5.5%	2.9%	-0.2%	3.6%	4.1%	1.6%	-5.7%	0.5%	-9.2%	14.9%	19.7%	4.8%	6.0%	-1.8%	9.7%
TVOM	% of Total	18.3%	31.2%	33.4%	46.0%	44.7%	43.0%	41.9%	30.4%	26.9%	23.9%	30.6%	36.7%	38.1%	38.8%	38.3%
	Annual growth rate (%)	6.9%	23.0%	2.7%	25.7%	3.1%	-7.2%	-9.5%	-38.6%	-15.1%	-2.0%	64.3%	46.2%	20.2%	9.7%	6.8%

Source: Same as Figure 2-4.

Table 2-14 Major Coal Mining Enterprises in 2006

	Mine Enterprises	Province	2006 (Mt)
1	Shenhua Group		202.990
2	China National Coal Group		90.624
3	Shanxi Jiaomei	Shanxi	69.960
4	Datong	Shanxi	61.753
5	LongMay Mining Group	Heilongjiang	53.740
6	Shaanxi Coal and Chemical Industrial Group	Shaanxi	38.650
7	Yankuang	Shandong	37.750
8	Yangquan	Shanxi	35.417
9	Huainan Mining Industry	Anhui	33.533
10	Lu'an Group	Shanxi	31.600
Total		656.017	

Source: *China Energy Databook*, V.7.0., Table 2B.3..

China's TVOMs have alleviated the country's coal shortages on one hand, but have also instigated some serious issues on the other hand. Small coal mines with an annual production output ranging from 10,000 tons to 30,000 tons have not only caused grave resource waste due to a low rate of recovery (averaged between 10 and 15 percent) but also have caused serious pollution. On top of this, TVOMs have a high incidence of major accidents and are contributing to long-standing safety problems at coal mines across the country. According to the State Administration of Work Safety (SAOWS), more than 70 percent of the country's coal mine deaths occurred in small mines that were backwardly equipped and poorly managed (Table 2-15). The Chinese government has been shutting down small coal mines since 1999; however, the huge demand for production expansion has delayed consolidation and increased the number of illegally-operating small coal mines. As of February 2009, China still has fourteen thousands small coal mines with inappropriate management, insufficient investment, outdated equipment, and poor safety records[15].

Table 2-15 Coal Mine Accidents by Producer Type (1993-2006)

Year	% of deaths from mining accidents (%)			Deaths per million tons mined (person)			
	State-owned Mines	Local State-owned	TVOM	State-owned Mines	Local State-owned	TVOM	Total
1993	32.4%	18.4%	49.2%	3.57	4.43	5.12	4.59
1994	7.7%	15.2%	67.7%	1.18	5.25	30.41	6.10
1995	8.2%	16.3%	68.1%	1.07	4.81	6.48	4.86
1996	10.0%	15.2%	70.2%	1.04	3.83	6.40	4.08
1997	11.6%	14.9%	67.6%	1.34	4.04	7.28	4.63
1998	8.3%	14.3%	72.6%	1.04	4.23	8.86	5.11
1999	7.9%	14.5%	72.0%	0.99	4.39	14.72	6.21
2000	12.9%	14.0%	67.8%	1.39	4.19	14.61	5.80
2001	13.2%	17.8%	64.3%	1.21	4.51	13.81	5.13
2002	12.9%	14.6%	72.5%	1.27	3.83	11.69	4.94
2003	13.9%	13.7%	72.4%	1.10	3.15	7.35	3.72
2004	14.2%	13.5%	72.3%	0.91	2.75	5.72	3.02
2005	16.6%	9.6%	73.8%	0.96	1.95	5.25	2.76
2006	14.8%	12.9%	72.3%	0.63	1.91	3.89	2.04

Source: *China Energy Databook*, V.7.0., Table 2B.4..

As Table 2-16 shows, the north region is the top coal-producing area in China followed by the southwest, east, northwest, south-central, and northeast. Coal production in the north region has increased rapidly since 2002, reaching its record high in 2006 at 969.09 Mt. In the meantime, the region's share of national coal production increased from 37.8% in 2000 to 41.1% in 2006. Shanxi Province in the north region alone accounted for 25% of the country's total output in 2006.

About three quarters of the coal that China produces is bituminous coal, most of the rest is anthracite, and lignite and brown coal make up the remaining 4% (Figure 2-5, Figure 2-6). Coking coal accounts for about 45% of total bituminous coal, although less than 40% of coking coal is used for coking (Table 2-17).

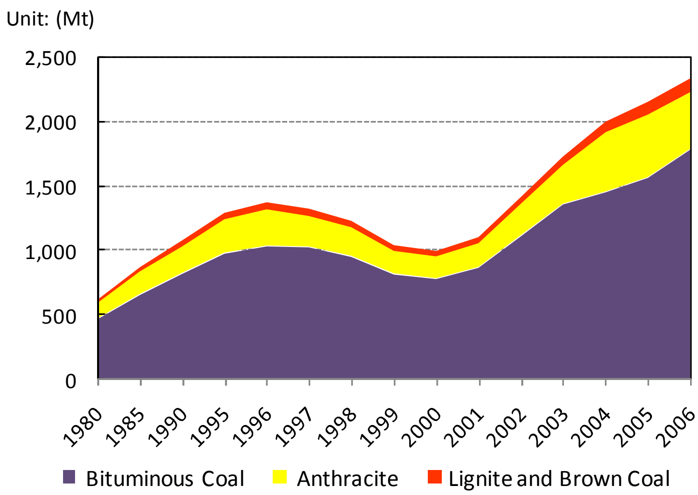
Table 2-16 Coal Production by Region (2000-2005)

(Unit: Mt)

Region		2000	2001	2002	2003	2004	2005	2006
East	Coal production	185.91	213.69	248.96	274.15	298.13	300.91	302.49
	% of total	17.6%	15.5%	17.1%	15.9%	15.0%	13.6%	12.8%
North	Net production	398.36	434.41	561.84	681.5	818.18	906.18	969.09
	% of total	37.8%	31.4%	38.6%	39.6%	41.1%	40.9%	41.1%
Northeast	Coal production	116.94	113.48	128.8	162.31	186.00	190.92	201.79
	% of total	11.1%	8.2%	8.9%	9.4%	9.3%	8.6%	8.6%
Northwest	Coal production	100.27	112.99	132.81	172.12	194.80	260.23	284.19
	% of total	9.5%	8.2%	9.1%	10.0%	9.8%	11.7%	12.1%
Southcentral	Coal production	116.05	191.97	147.62	192.82	224.18	276.21	283.44
	% of total	11.0%	13.9%	10.1%	11.2%	11.3%	12.5%	12.0%
Southwest	Coal production	136.55	130.53	160.27	216.99	234.3	283.83	316.99
	% of total	13.0%	9.4%	11.0%	12.6%	11.8%	12.8%	13.4%
Total		1,054.26	1,381.52	1,454.56	1,722.00	1,992.32	2,218.28	2,357.99

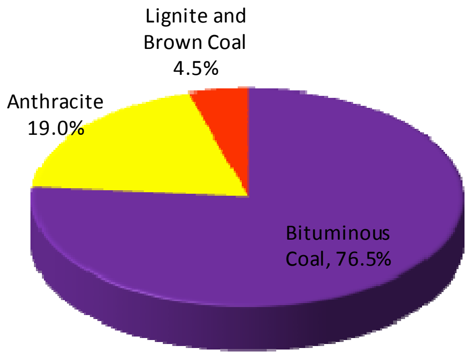
East: Anhui, Fujian, Jiangsu, Jiangxi, Shandong, Shanghai, Zhejiang; *North*: Beijing, Hebei, Inner Mongolia, Shanxi, Tianjin; *Northeast*: Heilongjiang, Jilin, Liaoning; *Northwest*: Gansu, Ningxia, Qinghai, Shaanxi, Xinjiang; *Southcentral*: Guangdong, Guangxi, Hainan, Henan, Hubei, Hunan; *Southwest*: Chongqing, Guizhou, Sichuan, Yunnan.
Source: *China Energy Databook*, V.7.0., Table 2A.3.1. - Table 2A.3.3..

Figure 2-5 Coal Production by Type of Coal (1980-2006)



Source: *China Energy Databook*, V.7.0., Table 2B.2., Table 2B.2..

Figure 2-6 Production Share by Type of Coal in 2006



Source: Same as Figure 2-6.

Table 2-17 Coking Coal Used in Coke Production (1980-2006)

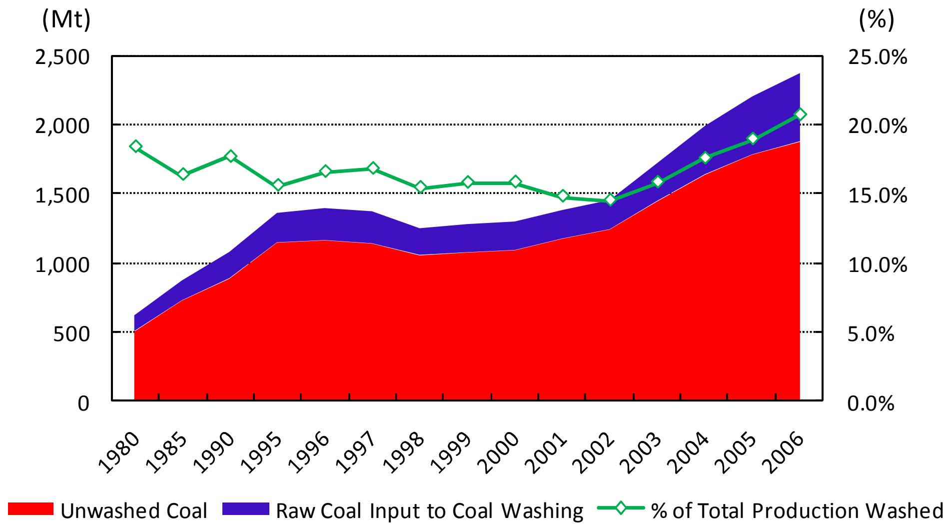
(Unit: Mt)

Year	Coking Coal Production	Used for Coking	Used for Other Purposes	Coke Production	% Coking Coal Used for Coking
1980	308.33	66.82	241.51	43.43	21.7%
1985	391.09	73.04	318.05	48.02	18.7%
1990	512.77	106.98	405.79	73.28	20.9%
1995	607.49	183.96	423.53	135.10	30.3%
1996	622.77	184.56	438.21	136.43	29.6%
1997	637.56	192.97	444.59	137.31	30.3%
1998	553.87	156.28	397.59	128.06	28.2%
1999	499.12	159.32	339.80	120.73	31.9%
2000	474.25	164.96	309.29	121.84	34.8%
2001	550.90	172.36	378.54	131.31	31.3%
2002	679.69	186.25	493.44	142.53	27.4%
2003	841.56	236.40	605.16	177.76	28.1%
2004	884.28	253.50	630.78	199.38	28.7%
2005	912.46	316.67	595.79	254.12	34.7%
2006	980.00	374.50	605.50	297.68	38.2%

Source: *China Energy Databook*, V.7.0., Table 2B.7..

The share of washed coal in China still remains low because many coal mines are located inland and lack access to water resources. Additionally, the technology for coal preparation is still under-developed and so the ash content of run-of-mine coal is high.

Figure 2-7 Production of Washed Coal (1980-2006)



Source: *China Energy Databook*, V.7.0., Table 2B.8..

Though coal resources are scatted throughout of the country, more than 60% of proven reserves are concentrated in Shanxi, Shaanxi, and Inner Mongolia, and limited amounts are distributed in coastal regions. Therefore, coal has to be transported from west to east and from north to south by rail and barge. The railway transportation network for coal has long been a bottleneck in developing the industry and has also affected China's overall economic development. Transportation capacity shortages have been cited as a major factor behind the tighter coal supplies since 2004. There are three major railway routes for coal transportation, i.e. the northern route from Northern Shanxi, Northern Shaanxi and Inner Mongolia, the middle route from Central Shanxi, and the southern route from Central and Southern Shaanxi, to coal consumption regions or coal-shipping ports. Of these, the northern route is the most important route and it has recently been expanded through additions to the Daqin and Shenshuohuang lines.

In 2006, coal accounted for 37.2% of total railway freight, a 5% increase from 1980 (Table 2-18).

Table 2-18 Transportation of Coal and Oil by Railway (1980-2006)

Year	Coal&Coke (Gt-km)	Oil (Gt-km)	Total Railway Feight (Gt-km)	Coal Products as % of Total Railway Feight
1980	183.54	30.07	570.73	32.2%
1985	269.18	34.07	811.16	33.2%
1995	407.04	61.27	1283.69	31.7%
1996	435.12	63.69	1,292.18	33.7%
1997	420.98	65.67	1304.64	32.3%
1998	389.74	67.84	1,226.15	31.8%
1999	389.49	77.40	1257.79	31.0%
2000	420.82	81.60	1,333.61	31.6%
2001	469.58	90.00	1424.98	33.0%
2002	512.64	97.32	1,507.82	34.0%
2003	569.33	102.93	1632.34	34.9%
2004	637.45	109.96	1,810.99	35.2%
2005	711.21	118.50	1934.61	36.8%
2006	755.08	118.02	2032.16	37.2%

Source: *China Energy Databook*, V.7.0., Table 2B.23..

Paralleling railway transportation capacity expansion efforts, China has increased coal-shipping at seven major Northern ports, to a total capacity of 444 million tons in 2006 (Table 2-19).

Table 2-19 Shipment Capacity at Seven Major Northern Ports

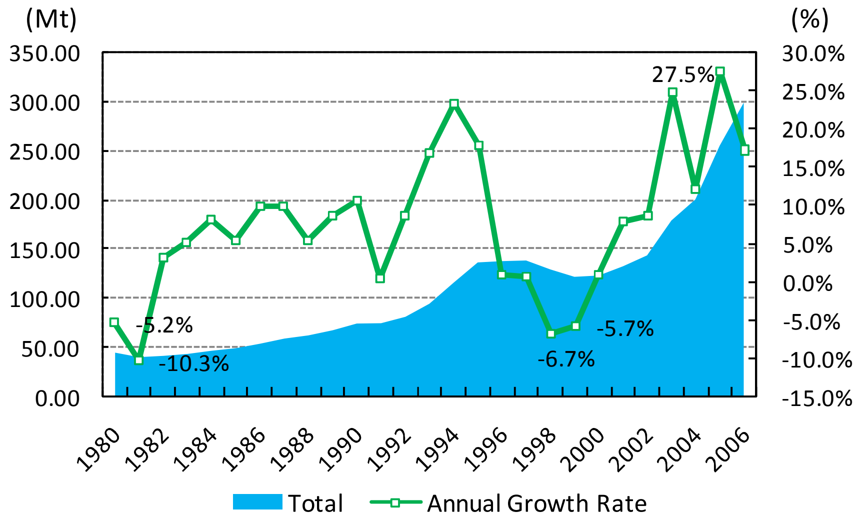
(Unit: Mt)

	2005	2006	2010
Qinhuangdao	137	187	187
Tianjin	73	73	100
Cangzhou	75	80	110
Tangshan	30	30	110
Qingdao	23	23	23
Rizhao	25	25	25
Lianyungang	22	26	40
Total	385	444	595

Source: Sagawa, A. and K. Koizumi (2007), *Present State and Outlook of China's Coal Industry*, The Institute of Energy Economics, Japan (IEEJ).

Production patterns of coke have followed closely those of coal production. (Figure 2-8). The consumption and production of iron and steel in China has grown rapidly in recent years and the demand for coke has increased accordingly. The output of coke in China reached 297.8 Mt in 2006, an increase of 17.1% over the previous year. Coke in China is produced by two types of facilities which are distinguished their levels of technology: "*Modern Coke*" and "*Old Coke*". The former type of coke is produced by modern industrial equipment, while the latter is made with rather backward technology such as clay or dirt kilns which are very inefficient and emit more pollutants per unit of output than modern equipment. Effluents discharged in coke production by either means create serious environmental pollution. Attempting to reduce the coke industry's effect on the environment, in 2005 the government decided to suspend operations of "*Old Coke*" production plants and strengthened environmental supervision and law enforcement in the coke making industry.

Figure 2-8 Coke Production (1980-2006)

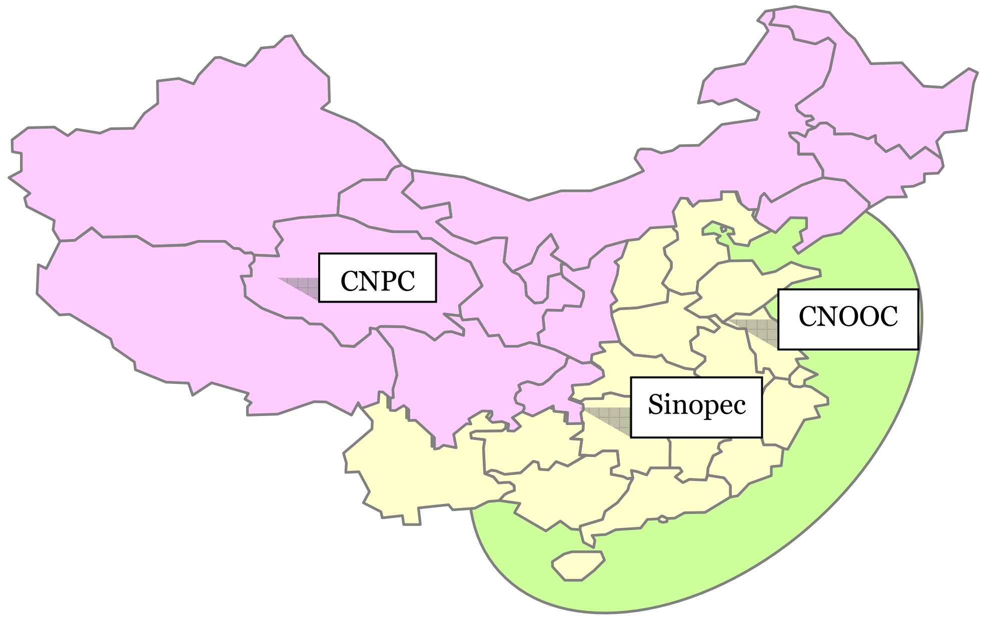


Source: *China Energy Databook*, V.7.0., Table 2B.6..

3.2. Oil and Petroleum Products

China drastically restructured its oil and gas industry in 1998 in anticipation of new turbulent economic situations ahead. Before the reform, there were two oil conglomerates in the state sector – the China National Petroleum Corporation (CNPC) which engaged in the upstream side of the sector and the China Petroleum and Chemical Corporation (Sinopec) which engaged in the downstream side. After the restructuring, both conglomerates had upstream and downstream business, differentiating their businesses by dividing China geographically into two territories, operating via local subsidiaries (Figure 2-9). Generally, CNPC and its affiliates dominate the north and west, while Sinopec companies dominate the central and eastern parts of China. With this reform, the government tried to encourage the formation of new "state oil majors" by promoting competition between the two firms.

Figure 2-9 China's Oil Major Territory in General



In April 2000, CNPC established PetroChina and later in October, Sinopec established Sinopec Corp. Both companies are listed on the Hong Kong and New York exchange markets and became the operations arms for CNPC and Sinopec. The other major state corporation is the China National Offshore Oil Corporation (CNOOC), which is in charge of offshore oil and gas exploration and production. In February 2001, CNOOC established CNOOC Ltd. and listed it on the New York and Hong Kong stock exchanges. A fourth state-owned oil company, Sinochem Corp., a traditional state-owned oil trading company, has also expanded its business into upstream oil exploration and production, refining, and chemical fields. Although the four state-owned companies all carried out initial public offerings (IPOs), the Chinese government still maintains a majority stake in each through their state-owned holding companies (Table 2-20).

Table 2-20 Snapshot of China's Big Three (2007)

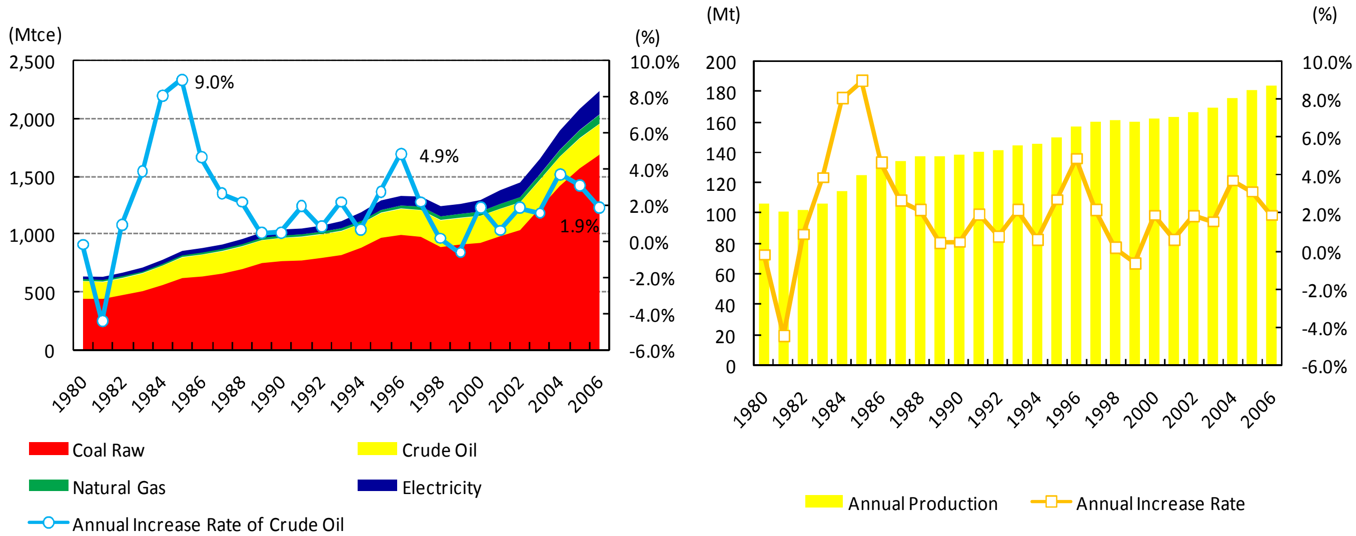
	PetroChina	Sinopec	CNOOC
Financial Statistics			
Sales ($ 1million)	110,154	158,938	11,892
Net profit ($ 1 million)	20,477	7,458	4,079
Ratio of net profit to sales	18.60%	4.7%	34.3%
Government stake	90.0%	77.4%	70.6%
Gross assests ($ 1 million)	139,848	96,658	23,657
Operating Statistics			
Oil output (kb/d)	2,298	799	372
Gas output (mcf/d)	4,458	774	560

Source: Company press releases.

China's crude oil production increased from 151.4 Mtce in 1980 to 264.03 Mtce in 2006, an annual growth rate of 2.2% (Figure 2-10). In 2006, crude oil accounted for 11.8% of the country's primary energy production.

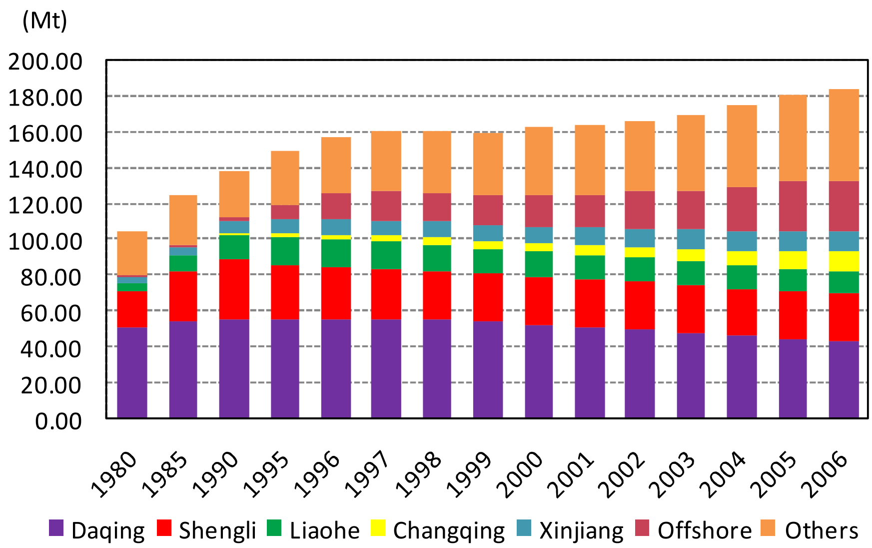
China's largest oil field, Daqing field in Heilongjiang Province, became operational in 1960 and it continues to lead the domestic industry today. Further important discoveries, including the major oil fields of Shengli in Shangdong Province and Liaohe in Liaoning Province enabled China to meet its domestic needs and export its extra crude oil to the rest of East Asia, especially to Japan, until 1993. Up until the early 1990s, output from the three major oil fields accounted for more than 70% of the nation's total oil production. Although production levels from the three major oil fields peaked around 1994, the country's domestic production has increased modestly because of developments in Western fields (such as Xingjiang and Tarim) and at some offshore sites. Production at Xinjiang increased from 4.09 Mt in 1980 to 11.92 Mt in 2006 with an annual growth rate of 4.2% and production at Tarim increased from 0.89 Mt in 1992 to 6.05 Mt in 2006, an annual growth rate of 14.7%. Meanwhile, growth in offshore oil production has been very rapid. In 2006, offshore wells accounted for 14.9% of total output, compared to a 0.2% share in 1980 (Figure 2-11).

Figure 2-10 Primary Energy Production - Crude Oil (1980-2006)



Source: *China Energy Databook*, V.7.0., Table 2A.1.2., Table 2A.1.4..

Figure 2-11 Crude Oil Production by Oilfield (1980-2006)



Source: *China Energy Databook*, V.7.0., Table 2B.9..

With limited domestic oil resources, China's major oil companies have been seeking overseas opportunities by expanding direct investments, equity purchases, and joint-investments since the early 1990s. After its first overseas investment in 1993 in Canada, CNPC has developed about 70 projects in several regions, including Africa, the Middle East, Russia, Central Asia, and South

America. Meanwhile, Sinopec has developed 36 projects in the Middle East, Africa, and East and South Asia. Although CNOOC was pressured to withdraw its offer to acquire Unocal in August 2005, the company has successfully obtained interests in Angola and acquired mining and exploration rights in East and South Asia as well as in Australia (Table 2-21).

Table 2-21 Major Oil Company's Overseas Expansion (As of the end of 2006)

Company	Total Project Number	Country Invested	Equity Oil (Mt/y)	Equity Gas (Million m^3/y)
CNPC	69	20 countries: Africa, Middle East, Central Asia, South America, etc.	28.07	3,800
Sinopec	36	14 countries: Asia, the United States, Middle East, etc.	0.88	-
CNOOC	18	5 countries: Asia, Australia, etc.	1.15	3

Source: IEEJ (2007), *China and India's Energy Status and Energy Policy Movement*, IEEJ.

China's oil refinery sector is an oligopoly split between CNPC and Sinopec. The two companies' total refinery capacity accounts for about 90% of the country's total (Table 2-22). In 2007, China had 7.5 Mmbbl/d of crude oil refining capacity. According to BP Statistics, capacity utilization in China increased from 68% in 1995 to 87% in 2007, which also implies that oil refinery facilities are now stretched nearly to the limit (Figure 2-12). To meet the country's growing demand for petroleum products, the state-owned oil companies have been building new refineries and upgrading existing plants in recent years.

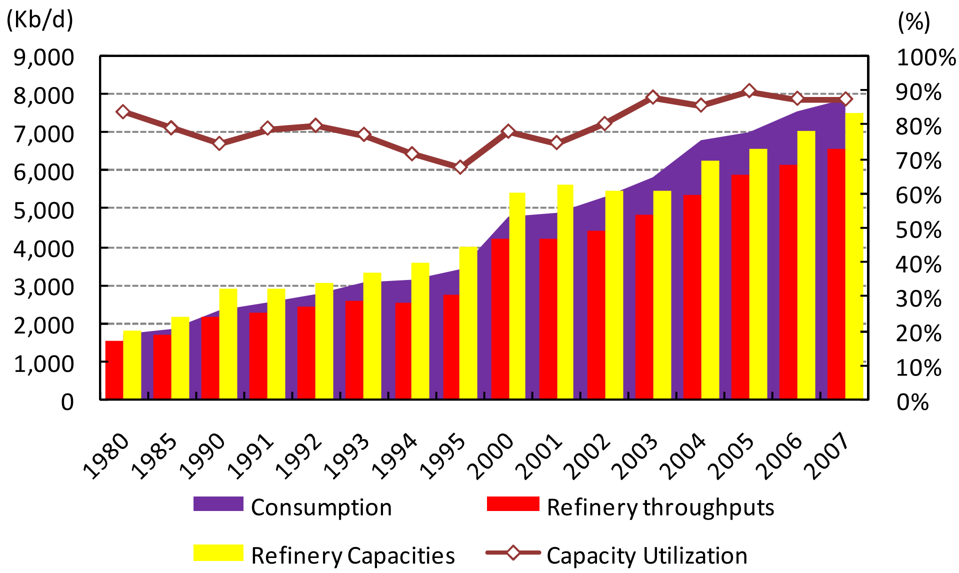
Table 2-22 Refinery Capacity by Company (2005-2010)

Company	Refinery Capacity		Expanding Plan		Total (by 2010)	
	kb/d	% of total	kb/d	% of total	kb/d	% of total
Sinopec	3,300	52%	1,510	44%	4,810	49%
CNPC	2,680	42%	1,120	32%	3,800	39%
CNOOC	-	-	240	7%	240	3%
Sinochem	-	-	440	13%	440	4.5%
Others	330	6%	160	5%	490	5%
Total	6,310	100%	3,470	100%	9,780	100%

Source: Zhang, Yue (2007), *Current Chinese Refinery Industry and Its Challenges*, IEEJ.

Refinery facilities in China are mainly distributed around major oil fields such as Daqing and Bohai. However, since the 1990s refineries have also been built in coastal regions such as Dalian, Shanghai, Zhejiang, Fujian, and Guangdong to handle imported crude oil. One of the major issues for China's refining sector is a lack of sufficient capacity to refine high-sulfur and heavier oils from the Middle East, which in 2006 accounted for more than 16% of total imports (Table 2-23).

Figure 2-12 Refinery Capacity and Capacity Utilization (1980-2007)



Source: BP Historical Data.

Table 2-23 Crude Oil Imports (2006)

Country	2006	
	Import Volume (t)	% of total
Saudi Arabia	23,871,515	16.4%
Angola	23,452,009	16.2%
Iran	16,774,243	11.6%
Russia	15,965,717	11.0%
Oman	13,183,282	9.1%
Congo	5,419,044	3.7%
Equatorial Guinea	5,266,516	3.6%
Sudan	4,846,543	3.3%
Yemen	4,543,167	3.1%
Venezuela	4,202,776	2.9%
Total	145,180,329	100.0%

Source: *China Energy Databook*, V.7.0., Table 7B.5.

The volume of refined products has increased significantly since the 1980s. Particularly, the output of gasoline has increased sharply from 10.79 Mt in 1980 to 55.91 Mt in 2006, an annual growth rate of 6.5%. The output of diesel oil has increased from 18.28 Mt to 116.53 Mt, an annual growth rate of 7.4%, due to a rapid increase in demand from the large-scale transportation sector as well as the country's personal motorization which began in the late 1980s. LPG, refinery gas, and chemical feedstock production have increased remarkably as well. However, their shares of the total are much less than gasoline and diesel oil (Table 2-24). Fuel oil is the only refined product that has dropped in production from 31.42 Mt in 1980 to 22.65 Mt in 2006, in response to government policies restricting its use: soon after China became a net oil importing country in 1993, the Chinese government suspended approving the construction of new oil-fired power plants.

Meanwhile, production of non-fuel oil-based products has in general increased as well. The production of petroleum coke, wax, and solvents rose by an average annual 12.5%, 5.3%, and 6.5% respectively between 1985 and 2006.

Given the soaring demand for oil and petroleum products, the country's oil companies have been working on establishing more integrated and complete oil pipeline networks. By 2005, China had more than 20,984 km of crude and finished oil pipelines with an annual throughput of 270.1 Mt. Most of the throughput was generally carried from Northern to Southern China; more recently an increasing amount of oil and petroleum products has been moving from Western to Eastern China (Table 2-25). The total oil pipeline turnover in 2005 was 76.7 Gt-km, of which 72.1 Gt-km was crude oil. Compared with the 118.5 Gt-km of oil products, including refined products, carried by railway in 2005, the amount of oil transported through pipelines is relatively small. Clearly oil transportation in China still relies heavily on long-distance railway freight (Table 2-18).

To secure a transportation route for crude oil imports, China has also constructed cross-broader oil pipelines. China's first cross-border oil pipeline started operation in July 2006, connecting Atasu in Northern Kazakhstan with Alashankou in Xinjiang. The 962 kilometer-long pipeline was jointly built by CNPC and Kazakhstan's KazTransOil. The first phase of the pipeline is expected to transport 10 million tons of oil a year; plans are to double the capacity by 2011.

Table 2-24 Petroleum Products (1980-2006) (Unit: Mt)

Year	Gasoline	Kerosene/ Jet Fuel	Diesel Oil	Fuel Oil	LPG	Refinery Gas	Chemical Feedstock	Lubricants
1980	10.79	3.99	18.28	31.42	1.23		2.79	1.97
1985	14.72	4.05	20.23	28.36	1.60	2.18	4.92	1.58
1990	21.57	3.93	26.09	32.68	2.62	2.81	7.85	1.97
1995	30.52	4.46	39.73	29.61	5.41	4.28	11.85	1.87
1996	32.81	5.36	44.19	25.05	6.06	4.50	13.33	2.27
1997	35.18	5.77	49.25	20.80	6.68	5.34	14.99	2.31
1998	34.65	5.75	48.84	18.34	7.47	5.45	16.56	2.15
1999	37.65	7.10	63.03	16.53	8.15	5.14	16.74	2.38
2000	41.35	8.72	70.80	20.54	9.15	5.67	20.08	3.33
2001	41.52	7.89	74.86	18.64	9.51	5.50	18.59	3.53
2002	43.20	8.26	76.69	18.46	10.35	5.62	21.05	3.63
2003	47.91	8.55	85.33	20.05	12.10	5.75	23.53	4.11
2004	52.50	9.71	101.62	20.83	14.08	6.75	26.12	4.64
2005	53.90	9.90	110.41	24.17	14.29	7.94	29.16	5.67
2006	55.91	9.69	116.53	22.65	17.40	8.20	33.03	5.72

Year	Petroleum Coke	Wax	Solvents	Aromatics	Commercial Feedstocks	Other/ Balance	Refining Losses	Product Subtotal
1980						4.10	0.82	74.56
1985	0.92	0.56	0.43	0.90	1.41	0.51	1.13	84.76
1990	1.36	0.69	0.51	1.22	1.99	-1.36	2.96	106.65
1995	2.40	0.85	0.69		2.84	5.64	4.25	139.28
1996	2.91	0.95	0.81		4.14	7.37	2.71	148.63
1997	3.20	0.92	1.55		4.15	1.38	3.82	149.90
1998	3.57	1.12	1.80		5.21		3.10	157.90
1999	3.92	1.30	1.32		4.03		5.67	154.33
2000	4.52	1.37	1.97		6.66		7.22	155.78
2001	4.86	1.35	1.82		6.35		6.17	157.79
2002	5.08	1.31	2.07		7.00		8.92	158.08
2003	6.03	1.48	2.41		7.11		9.71	159.89
2004	7.35	1.67	2.02		7.50		11.95	163.92
2005	9.69	1.64	1.76		7.66		11.67	169.69
2006	10.98	1.67	1.60		8.65		12.77	171.99

Source: *China Energy Databook, V.7.0.*, Table 2B.11..

Table 2-25 Crude Oil and Oil Product Pipelines (1998-2005)

Year	Length		Capacity		Throughput		Turnover	
	Crude Oil (km)	Oil Product (km)	Crude Oil (Mt/yr)	Oil Product (Mt/yr)	Crude Oil (Mt)	Oil Product (Mt)	Crude Oil (Mt-km)	Oil Product (Mt-km)
1998	9,938.0	1,319.8	311.8	60.8	146.6	15.6	57,359.0	690.9
2000	11,200.6	1,196.6	27.4	44.1	158.3	14.6	59,158.0	974.5
2002	8,698.0	1,185.0	233.7	46.3	125.3	15.3	42,051.0	748.0
2005	15541.0	5443.0	415.1	123.2	234.3	35.8	72,131.0	4580.1

Source: *China Energy Databook, V.7.0.*, Table 2B.25., Table 2B.26..

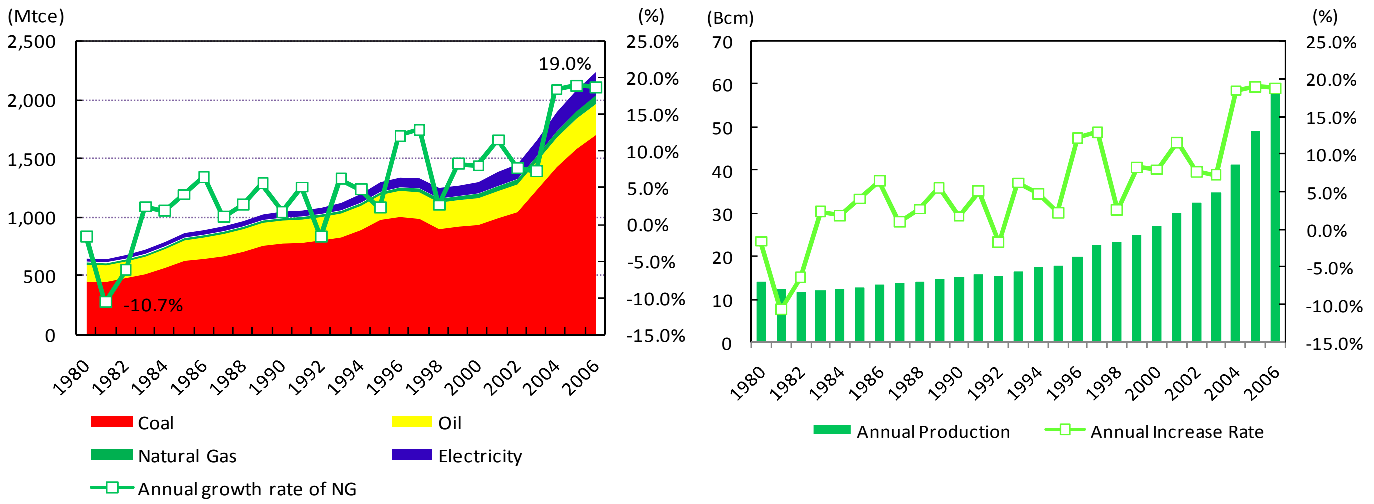
As previously mentioned, in February 2009, China and Russia signed a deal under which Russia would supply China with 15 million tons of oil each year for the next 20 years in exchange for a loan worth $25 billion to the Russian companies Transneft and Rosneft for pipeline and oil field development[16]. The pipeline will be built from the Siberian town of Skovorodino to China's Daqing oil field, creating a branch of the main East Siberia-Pacific Ocean (ESPO) trunk pipeline, and start supplying China with oil in 2011.

3.3. Natural Gas

Output of natural gas increased from 18.98 Mtce (or 14.27 Bcm) in 1980 to 77.88 Mtce (or 58.55 Bcm) in 2006 with an annual growth rate of 5.6%. Despite a rapid 13.6% annual increase in production from 2000 to 2006, by the end of the period natural gas accounted for only 3% of China's primary energy production (Figure 2-13).

Natural gas production in China is also dominated by CNPC, Sinopec and CNOOC. In terms of production, CNPC is the largest natural gas supplier by virtue of its considerable assets in the Central (Sichuan basin, Ordos basin, Qaidam basin) and in the Western (Tarim basin, Junggar basin, Turphan-Hami basin) regions of China; these fields are controlled by PetroChina, the CNPCs operations arm.

Figure 2-13 Primary Energy Production - Natural Gas (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 2A.1.2..

As Table 2-26 shows, CNPC produced 43.87 Bcm in 2006, accounting for 73.7% of national total gas production. Meanwhile, CNOOC produced 8.4 Bcm of natural gas, or 14.1% of the national total, followed by Sinopec's 7.25 Bcm of gas output or 12.2% of the national total.

Table 2-26 Natural Gas Production by Producer (2000-2006)

	2000	2001	2002	2003	2004	2005	2006
Daqing	2.3	2.4	2.02	2.03	2.03	2.44	2.45
Liaohe	1.15	1.27	1.13	1.05	1.00	0.92	0.89
Huabei	0.44	0.52	0.53	0.57	0.58	0.57	0.55
Dagang	0.4	0.42	0.39	0.35	0.34	0.33	0.36
Xinjiang	1.62	1.9	2.02	2.21	2.56	2.90	2.88
Tarim	0.75	11.8	1.09	1.09	1.36	5.68	11.01
Turpan-Hami	0.92	1.09	1.14	1.23	1.34	1.53	1.67
Sichuan	7.99	9.08	8.75	9.19	9.78	11.63	13.13
Changqing	2.06	3.68	3.91	5.18	7.45	7.53	8.02
Qinghai	0.39	0.64	1.15	1.54	1.79	2.12	2.45
Total of CNPC	18.31	22.5	22.46	24.76	28.56	36.08	43.87
Yumen	0.02	0.04	0.06	0.03	0.02	0.08	0.08
Jidong	0.06	0.06	0.04	0.04	0.06	0.08	0.01
Jilin	0.2	0.22	0.22	0.23	0.25	0.27	0.28
Shengli	0.69	0.91	0.75	0.81	0.89	0.88	0.80
Zhongyuan	1.34	1.61	1.61	1.7	1.75	1.66	1.60
Henan	0.05	0.09	0.11	0.10	0.10	0.10	0.08
Jianghan	0.09	0.08	0.13	0.1	0.11	0.12	0.12
Jiangsu	0.02	0.03	0.02	0.03	0.05	0.06	0.06
Yunnan/Guizhou/Guangzi	0.08	0.09	0.07	0.09	0.10	0.08	0.06
Sinopec Star	1.65	2.19	2.3	2.36	2.66	3.20	4.28
Others	-	-	0.13	0.15	0.17	0.18	0.24
Total of Sinopec	3.93	5	5.09	5.34	5.83	6.29	7.25
CNOOC, etc.	3.96	5.85	5.31	4.22	6.39	8.12	8.4
Total of the Nation	26.2	33.35	32.87	34.32	40.78	50.49	59.52

Note: Data in this table is different from Figure 2-13 due to data sources.
Source: Ni, Chun Chun (2007), *China's Natural Gas Industry and Gas to Power*, IEEJ.

By the end of June 2006, high-pressure natural gas pipelines in China exceeded 24,000 km in length, yet much natural gas is still consumed in the same region where it is produced. Driven by the rapid growth of gas demand in the eastern and southern parts of China, the industry has undertaken efforts to upgrade the gas transportation infrastructure to enable gas to be piped from remote basins to developed cities (Table 2-27).

Table 2-27 Major Natural Gas Pipelines

(Unit: Bcm)

Pipeline&Route	Length (km)	Supply Source	Capacity (Bcm/y)	Year of Commerical Operation	Operator
Major Existing Pipelines					
Yacheng 13-1-Hong Kong	778	Yacheng 13-1 gas field	2.9	1996	CNOOC
Tazhong-Lunnan	315	Tarim basin	0.7	1996	PetroChina
Seibei-Golmud	189	Qinghai gas field	0.8	1996	PetroChina
Shanshan-Urumqi	302	Xinjiang gas field	N.A.	1997	PetroChina
Shanjing (Jingbian-Beijing)	853	Ordos basin	4	1997	PetroChina
Jingbian-Xi'an	488	Ordos basin	0.5	1997	PetroChina
Jingbian-Yinchuan	320	Ordos basin	0.6	1997	PetroChina
Pinghu-Shanghai	375	Pinghu gas field	0.7	1999	CNOOC
Sebei-Lanzhou	953	Qinghai gas field	2.0	2001	PetroChina
Changqing-Hohhot	506	Changqing gas field	1	2003	PetroChina
West-East	3,900	Tarim basin	12	2004	PetroChina(95%), Sinopec(5%)
Zhongxian-Wuhan	760	Sichuan basin	3	2005	PetroChina
Shanjing II	935	Ordos basin	12	2005	PetroChina
Inter-connector of West-East & Shanjing II	886	Mutual supply	-	2005	PetroChina
Inter-connector of Huaiyang & Wuhan	450	Mutual supply	-	2007	PetroChina
Daqing-Harbin	78	Daqing gas field	5	2007	PetroChina
Daqing-Qiqihaer	156	Daqing gas field	0.8	2008	PetroChina
Changaing-Wuhai-Linhe	401	Changqing gas field	0.4	2008	PetroChina
Plans of Domestic Pipelines					
Yulin-Shandong	1,100	Ordos basin	3	2008	Sinopec
Yongqing-Tangshan-Qinhuangdao	320	Northeast and North PLs	9	2009	PetroChina
Sichuan-East (Puguang-Shanghai)	1,702	Puguang gas field	12	2010	Sinopec
West-East II	8,794	Tarim basin & Central Asia	30	2010	PetroChina
Shanjing III	820	Mutual supply	15	2010	PetroChina
Changling-Changchun-Jihua	221	-	-	-	PetroChina
Sebei-Lanzhou II	945.3	Qinghai gas field	3.4	-	PetroChina

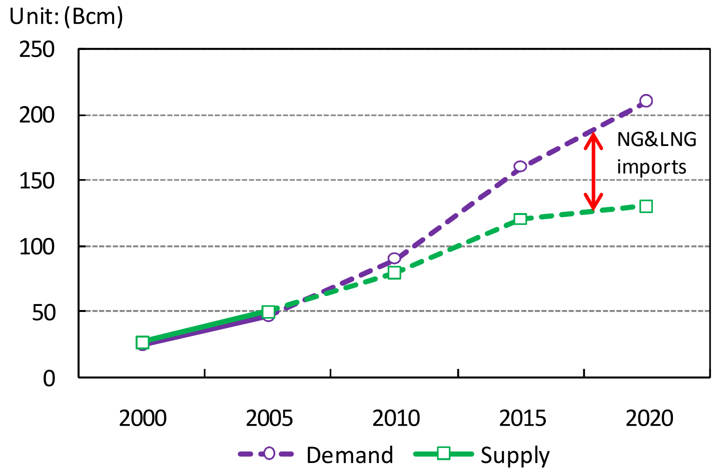
Source: Same as Table 2-27.

According to the NDRC, natural gas demand is projected to reach 210 Bcm by 2020, while the domestic supply is projected to provide only 180 Bcm. The balance will need to be supplied through either cross-border piped gas or LNG imports, as shown in Figure 2-14.

To meet the rising domestic demand for natural gas, accommodating imports at LNG terminals has been planned by the three major oil and gas companies.

China's first shipment of LNG from Australia's North West Shelf LNG (NWS LNG) arrived on May 26, 2006 at Dapeng LNG terminal in Guangdong Province and was purchased by CNOOC. Along with the existing operational LNG projects in Guangdong and Fujian, other LNG terminals are either under construction or planned, as summarized in Figure 2-15 and Table 2-28.

Figure 2-14 NG Demand and Supply Projection (2000-2020)



Source: Same as Table 2-27.

Due to the relatively high price of LNG and the proximate location of additional supplies in neighbouring countries, China has been looking to build several cross-border pipelines to tap into their gas-rich neighbours. The Central Asia-China gas pipeline eventually began construction in 2008 after years of feasibility studies and negotiations. The total length of the pipeline is 2,018 kilometres, of which 188 kilometres is in the Turkmen section, 530 kilometres is in the Uzbek section, and 1,300 kilometres is in the Kazakhstan section. The first and second stages of the pipeline are scheduled to be finished in 2009 and 2011. The pipeline will be connected to China's second West-East pipeline and is expected to transmit 30 Bcm of natural gas from Central Asia, mainly from Turkmenistan, every year for 30 years[17].

Agreement on the construction of the Myanmar-China cross-border oil and gas pipelines was officially completed in March 2009 by the two governments[18]. The oil pipeline is expected to provide an alternative route for crude from the Middle East and Africa instead of the existing oil cargo channel through the congested

Malacca Strait, while the gas pipeline is expected to deliver natural gas from Myanmar's offshore gas field (Blocks A-1 and A-3 in the Bay of Bengal) to China for 30 years. The pipelines are designed to terminate in China's Yunnan and Guizhou provinces[19].

Although a Russia-China gas pipeline project is also proposed, conflicts regarding pricing between Russia's Gazprom and CNPC have delayed the progress of the proposal.

Figure 2-15 LNG Terminals in China

Note: Terminals, which are under construction and are pre-approved are also included.
Source: Same as Table 2-27.

Table 2-28 LNG Terminals in China

LNG Terminal	Year of Commerical Operation	First Phase Volume (mtpa)	Operators	Sources	Status
Dapeng, Guandong	2006	3.7	CNOOC (33%), BP (30%), others (37%)	NWS, Australia; Qatargas[1)]	Under operation
Putian, Fujian	2009	2.6	CNOOC (60%), FIDC (40%)	Tangguh, Indonesia	Under operation
Yangshan, Shanghai	2009	3.0	CNOOC (45%), Shenergy (55%)	Tiga, Malaysia	Under construction
Dalian, Liaoning	2011	3.0	PetroChina, Local government	Qatagas 4 or Gorgon or Browse	Under construction
Rudong, Jiangsu	2011	3	PetroChina (55%), POG (35%), JGIG (10%)		Approved
Ningbo, Zhejiang	2012	3.0	CNOOC (51%), ZEG (29%), NEPD (20%)	Total, Qatargas	Approved
Qingdao, Shandong	2012	3.0	Sinopec, China Huaneng Group	Unknown	Pre-approved
Total		**21.3**			

1): CNOOC schedules to import 2 mtpa LNG from Qatargas for 25 years in September 2009.

FIDC: Fujian Investment and Development Corporation; POG: Pacific Oil and Gas; JGIG: Jiangsu Guoxin Investment Group; ZEG: Zhejiang Energy Group Co., Ltd.; NEPD: Ningbo Electric Power Development Co., Ltd.

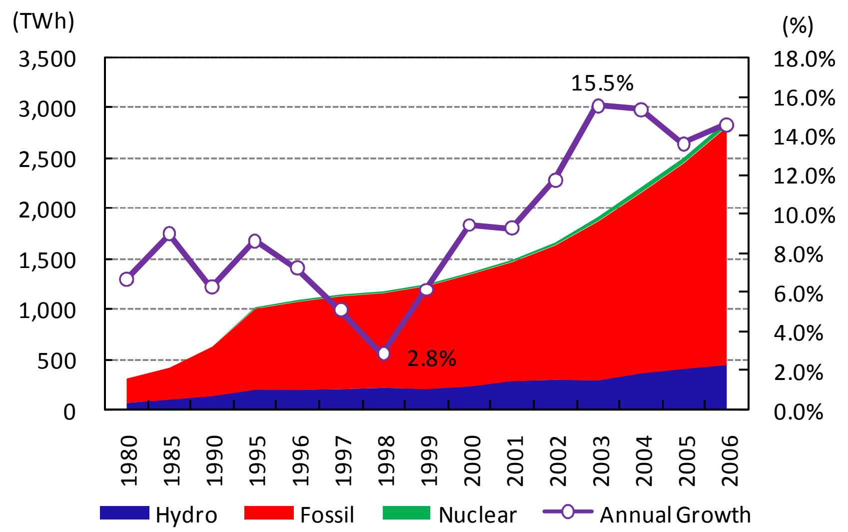
Note: "Pre-approved" means the feasibility study is approved by the government, while "approved" means that terminal construction is approved.

Source: Same as Table 2-27.

3.4. Electricity

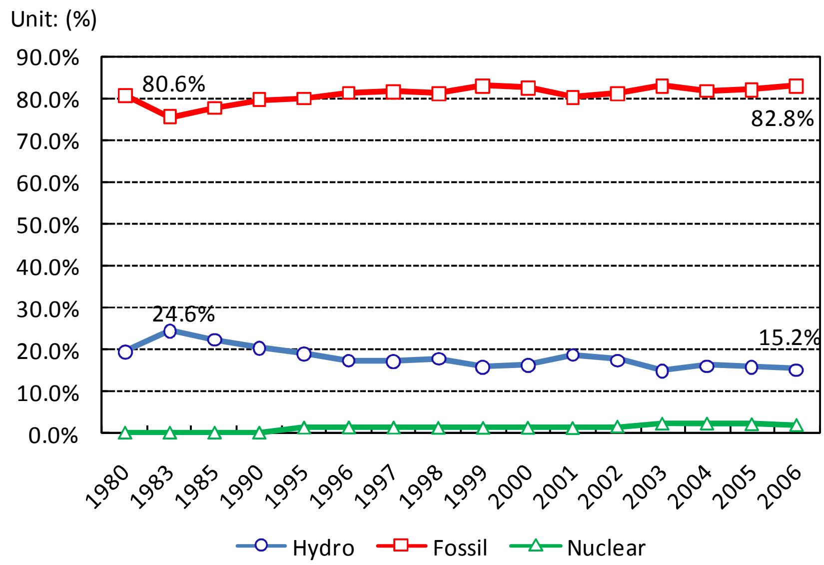
Driven by strong demand from heavy industry users, power generation increased to 2,860.23 TWh, almost ten times the 300.63 TWh generated in 1980, giving an annual average growth rate of 9.3% (Figure 2-16). The share of generation from hydropower capacity dropped significantly from 24.6% in 1983 to 15.2% in 2006, while thermal power consistently accounted for about 80% of the total during the period, of which more than 90% was from coal-fired power plants (Figure 2-17). Historically, power generated in East and South Central China has accounted for more than 50% of total power generation between 1988 and 2006 due to the two regions' fast economic development (Table 2-29).

Figure 2-16 Gross Electricity Generation (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 2A.4.1..

Figure 2-17 Gross Electricity Generation (Shares) (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 2A.4.2..

Table 2-29 Electricity Generation by Region (1988-2006)

Region	1988		1990		1995		2000		2006	
	TWh	% of Total	TWh	% of Total	TWh	% of Total	TWh	% of Total	TWh	% of Total
East China	160.35	29.4%	179.51	28.9%	298.27	29.7%	418.09	30.5%	940.43	32.9%
North China	96.47	17.7%	107.36	17.3%	165.24	16.5%	231.73	16.9%	493.364	17.3%
NorthEast China	82.62	15.2%	90.35	14.6%	119.35	11.9%	135.21	9.9%	211.569	7.4%
NorthWest China	42.40	7.8%	51.71	8.3%	76.25	7.6%	103.60	7.6%	218.471	7.7%
SouthCentral China	113.80	20.9%	134.30	21.6%	240.34	24.0%	332.95	24.3%	676.209	23.7%
SouthWest China	49.57	9.1%	57.56	9.3%	103.87	10.4%	150.35	11.0%	314.094	11.0%
Grand Total	545.21	100.0%	620.78	100.0%	1,003.32	100.0%	1,371.92	100.0%	2854.137	100.0%

Source: *China Energy Databook, V.7.0.*, Table 2A.2.7..

Although the Chinese government has been advocating adjusting the power generation mix since the mid-1980s to cope with chronic power shortage issues, new capacity installations have still been predominantly thermal power, and these thermal power plants are mainly coal-fired. Although the construction of new diesel power plants has been officially suspended since 1993, to deal with acute power shortages and to avoid blackouts, small diesel plants constructed by self-generators have proliferated since the middle of the 1990s. The number of gas-fired power plants has increased since 1997, with the growth rate quickening since the beginning of commercial operation of the West-East pipeline and the Dapeng (Guangdong) LNG terminal. By 2006, more than 12 GW gas turbines have been installed.

Between 1980 and 2006, hydropower's share of national installed electricity generation capacity was reduced sharply from 32% (its record high in 1984) to 20.9% in 2006, while thermal power capacity increased from 69.2% in 1980 to 77.6% in 2006. More than 55 % of thermal power capacity is located in East and South-central China, while about 60% of hydropower capacity is installed in South-central and Southwest China. The Three Gorges Dam is the biggest hydro project in China and the largest dam in the world. The project has 26 separate 700 MW generators with a total capacity of 18.2 GW. 14 units installed on the dam's left bank went into operation in September 2005, while the 12 plants on its right bank went into operation in October 2008.

From the beginning of a period of double digit GDP growth that started in 2003, China's rate of newly installing generation capacity increased dramatically. In 2006 alone, China added more than 100 GW of new capacity, of which 86.8%

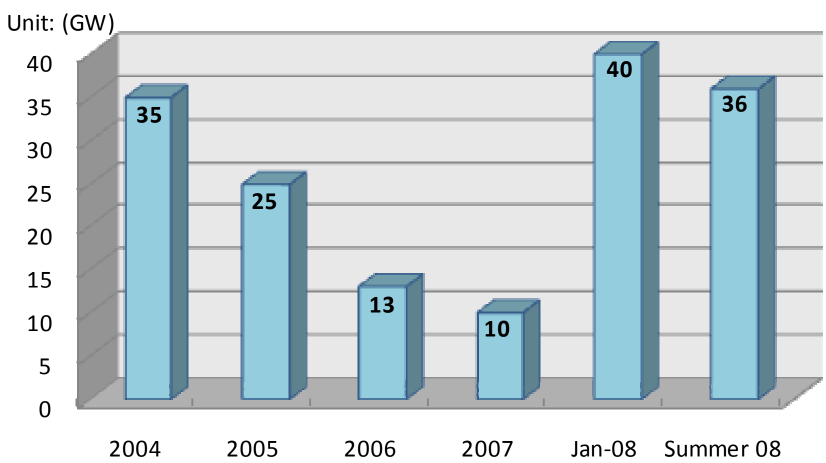
was thermal and 12.1% was hydropower capacity (Table 2-30). Despite this rapid growth in newly installed generation capacity, severe power shortages occurred between 2004 and 2008 due to a lack of actually operational generation capacity (Figure 2-18)[20].

Table 2-30 Electricity Generation Capacity (1980-2006)

Year	Hydro		Fossil		Nuclear		Wind		Total
	GW	% of Total	GW	% of Total	GW	% of Total	GW	% of Total	GW
1980	20.32	30.8%	45.55	69.2%					65.87
1984	25.60	32.0%	54.52	68.0%					80.12
1990	36.05	26.1%	101.84	73.9%					137.89
1995	52.18	24.0%	162.94	75.0%	2.10	1.0%	0.04	0.0%	217.22
2000	79.35	24.9%	237.54	74.4%	2.10	0.01	0.34	0.00	319.32
2001	82.70	24.5%	252.80	74.8%	2.10	0.6%	0.40	0.1%	338.00
2002	86.07	24.1%	265.55	74.5%	4.47	0.01	0.47	0.00	356.57
2003	94.90	24.2%	289.77	74.0%	6.19	1.6%	0.57	0.1%	391.41
2004	105.24	23.8%	329.48	74.5%	6.84	0.02	0.76	0.00	442.39
2005	117.39	22.7%	391.38	75.7%	6.85	1.3%	1.06	0.2%	517.18
2006	130.29	20.9%	483.82	77.6%	6.85	0.01	2.07	0.00	623.70

Source: *China Energy Databook, V.7.0.*, Table 2B.14..

Figure 2-18 Power Shortage (2004-2008)



Source: China Electricity Council press release.

In additional to overall growth in the electricity generation sector, the average size of generating units is also increasing. The average capacity of installed thermal power units (for units of over 6 MW) in China increased from 45 MW per unit in 1993 to 92 MW in 2007, an annual growth rate of 5.2%. The share of the total number of under-100MW, small-size thermal power plants dropped from 81.5% in 1995 to 73.5% in 2007 (Table 2-31). The decline in small units has been particularly fast since 2005, due to the government's energy efficiency policy. Between 2006 and July 2009, China has closed 54 GW of small-size thermal power plants, nearly 1.5 years ahead of its closure schedule (Figure 2-19).

Table 2-31 Installed Thermal Electricity Capacity - Unit Number (1995-2007)

Unit Size	1995		2000		2004		2005		2006		2007	
	Units	% of Total	Units	% of Total	Units	% of Total	Units	% of Total	Units	% of Total	Units	% of Total
6MW - 100MW	2,371	81.5%	2,770	78.1%	-	-	-	-	4,856	77.0%	4,420	73.5%
100MW - 200 MW	243	8.4%	321	9.1%	414	-	466	-	559	8.9%	553	9.2%
200MW - 300MW	177	6.1%	193	5.4%	218	-	228	-	241	3.8%	251	4.2%
300MW - 600MW	119	4.1%	262	7.4%	394	-	480	-	508	8.1%	578	9.6%
600MW and above						-		-	140	2.2%	209	3.5%
Total	2,910	100.0%	3,546	100.0%	-	-	-	-	6,304	100.0%	6,013	100.0%

Source: Ueda, T. and T. Furukawa (2009), "Current Movement of China's Electricity and Energy Industry", *Electricity Industry in Foreign Countries*, Japan Electric Power Information Center (JEPIC), March 2009, p11.

Table 2-32 Installed Thermal Electricity Capacity - Installed Capacity (1995-2007)

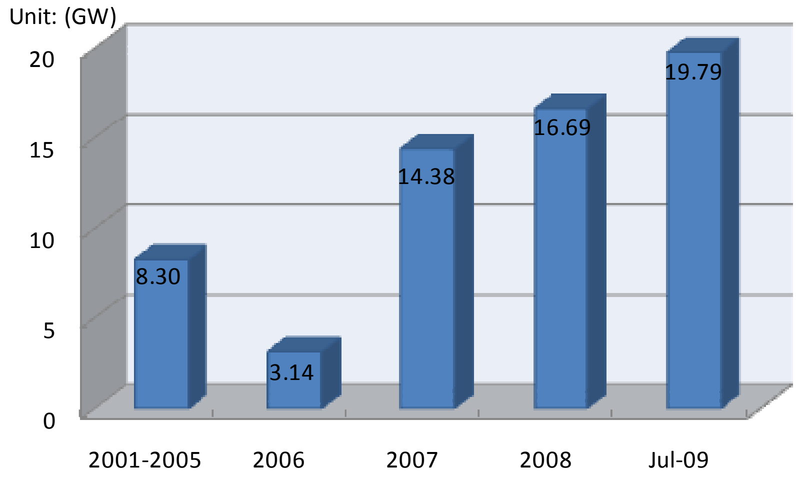
Unit Size	1995		2000		2004		2005		2006		2007	
	GW	% of Total	GW	% of Total	GW	% of Total	GW	% of Total	GW	% of Total	GW	% of Total
6MW - 100MW	4,047	24.8%	4,643	19.5%	-	-	-	-	8,478	17.5%	7,646	13.8%
100MW - 200 MW	2,694	16.5%	3,664	15.4%	4,974	-	5,676	-	6,921	14.3%	6,957	12.5%
200MW - 300MW	3,560	21.8%	3,883	16.3%	4,426	-	4,632	-	4,966	10.3%	5,175	9.3%
300MW - 600MW									16,209	33.5%	18,451	33.2%
600MW and above	3,968	24.4%	9,088	38.3%	14,218	-	17,491	-	8,888	18.4%	13,128	23.6%
Total	16,294	100.0%	23,754	100.0%	32948	-	39,137	-	48,382	100.0%	55,607	100.0%

Source: Same as Table 2-32.

Meanwhile, the share of the total number of 300 MW and above units increased from 4.1% in 1995 to 13.1% in 2007. Particularly during the 11th Five-year Plan period, 600 MW and above supercritical thermal power plants have been promoted and ultra-supercritical thermal power plants have been introduced because of technology improvements by domestic plant manufacturers. In 2007, newly installed 300 MW and above thermal power plants accounted for 89.7%

of total newly installed thermal power capacity, while 600 MW and above units accounted for 58.7%, of which 4 units are ultra-supercritical[21].

Figure 2-19 Closure of Small-size Thermal Power Plants (2001-July 2009)

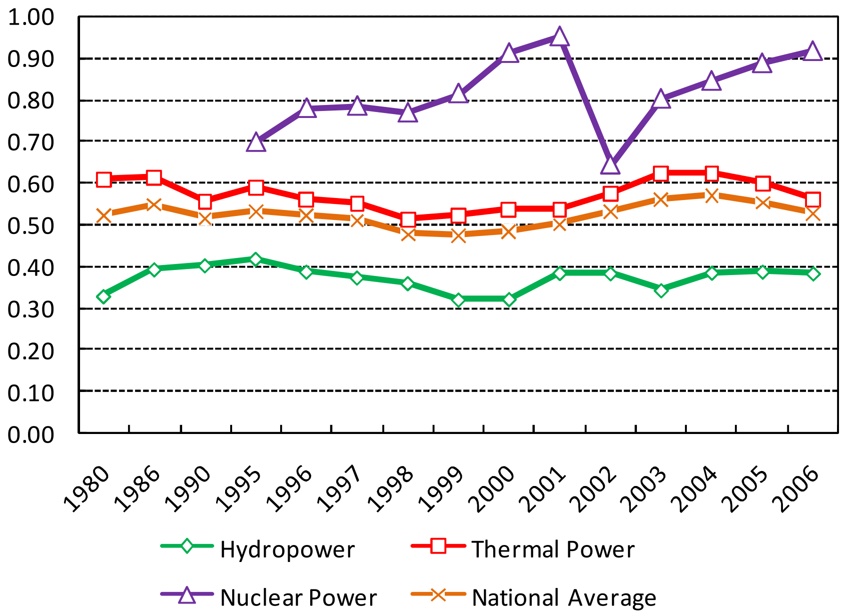


Source: Various press releases.

The average capacity factor of thermal plants peaked in 2004 and dropped to 0.56 by 2006, while hydropower's average capacity factor increased from 0.33 in 1980 to 0.38 in 2006. Nuclear power plants now have a comparatively higher average capacity factor of 0.81 (Figure 2-20). Generally, large thermal and hydro power plants have larger capacity factors and it is likely that grid companies will purchase more power from large capacity and more efficient units rather than small-size inefficient power plants due to current government energy policies.

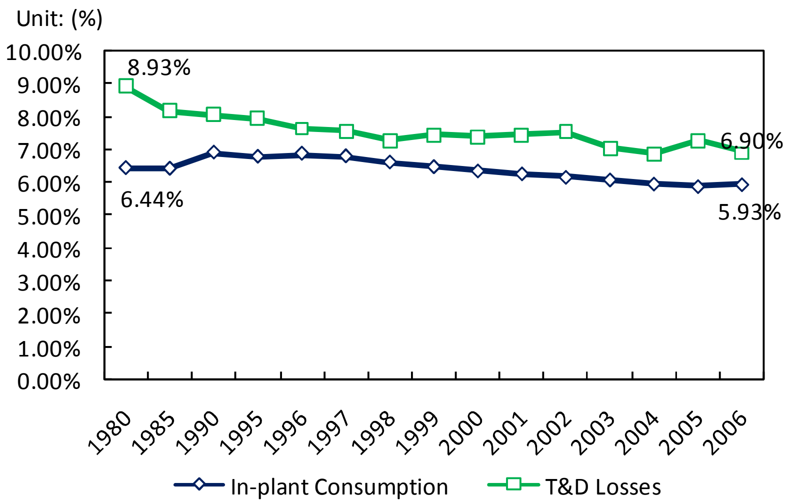
In-plant power consumption decreased from 6.4% in 1980 to 5.93% in 2006, while transmission and distribution (T&D) losses dropped from 8.9% to 6.9% during the same period (Figure 2-21). Given the huge amount of electricity generated by China today, improving the rate of T&D losses will be another important contribution to China's environmental protection goals, as well the improvement of energy efficiency of coal-fired power plants.

Figure 2-20 National Average Capacity Factors by Source (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 2B.17..

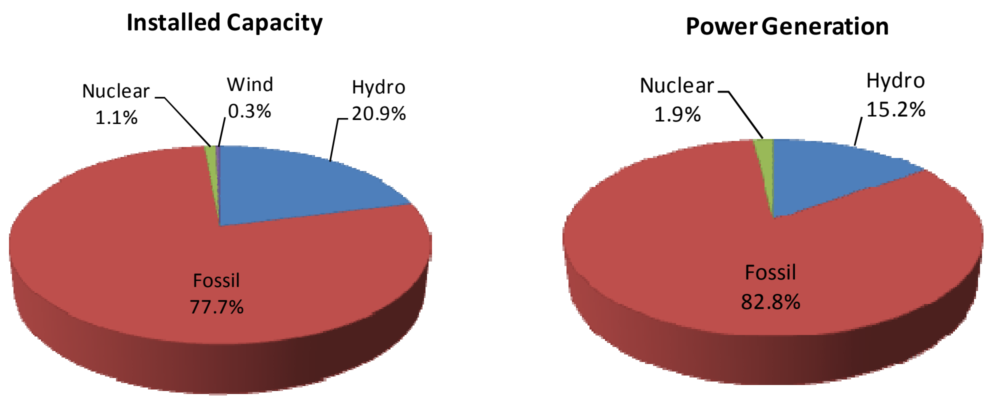
Figure 2-21 In-plant Power Consumption and T&D Losses (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 2B.13..

Although nuclear power still accounts for a small fraction of China's total installed capacity and gross generation, promoting nuclear power has been on the country's energy policy agenda since 2005. In 2006, nuclear power capacity reached 6.9 GW accounting for 1.1% of total capacity, while nuclear power generation reached 54.8 TWh accounting for 1.9% of total gross power generation (Figure 2-22). As of the end of 2007, China had 11 nuclear power plants (total 8.9 GW) in operation, as shown in Figure 2-33. Currently, only CNNC, CGNPC, and CPI are licensed to own and operate nuclear power plants. Other state-owned companies, such as power companies, are allowed to have minority shares in new projects.

Figure 2-22 Shares of Installed Capacity and Power Generation by Fuel Type (2006)



Source: *China Energy Databook, V.7.0.*, Table 2B.14., Table 2A.4.2..

Table 2-33 Existing Nuclear Power Plants (As of the end of 2008)

Name of Nuclear Power Plant (NPP)		Location	Capacity (MW)	Reactor Type	Operator	Construction Date	Operation Date
Qinshan Phase I NPP		Haiyan, Zhejiang	310	PWR:CNP-300	CNNC	20-Mar-1985	15-Dec-1991
Qinshan Phase II NPP	Unit 1	Haiyan, Zhejiang	650	PWR:CNP-600	CNNC	2-Jun-1996	15-Apr-2002
	Unit 2		650	PWR:CNP-600	CNNC	23-Mar-1997	3-May-2004
Qianshan Pahse III NPP	Unit 1	Haiyan, Zhejiang	700	CANDU-6	CNNC	8-Jun-1998	31-Dec-2002
	Unit 2		700	CANDU-6	CNNC	25-Sep-1998	24-Jul-2003
Guangdong Daya Bay NPP	Unit 1	Shenzhen, Guangdong	984	PWR:M310	CGNPC	7-Aug-1987	1-Feb-1994
	Unit 2		984	PWR:M310	CGNPC	7-Apr-1988	6-May-1994
Guangdong Linao NPP	Unit 1	Shenzhen, Guangdong	990	PWR:M310	CGNPC	15-May-1997	28-May-2002
	Unit 2		990	PWR:M310	CGNPC	28-Nov-1997	8-Jan-2003
Jiangsu Tianwan NPP	Unit 1	Tianwan, Jiangsu	1006	PWR:VVER-91	CNNC	20-Oct-1999	17-May-2007
	Unit 2		1006	PWR:VVER-91	CNNC	20-Sep-2000	16-Aug-2007
Total			**8,970**				

CNNC: China National Nuclear Corporation; CGNPC: China Guangdong Nuclear Power Holding Co., Ltd.;
Source: Various press releases.

Table 2-34 Under Construction and Planned Nuclear Power Plants

Name of Nuclear Power Plant (NPP)		Location	Capacity (MW)	Reactor Type	Operator	Construction Date	Operation Date
Lingao Phase II NPP	Unit 1	Shenzhen, Guangdong	1,000	PWR :CPR-1000	CGNPC	Dec-2005	2010
	Unit 2		1,000	PWR :CPR-1000	CGNPC	Jun-2006	2011
Qinshan Phase II NPP	Unit 3	Haiyan, Zhejiang	650	PWR:CNP-600	CNNC	Apr-2006	2011
	Unit 4		650	PWR:CNP-600	CNNC	Jan-2007	2012
Hongyanhe NPP	Unit 1	Dalian, Liaoning	1,000	PWR :CPR-1000	CPI,CGNPC	Aug-2007	2012
	Unit 2		1,000	PWR :CPR-1000	CPI,CGNPC	Apr-2008	2013
	Unit 3		1,000	PWR :CPR-1000	CPI,CGNPC	Mar-2009	2014
	Unit 4		1,000	PWR :CPR-1000	CPI,CGNPC	Mar-2009	2014
Ningde NPP	Unit 1	Fujian	1,000	PWR :CPR-1000	CGNPC, Datang	Feb-2008	2012
	Unit 2		1,000	PWR :CPR-1000	CGNPC, Datang	Nov-2008	2013
	Unit 3		1,000	PWR :CPR-1000	CGNPC, Datang	2010	2014
	Unit 4		1,000	PWR :CPR-1000	CGNPC, Datang	2010	2015
Fuqing NPP		Fujian	1,000*2	PWR :CNP-1000	CNNC, Huadian	Unit 1: Nov-2008	-
Qinshan I Extension		Haiyan, Zhejiang	1,000*2	PWR :CNP-1000	CNNC	Unit1: Dec-2008	Unit1: 2013
Yangjiang NPP		Guangdong	1,000*4	PWR :CPR-1000	CGNPC	Unit1: Dec-2008	Unit1: 2013
Sanmen NPP		Zhejiang	1,100*2	PWR: AP-1000	CNNC	Unit1: Mar-2009	Unit1: 2013
Haiyang NPP		Shandong	1,100*2	PWR: AP-1000	CPI	Unit1: Sep-2009	Unit1: 2014
Taishan NPP		Guangdong	1,600*2	PWR: EPR	CGNPC	Unit1: Sep-2009	Unit1: 2014

CNNC: China National Nuclear Corporation; CGNPC: China Guangdong Nuclear Power Holding Co., Ltd.; CPI: China Power Investment Corporation.
Source: Various press releases.

Electrification in China's rural and remote areas has improved during the past decade. Rural electrification increased from 43% in 1978 to 98.5% in 2005 through programs to increase the construction of small hydropower plants and extend power grids (Table 2-35). To complete electrification for the remaining 20 million people who still live without electricity by the end of 2006, the government has decided to further promote the availability of renewable power generation for rural households.

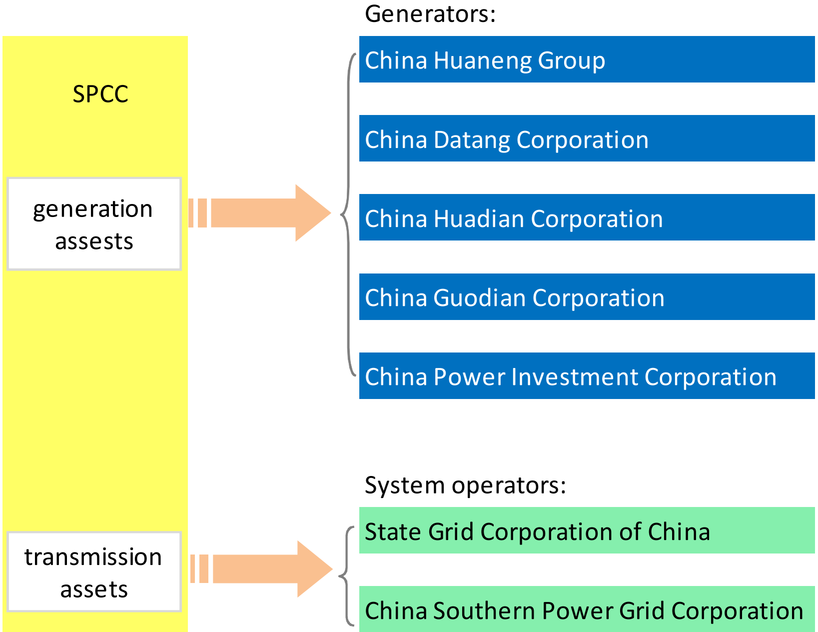
Table 2-35 Rural Electrification (1978-2005)

	Unit	1978	2000	2005
Rural population	million	790.1	808.4	745.4
Poverty standards	yuan/person	100.0	625.0	683.0
Poverty population	million	250.0	32.1	23.7
Percentage of Poverty	%	30.7	3.5	2.5
Population without electricity	million	450.0	35.0	11.5
Percentage of electrification	%	43.0	95.7	98.5
Electricity conosumption per capita	kWh	7.9	83.6	149.0

Source: *China Energy Databook, V.7.0.*, Table 2B.22..

Between 1980 and 2007, the Chinese power sector experienced three waves of system reform. First, to promote electric power development, local and provincial governments were allowed to invest in power generation (1985-1993). During the second wave of reforms (1994-1999) in 1997, the governance and regulatory functions of the Ministry of Electric Power were transferred to the State Economic and Trade Commission (SETC), while the business functions of the power sector was given to the State Power Corporation of China (SPCC). In March 2002, the Chinese government issued a “Plan for Electric Power System Reform” in State Council Notice No.5 (2002), which was a guiding document for China’s electric power system reform incorporating the concepts of separating the generation sector from the transmission sector and introducing competitive principles. Based on this plan, power generation assets previously owned by the SPCC were restructured into five state-owned holding companies, namely China Huaneng Group, China Datang Group, China Huadian Corporation, China Guodian Corporation and China Power Investment Corporation (Figure 2-23). By 2006, these five holding companies operated more than 38% of China’s installed capacity, slightly less than all local generators combined (Figure 2-25). Meanwhile, the transmission assets of the SPCC were allocated to the State Grid Corporation of China (SGCC) and the China Southern Power Grid Corporation (CSPGC) (Table 2-36, Figure 2-25).

Figure 2-23 Restructuring of the SPCC



Source: Ni, Chun Chun (2005), *Analysis of Applicable Liberalization Models in China's Electric Power Market*, IEEJ.

Table 2-36 Regional Power Grid Companies and Service Territories

Regional Power Grid Company		Service Territory
State Grid Corporation of China	North China Power Grid	Bijing, Tianjin, Hebei, Shanxi, West Inner Mongolia, Shandong
	Northeast China Power Grid	Heilongjiang, Jilin, Liaoning, East Inner Mongolia
	East China Power Grid	Shanghai, Zhejiang, Anhui, Jiangsu, Fujian
	Central China Power Grid	Jiangxi, Henan, Hubei, Hunan, Chongqing, Sichuan
	Nothwest China Power Grid	Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang
China Southern Power Grid		Guangdong, Guangxi, Yunnan, Guizhou, Hainan

Source: Same as Figure 2-23.

Figure 2-24 Power Network Operators in China

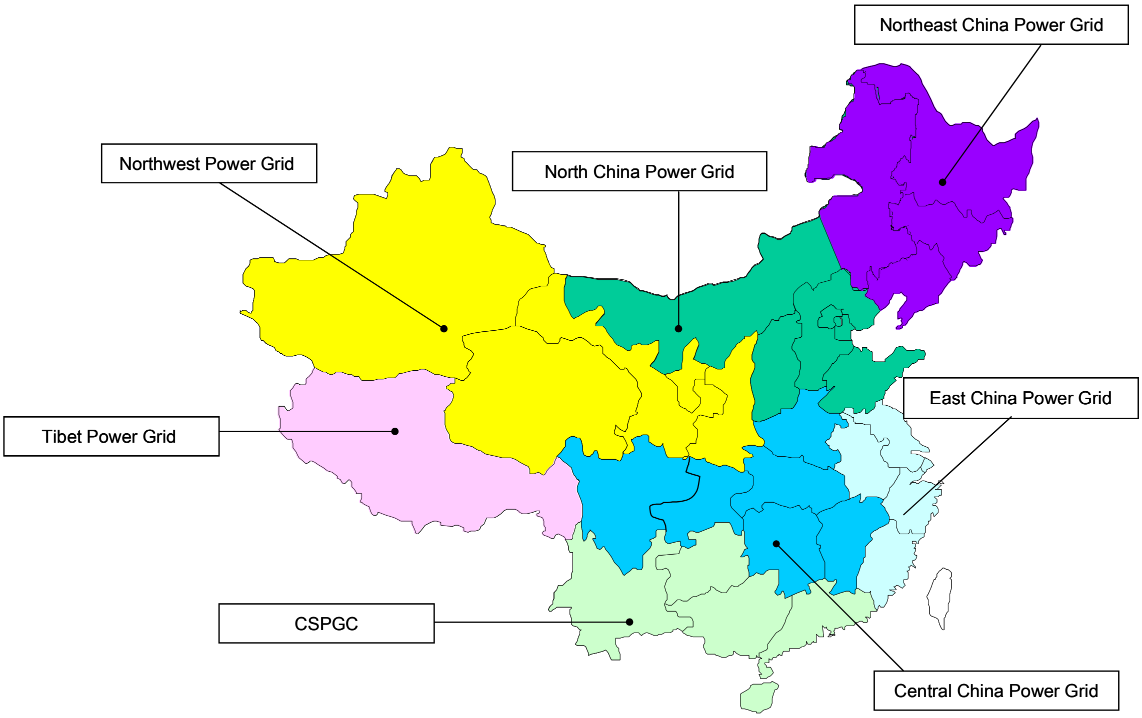
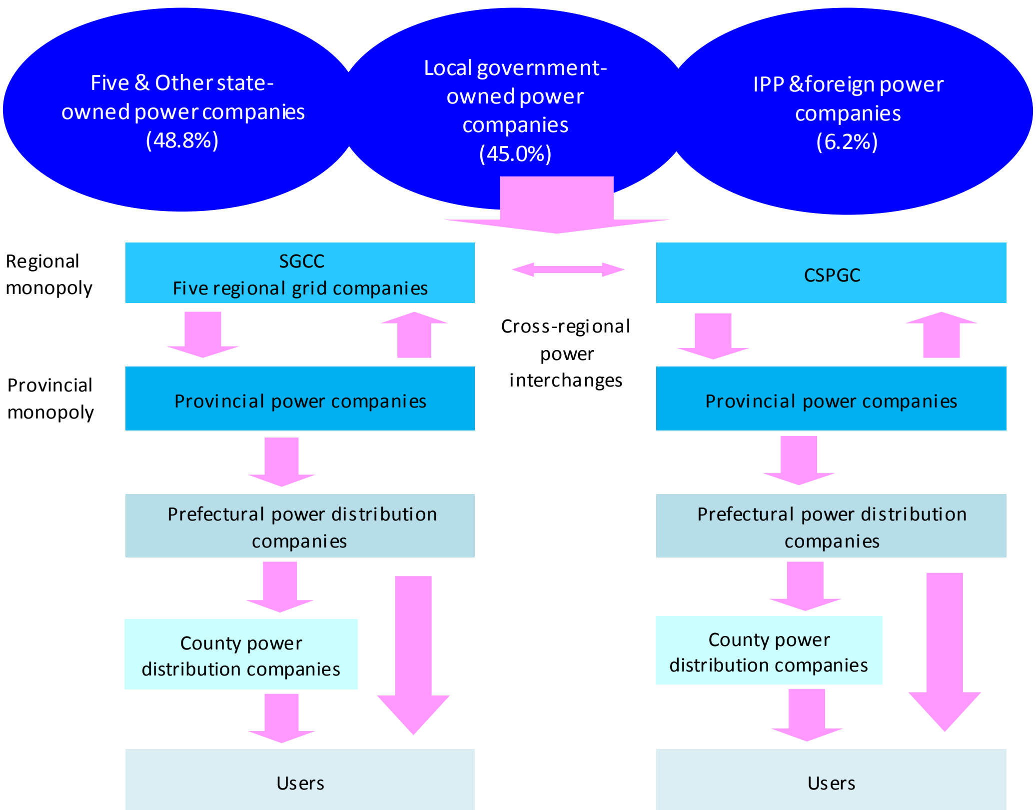


Figure 2-25 Electric Power Supply System in China



Source: Same as Figure 2-23.

3.5. Renewable Energy Resources

Firewood and crop straw are the primary fuel sources of China's biomass energy. About 60% of crop straw is used by rural householders for cooking and heating. About 21.8 million household-scale biogas digesters were in operation in 2006, producing 8.4 Bcm biogas per year. Biogas digesters are mainly used in Guangxi, Sichuan, Hunan, Yunnan, and Jiangxi provinces, where livestock farming is concentrated. Meanwhile, biogas power capacity and generation reached 2.1 GW, and 5,040 GWh, respectively.

Small hydropower projects have been a major element of rural electrification and rural economic development. In 2006, 50 GW of small hydropower capacity (less than 50 MW each) was installed, accounting for 38.4% of total hydropower capacity, mainly installed in Sichuan, Yunnan, Fujian, Zhejiang and Hubei provinces. The annual growth rate in small hydropower capacity between 2000 and 2006 was 9.4%.

Because the generation cost of geothermal power is higher, and therefore less competitive, than that of hydropower, by 2006 China's geothermal power capacity was only 32 MW. Tibet, the only region with commercial geothermal power plants, has 3 in operation (Table 2-37).

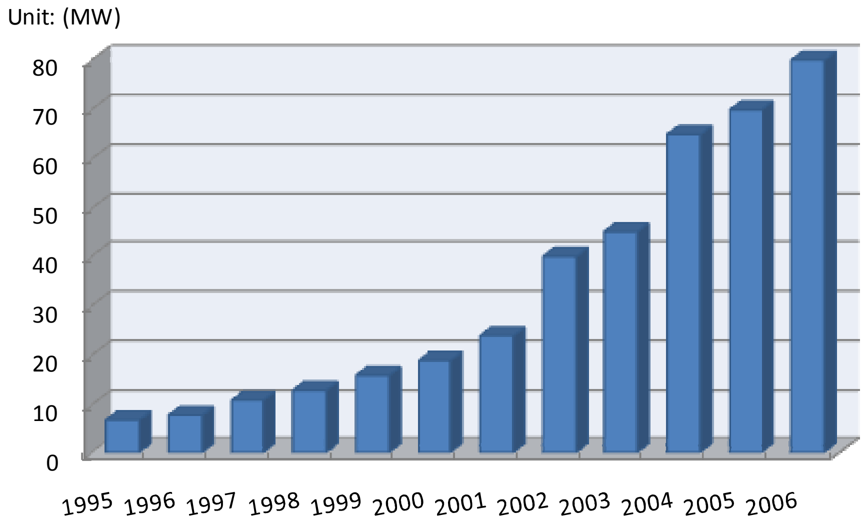
Table 2-37 Geothermal Power Plants

Province	Name of Geothermal Power Sation	Max. Output (MW)	MW/unit	Number of units	Year of operation
Hunan	Huitang (self-consumption)	0.3	0.3	1	1975
Guangdong	Fengshun(self-consumption)	0.3	0.3	1	1984
Tibet	Yangbajin	25.18	1*1; 3*7; 3.18*1	9	1977-1996
	Langjiu	2	1	2	1987
	Naqu	1	1	1	1993

Source: Electric Power International Cooperation Center (2008), "Research of China's Renewable Energy", *Electricity Industry in Foreign Countries*, JEPIC, November 2008, p47.

Solar power generation has been a long term focus of China's rural electrification plans, especially through the use of solar water heaters. Photovoltaic (PV) cell generation capacity increased from 7 MW in 1995 to 80 MW in 2006, with an annual growth rate of 24.8% (Figure 2-26). The rate of new installations was particularly fast between 2000 and 2006. Meanwhile, solar water heaters and solar heated houses reached 90 million square-meters and 30 million square-meters in 2006, respectively.

Figure 2-26 Capacity of PV Cells (1995-2006)

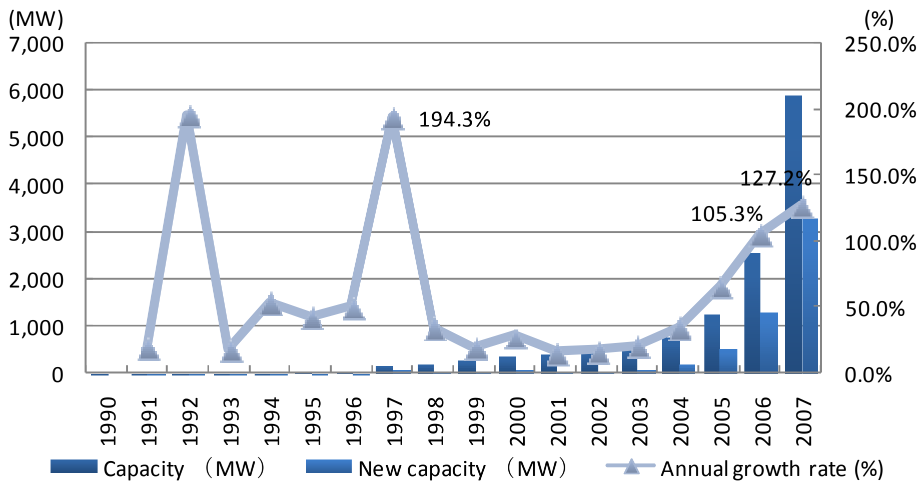


Source: Date between 1995 and 2005 from IEEJ (2008), Renewable Energy in China, Data of 2006 from *China Energy Databook, V.7.0.*, Table 2B.28..

China's wind power generation capacity increased from 4 MW in 1990 to 5.9 GW in 2007, an average annual growth rate of 53.4%. In 2006 and 2007, annual growth in newly installed wind capacity exceeded 100%. In 2007 the annual growth of wind sector capacity reached 127.2%, the highest increase since 2000 (Figure 2-27).

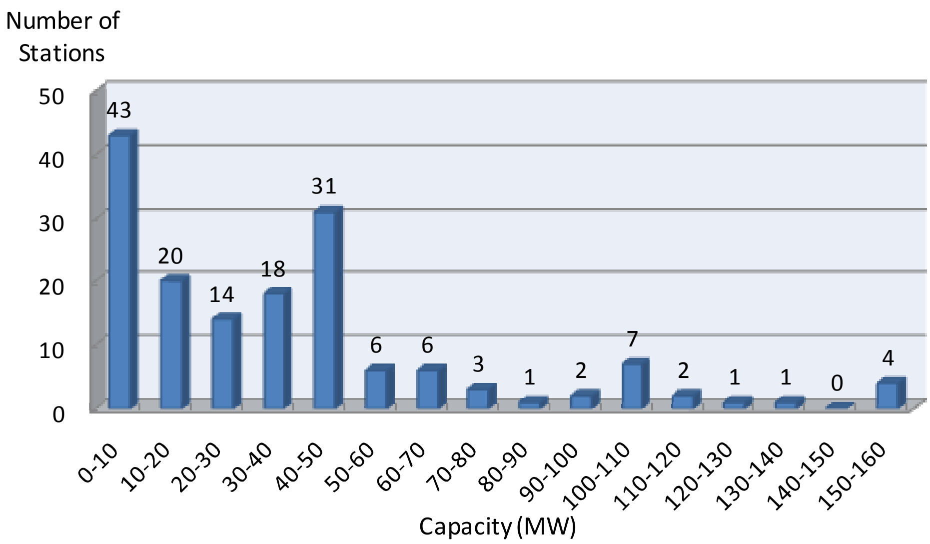
By the end of 2007, a total of 158 wind power stations with a total of 6,469 wind power units were built in 21 provinces, of which 126 stations were less than 50 MW, 18 stations were between 50 and 100 MW, 11 stations were between 100 and 150 MW, and 4 stations are above 160 MW (Figure 2-28). Inner Mongolia has the largest installed wind power generation capacity among the provinces in China, followed by Jilin, Liaoning, Hebei, and Heilongjiang. The autonomous region and four provinces account for 60% of China's total wind power generation capacity, indicating that China's wind power resources development has been concentrated in the three northern regions (Figure 2-29).

Figure 2-27 Capacity of Wind Power (1990-2007)



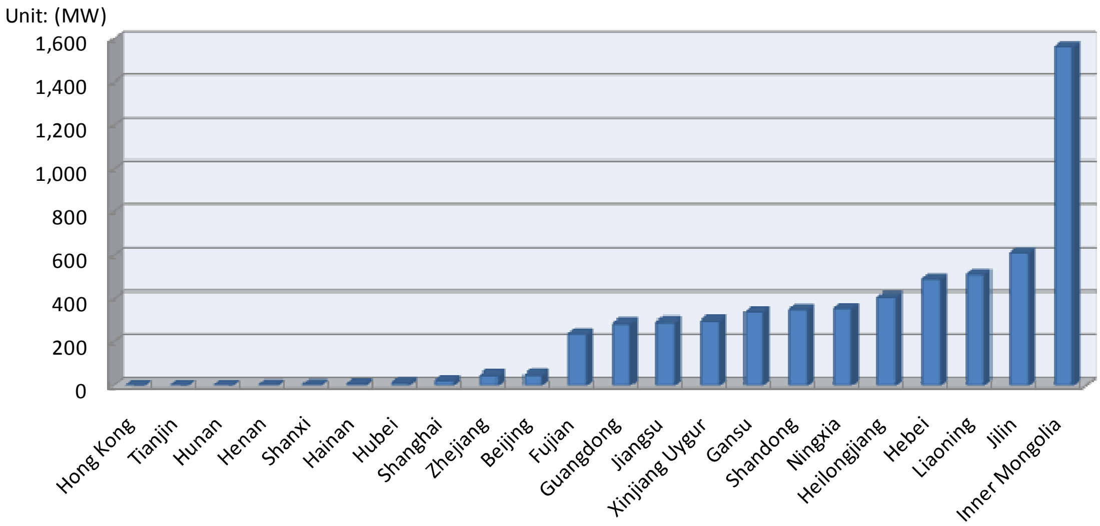
Source: Ni, Chun Chun (2008), *China's Wind-Power Generation Policy and Market Developments*, IEEJ.

Figure 2-28 Capacity Scale of Wind Power Stations



Source: Same as Table 2-37.

Figure 2-29 Wind Power Generation Capacity by Province (2007)



Source: Same as Table 2-37.

In 2007, units with capacities of 1 MW and above accounted for 22.4% of total wind power generation capacity, indicating that domestic turbine manufacturers have improved their technology and the production costs for large-scale wind power plants (1.5 MW class).

As for capacity load factors, Hebei Province has the best performance in the country (about 30%) followed by Xinjiang and Hainan (above 20%). Capacity load factors of wind plants in other provinces are around 15%, while Jiangsu's wind power load factor is about 4% (Table 2-38).

Factors behind fast growth in China's wind power generation market include the government's legislative support for wind power and technological and process improvements in the wind power generation equipment manufacturing industry. To reduce wind power generation costs and to foster domestic wind plant manufacturing, the government introduced a series of wind power concession projects in 2003[22]. These projects are designed to select investors for wind power projects through competitive tender bidding processes which prioritize power sales costs and the domestic content of wind power generation facilities. From its initiation in 2003 until 2007, five bidding phases have resulted in open tender bidders operating wind power generation projects totalling 3.4 GW. The capacity additions targeted in each phase quintupled from 200 MW for Phase 1 wind power concession projects in 2003 to 950 MW for Phase 5 projects in 2007, signaling the rapidly increasing potential of China's wind power generation sector. The central government-led wind power concession projects that entered commercial operations by the end of December 2007 accounted for about 815 MW or 23.9% of total wind power capacity.

Table 2-38 Capacity Load Factors of Wind Power Plants by Region (2004-2006)

Region	Province	Capacity (MW)			Power Generation (GWh)			Capacity Load Factor (%)			
		2004	2005	2006	2004	2005	2006	2004	2005	2006	Average (%)
North	Hebei	13.4	48.0	217.8	40	149	364	34.1	35.4	19.1	29.5
	Shandong	12.3	30.6	106.5	16	50	157	14.8	18.7	16.8	16.8
	Inner Mongolia	50.2	80.8	320.7	88	134	208	20	18.9	7.4	15.4
Northeast	Liaoning	126.5	126.5	206.6	215	204	236	19.4	18.4	13.0	17.0
	Jilin	30.1	79.4	208.3	71	60	302	26.9	8.6	16.6	17.4
	Helongjiang	36.3	52.4	115.3	36	107	168	11.3	23.3	16.6	17.1
East	Shanghai	-	24.4	24.4	-	30	46	-	14.0	21.5	17.8
	Jiangsu	-	-	15.0	-	-	5	-	-	3.8	3.8
	Zhejiang	33.0	37.2	37.2	50	55	48	17.3	16.9	14.7	16.3
	Fujian	12.0	52.0	88.8	19	37	163	18.1	8.1	21.0	15.7
South	Guangdong	83.4	83.4	183.5	149	156	243	20.4	21.4	15.1	19.0
	Hainan	8.7	8.7	14.7	10	15	39	13.1	19.7	30.3	21.0
Northwest	Gansu	64.1	64.1	87.9	57	90	102	10.2	16.0	13.2	13.1
	Ningxia	42.5	112.2	122.7	46	148	222	12.4	15.1	20.7	16.0
	Xinjiang	105.4	105.4	165.4	243	229	394	26.3	24.8	27.2	26.1

Source: Same as Table 2-37.

In addition, the Clean Development Mechanism (CDM) under the Kyoto Protocol is one of the indirect factors stimulating growth in the sector. According to the United Nations Environment Program (UNEP) database, a total of 202 Chinese projects were registered with the CDM Executive Board as of June 4, 2008, including 60 wind power generation projects (for a total capacity of 2.99 GW), which account for 30.7% of all Chinese CDM projects and 45.5% of the world's total CDM wind power generation projects. CDM projects thus occupy nearly a full half of total domestic wind power generation capacity, strongly indicating that China has taken advantage of CDM under the Kyoto Protocol for accelerating the deployment of wind power generation projects.

Table 2-39 1st through 5th-Phase Wind Power Concession Projects and their Progress (As of December 2007)

Phase	Year	Wind Power Concession Project	Capacity (MW)	Capacity in Operation (MW)
Phase 1	2003	Jiangsu Rudong Wind Power Station I	100	100
		Guangdong Huilai Shibeishan Power Station	100	100
Phase 2	2004	Jiangsu Rudong Wind Power Station II	150	150
		Jilin Tongyu Tuanjie Wind Power Station	400	200
		Inner Mongolia Huiteng Xile Wind Power Station	200	200
Phase 3	2005	Jiangsu Dongtai Wind Power Station	200	Under construction
		Jiangsu Dafeng Wind Power Station	200	50
		Gansu Anxi Wind Power Station	100	15
Phase 4	2006	Inner Mongolia Ximeng Huitengliang Wind Power Station	600	Under construction
		Inner Mongolia Baotou Bayin Wind Power Station	200	Under construction
		Hebei Zhangbei Danjinghe Wind Power Station	200	Under construction
Phase 5	2007	Inner Mongolia Niaolan Yiligeng Wind Power Station	300	Under construction
		Inner Mongolia Tongliao Beiqinghe Wind Power Station	300	Under construction
		Hebei Shangde Yudaokou Wind Power Station	150	Under construction
		Gansu Yumen Changma Wind Power Station	200	Under construction
Total			**3,400**	**815**

Source: Same as Figure 2-27.

Table 2-40 Approved CDM Projects in China

Category	Number of Registered Projects
Hydropower	69
Wind power	60
Energy conservation	19
Biomass	11
Landfill gas	10
HFCs	10
N2O	8
CBM	8
Fuel conversion	6
Afforestation/reforestation	1
Total	**202**

Source: Same as Figure 2-27.

[1] *China Energy Data Book V.7.0.*, Table 2A.1.2., Lawrence Berkeley National Laboratory.
[2] The Oil Reserve Center is the successor of the Oil Reserve Office, which was established in May 2003, and was affiliated with the Bureau of Energy, NDRC. The Office was taken charge of its plan for oil reserves and functioning programs.
[3] The "11th Five-year Plan", March 16, 2006, NDRC; The "11th Five-year Plan for Development of Energy", April 2007, NDRC.
[4] "Production Targets of Oil and Natural Gas", *Tepia Monthly*, April 2009, Vol.4.
[5] Zhao, Xiaoping, "Basic Concept of Development of Electric Power Industry for the 11th Five-year Plan", speech on December 27, 2006.
[6] The target has unofficial revised to approximately 80 GW by 2020.
[7] The "11th Five-year Plan for Development of Nuclear Power Industry", August 2006, Commission of Science Technology and Industry for National Defense, China; The "Middle and Long Term Development Plan for Nuclear Power", October 2007, NDRC.
[8] "The nuclear fuel cycle, also called nuclear fuel chain, is the progression of nuclear fuel through a series of differing stages. It consists of steps in the front end, which are the preparation of the fuel, steps in the service period in which the fuel is used during reactor operation, and steps in the back end, which are necessary to safely manage, contain, and either reprocess or dispose of spent nuclear fuel. If spent fuel is not reprocessed, the fuel cycle is referred to as an open fuel cycle (or a once-through fuel cycle); if the spent fuel is reprocessed, it is referred to as a closed fuel cycle.", cited from Wikipedia, http://en.wikipedia.org/wiki/Nuclear_fuel_cycle.
[9] For more details, please refer to the United States National Renewable Energy Laboratory's (NREL) fact sheet at http://www.nrel.gov/china.
[10] For full text of the Law, please refer to http://www.martinot.info/China_RE_Law_Beijing_Review.pdf.
[11] An, Bei, "Sino-Russia Concluded 'Loan for Oil Supply' Deal", *China Oil and Gas Weekly News*, China5E Magazine, March 9, 2009, Vol. 104.
[12] "China Will Examine the Possibility of Using a Portion of Foreign-exchange Reserves for Supporting Overseas Energy Exploration", *China Energy Weekly News*, China5E Magazine, February 23, 2009, Vol. 191.
[13] For detailed information of other Ministries, please refer to IEA (2007), *World Energy Outlook 2007: China and India Insight*, Paris: OECD/IEA, pp.268-270.
[14] Responsibility of NDRC, NDRC, http://nyj.ndrc.gov.cn/jgsz/default.html.
[15] Zhang, Guobao, "China Will Promote Restructuring and Merger of Coal Mines", Xinhua Net, February 2009.
[16] "Russia Signed 20 Year Contract for Crude Oil Supply to China in Exchange for $25bn Loan", China Digital Times Net, March 31, 2009.
[17] Yenikeyeff, Shamil (2008), "Kazakhstan's Gas: Export Markets and Export Routes", Oxford Institute for Energy Studies, http://www.oxfordenergy.org/pdfs/NG25.pdf.
[18] "China and Myanmar Signed on Construction of Oil and Gas Pipeline Agreements", *China Oil and Gas Weekly News*, China5E Magazine, March 30, 2009, Vol. 107.
[19] "China Signs Burmese Gas Deal for 30-year Supply", Sanooaung, December 28, 2008,http://sanooaung.wordpress.com/2008/12/28/china-signs-burmese-gas-deal-for-30-year-supply/.
[20] Power shortages occurred in 2008 was due to snow disaster happened and rapid increase of coal price of the year.
[21] Ni, Chun Chun (2008), *Movement of IGCC and CCS Technology in the World: China*, IEEJ, http://eneken.ieej.or.jp/data/summary/1746.pdf.
[22] Under the concession project that amounts to the Chinese version of the private finance initiative (PFI), special permits are given for development of state-owned resources and government-controlled infrastructure construction.

Chapter 3 Energy Consumption

1. Energy Conservation Policy

China initiated its energy conservation policy works in the early 1980s. In order to implement economy-wide energy conservation the following measures have been undertaken since that time.

1) Improving the Legal Framework for Energy Conservation
China's energy efficiency programs started in the 1980s. However, many of these programs lacked impact during the country's transitional period from a planned economy to a market-based one[1]. In order to improve the legal system for energy efficiency, the National People's Congress in 1997 passed the *Energy Conservation Law of China*, which came into force in January 1998. The *Energy Conservation Law* made provisions for the administration of energy conservation programs, the promotion of rational energy use and support for advances in energy conservation technologies. Since then, various regulations, provisions, and policies have been formulated to help implement the law. The law was later revised and the updated version came into effect in April 2008.

To complement the implementation of the *State Council Office Notice on the Carrying Out of Resource Conservation Activities* (April 2004), the *Energy Conservation Law* and the *Government Procurement Law* (January 2002), the government also published a formal list of energy efficient products to be prioritized in public procurement in December 2004. Certified by the China Quality Certification Center (CCQC), the list of products was issued as the "List of Energy Efficient Products for Government Procurement", or simply the "Energy Efficiency List". To date, the "Energy Efficiency List" has been revised five times and its sixth upgrade was scheduled for July 2009. The Fifth "Energy Efficiency List" includes 23 energy efficiency products and 7 water saving devices[2].

By the end of 2008, at the central governmental level alone, about 40 energy conservation regulations and provisions had been issued[3]. In addition to efficiency regulations and provisions promulgated by the central government such as the *Energy Conservation Management Method for Key Energy*

Consumption Enterprises, local governments have also established their own energy conservation policies which reflect local energy consumption patterns and needs.

2) Establishing Energy Conservation Management Systems

China has gradually enhanced its energy conservation administration system since it was introduced as a government function in the earlier 1980s. At the central government level, energy conservation administrative organizations were established by Ministries and Commissions and parallel structures at a local level were also established.

Between the early 1980s and the middle of the 1990s, central government control of energy conservation was somewhat successful. Since then, several reforms of central government organizations have been implemented, as shown in Table 2-12, and the energy efficiency governance functions of both the Ministries and Commissions have been significantly changed. However, government departments for administrating energy conservation continue to play a role.

Today, the Department of Environment and Resource Conservation (DERC) under NDRC is responsible for formulating national energy conservation policies and implementing the *Energy Conservation Law*. It has also been charged with supervising the development of energy efficiency standards and the labeling of energy efficiency products in China.

The State Administration of Quality, Supervision, Inspection and Quarantine (AQSIQ) is authorized to supervise and manage certification and accreditation as well as manage all standards.

The Certification and Accreditation Administration of China (CNCA) is responsible for over sight of products subject to compulsory certification and for supervising certification organizations, certification training, and consulting organizations.

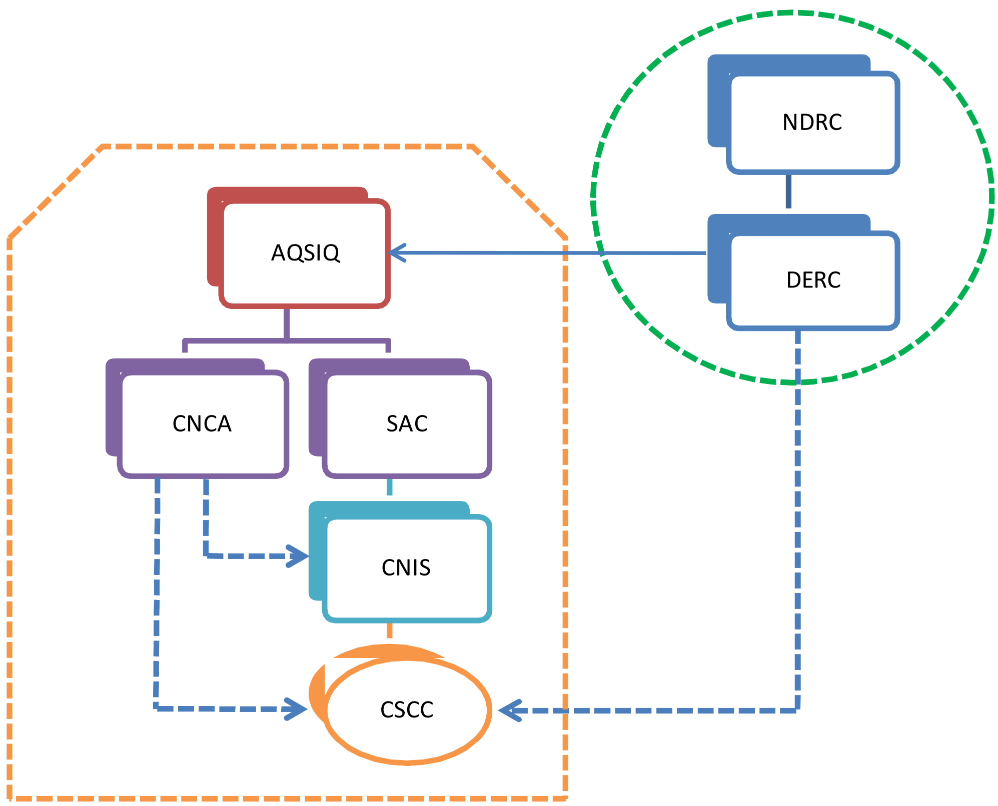
The Standardization Administration of China (SAC) is charged with the management, supervision, and overall coordination of standardization tasks in

China. Both CNCA and SAC are supervised by AQSIQ.

The China National Institute of Standardization (CNIS) is a research institute also under the supervision of AQSIQ. CNIS provides technical support to AQSIQ in the development of standardization. CNIS is also responsible for the development of the energy information labeling programs under the supervision of NDRC and AQSIQ.

The China Certification Center for Energy Conservation Products (CECP) also known as the China Standard Certification Center (CSCC) is a non-profit independent certification organization that was established in 1998 to administer the energy labeling program for energy-efficient, water-conservation, and China Compulsory Certification (CCC) products. CECP is under the guidance of NDRC and AQSIQ and is administratively affiliated with CNIS[4].

Figure 3-1 Energy Conservation Institutional Framework



In addition to the above-mentioned governmental energy management institutes, in the 1980's energy conservation service centers were also established to offer energy efficiency services. During this period, there were 200 centers with several thousand staff providing technology consultation, monitoring, and training in energy conservation, mainly related to energy use in the industrial sector. Some of these service centers later also took on some responsibilities for implementing the *Energy Conservation Law* when it came into effect in 1998. Private institutes were also established to provide consultations, education, evaluation of energy conservation projects, and help with international cooperation in energy use related projects.

3) Establishing Energy Conservation Design Codes and Energy Conservation Standard Systems

Creating and implementing energy conservation design codes and standards has been a significant step in promoting energy efficiency in China. By the end of 2005, about 30 energy conservation design codes and more than 120 energy efficiency standards had been brought into effect by the central government. China's energy conservation design codes mainly focus on the industrial sector. In the 1980s, the government promulgated energy saving codes for more than 10 industrial sectors, including the important building sector. In 1986, the government enacted the *Energy Conservation Design Standard for Residential Buildings* (JGJ26-86), which was designed to improve energy conservation in the residential new buildings sector by about 30%. In 1996, the initial *JGJ26-86 Standard* was renewed and the conservation target for new buildings was revised to 50% (JGJ26-95). The *Administration Provision for Energy Conservation for Residential Buildings*, which mandatorily applies to all new residential buildings, has been in effect since October 2000. During the 10th Five-year Plan period, a series of energy standards for buildings was issued by the government, such as the *Energy Efficiency Design Standard for Residential Buildings in Summer Hot/Winter Cold Areas*, the *Energy Efficiency Design Standard for Residential Building in Summer Hot/Winter Warm Areas*, and the *Design Standards for Lighting in Residential Building*.

Energy use standards and codes for the transportation sector is a relatively new area for Chinese policy makers and hence this sector has attracted a lot of attention in recent years. The country's first compulsory standard that caps fuel consumption for passenger cars, the *Limits of Fuel Consumption for Passenger Cars*, was promulgated in September 2004. The first stage of this standard was enacted in July 2005 and it aimed to increase the fuel efficiency of passenger cars by up to 10 percent by 2008. The second stage, which came into effect in 2008, required a further 10 percent fuel efficiency increase.

Minimum energy efficiency standards for some products, particularly appliances, came into effect at the end of the 1980s[5]. Initially, in December 1988, the Bureau of Technology Supervision released energy efficiency standards for 9 appliances which came into force in December 1990. Since then, energy efficiency standards for appliances have steadily developed[6]. Currently, mandatory energy efficiency standards cover 6 product categories: household appliances, lighting equipment, commercial equipment, industrial equipment, vehicles, and office equipment. These 6 categories all together contain a total of 35 individual standards[7].

4) Establishing Certification and Labeling Systems for Energy Efficiency Products

China has implemented a voluntary certification program for energy efficiency products since CECP enacted and promulgated the *Administration Measure for Certification of Energy Efficiency Products* in 1999. To date, CECP has certified products in 55 categories, as summarized in Table 3-1[8]. The program requires manufacturers to submit records of an on-site production facilities audit, undertake product testing in certified third-party laboratories, and to comply with ISO 9000 standards[9]. Manufacturers whose products meet the criteria are entitled to label their individual products or production packaging with the energy efficiency logo mark (Figure 3-2).

In accordance with the *Measures for the Administration of Energy Efficiency Labels*, issued in 2004, the NDRC, AQSIQ, and CNCA have together issued conservation labels for four groups' products within the *Catalogue of the People's Republic of China on the Products to Be Attached with Energy Efficiency Labels* (Table 3-2). The official name of the energy efficiency label is the "China Energy Label". The label includes information such as: (1) the name of the producer; (2) the product model; (3) the level of energy efficiency; (4) per watt energy consumption; and (5) the China energy efficiency standards referenced to determine the product's degree of energy efficiency, as shown in Figure 3-3.

Table 3-1 CECP Certificated Products

Energy Conservation Products	Appliances Industrial equipment Lighting Office equipment
Water Saving Products	Industrial products Residential products Unconventional water resources utilized products Agriculture products
Environmental-Friendly Products	Decoration stuff for construction Recycling products and others Air purifying equipments Office equipment and products Waste treatment equipments and others
China Compulsory Certification (CCC) Service	Solvent carpentry paint Ceramic tile

Source: Li, Tienan (2005), *China: Certification as a Means of Raising Confidence in Declared Energy Performance Values*, presentation paper, CECP.

Figure 3-2 Energy Efficiency Logo

Source: Same as Table 3-1.

Unlike mandatory minimum efficiency standards under the voluntary energy efficiency certification program, manufacturers are allowed to self-report the energy consumption of each product model[10].

Table 3-2 Catalogue of Products Requiring Energy Efficiency Labels

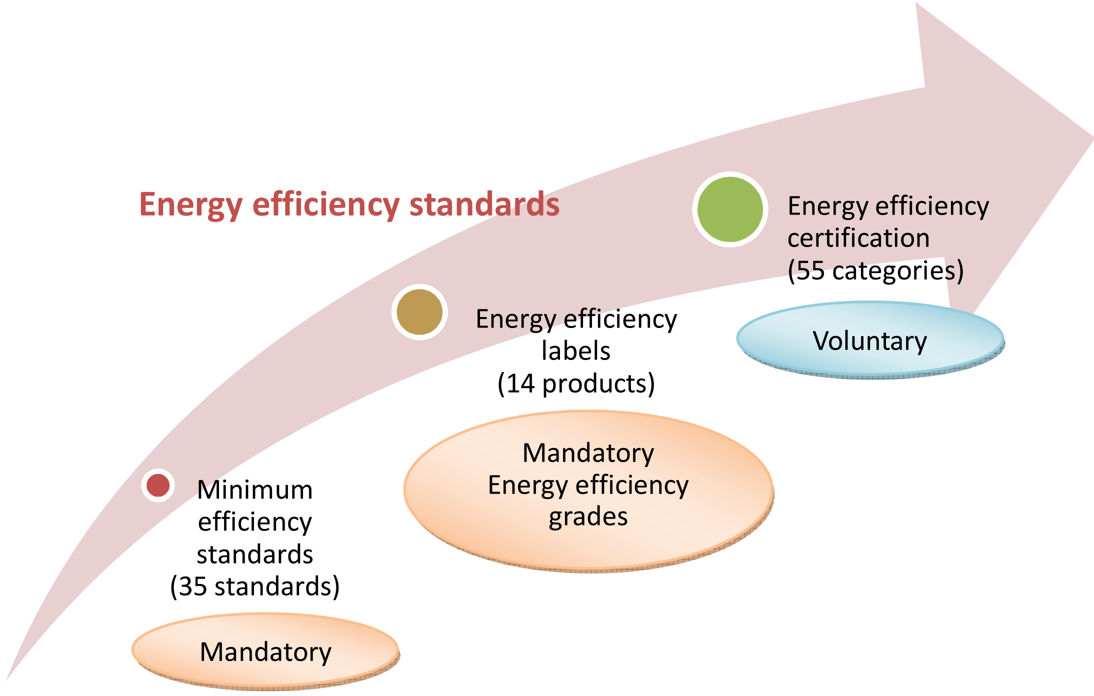
Group	Product Catalogue
1st Group (effective on March 1, 2005)	> Household refrigerators > Room air conditioners
2nd Group (effective on March 1, 2007)	> Electric washing machines > Unitary air conditioners
3rd Group (effective on June 1, 2008)	> Self-ballasted fluorescent lamps > High pressure sodium lamps > Small and medium three-phase asynchronous motors >Water chillers > Domestic instantaneous gas water heaters and gas fired heating and hot water combination-boilers
4th Group (effecitve on March 1, 2009)	> Variable speed room air conditioners > Multi-connected air condition unit > Electrical storage water heaters > Household induction cookers > Computer monitors > Copy machines

Source: "Policy and Regulation", China Energy Label Network, http://test.energylabel.gov.cn/index.aspx.

Figure 3-3 China Energy Label

Source: Cheng, Jianhong (2009), "*Energy Conservation Program in China and the Role of International Cooperation in S&L*", presentation paper, IEEJ.

Figure 3-4 Status of Energy Efficiency Standards and Labeling



5) Formulating Incentive Policies to Encourage Energy Conservation

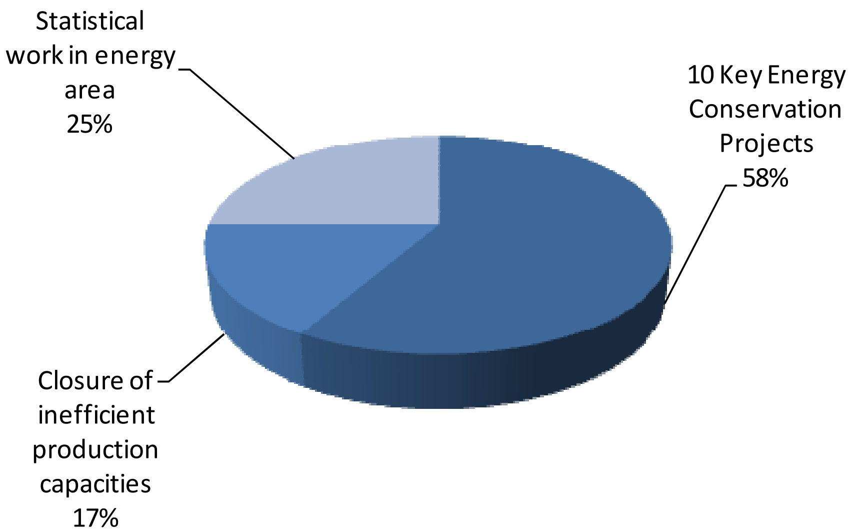
Between the 1980s and the early 1990s, the Chinese government implemented various incentive policies to promote energy conservation. These policies included low interest rate loans, pre-tax loan payments, three-year product tax and value-added tax exemptions for new energy conserving products, import tariff reductions, and exemptions for the introduction of energy conserving technology and equipment. Special allocations have been made in central level government budgets for an energy conservation infrastructure construction fund - *The Energy Conservation Infrastructure Construction Fund* and an energy conservation renovation fund - *The Energy Conservation Technical Renovation Fund* [11]. Overall, the government actively pursued energy conservation investment between the 1980s and the early 1990s.

By the middle of the 1990s, deepening economic reforms, especially those regarding state tax revenue allocations and financial system reforms, resulted in enterprises only playing roles in business operating entities. It became impractical for the government to continually implement fiscal incentives, preferred tax policies, and financial services for the energy conservation projects.

In accordance with the national economy development program, in the second half of the 1990s the Chinese government attempted to adopt market mechanisms and market-based incentive polices for energy efficiency projects. Commercial interest rates were introduced for enterprises to fund their energy conservation projects and government subsidies for energy efficient stoves, methane gas, and so on were suspended for rural areas.

The national gains in energy efficiency made during the 1980s and 1990s were reversed after 2002. From 2002, a boom in economic growth led to a surge in demand for heavy industry products. Energy intensity rose, the production and consumption of all forms of energy accelerated, oil imports soared, and levels of emissions of carbon and other pollutants increased. During this time, the government once again recognized that a range of economic incentives would be needed to revitalize energy efficient behavior. To this end, a series of incentive instruments have been implemented since 2005, including government special funds for supporting energy efficiency and emissions reduction. In 2007, 12 billion yuan in fiscal support were provided for this purpose[12] (Figure 3-5).

Figure 3-5 Government Special funds for Energy Efficiency in 2007



Source: World Bank (2008), *Mid-term Evaluation of China's 11th Five Year Plan*, Report No. 46355-CN.

6) Reforming Energy Prices and Introducing Pricing Mechanisms Favorable To Energy Conservation

In the planned economy period, China practiced an energy quota system in which energy prices were heavily controlled by the central government. Under this system, enterprises and consumers lacked incentives to save energy. From the middle of the 1980s, the government began to gradually relax energy prices while implementing a series of energy price reforms, as summarized in Table 3-3. Electricity prices and prices for refinery products have been adjusted frequently between 1985 and September 2009, and these efforts have been especially noteworthy since 2003. These price adjustments have encouraged energy producers to increase their resource development investments and output levels, and have also promoted energy conservation by consumers on the demand side. However, a further deepening of price reform is required, especially for natural gas and electricity, to improve energy efficiency and to meet the government's energy intensity targets by 2010.

Table 3-3 Major Energy Prices Adjustment (1985 - September 2009)

Year	Price reform	Energy sources
1985	Introducing "Cost plus benefit" mechanism for power generation	Electricity
1994	Introducing market-based coal price (except coal for power generation)	Coal
1999	Deomestic crude oil price linked with international oil market	Crude oil
2003	Price increase for wholesale power	Electricity
2004	Introducing differential power price to high energy consumption industry users	Electricity
2005	Price increase for gasoline, diesel and jet fuel	Petroleum products
2005	Price increase for wholesale and retail natural gas	Natural gas
2005	Introducing fuel adjustment mechanism for power generation	Electricity
2006	Adding 0.001 yuan/kWh renewable energy price to retail power price	Electricity
2006	Price increase for power transmission and distribution	Electricity
2006	Price increase for gasoline, diesel and jet fuel	Petroleum products
2007	Price increase for refinery products, price cut for gasoline and jet fuel	Petroleum products
2008	Price increase for gasoline, diesel and jet fuel (June)	Petroleum products
2008	Price increase for wholesale and retail power prices	Electricity
2008	Price cut for gasoline, diesel and jet fuel (December)	Petroleum products
2009	Price cut for gasoline, diesel and jet fuel (January)	Petroleum products
2009	Price increase for gasoline, diesel and jet fuel (March), (June)	Petroleum products
2009	Price cut for gasoline, diesel and jet fuel (July)	Petroleum products
2009	Price increase for city water (July)	Water
2009	Price increase for gasoline, diesel and jet fuel (September)	Petroleum products

Source: NDRC.

7) Launching Energy Saving Projects

China has been implementing 10 key energy conservation projects since they were announced in the *Middle and Long Term Energy Conservation Plan* (2005-2020), issued November 2004; these projects incorporate and apply major energy efficiency innovations in manufacturing, transportation, commercial and residential buildings, and public facilities[13].

Table 3-4 Ten Key Energy Conservation Projects

1)	Coal-fired industrial boiler (Kiln) retrofit project
2)	District combined heat and power (CHP) project
3)	Waste heat utilization project
4)	Energy conservation and petroleum substitution project
5)	Motor system energy conservation project
6)	Energy system optimization project
7)	Building energy conservation project
8)	Green lighting project
9)	Government agency energy conservation project
10)	Energy saving monitoring and testing, and technology service system building project

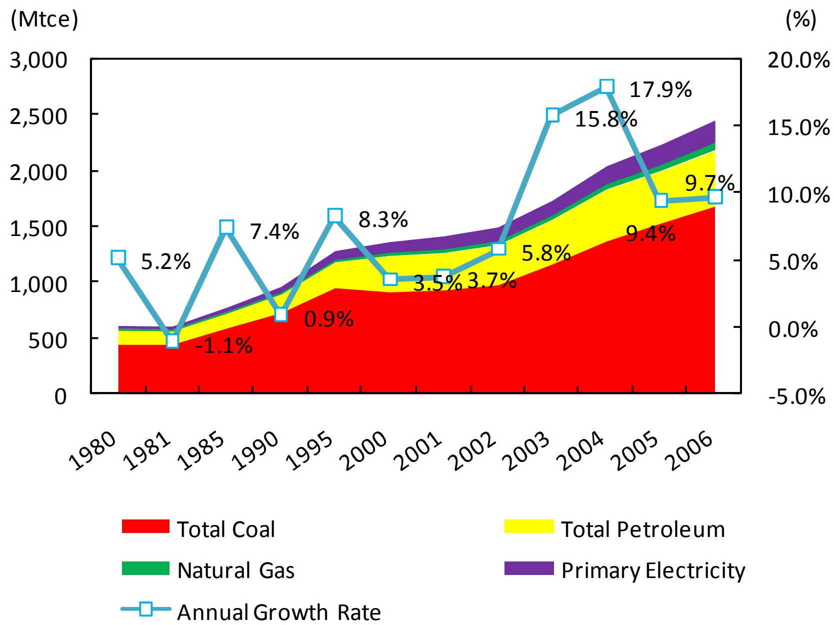
Source: "*Middle and long Energy Conservation Plan*", December 2004, NDRC.

China has also carried out the *1,000 Large Industrial Enterprises Energy Conservation Action Plan* aimed at saving 100 million tons of coal equivalent energy by 2010. The companies involved together account for about one-third of total national energy consumption and nearly 50% of industrial energy demand[14]. A total of 1,008 enterprises were identified and charged with setting up energy efficiency management groups, establishing efficiency improvement targets for all units within the enterprise, establishing procedures for energy audits, drawing up energy saving plans, investing in energy saving technologies, and introducing internal incentives to save energy. Local governments are responsible for monitoring, guiding and supervising the performance of these enterprises, the State Statistical Bureau is charged with collecting and publishing information about the program's progress on its web site, and the State-owned Assets Supervision and Administration Commission is in charge of using energy saving as a variable in evaluating state-owned enterprise performance. Industry associations are also obliged to actively participate in the program.

2. Overview of Energy Consumption

China's primary energy consumption increased by about 4 times from 615 Mtce in 1980 to 2,455 Mtce in 2006, with an average annual growth of 70.8 Mtce or an annual growth rate of 5.5% per annum. China's primary energy consumption rose by an average 10.4% per year between 2000 and 2006, more than twice as fast as during the 1980 to 2000 period, due to a high annual average of more than 9% economic growth and high growth of industry over the five-year period (Figure 3-6). As a result, between 2000 and 2006 China's energy intensity rose above 1, more than twice the average intensity during the four preceding five-year plan periods (Figure 3-7). The continual improvements in energy intensity between 1980 and 2000 are thought to have been mainly due to energy conservation policies, technological progress, and industry structural change[15].

Figure 3-6 Primary Energy Consumption (1980-2006)

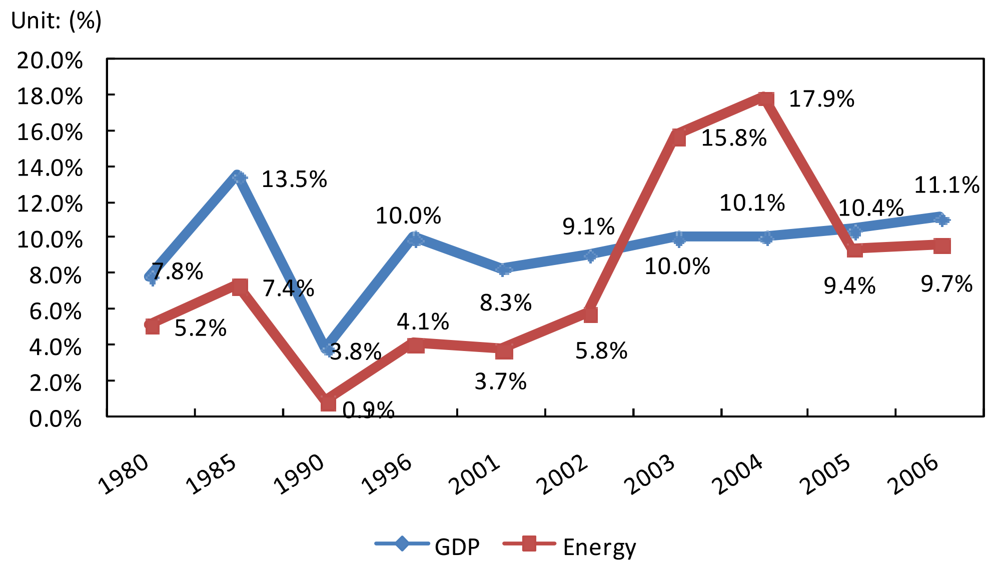


Source: *China Energy Databook*, V.7.0., Table 4A.1.2., Table 4A.1.5..

Although China is the world's second largest energy consuming country after the United States, its per capita primary energy consumption in 2005 was remarkably low at 1,873 kgce, 645 kgce less than the world average (Figure 3-8). The average annual rate of increase in per capita energy consumption was 1.7%

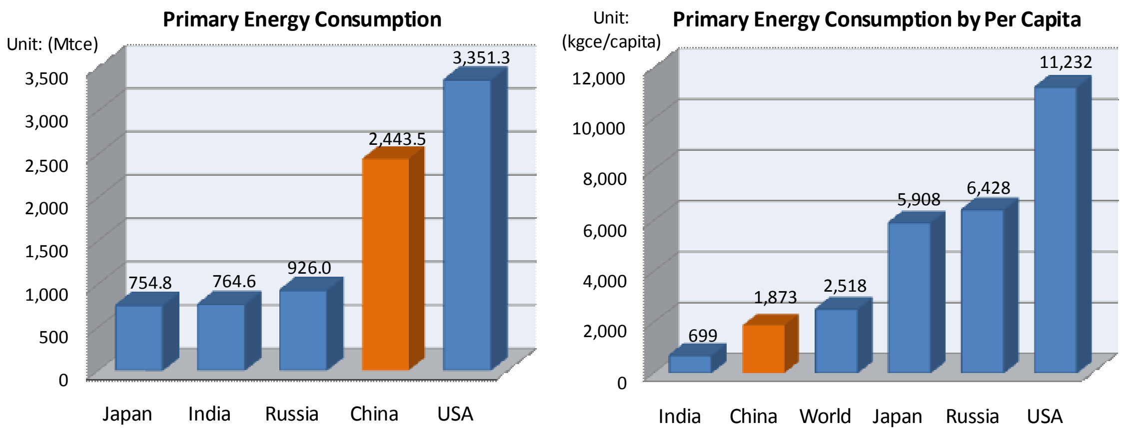
between 1990 and 2000 and 7.9% between 2001 and 2006. Meanwhile, the average growth rate of the population was 1.0% and 0.6% for the same periods. This implies that population growth has not been the main contributor to China's rapidly increasing primary energy consumption. Rather, active economic development and great improvements in average quality of life lie behind the increase in energy consumption (Figure 3-9).

Figure 3-7 Energy Intensity (1980-2006)



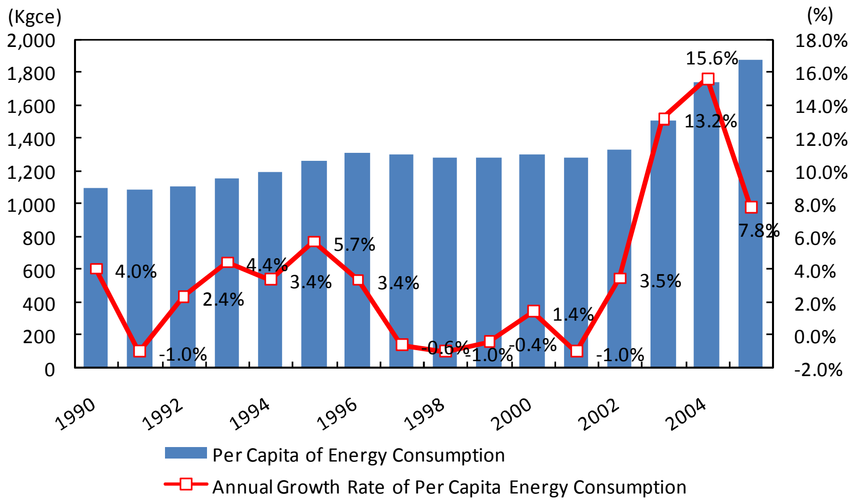
Source: *China Energy Databook, V.7.0.*, Table 4B.12..

Figure 3-8 Comparison of Primary Energy Consumption by Selected Countries (2005)



Source: *China Energy Databook, V.7.0.*, Table 9B.2..

Figure 3-9 Per Capita Primary Energy Consumption (1990-2006)



Source: Same as Figure 3-8.

In part to combat China's rising energy intensity, in the 11th Five-year Plan the central government set an ambitious goal of a 20% reduction in energy intensity between 2005 and 2010 with an annual average reduction of 4% per year and to sustain this rate of reduction until 2020. To achieve this goal, the government allocated targets to both individual provinces and individual high energy intensity industries. The final commitment of each province approved by the State Council is shown in Table 3-5.

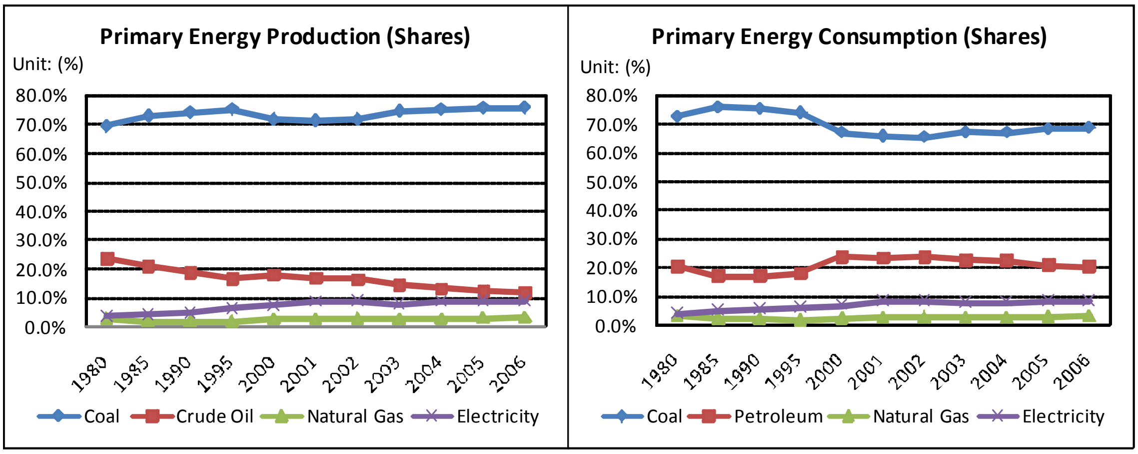
Table 3-5 Energy Intensity Reduction Targets by Province (2005-2010)

Region	Base data 2005 (tce/1,000 Yuan)	Target for 2010 (tce/1,000 Yuan)	Reduction (%)	Region	Base data 2005 (tce/1,000 Yuan)	Target for 2010 (tce/1,000 Yuan)	Reduction (%)
Nationwide	12.2		20	Henan	13.8	11	20
Beijing	8	6.4	20	Hubei	15.1	12.1	20
Tianjin	11.1	8.9	20	Hunan	14	11.2	20
Hebei	19.6	15.7	20	Guangdong	7.9	6.6	16
Shanxi	29.5	22.1	25	Guangxi	12.2	10.4	15
Inner Mongolia	24.8	18.6	25	Hainan	9.2	8.1	12
Liaoning	18.3	14.6	20	Chongqing	14.2	11.4	20
Jilin	16.5	11.6	30	Sichuan	15.3	12.2	20
Heilongjiang	14.6	11.7	20	Guizhou	32.5	26	20
Shanghai	8.8	7	20	Yunnan	17.3	14.4	17
Jiangsu	9.2	7.4	20	Tibet	14.5	12.8	12
Zhejiang	9	7.2	20	Shaanxi	14.8	11.8	20
Anhui	12.1	9.7	20	Gansu	22.6	18.1	20
Fujian	9.4	7.9	16	Qinghai	30.7	25.5	17
Jiangxi	10.6	8.5	20	Ningxia	41.4	33.1	20
Shangdong	12.8	10	22	Xinjiang	21.1	16.9	20

Source: World Bank (2008), *Mid-term Evaluation of China's 11th Five Year Plan*.

The share that each primary energy source contributes to consumption closely parallels energy production distribution patterns, except that consumption of oil is slightly more than its share of domestic production due to net oil imports. Coal consumption increased its share of total consumption from 72.7% in 1980 to a record high of 75.6% in 1990 and then dropped back to 68.6% by 2006. The consumptions of primary electricity as a part of total energy consumption increased from 3.8% in 1980 to 8.0% in 2006, while the shares of oil and natural gas consumption in 2006 remained at the same levels as in 1980.

Figure 3-10 Comparison of Primary Energy Production and Consumption (1980-2006)

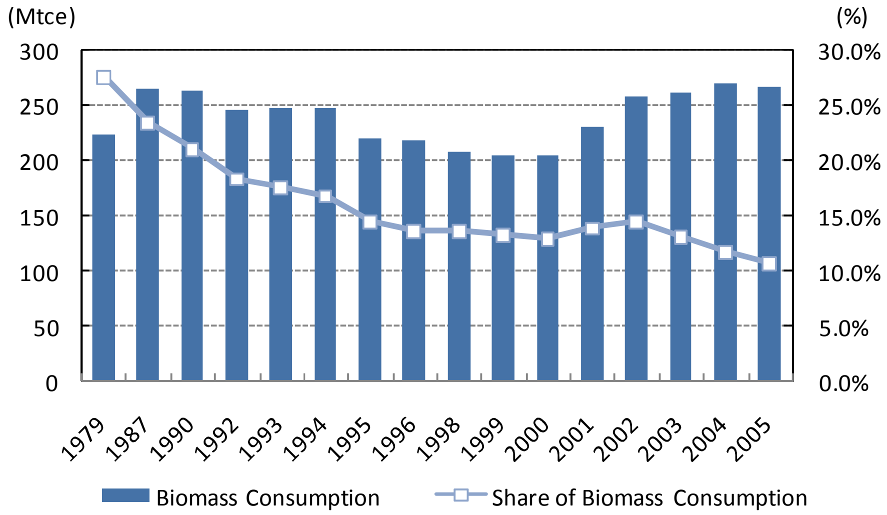


Source: *China Energy Databook, V.7.0.*, Table 2A.1.3, Table 4A.1.4..

In 2006, biomass contributed a smaller share to total energy consumption than in 1979 because of relatively minute growth in biomass consumption over that period. Improvements in electrification and the introduction of more efficient biomass stoves in rural households may be contributing factors in this trend (Figure 3-11).

East China and South-central China together consume more than 50% of China's final energy, followed by the North China region, which reflects the fact that China's economic activities are mainly concentrated in three regions, that is, the Pearl River Delta, the Yangtze River Delta, and the Pan Bohai region (Table 3-6).

Figure 3-11 Biomass Consumption (1979-2005)



Source: *China Energy Databook, V.7.0.* Table 4B.1..

Table 3-6 Final Energy Consumption by Province (2002-2006)

(Unit: Mtce)

Region	2002	2003	2004	2005	2006
East	481.09	531.07	605.14	776.70	867.29
SouthCentral	352.63	404.42	467.99	564.44	634.04
North	323.82	327.42	396.83	476.79	528.26
NorthEast	201.63	168.08	217.12	247.39	279.53
SouthWest	180.24	200.43	208.73	249.06	271.38
NorthWest	106.15	144.66	156.51	183.13	201.70
Nationwide	1,474.00	1,689.79	1,976.78	2,211.51	2,442.23

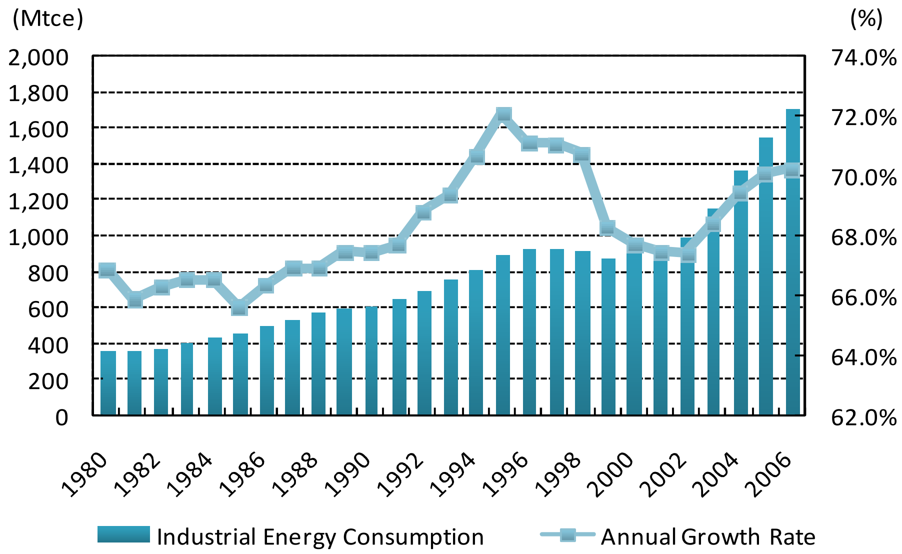
Source: *China Energy Databook, V.7.0.*, Table 4A.2.9. - Table 4A.2.13..

3. Energy Consumption by Sector

3.1. Industrial Sector

China's industrial sector is the largest end-user of final energy and accounted for roughly two-thirds of end-use energy consumption between 1980 and 2006. Industrial energy consumption increased 65.6% - from 374 Mtce to 619 Mtce - between 1980 and 1990 and 163.3% - from 652 Mtce to 1716 Mtce - between 1991 and 2006. The average annual rate of increase in energy consumption was 5.2% between 1980 and 1990 and was 6.7% between 1991 and 2006 (Figure 3-12).

Figure 3-12 Industrial Energy Consumption (1980-2006)

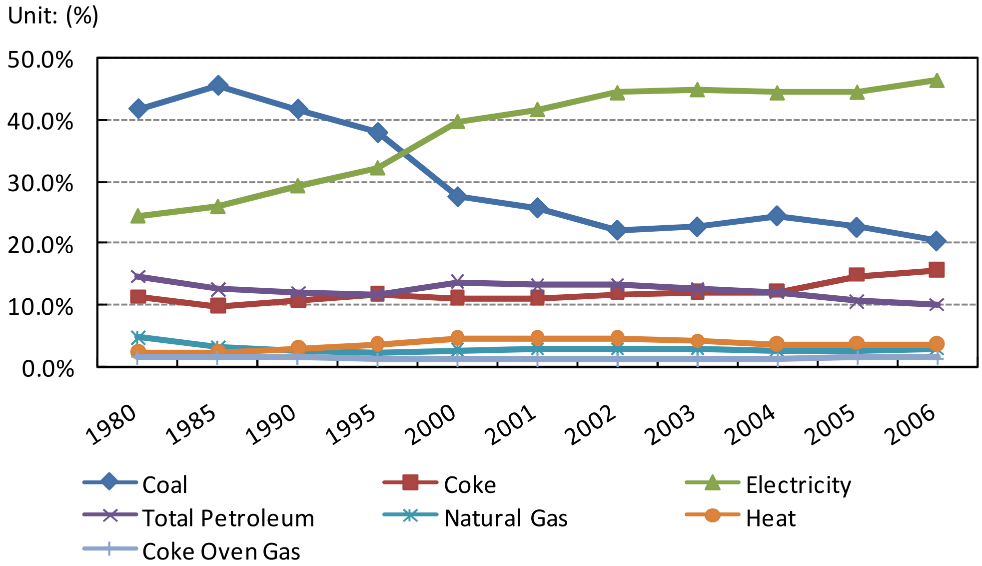


Source: *China Energy Databook, V.7.0.*, Table 4A.4.1., Table 4A.4.2..

More than 40% of industrial energy came from coal in the 1980s; however, coal's share of industrial energy consumption has been constantly decreasing since 1990 (except for the year 2003). By 2006, coal's share dropped from its peak at 45.4% in 1985 to only 20.3% of the energy used in industry. The sector has shifted from coal to electricity consumption. Electricity's proportion of total industrial energy consumption increased from 24.3% (90 Mtce) in 1980 to 46.4% (783 Mtce) in 2006. Shares of coke and heat used in the industry slightly increased, while the share of petroleum and natural gas use declined. Coke oven gas consumption remained at a constant level over the period (Figure 3-13). The metals, chemicals, and non-metal mineral products subsectors continue to account for more than 50% of total industrial end-use energy consumption with machinery, electronics, and other manufacturing bringing the total to about 70% (1995-2006) (Figure 3-14).

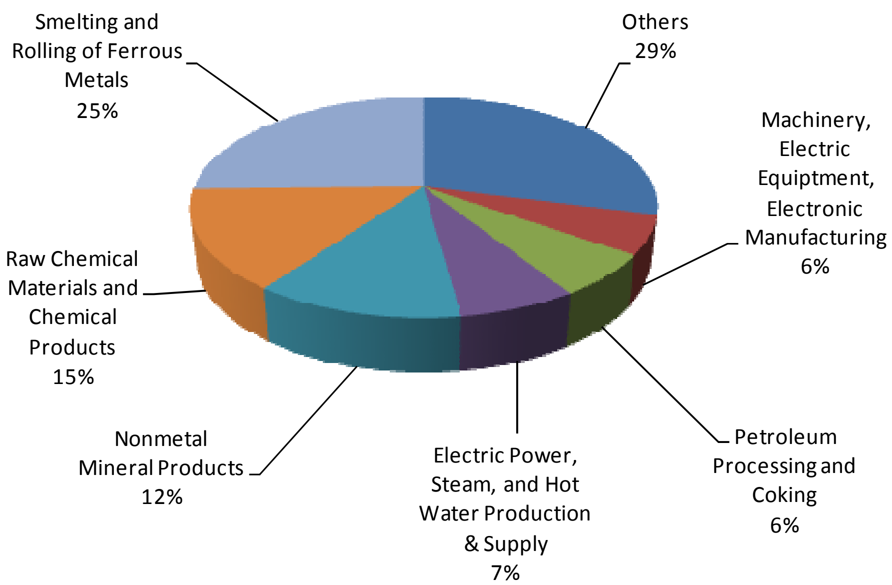
The electricity sector, as categorized as an industrial subsector, consumed 7.7% (131.5 Mtce) of total industrial end-use energy in 2006. Coal accounted for 96.9% of electric utility fuel consumption in 2006. The sector's use of crude oil dropped dramatically from 8.2 Mtce in 1980 to 0.33 Mtce in 2006, while fuel oil declined slightly from 20.28 Mtce to 13.26 Mtce over the same period. Due in part to the start of operations of the West-East gas pipeline in 2005, natural gas consumption increased from 0.32 Mtce to 5 Mtce between 1980 and 2006, giving an average annual growth rate of 11.2% (Table 3-7).

Figure 3-13 Industrial Energy Consumption by Energy Type (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 4A.5.2..

Figure 3-14 Industrial Sector End-use by Subsector (2006)



Source: *China Energy Databook, V.7.0.*, Table 4A.6.12..

Table 3-7 Thermal Electric Utility Fuel Use (1980-2006)

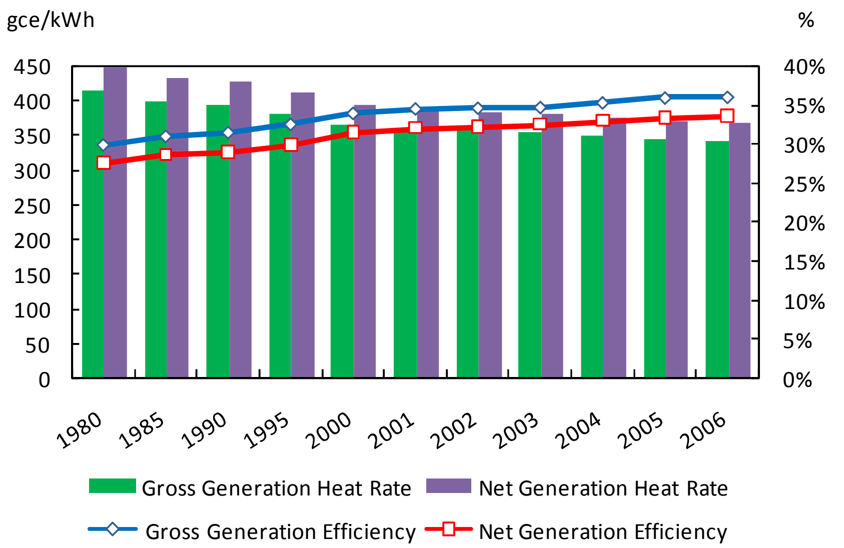
(Unit: Mtce)

Year	Total Coal	Crude Oil	Fuel Oil	Gaso line	Diesel Oil	Liquid Petroleum Gas	Refinery Gas	Natural Gas	Coke Other Products	Coke Oven Gas	Petroleum Other Products	Total Petroleum
1980	90.31	8.20	20.28		1.05			0.32		0.53		29.54
1985	117.39	3.99	14.89		1.51	0.00		0.36		0.55		20.38
1990	194.24	1.78	13.97	0.00	1.81	0.02	0.10	0.97	0.00	0.40	0.00	17.65
1995	317.3	0.88	15.31	0.00	2.98	0.00	0.31	1.05		0.50	0.00	19.43
2000	398.49	1.21	11.64	0.01	3.32	0.03	0.39	2.02		0.63	0.31	16.85
2001	426.96	1.17	11.98	0.01	3.50	0.02	0.36	1.73	0.01	0.63	0.37	17.35
2002	489.8	1.12	13.04	0.01	3.29	0.03	0.32	1.47		0.81	0.47	18.24
2003	585.31	1.34	15.10	0.01	3.95	0.03	0.27	1.76		0.67	0.66	21.33
2004	656.61	0.26	20.42	0.00	4.88	0.04	0.48	2.53		1.49	0.64	26.66
2005	737.3	0.30	15.81	0.01	5.34	0.00	0.57	4.19		2.12	0.92	22.91
2006	847.97	0.33	13.26	0.00	4.56	0.00	0.54	5.00		3.20	0.59	19.21

Source: *China Energy Databook, V.7.0.*, Table 4A.9.2..

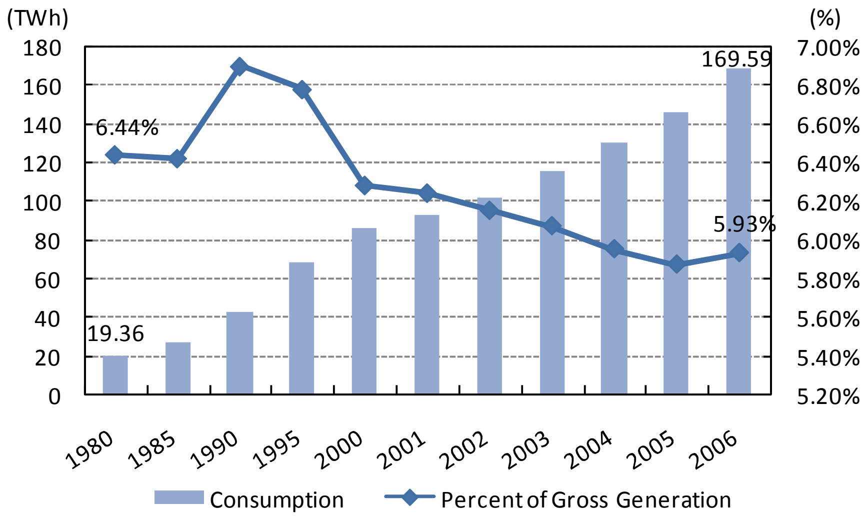
Coal consumption per kWh for coal-fired power plants has improved steadily since 1980. Gross generation heat rate declined from 413 gce/kWh in 1980 to 342 gce/kWh in 2006, while net generation heat rate dropped from 448 gce/kWh to 367 gce/kWh over the same period (Figure 3-15). The rising capacity of power plants and the improvement of in-plant consumption rates contributed to this trend. Total in-plant electricity consumption has been rising but its proportion of gross generation has been decreasing due to improvements in power plant energy efficiency (Figure 3-16).

Figure 3-15 Average Heat Rates of Fossil Fuel-Fired Power Plants (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 4B.5..

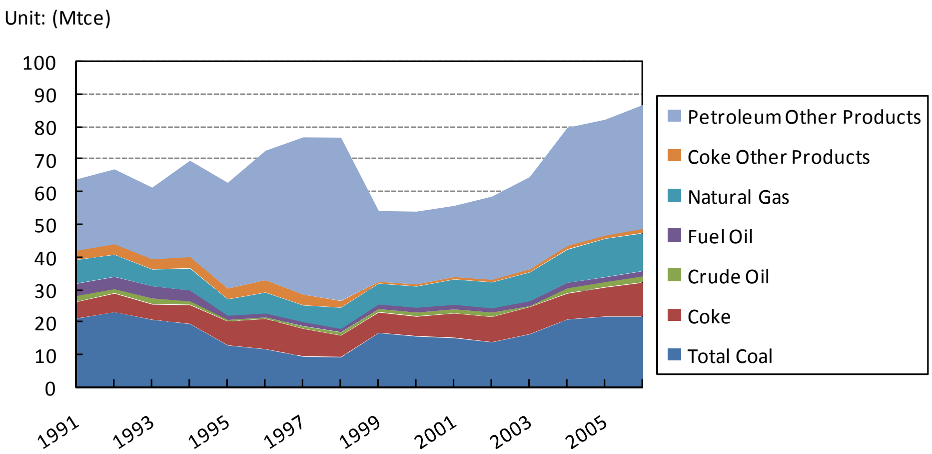
Figure 3-16 Power Sector In-Plant Electricity Consumption (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 4B.6.

In 2006, 87 Mtce of energy was consumed as feedstock. Coal, coke, and natural gas together accounted for more than 50% of feedstock energy use. The use of natural gas and petroleum products as feedstocks increased from 7.24 Mtce and 22.12 Mtce in 1991 to 11.5 Mtce and 38.41 Mtce each in 2006. Coke consumption doubled from 5.1 to 10.53 Mtce , while both crude oil and fuel oil dropped from their 1991 levels. Coal consumption remained at the same level as in 1991 (Figure 3-17).

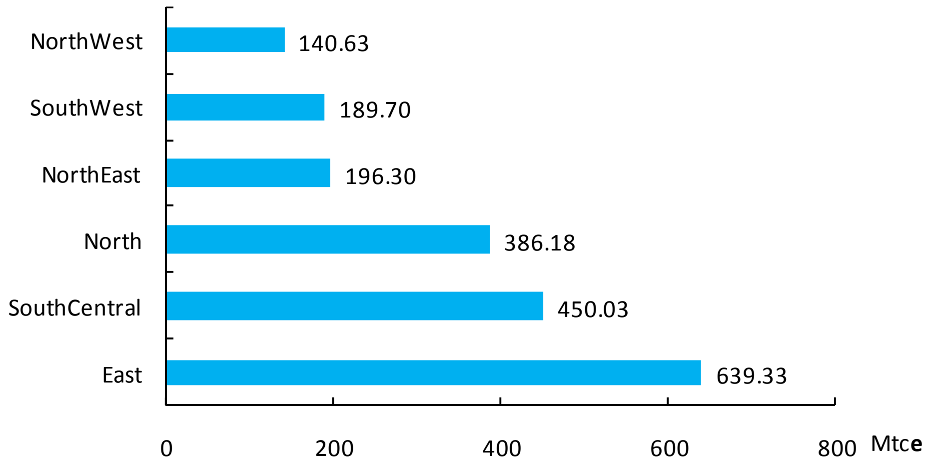
Figure 3-17 Energy Used as Feedstock (1991-2006)



Source: *China Energy Databook, V.7.0.*, Table 4A.8.2..

Consumption in the industrial sector is mainly concentrated in East, South-central and North China, as shown in Figure 3-18.

Figure 3-18 Industrial Sector Energy End-use by Province (2006)

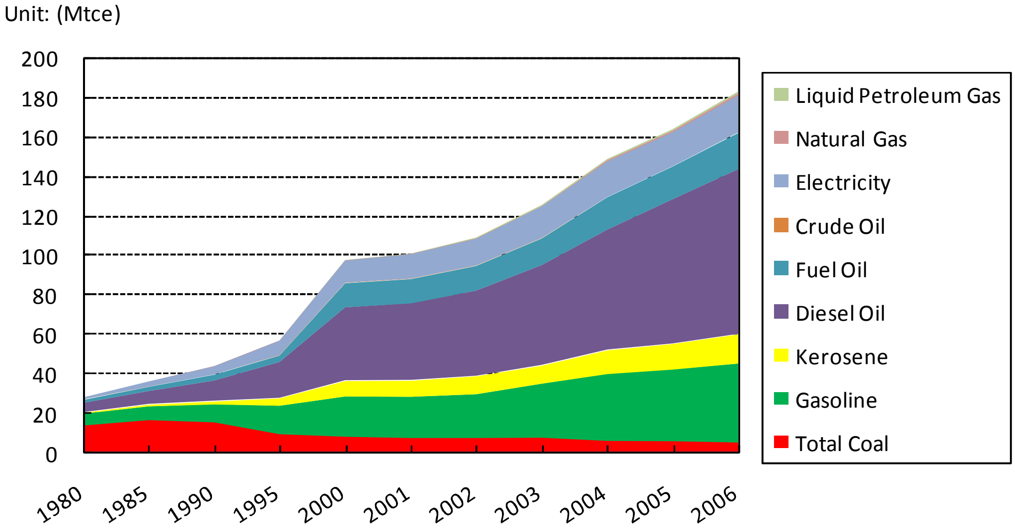


Source: *China Energy Databook, V.7.0.*, Table 4A.7.5..

3.2. Transportation Sector

Petroleum products (gasoline, kerosene, diesel oil, fuel oil, and crude oil) are the major energy sources for the transportation sector. Their total share in the sector's end-use increased from 46.8% in 1980 to 87% in 2006. Coal's share dropped sharply from 50% to only 2.9% because of the phasing out of coal-fired steam engines. Today, coal is mainly used in the transportation sector as building heating fuel in railway station facilities. With the prevalence of railway electrification and an increase in the capacity of railway, shares and total quantities of electricity, diesel and gasoline consumption have increased greatly. Because of the rapid development of air passenger transport, kerosene consumption has increased substantially from 0.46 Mtce in 1980 to 14.72 Mtce in 2006, at an average annual growth rate of 14.2%. Consumption of natural gas also increased dramatically from 0.01 Mtce to 1.07 Mtce, at an annual growth rate of 18.4%, due to the promotion of natural gas vehicles for public transport in metropolitan areas such as Beijing and Shanghai. Consequently, transportation end-use consumption increased about six times from its 1980 level of 27.69 Mtce to 180.19 Mtce in 2006.

Figure 3-19 Transportation Energy Use (1980-2006)

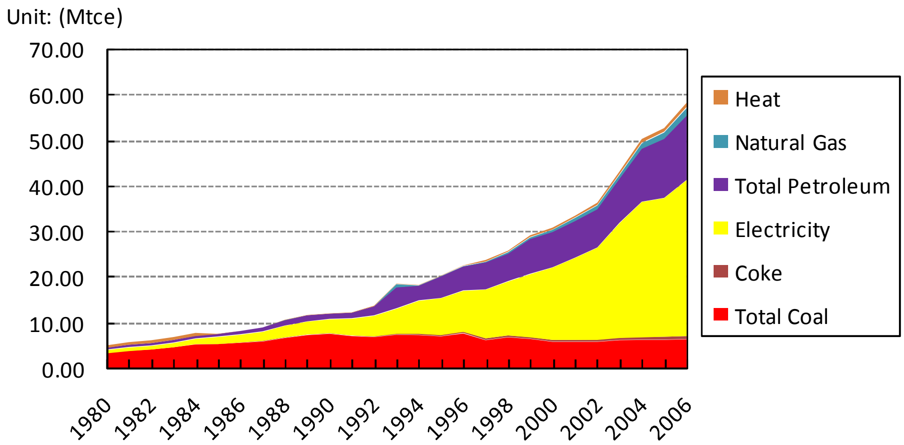


Source: *China Energy Databook, V.7.0.*, Table 4A.10.2..

3.3. Commercial Sector

Energy consumption related to commercial end-uses has been steadily increasing since 1980. This sector's share of total end-use energy consumption increased from 0.9% in 1980 to 2.4% in 2006. Coal used to be a major energy source for commercial end-use, however, because of improvements in the heating systems in China's commercial and public buildings its usage dropped from 65.9% to 11%. Parallel reductions in heat consumption from such building heating system improvements was offset over the period by a strong increase in demand for building lighting and air conditioning. Consequently, electricity consumption increased from 0.68 Mtce (13.8%) to 34.23 Mtce (58.9%). Natural gas consumption in the commercial sector increased from 0.66 Mtce to 1.75 Mtce over the period and its share remained steady throughout the period.

Figure 3-20 Commercial Sector Energy Consumption (1980-2006)



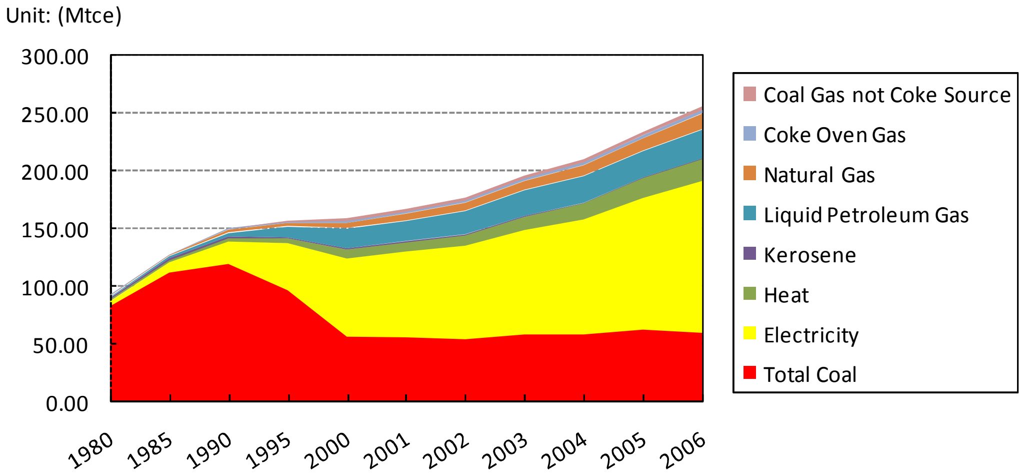
Source: *China Energy Databook, V.7.0.*, Table 4A.15.2..

3.4. Residential Sector

Residential energy consumption increased from 91.6 Mtce in 1980 to 259.5 Mtce in 2006 at an average rate of 4.1% per annum. Like the transportation and commercial sectors, total coal use in this sector dropped from its peak at 125.13 Mtce in 1988 to 59.88 Mtce in 2006. Consequently, coal's share in total residential end-use consumption also declined sharply from 90.1% in 1980 to only 23.4% in 2006 because of a dramatic increase in electricity consumption and the accessibility of natural gas for residential purposes.

Electricity consumption over the period from 1980 to 2006 increased from 4.25 Mtce to 131.36 Mtce and its share rose from 4.6% to 51.4% of the sector's energy consumption; much of this rise in electricity use may be due to the recent widespread use of residential electrical appliances. Shares of district heating (1.7% to 7.6%), LPG (0.8% to 9.8%), and natural gas (0.3% to 5.3%) also increased with improvements in the heating and cooking systems of the residential sector. Generally, district heating in the residential sector is very much concentrated in North and Northwest China, while LPG is most heavily consumed in East and South-central China. Although the Southwest leads the nation in natural gas consumption, consumption in the North, East, and Southern China has also increased due to the development of the national gas pipeline network (Figure 3-21).

Figure 3-21 Residential Energy Consumption (1980-2006)

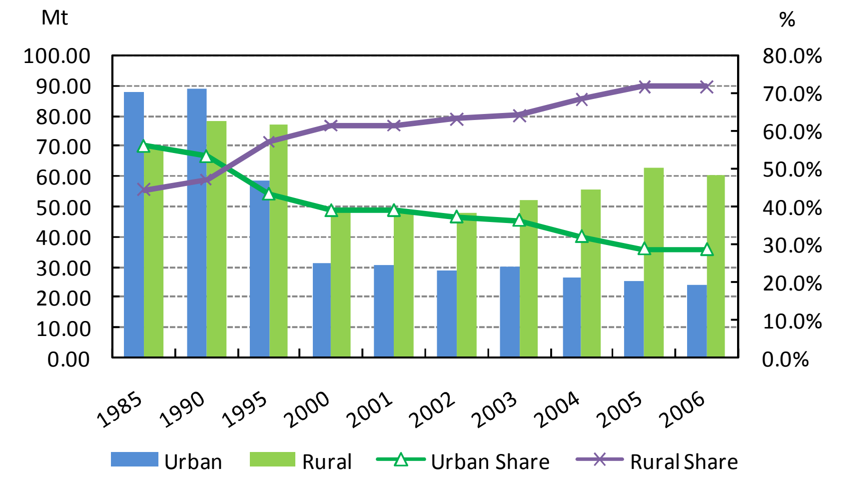


Source: China Energy Databook, V.7.0., Table 4A.12.2..

Urban residents consumed 157.14 Mtce of energy and accounted for 60.5% of total residential end-use in 2006. Coal was the primary energy source for rural households, where it comprised 71.5% of energy consumption (Figure 3-22). From 1985 to 2006, the average annual growth rate in electricity consumption in rural households (13.1%) is very close to that of urban households (14%). However, the gap in consumption between urban and rural areas of China has widened because relatively more electric appliances have been brought into use in urban households. (Figure 3-23).

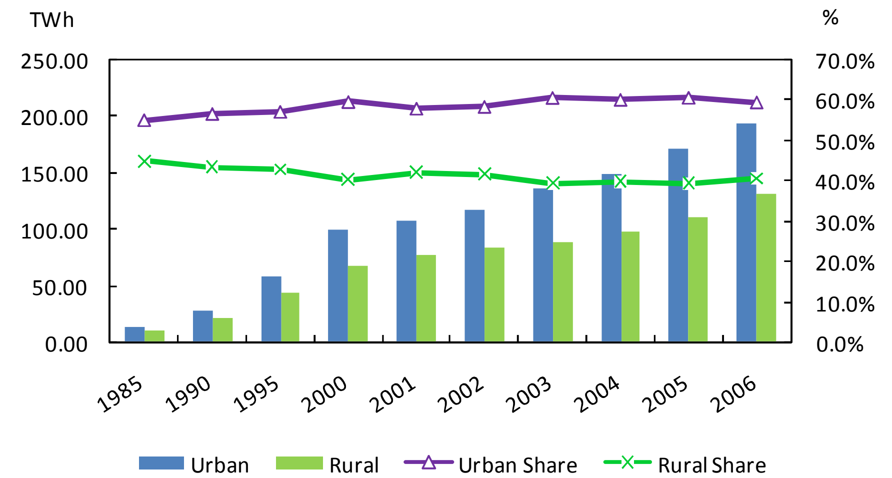
Unlike the industrial sector, more than 60% of total residential energy consumption is used by households in the north, northeast, and northwestern regions due to the cold winter weather. (Figure 3-24).

Figure 3-22 Urban and Rural Residential Coal Consumption (1985-2006)



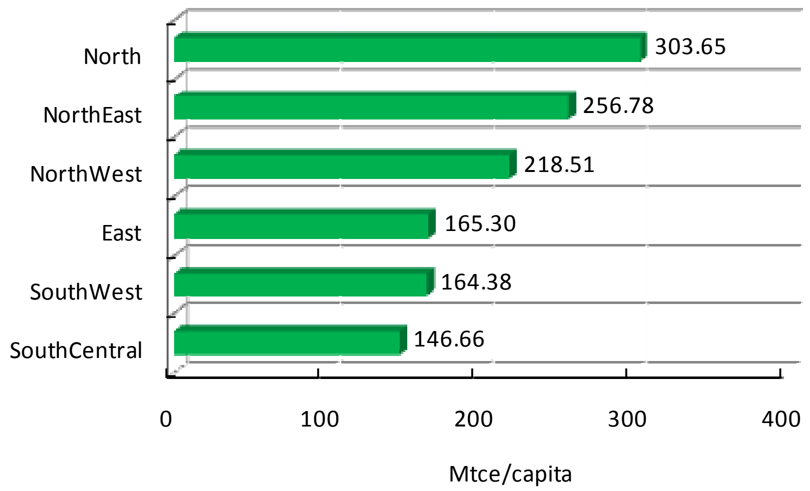
Source: *China Energy Databook, V.7.0.*, Table 4A.13.1..

Figure 3-23 Urban and Rural Residential Electricity Consumption (1985-2006)



Source: *China Energy Databook, V.7.0.*, Table 4A.13.2..

Figure 3-24 Residential Energy Consumption by Region (2006)



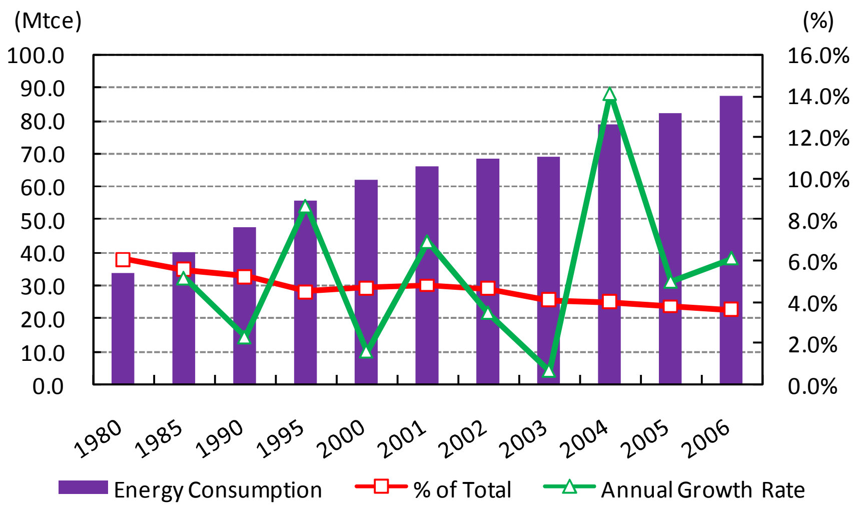
Source: *China Energy Databook, V.7.0.*, Table 4A.14.10..

3.5. Agricultural Sector

Between 1980 and 2006, the agricultural sector's energy consumption increased moderately from 33.7 Mtce to 87.2 Mtce at an average annual growth rate of 3.7%. The average annual increase in agriculture energy consumption between 2001 and 2006 is twice as high as that of the period between 1980 and 2000. Meanwhile, agriculture's share in final energy consumption dropped from 6.0% in 1980 to 3.6% in 2006 due to faster energy consumption growth in other sectors (Figure 3-25).

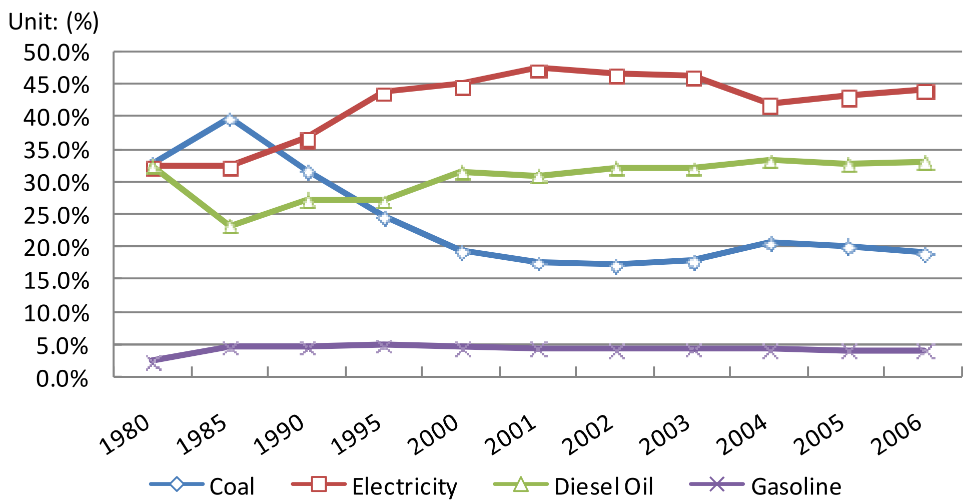
As for the agricultural sector's energy consumption by energy source, shares of electricity and gasoline increased from 32.4% and 2.3% in 1980 to 44% and 4.1% in 2006. Meanwhile, coal's share dropped sharply from 32.9% to 19% during the period while diesel consumption remained almost flat (Figure 3-26).

Figure 3-25 Agricultural Sector Energy Consumption (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 4A.4.1., Table 4A.4.2..

Figure 3-26 Agricultural Energy Consumption by Energy Type (Shares) (1980-2006)



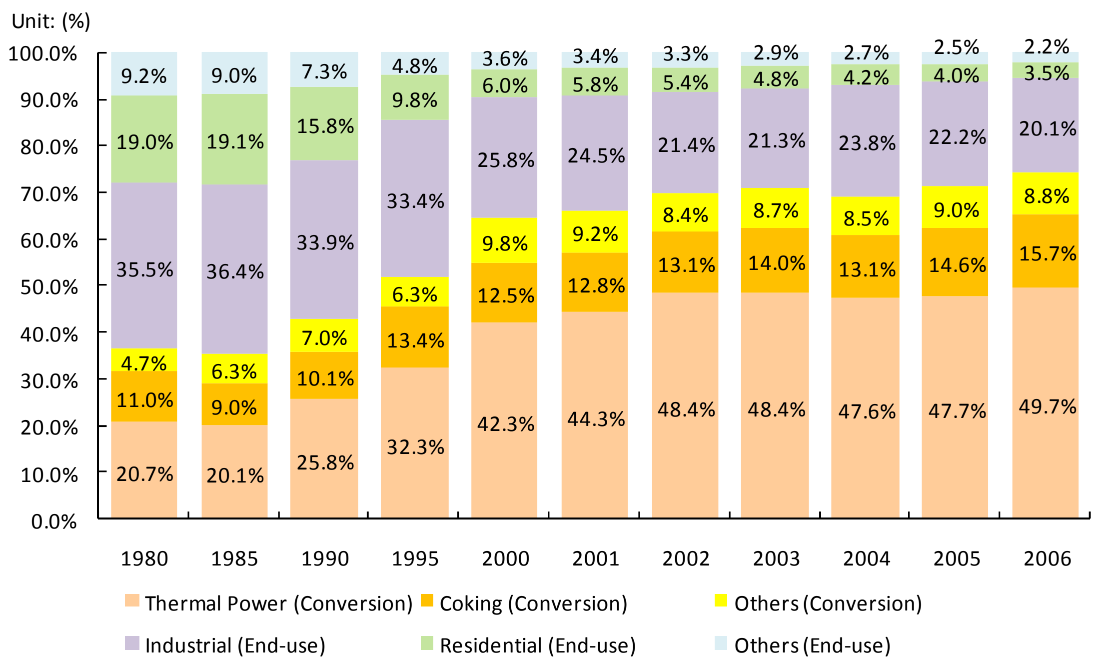
Source: *China Energy Databook, V.7.0.*, Table 4A.11.3..

4. Energy Consumption by Sources

4.1. Coal End-use

Coal use has expanded since 1980. The share of direct end-use of coal dropped from 63.6% to 25.8%, while the share of coal used for conversion increased from 36% to 74.2%. The share of coal used for power generation and its share in total coal end-use increased sharply from 57% to 67% and from 20.7% to 49.7%. Today, thermal power accounts for about half of total coal consumption. Shares of residential, transportation, construction, and agriculture in direct coal end-use has dropped since 1980, while industry's share of direct coal end-use has increased steadily; in 2006, industry alone accounted for 77.8% of total direct end-use of coal (Figure 3-27).

Figure 3-27 Coal End-use and Inputs to Conversion (Shares) (1980-2006)



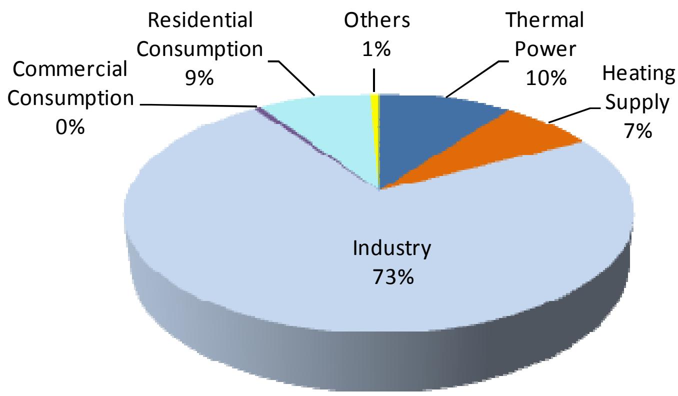
Source: *China Energy Databook, V.7.0.*, Table 4A.18.1..

Direct coal end-use declined dramatically between 1996 and 2002, at an average rate of 7.6% per year, due to changes in the nation's industrial structure and a radical decline in the use of coal in the residential sector. Introducing cleaner energy such as LPG and natural gas and the widespread use of residential electric appliances such as rice cookers and microwaves are theorized to be the main reasons behind the decline of end-use coal.

To meet the demand for fuel caused by the remarkable increase in the number of thermal power plants between 1999 and 2006, coal inputs into power generation increased 126.4%. The average growth rate of coal consumption for power generation between 1980 and 2000 was 7.7%, while the rate between 2001 and 2006 was 14.7%. Meanwhile, the average rate of increase in thermal power capacity between 1980 and 2000 was 8.6%, whereas this rate increased to 13.8% between 2001 and 2006.

Coke oven gas is mainly used by industry, which accounts for 88.2% of total coke oven gas end-use. The product has also been used in fuel conversion converted for other uses, especially for electricity and heating supply.

Figure 3-28 Coke Oven Gas End-use and Inputs to Conversion (Shares) (2006)

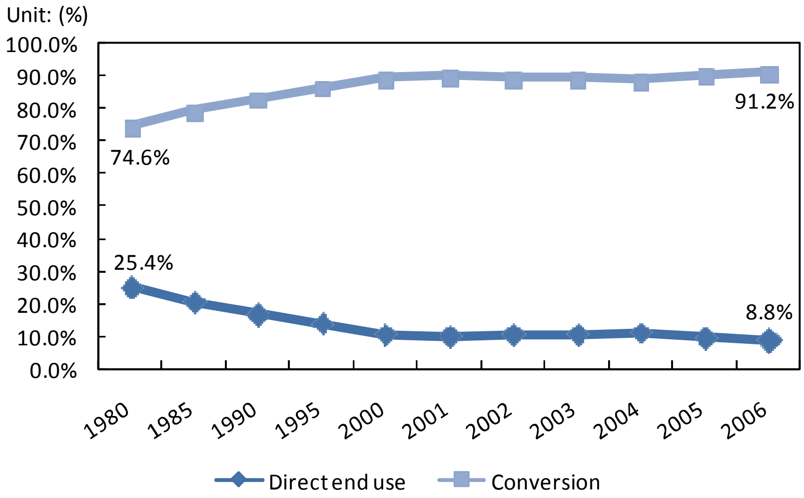


Source: *China Energy Databook, V.7.0.*, Table 4A.19.1..

4.2. Petroleum and Petroleum Products End-use

Petroleum end-use increased from 84.6 Mt in 1980 to 346.6 Mt in 2006, increasing at an average rate of 5.6% per year. The share of direct end-use of oil has increased constantly since 1980. In 2006 this accounted for 91.2% of total oil end-use. Meanwhile, the share of oil conversion dropped from 25.4% in 1980 to 8.8% in 2006 (Figure 3- 29).

Figure 3- 29 Total Petroleum End-use (1980-2006)

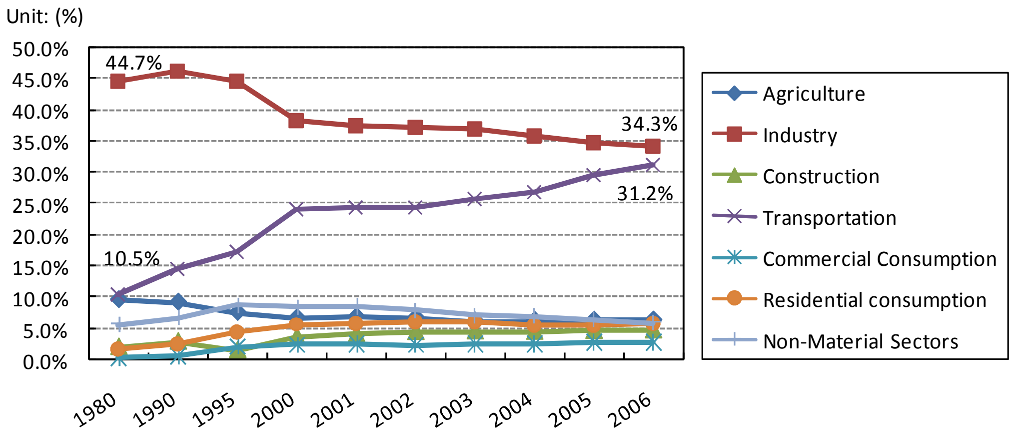


Source: *China Energy Databook, V.7.0.*, Table 4A.20.2..

Oil inputs into thermal power dropped from 20.7 Mt in 1980 to 11.8 Mt in 2000, a record low at an average decrease of 2.8% per year. However, from 2001 onwards, this rate has continued to increase again due to systemic power shortages over the period.

The transportation and industry sectors have recorded the most noticeable changes as a percentage of total oil consumption over recent years, as shown in Figure 3-30. In 2006, transportation accounted for 32.4% of total oil use, up about 21% from 1980. Industrial end-users's oil consumption had fallen steadily from 44.7% to 34.3% over the same period. Although the commercial sector makes up the smallest portion of total oil end-use, it has the fastest annual growth rate. Rapid increases in retail transportation might be the major reason behind this growth. While oil consumption is growing second fastest in the residential sector, this sector's share of oil consumption did not exceed 6% in 2006. It is projected that oil consumption in the residential sector will continue to grow rapidly due to the country's fast-paced motorization. Agricultural consumption of oil has increased as well (from 11.7 Mtce in 1980 to 31.7 Mtce in 2006), but declined as a percentage of total oil end-use (from 9.6% to 6.4%).

Figure 3-30 Petroleum End-use by Sector (Shares) (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 4A.20.1..

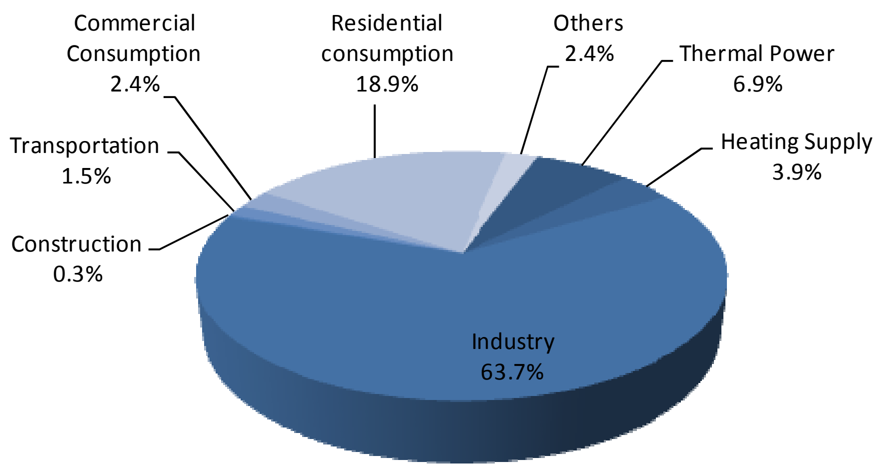
Oil input into energy conversion has only slightly increased since 1980 with an increase of only 2.6 Mt, after overall fuel mix shifts between 1980 and 2006 are accounted for. Consumption of all kinds of oil products in direct end-use increased over the period but diesel, fuel oil, and gasoline together accounted for about 65% of total consumption. LPG is the fastest growing end-used oil product due to the nation-wide occasional use of LPG as a cooking fuel. However, its share of all petroleum product consumption still stood at a mere 7.1% in 2006. Kerosene consumption has increased slightly, mainly due to an increase in jet fuel consumption.

4.3. Natural Gas End-use

In 2006, 54.3 Bcm of natural gas was consumed, which was 4 times higher than in 1980. The average annual rate of increase between 2001 and 2006 was 15.2%. This was much faster than the rate of increase during the 1980 – 2000 years, when it grew at a mere 2.1% per year. Conversion of natural gas to other products increased from 0.24 Bcm in 1980 to 5.89 Bcm in 2006. In 2006, thermal power plants accounted for 6.9% of total gas end-use, while heating supply use accounted for 3.9%. A large part of end-use gas is currently consumed by the industrial sector and primarily by the chemical fertilizer industry. Industrial end-use increased from 12.8 Bcm in 1980 to 34.6 Bcm in 2006, while the sector's share in total gas end-use dropped from 92.1% to 63.7%

over the period mainly due to the growth in residential use, which accounted for 18.9% of gas used in 2006. It is expected that the share of natural gas consumption will gradually shift from the fertilizer industry to the residential sector over time (Figure 3-31).

Figure 3-31 Natural Gas End-use by Sector (2006)

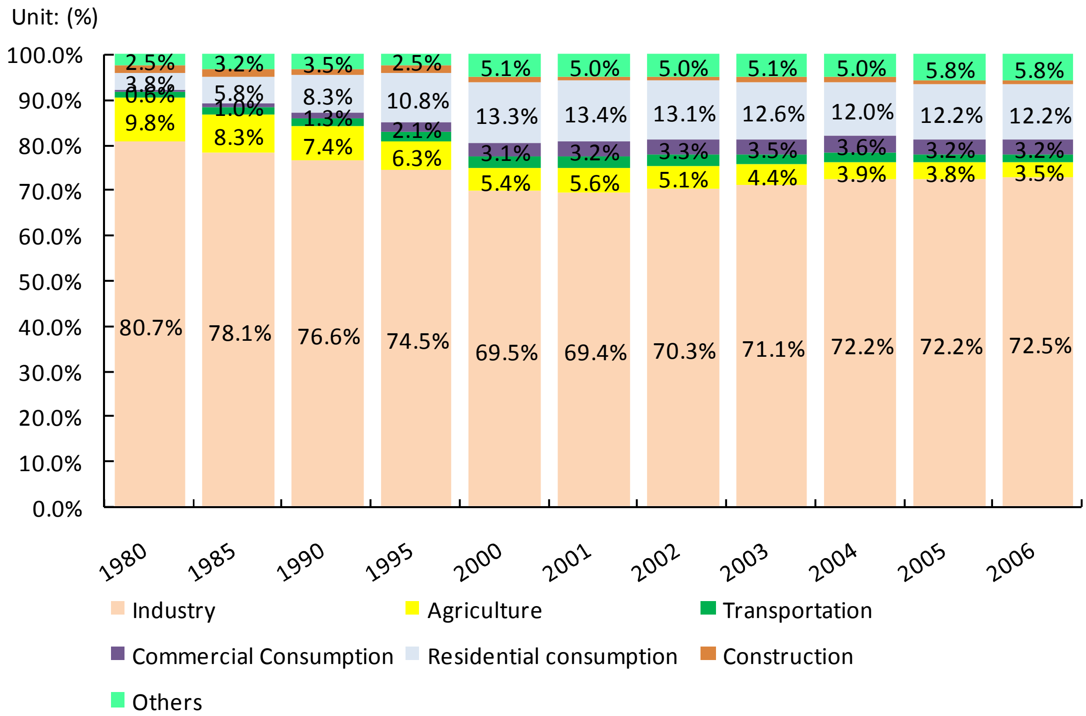


Source: *China Energy Databook, V.7.0.*, Table 4A.25.1..

4.4. Electricity End-use

Electricity consumption has the fastest growth rate for any energy source over the past 26 years, rising from 276.3 TWh in 1980 to 2,672.9 TWh in 2006, at an average growth rate of 9.1% per year. Although industry accounts for most of this consumption, its share has declined from 80.7% in 1980 to 72.5% in 2006. The agriculture sector's share of electricity end-use also has dropped steadily from 9.8% to 3.5 % over the period. Conversely, consumption by the residential sector has risen dramatically, from 3.8% to 12.2% of total use, mainly due to the wide spread use of electric appliances and other electric devices, especially in urban areas. Meanwhile, electricity consumption in the commercial sector has also increased remarkably from 0.6% to 3.2% because of needs created by the widespread new construction of hotels and office buildings.

Figure 3-32 Electricity End-use by Sector (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 4A.26.1..

[1] Price, Lynn, E. Worrell, J. Sinton (2001), "Industrial Energy Efficiency Policy in China", Lawrence Berkeley National Laboratory (LBNL), http://ies.lbl.gov/iespubs/50452.pdf.
[2] For details please refer to http://hzs.ndrc.gov.cn/newzwxx/W020090212508616293809.pdf.
[3] Li, Zhidong (2009), "China's Strategy for the Post-Kyoto Protocol", IEEJ, http://eneken.ieej.or.jp/data/summary/1870.pdf.
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[6] The Lawrence Berkeley National Laboratory, China Energy Group has collaborated China in the area of energy efficiency standards and labeling since later 1990s through programs such as CLASP (The Collaborative Labeling and Appliance Standards Program). For more details and related references, please visit the Group's web site at http://eetd.lbl.gov/l2m2/china.html.
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[10] Nan, Zhou (2008).
[11] The *Energy Conservation Infrastructure Construction Fund* was undertaken between 1980s and 1993. It was cancelled in 1994. While the *Energy Construction Technical Renovation Fund* was merged into the general technical renovation fund in 1998.
[12] World Bank (2008), *Mid-term Evaluation of China's 11th Five Year Plan*, Report No. 46355-CN.
[13] The plan issued by the NDRC did not only demonstrated that energy efficiency and conservation did indeed lie at the heart of China's new energy policy but also laid out specific targets and objectives and identified key steps to be taken. These priorities were further elaborated in the 11th Five-year plan and work has been underway since 2006. For full text (in Chinese), please refer to http://www.ndrc.gov.cn/xwfb/t20050628_27571.htm.
[14] *The 1000 Large Industrial Enterprises Energy Conservation Action Plan*, April 2006, NDRC, http://hzs.ndrc.gov.cn/newzwxx/t20060413_66111.htm.
[15] According to the World Bank 2008 Report (Report No. 46355-CN), during the 1980 to 2000 period, contributions to the reduction in energy intensity from technical progress and structural change are considered to be 30-40 percent and 60-70 percent, respectively.

Chapter 4 Equipment and Activities

1. Transportation Equipment and Modes

Transportation in China has also experienced major growth and expansion since 1949 and especially since the early 1980s.

Railroads, which use to be the primary modes of transportation have doubled in length since the mid-twentieth century. This now extensive network provides rail service to the entire nation. Up until the end of the 1980s, freight transportation was almost evenly divided between rail and water, with a small portion carried by truck. However, since 1990, water shipping has widely overtaken railroads as the primary mode of freight transportation. Although air transport still only accounts for a very small portion of total freight, it is the fastest growing mode of freight transportation. Freight carried on highways has also increased sharply, rising from 76.4 billion t-km in 1980 to 975.4 billion t-km in 2006. After peaking in 1989, pipeline transport has increased again since 2002 due to strong demand for petroleum and natural gas and the commercial operation of new oil and gas pipelines (Figure 4-1).

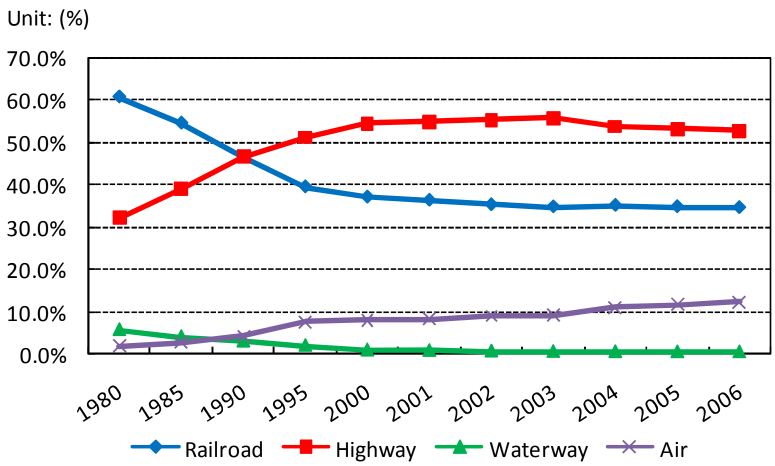
Figure 4-1 Freight Movements by Mode (1980-2006)

Year	Railroad		Highway		Waterway		Pipeline		Air		Total
	billion t-km	% of total	billion t-km	% of total	billion t-km	% of total	billion t-km	% of total	billion t-km	% of total	
1980	571.7	47.5%	76.4	6.4%	505.3	42.0%	49.1	4.1%	0.1	0.0%	1,202.6
1985	812.6	44.8%	169.3	9.3%	772.9	42.6%	60.3	3.3%	0.4	0.0%	1,812.6
1990	1,062.2	40.5%	335.8	12.8%	1,159.2	44.2%	62.7	2.4%	0.8	0.0%	2,620.8
1995	1,287.0	36.0%	469.5	13.1%	1,755.2	49.1%	59	1.7%	2.2	0.1%	3,573.0
2000	1,377.1	31.1%	612.9	13.8%	2,373.4	53.6%	63.6	1.4%	5.0	0.1%	4,432.1
2001	1,469.4	30.8%	633.0	13.3%	2,598.9	54.5%	65.3	1.4%	4.4	0.1%	4,771.0
2002	1,565.8	30.9%	678.3	13.4%	2,751.1	54.3%	68.3	1.3%	5.2	0.1%	5,068.6
2003	1,724.7	32.0%	710.0	13.2%	2,871.6	53.3%	73.9	1.4%	5.8	0.1%	5,385.9
2004	1,928.9	27.8%	784.1	11.3%	4,142.9	59.7%	81.5	1.2%	7.2	0.1%	6,944.5
2005	2,072.6	25.8%	869.3	10.8%	4,967.2	61.9%	108.8	1.4%	7.9	0.1%	8,025.8
2006	2,195.4	24.7%	975.4	11.0%	5,548.6	62.4%	166.4	1.9%	9.4	0.1%	8,895.2

Source: *China Energy Databook, V.7.0.*, Table 5B.1..

The increasing number of motor vehicles used in China and improvements to the highway infrastructure have brought about significant changes in passenger transportation. In 1990, passenger mileage on highways exceeded passenger miles on railroads for the first time. Passengers using air transportation increased from 4 billion p-km in 1980 to 204.5 billion p-km in 2006 with an average rate of increase of 17% per annum. Although river and ocean transportation of freight has grown, passenger travel by water declined from 12.9 billion p-km to 7.4 billion p-km over the same period. By 2006, the share of passenger-kilometres carried by waterways accounted for only 0.4% of total passenger transport (Figure 4-2).

Figure 4-2 Passenger Travel by Mode (Shares) (1980-2006)

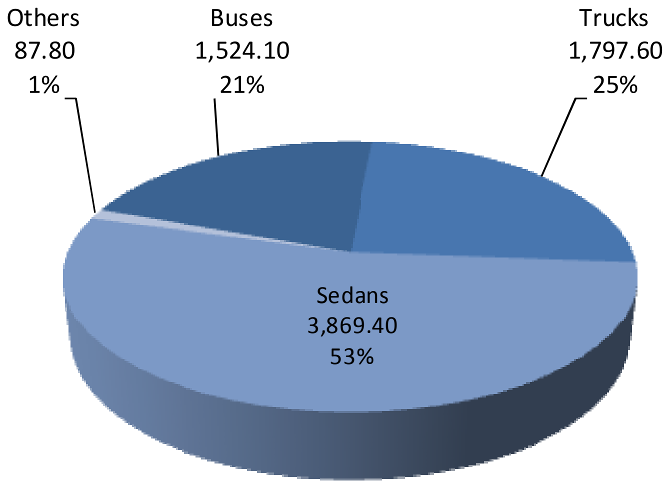


Source: *China Energy Databook, V.7.0.*, Table 5B.2..

Production of motor vehicles rose sharply between 1980 and 2006. The number of motor vehicles in China jumped from 222,300 units at the start of 1980 to 7.3 million units in 2006 of which buses accounted for 21%, sedans 54% and trucks 25% (Figure 4-3). Production of motorcycles increased about 4 times from 5.1 million units in 1994 to 20.5 million units in 2006 with an annual growth rate of 12.3% per year.

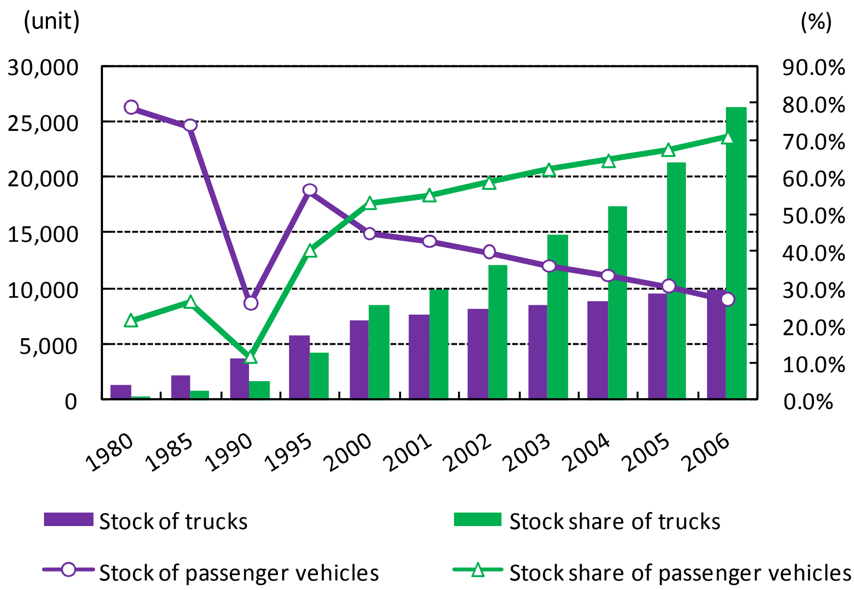
Following vehicle production patterns, the comparative stock share of passenger vehicles and trucks reversed between 1980 and 2006. In 1980, the stock of passenger vehicles was 350,800 units, which only accounted for 21.3% of total vehicle stock. However, by 2006, the share of passenger vehicles leapt to 70.8% with 26 million units in stock (Figure 4-4).

Figure 4-3 Motor Vehicles Production in 2006



Source: *China Energy Databook, V.7.0.*, Table 5B.6..

Figure 4-4 Stock of Trucks and Passenger Vehicles (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 5B.3..

As household income has continued to increase, the stock number of private motor vehicles has increased remarkably since 1985. In 1985, the stock of private vehicles was 284,900 units, which accounted for 9.4% of total motor vehicle stock. However, private vehicles as a share of total vehicles jumped to

63.1% in 2006, comprised of 4.9 million trucks and 18.2 million passenger vehicles (Table 4-1). The annual rate of increase in private vehicle stock between 1985 and 2006 (23.3%) was almost twice that for all motor vehicles (12.7%) over the period.

Table 4-1 Stock of Private and Civilian Motor Vehicles (1985-2006)

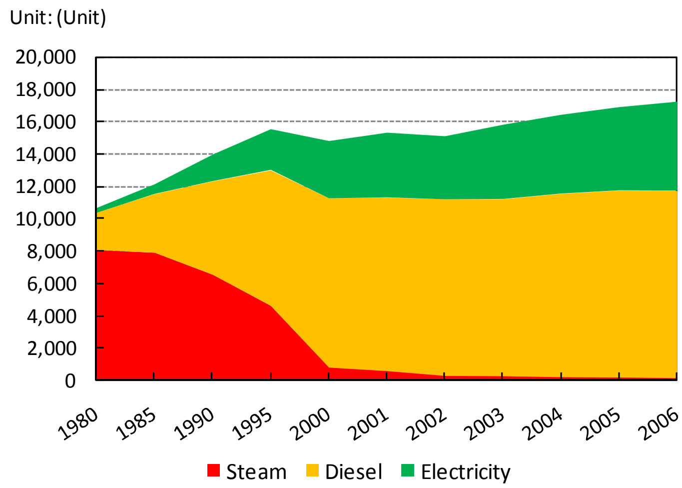
(Unit: thousands)

Year	Stock of Private Motor Vehicles			Stock of Total Motor Vehicles	% of Total
	Trucks Subtotal	Passenger Vehicles Subtotal	Total		
1985	264.80	19.30	284.90	3,026.50	9.4%
1990	574.80	240.70	816.20	14,352.20	5.7%
1995	1,318.30	1,141.50	2,499.60	10,400.00	24.0%
2000	2,590.90	3,650.90	6,253.30	16,089.10	38.9%
2001	2,989.50	4,698.50	7,707.80	18,020.40	42.8%
2002	3,412.90	6,237.60	9,689.80	20,531.70	47.2%
2003	3,673.50	8,458.70	12,192.30	23,829.25	51.2%
2004	4,028.16	10,696.91	14,816.60	26,937.14	55.0%
2005	4,521.06	13,839.25	18,480.70	31,596.63	58.5%
2006	4,949.12	18,235.66	23,333.20	36,973.50	63.1%

Source: *China Energy Databook, V.7.0.*, Table 5B.3., Table 5B.4..

The stock of railway locomotives has steadily increased; however, engine type has shifted from steam to diesel and electric due to environmental concerns (Figure 4-5).

Figure 4-5 Stock of Railway Locomotives by Engine Type (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 5B.9..

By 2006, steam locomotives had almost been phased out and accounted for less than 1% of total railway locomotives. Meanwhile, diesel locomotives increased from 21.7% in 1980 to 67.5% of total locomotives in 2006 and electric locomotives rose from 2.7% to 31.8% in the same period. Heavy investment in electrification of railways is the main reason for the rapid increase in the number of electric engines.

Energy intensity has improved for all freight transport since 2000. Water transportation intensity dropped sharply from 9 kg diesel per 1,000t-km in 2000 to 5 kg diesel in 2006 due to an increase in the average capacity of cargo carriers.

Table 4-2 Rail, Water, and Air Freight Transport Energy Intensities (2000-2006)

Transportation by Mode		2000	2001	2002	2003	2004	2005	2006
Rail Transport	Diesel Locomotives (kg diesel/1000 t-km)	2.58	2.57	2.59	2.54	2.50	2.46	2.43
	Electric Locomotives (kWh/1000 t-km)	11.32	11.31	11.08	11.00	11.12	11.18	11.00
Water Transport (kg/1000 t-km)		9.0	2.0	6.0	6.0	6.0	7.0	5.0
Air Transport (kg/t-km)		0.40	0.38	0.36	0.35	0.34	0.34	0.33

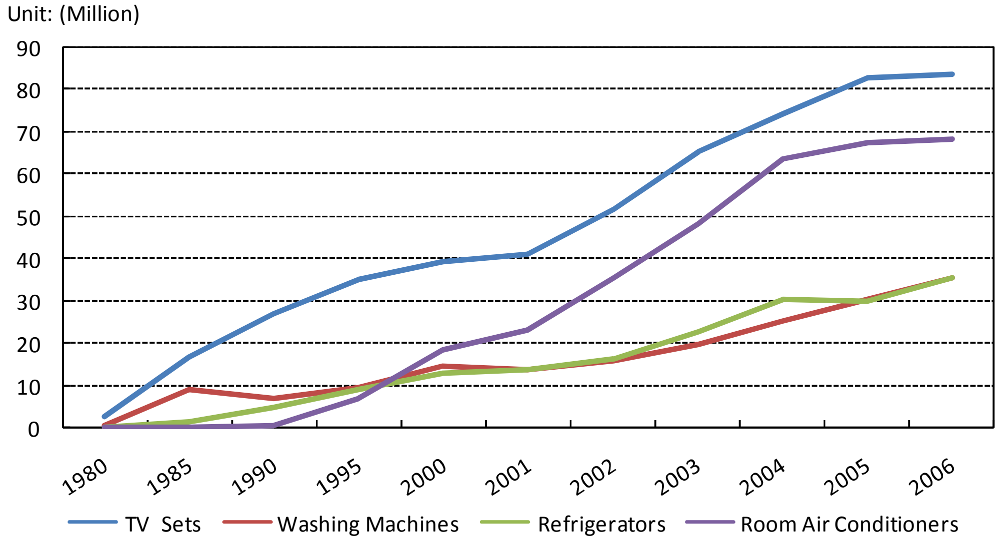
Source: *China Energy Databook, V.7.0.*, Table 5B.10..

2. Penetration and Energy Efficiency of Major Appliances

Major electric appliances started to become wide spread in the beginning of the 1980s in China due to rising personal income levels and growing urbanization. Although statistics for the total stock number of individual appliances is not available from 1992, manufacturing output is an indication of the tremendous growth in consumer demand for household appliances. Starting from a low production and technology level in the early 1980s, China has become one of the largest manufacturers of appliances in the world. In 1980, the total output of refrigerators was 49,000 units and production of televisions, washing machines, and air conditioners was 2.5 million, 245,000, and 13,000 units, respectively.

By 2006, the output of refrigerators and washing machines reached 35.3 million and 35.6 million units respectively. Meanwhile, TV sets and air conditioners increased to 83.8 million and 68.5 million units respectively (Figure 4-6). Of these, air conditioners have expanded the fastest with an average annual growth rate of 39% over the period.

Figure 4-6 Production of Major Appliances (1980-2006)

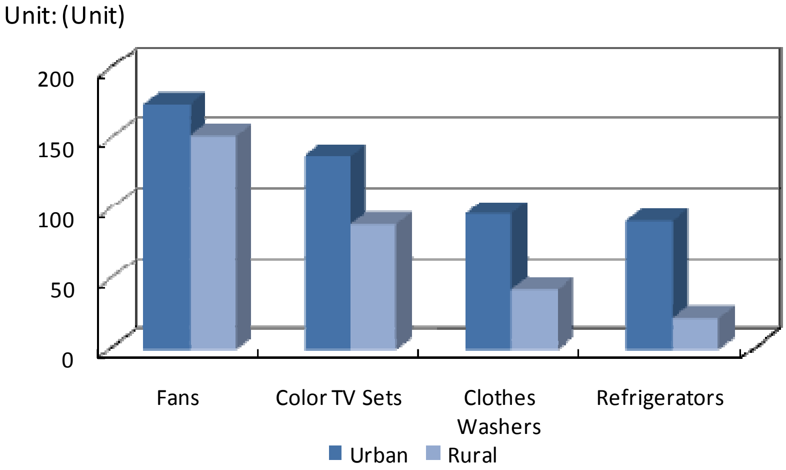


Source: *China Energy Databook, V.7.0.*, Table 5B.11.

Appliance penetration rates in urban households vary according to each product. By 2006, urban households had at least one or more TV sets and cooking appliances such as rice cookers. More than 90% of households had one washing machine and one refrigerator. The penetration rate for air conditioners increased from 30.8% in 2000 to 87.8% in 2006 and this in turn was the primary driver of rising residential power demand.

In contrast with urban households, growth in penetration rates of electrical appliances in rural households remains comparatively low. By 2006, the rural penetration rate of TV sets and refrigerators was 89.4% and 22.5% of households respectively, while less than half of rural households had washing machines (Figure 4-7). To promote house appliance use in rural areas, in February 2009, the Ministry of Finance launched a subsidy program for rural households to buy designated brands of appliances; these subsidies are available for purchases of color TVs, refrigerators, mobile phones, washing machines, freezers, motorcycles, computers, water heaters, and air conditioners[1]. It is expected that through the program the figures for rural household appliance penetration will grow but low incomes and unreliable power supply might be barriers to program implementation.

Figure 4-7 Comparison of Ownership of Major Appliances in Urban and Rural Households (2006)

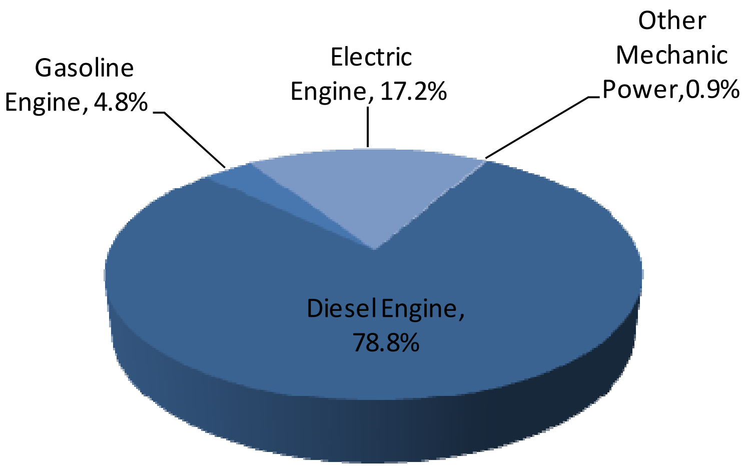


Source: *China Energy Databook, V.7.0.*, Table 5B.12., Table 5B.14..

3. Agricultural Machinery

Agricultural machinery stock energy consumption increased approximately four times from 147.5 GW in 1980 to 684 GW in 2006, with an average growth rate of 6.1% per annum. The fastest growth has been for small working tractors which are often also used for transportation. More than 78% of rural equipment is powered by diesel engines with lower utilization of electric, gasoline, and other types of engines (Figure 4-8).

Figure 4-8 Shares of Rural Equipment Capacity by Type of Engine (2005)



Source: *China Energy Databook, V.7.0.*, Table 5B.16..

4. Industrial Products

Output of China's major energy-intensive industries has increased since 1980. Paper, iron, steel products, plate glass, and ethylene have maintained growth consistent with GDP growth or overtaken the annual GDP growth rate (around 10%), while growth in output of certain other chemicals, especially synthetic ammonia, has been slower (Table 4-3).

Table 4-3 Output of Major Energy-Intensive Industrial Raw Materials (1980-2006) (Unit: Mt)

Year	Paper & Paperboard	Pig Iron	Crude Steel	Rolled Steel Products	Cement	Plate Glass (M cases)	Soda Ash	Caustic Soda	Sulfuric Acid	Synthetic Ammonia	Ethylene
1980	5.35	38.02	37.12	27.16	79.86	24.66	1.61	1.92	7.64	14.97	0.49
1985	9.11	43.84	46.79	36.93	145.95	49.42	2.01	2.35	6.76	17.18	0.65
1990	13.72	62.38	66.35	51.53	209.71	80.67	3.80	3.35	11.97	21.29	1.57
1995	28.12	105.29	95.35	89.80	475.61	157.32	5.98	5.32	18.11	27.66	2.40
2000	24.87	131.01	128.50	131.46	597.00	183.52	8.34	6.68	24.27	33.64	4.70
2005	62.05	343.75	353.24	377.71	1068.85	402.10	14.21	12.40	45.45	45.96	7.56
2006	68.63	412.45	419.15	468.93	1236.76	465.75	15.60	15.12	50.33	49.37	9.41
Annual Growth Rate	11.5%	9.9%	10.0%	11.8%	11.3%	12.3%	9.3%	8.5%	8.1%	5.0%	10.5%

Source: *China Energy Databook, V.7.0.*, Table 5B.17..

[1] "Implementation Guideline for Electric Appliances to Rural Areas", February 1, 2009, MOF.

Chapter 5 Energy Prices

Until the reform period of the early 1980s, energy prices were set exclusively by government agencies and changed infrequently. Because energy prices did not change when energy production costs or demand shifted, they often failed to reflect the true value of energy production, causing finite energy resources to be misallocated and used inefficiently. Additionally, more energy commodities have been imported in recent years, exposing the domestic market to international market fluctuations. As market principals have been introduced, the Chinese government acknowledged the problem and referred to it as an "irrational" pricing mechanism.

The best way to generate the level of energy price accuracy required for maximum economic and energy-use efficiency is through freeing the forces of demand and supply to determine market prices. Hence, governmental policies of the 1980s increasingly advocated the use of prices that were "mutually agreed upon by buyers and sellers", that is, determined through the market.

Moderate energy pricing reform was undertaken between the 1980s and 1990s and even stronger measures have been implemented since early 2000. Pricing reform between the 1980s and 1990s aimed to stimulate energy producers to expand production capacity without government investment. The current reform efforts are attempting to reduce the differences in prices between international and domestic markets, especially for oil, in order to alleviate domestic energy producers' losses as well as to gradually embed rational pricing mechanisms based on market principles.

Pricing reform for each energy commodity is different. Comparatively, coal and oil prices have changed most rapidly. Coal prices were completely liberalized by 2002 and the pricing mechanism for petroleum products was finally established in May 2009 after partial decontrol started in 1992. The price of electricity, which has a broader and more direct impact on end-users compared to other energy prices, has risen several times over the period. However, the price of electricity still remains tightly controlled by the government. Overall, natural gas is probably the only commodity lagging behind in pricing reform but reforms are expected to speed up in preparation for gas imports from Central

Asia via cross-country pipelines coming on line.

1. Coal Pricing

Between 1984 and 1994, as with many other goods, a two-tiered price system was created for coal: the price of coal which met plan-allocated quotas was set by the government and the price of coal for quantities beyond production quotas was guided by the government, that is, allowed to be sold at higher prices; this was called the "One-mine, Multiple-prices" system. The system was partially reformed in 1984 when the government allowed township and village owned mines (TVOM) to sell their entire output at negotiation-based prices[1]. In 1985, the government raised coal prices to alleviate industry-wide losses, causing the average price of coal to rise by 16.8% from 27.78 yuan/ton to 32.44 yuan/ton. Eventually, in January 1994, market prices were fully implemented for all types of coal mines and the One-mine, Multiple-prices system was abolished. However, to minimize the impact of rising coal prices on the electric power sector, coal prices for power generation were guided by the government between 1994 and 2005. In 2005, the government abolished coal guidance pricing for power generation as well. Instead, a primary fuel adjustment system was introduced into electricity pricing which allowed generators to cover increases in the cost of purchased coal.

Previously, costs of safety, environment, and rehabilitation had not been included in the normal price of coal. This not only failed to reflect the true value of these resources but also led to uncompensated resources consumption and unrecovered costs of environmental damage. Many state-owned coal companies also had to face legacy issues such as rebuilding exhausted coalmines and staff re-employment difficulties. To solve these problems China started to levy a production safety cost in April 2005 and in September 2006 a coal resources tax was levied nation-wide. In 2007, the government began a pilot compensation system for coal resources use in eight major coal producing provinces, which required coal mining companies to pay for exploration and extraction rights[2].

In addition, Shanxi Province, one of the major coal sources in China, has been carrying out a trial program for sustainable development of coal companies since March 2007. One of the important features of the trial program is to establish three funds through levies: a coal sustainable development fund, a mine environmental recovery fund, and a coalmine redevelopment fund. These three funds, along with mining rights fees, are included into total production costs of coal and passed on to coal consumers. Therefore, in addition to production costs, coal producers in Shanxi Province now have to factor in environmental, resources, ecology and redevelopment costs, hence creating a "full cost" of coal production.

Figure 5-1 Major Coal Price Reforms (1980-Present)

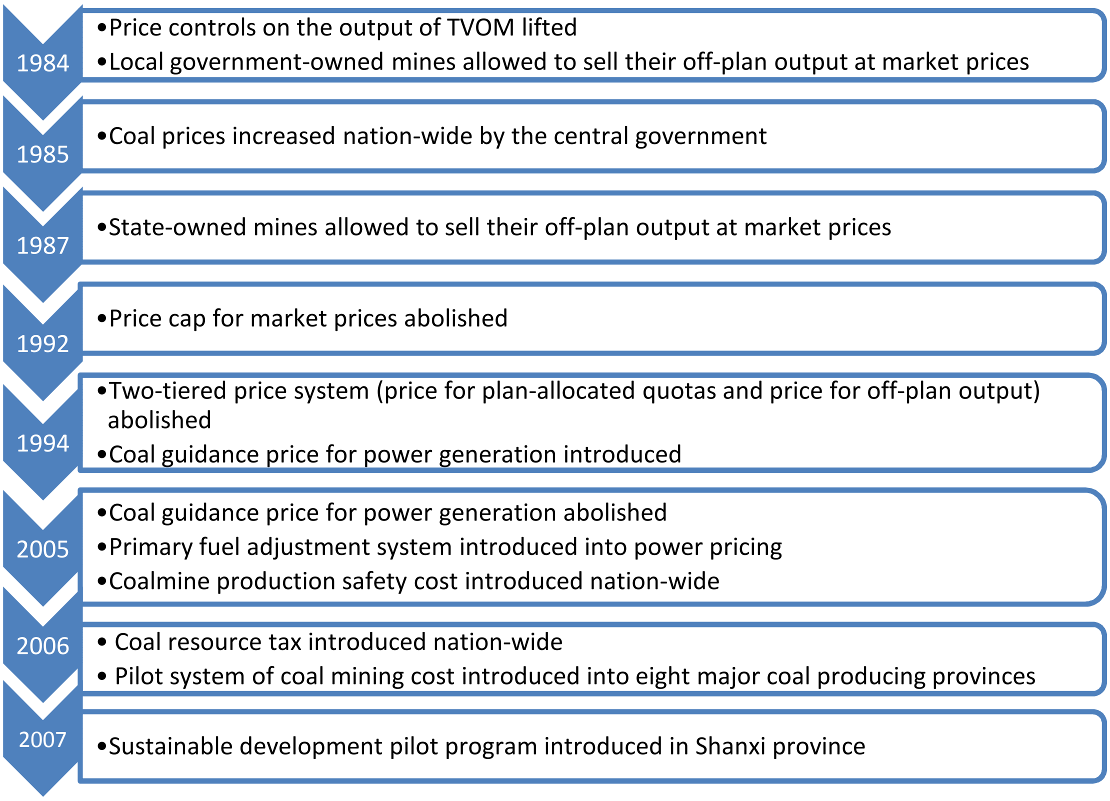
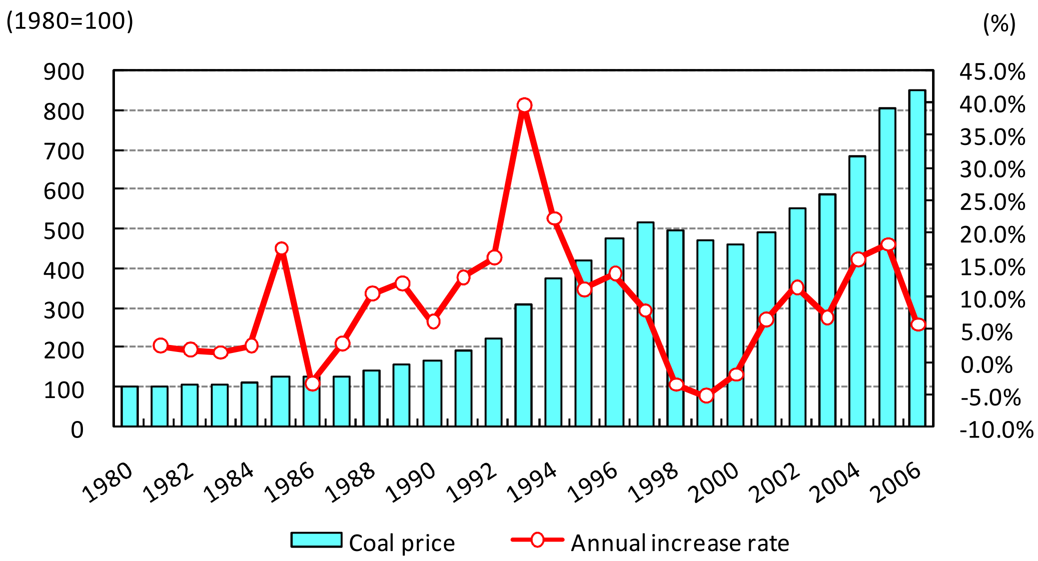


Figure 5-2 shows the fast rise in coal prices as they were allowed to gradually float starting in 1984. There is a deviation from the upward trend during the 1998-2000 period due to a domestic economic downturn. From 1980, average ex-factory coal prices increased almost 8.5 times to 851.9 yuan/ton in 2006 and such increases are on top of the continued uptrend in coal prices since 2002. The average rate of increase between 2003 and 2006 is significantly higher (13.2%) than the average annual increase rate between 1980 and 2006 due to tight coal supplies, pricing reform and increases in transportation fees during the post 2002 period[3].

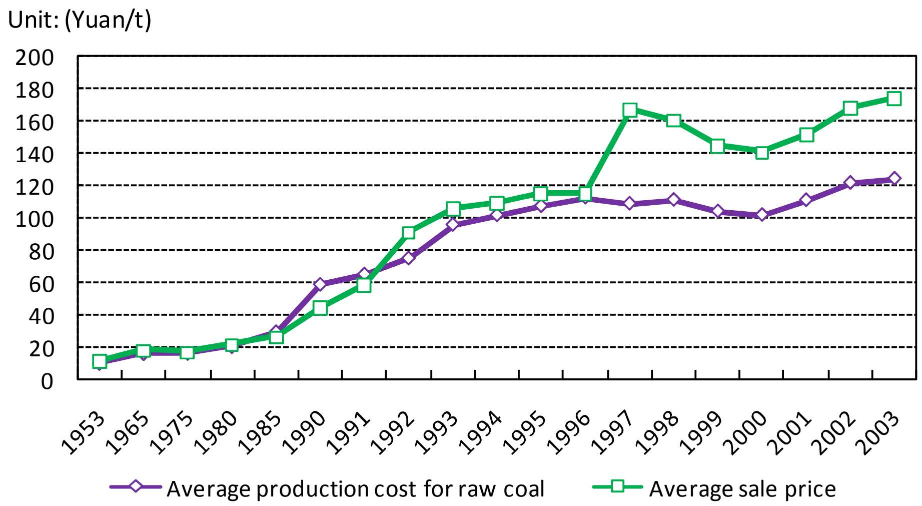
Figure 5-2 Ex-Factory Coal Price Index (1980-2006) (1980=100)



Source: *China Energy Databook, V.7.0.*, Table 6B.1..

Before the market price system was fully introduced, profits of state-owned coal mines were set at a very low level and in some years business profits were even negative, as shown in Figure 5-3.

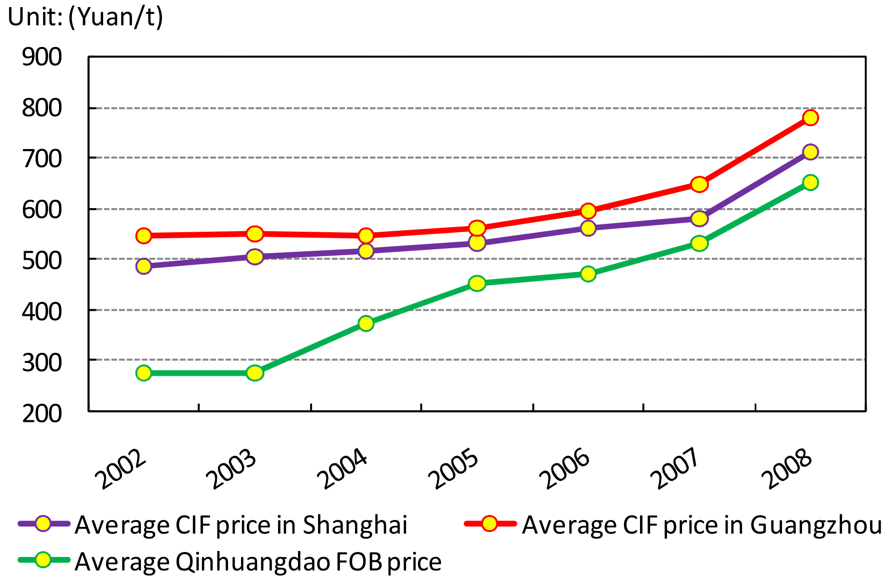
Figure 5-3 Production Cost and Average Sale Price of State-owned Mines (1953-2003)



Source: Xing,Ying (2008), "Change of Coal Pricing Mechanism in China", *Electricity Industry in Foreign Countries*, JEPIC, April 2008, p29.

Generally, coal prices near coal supplies are lower than in the eastern and southern coastal provinces (Figure 5-4). In 2008, the average freight on board (FOB) price at the transit hub Qinhuangdao was 650 yuan/ton, while cost, insurance and freight (CIF) prices in Shanghai and Guangzhou were 60 yuan/ton and 130 yuan /ton higher respectively.

Figure 5-4 Qinhuangdao FOB Price and CIF Prices in Shanghai and Guangzhou (2002-2008)



Source: IEEJ.

Table 5-1 Average Freight on Road (FOR) Raw Coal Price by Province (1997-2006) (Unit: Yuan/ton)

Year	Shandong Province	Hebei Province	Henan Province	Shanxi Province
1997	140	130	110	120
1998	160	130	120	130
1999	160	140	140	130
2000	170	150	140	140
2001	190	170	160	150
2002	210	190	200	180
2003	370	310	390	320
2004	650	700	710	590
2005	630	660	700	580
2006	675	690	730	610

Source: IEEJ.

2. Oil Pricing

China's oil pricing reform efforts can be divided into three stages: the first stage from 1981 to 1994, the second from 1994 to 1998 and the third from 1998 to the present.

During the first stage, in 1981, the government introduced a two-tiered pricing system, similar to the one used for coal pricing during the mid 1980s, to boost oil companies' investment funds.

During the second stage, in 1994, the government replaced the two-tiered mechanism with a single price, which was higher than the average two-tiered one. The second pricing reform not only promoted domestic oil production but also improved the oil distribution market.

During the third stage, in 1998, the government had previously allowed the price of crude oil to track the price of Singaporean crude oil but with the requirement that prices be set by the government according to this mechanism. The crude oil price was calculated and confirmed monthly by CNPC and Sinopec. Meanwhile, prices for oil products were guided by the government: the government set gasoline and diesel base prices according to average FOB Singaporean crude oil price. Enterprises had been allowed to set their wholesale and retail prices within certain ranges of the base prices (5% to -5%) and the differences between wholesale and retail prices were restricted by the government.

In March 2001, the government stopped linking the domestic price of crude oil to the Singaporean crude oil price. Concurrently, the government also modified the oil product pricing system. Instead of linking these product prices to their price in Singapore, the government decided to relate oil product prices to the average of oil products prices in the three major markets of Singapore, Rotterdam, and New York. Finally, under this system the domestic oil product price was no longer directly tied to the international oil market, but was only adjusted domestically when international oil price changes exceeded an amplitude of 8 percent. Final gasoline and diesel sales prices could then increase or decrease in the domestic market by 8 percent. Notably, this new pricing policy came into effect at a time when international oil prices were at their lowest levels in twenty years. This relatively free market approach was able to diminish the domestic economic effects of the gradual rise of international prices from about US$ 15 per barrel in 1998 to US$25 per barrel in 2002, but its efficacy started to fall apart as international prices rose beyond US$40 per barrel in 2004.

To alleviate increasing policy-induced refining losses, in late 2005 the government switched the oil products price peg from oil products to crude oil in a gradual and controlled manner. Under the crude-based oil products pricing mechanism the government linked oil product prices to a weighted average of Dubai, Brent, and Minas crude oil prices, also incorporating into the price mechanism of the average crude processing costs, reasonable rates-of-return, and taxes and fees. However, NDRC did not officially release its domestic refined oil products pricing formula until December 2008 in its government notice - the *State Council Notice on Implementation of Oil Product Prices and Taxes Reform* and its follow up notice in May 2009 - *Administration Measures for Oil Prices*[4]. According to the two notices, the government can revise product prices once average cost and freight (CFR) prices of the international crude markets over a minimum 22 consecutive working days moved outside a 4% fluctuation from the previous period's weighted crude basket average. However, the government will continue controlling domestic oil product prices even when prices of the basket of the three crude grades cross the 4% fluctuation milestone. The aim of this reform was to progressively decrease government interference in the pricing process so as to integrate China's oil markets with international markets, to provide clear commercial incentives for oil companies, and to send clear price signals to oil consumers (Figure 5-5).

This gradual exposure to liberalized and volatile global crude prices has strained China's oil pricing system. Fearful of passing price inflation on to major oil consuming industries, as well as low-income farmers and taxi drivers, the central government continues to tightly constrain consumer prices. As international crude oil prices soared between 2004 and 2008, oil refining and sales firms suffered huge losses. Sinopec lost 12 billion yuan through its refining operations in 2005, 30 billion in 2006, 13.7 billion in 2007, and 6.2 billion in 2008. To cover these partial policy-induced operational losses, the Chinese government subsidized Sinopec between 2005 and 2008 and CNPC in 2008. While downstream profits have suffered from high international crude oil price, upstream profits have grown dramatically. The government responded in 2006 by introducing a windfall tax on all oil produced in China and sold for more than $40/barrel. This tax is assessed on a sliding scale from 20 to 40 percent. The government uses some of the revenue to compensate farmers, urban transportation providers, and city taxi drivers who are affected by increasing gasoline and diesel prices (Table 5-2).

Figure 5-5 Major Oil Price Reform (1980-present)

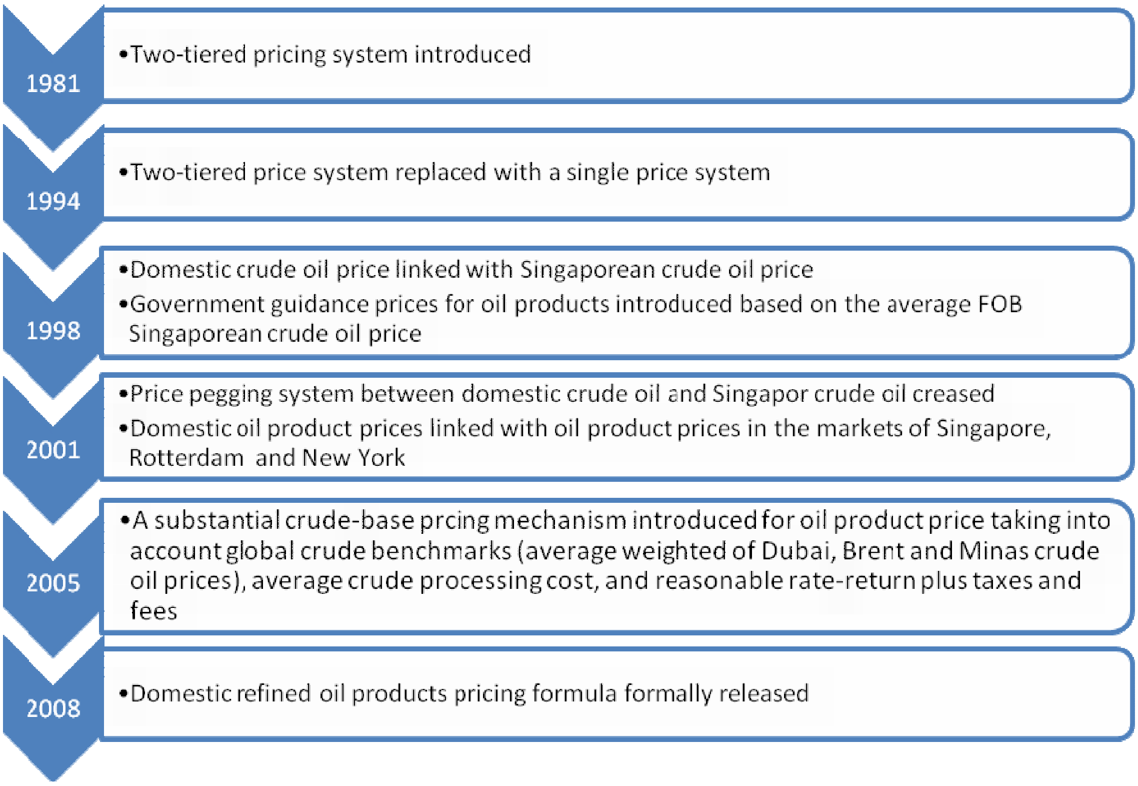


Table 5-2 Sinopec's Losses in Refining Operation and Concurrent Government Subsidies

Year	Lost in refining operation (Billion Yuan)	Government Subsidy (Billion Yuan)
2005	12	10
2006	30	5
2007	13.7	4.9
2008	6.2	5

Source: Various press releases.

Since the official announcement of the refined version of the crude basket based oil product pricing formula in December 2008, the government has so far adjusted domestic oil product prices seven times, as shown in Table 5-3. This data shows that under the country's new fuel pricing mechanism the Chinese government has adjusted oil price more frequently than before.

Table 5-3 History of Oil Price Adjustment (2005-September 2009)

Year	Date	Oil product	Price adjustment range (Yuan/t)
2005	23-Mar	Gasoline	300
	10-May	Diesel	150
	23-May	Gasoline	-150
	25-Jun	Gasoline	200
		Diesel	150
		Jet fuel	300
	23-Jul	Gasoline	300
		Diesel	250
		Jet fuel	300
2006	26-Mar	Gasoline	300
		Diesel	200
		Jet fuel	300
	24-May	Gasoline	500
		Diesel	500
		Jet fuel	500
2007	14-Jan	Gasoline	-220
		Jet fuel	90
	31-Oct	Gasoline	500
		Diesel	500
		Jet fuel	500
2008	20-Jun	Gasoline	1,000
		Diesel	1,000
		Jet fuel	1,500
	19-Dec	Gasoline	-900
		Diesel	-1,100
		Jet fuel	-2,400
2009	14-Jan	Gasoline	-140
		Diesel	-160
		Jet fuel	-140
	25-Mar	Gasoline	290
		Diesel	180
		Jet fuel	300
	1-Jun	Gasoline	400
		Diesel	400
		Jet fuel	410
	30-Jun	Gasoline	600
		Diesel	600
		Jet fuel	620
	28-Jul	Gasoline	-220
		Diesel	-220
		Jet fuel	-230
	1-Sep	Gasoline	300
		Diesel	300
		Jet fuel	310

Source: NDRC.

Table 5-4 Price Cap on Gasoline and Diesel Prices by Province and Major City (September 1, 2009 onward)

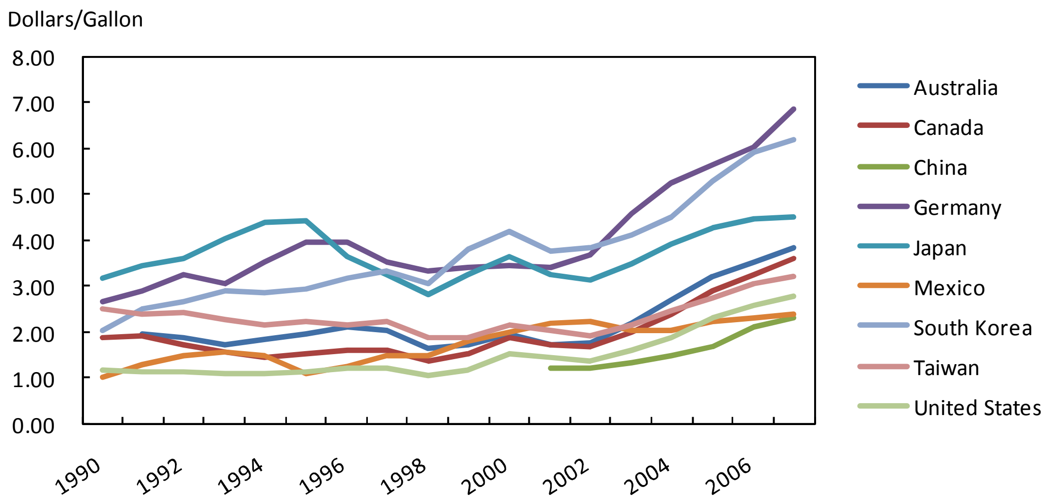
Province	90# Gasoline (II) (Yuan/t)	90# Gasoline (III) (Yuan/t)	0# Diesel (Yuan/t)
Beijing	-	8,010	7,340
Tanjin	7,565		6,825
Hebei	7,565		6,825
Shanxi	7,635		6,880
Liaoning	7,565		6,825
Jilin	7,565		6,825
Heilongjiang	7,565		6,825
Shanghai	7,580		6,830
Jiangsu	7,620		6,865
Zhejiang	7,620		6,880
Shandong	7,575		6,835
Hubei	7,590		6,850
Hunan	7,630		6,910
Henan	7,585		6,845
Hainan	7,710		6,960
Guangdong	7,645		6,895
Guangxi	7,710		6,960
Ningxia	7,570		6,825
Gansu	7,550		6,845
Xinjiang	7,345		6,720

City	90# Gasoline (II) (Yuan/t)	90# Gasoline (III) (Yuan/t)	0# Diesel (Yuan/t)
Hohhot	7,580		6,840
Hefei	7,585		6,845
Fuzhou	7,620		6,870
Nanchang	7,585		6,845
Chengdu	7,785		7,060
Chongqing	7,770		7,025
Guiyang	7,745		6,985
Kunming	7,775		7,015
Xian	7,550		6,835
Xining	7,515		6,855

Source: NDRC.

China's retail fuel prices vary by region, as shown in Table 5-4. According to NDRC, domestic fuel prices are lower than in Japan, Korea, India, Mongolia, and many European countries but higher than in oil exporting states in the Middle East and in some cities in the United States (Figure 5-6).

Figure 5-6 Retail Gasoline Prices in Selected Countries (1990-2007)



Source: Energy Information Administration.

3. Natural Gas Pricing

Until recently, China's well-head gas prices and consumer prices varied greatly depending upon the gas field of origin. However, in December 2005, the NDRC issued a new notice (the Notice) aimed at reforming the existing natural gas pricing system. The Notice was intended to establish a market-oriented price mechanism in China's gas industry and its main points are as follows:

1) *Simplify well-head prices and consumer categories:* The notice simplified well-head pricing by establishing two categories of gas fields, i.e. Grade I and Grade II. Production from Grade I well-heads accounts for 85% of total domestic gas production. Additionally, the notice established different city-gate prices for three different consumer categories. Prices paid by fertilizer production plants are the lowest, while prices for city gas are the highest, as shown in Table 5-5.

2) *Link the price at the well-head with alternative fuel prices:* Aiming to form a market-oriented price mechanism in the sector, the government decided to raise the government-set well-head price to a level more in line with other energy resources, namely crude oil, LPG, and coal. The weighted ratio of

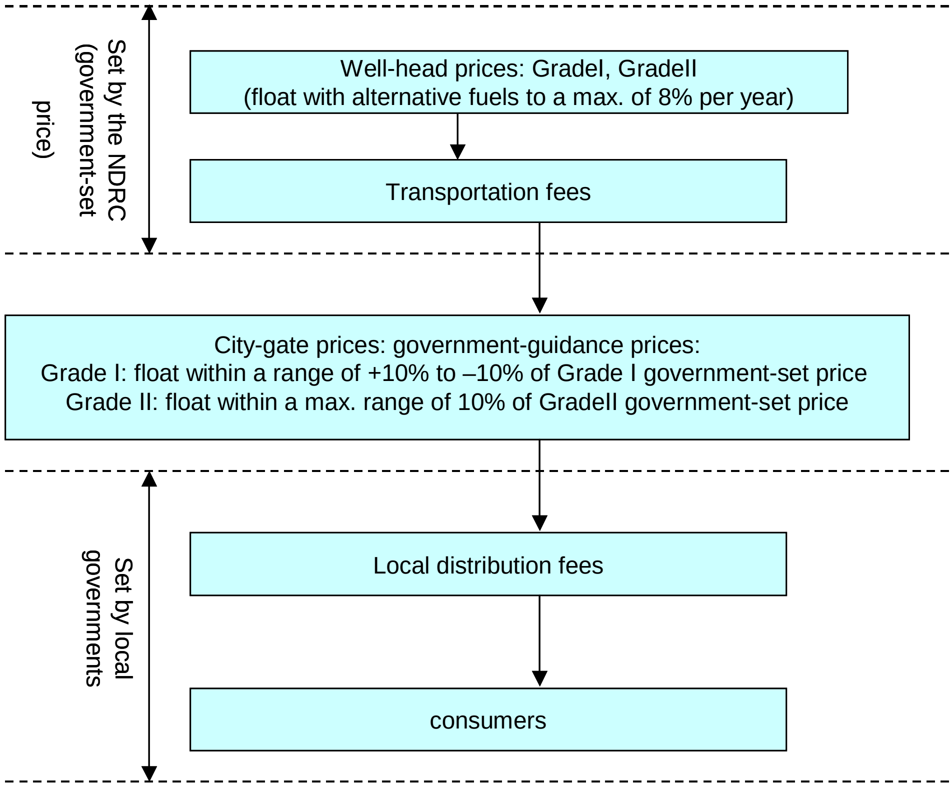
crude oil, LPG and coal used in this calculation is 40:20:40. The price of oil used in the formula is calculated by finding a weighted FOB price of WTI, Brent, and Minas prices. The LPG price is equal to the price of LPG FOB in Singapore, and the coal price used is an average of the delivered prices of high grade coal from Shanxi and Datong, and blended coal prices from Shanxi, at point of delivery to Qinghuang Island. The Notice establishes an 8% per year limit on the amount the government can adjust the price through this price-setting mechanism. Furthermore, as there are price differences between Grade I and Grade II gas fields, these alternative fuel-linked price adjustments currently apply only to Grade II gas fields, while the application of this pricing mechanism is postponed for Grade I gas for a 3 to 5-year period.

3) *Shift from a two-tiered city-gate gas pricing system to a government guidance pricing alone:* When the new pricing system comes into effect for Grade I well-heads, city-gate prices will be set within a plus 10% - minus 10% fluctuation range of government-set well-head prices, while city-gate prices for Grade II well-heads are limited to a 10% fluctuation range. However, there is no price cap for the lowest city-gate price for Grade II.

4) *Increase gas prices and reduce price differences between Grade I and Grade II gas fields:* The benchmark for self-sale prices is set at 980 yuan per 1,000 cubic meters for Grade II gas fields. The benchmark for Grade I will be raised to the Grade II level over three years of implementation. Further provisions are made to raise prices over a 5-year period for gas from the Xinjiang and Qinghai gas fields that is used in fertilizer production and that reaches city-gates. Furthermore, in recognition of the independence of gas resources and the need to transport some gas over long-distances through pipelines, the Notice did not change the city-gate price for West-East pipeline gas.

In addition, the government also raised the city-gate prices for industrial and city gas by 50-150 yuan per 1,000 cubic meters and for fertilizer by 50-100 yuan per 1,000 cubic meters, as shown in Table 5-5.

Figure 5- 7 Current Gas Pricing System



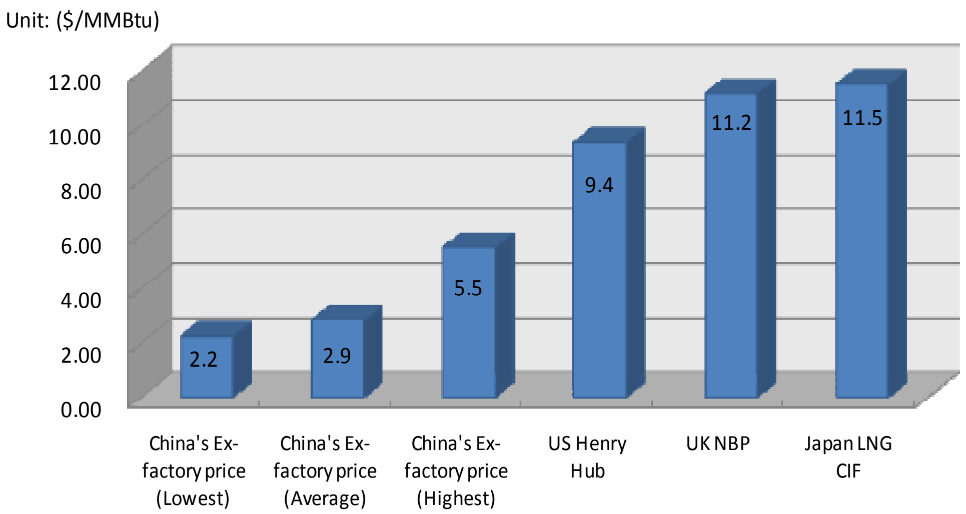
As of the end of October 2008, China's average ex-factory natural gas price was 8 yuan/m3 ($2.85/MMBtu), about a quarter of the average international gas price (Figure 5-8). The country's average price for commercial consumers was 2.62 yuan/m3, while the average price for industrial users was 2.42 yuan/m3. Both the highest commercial and industrial gas prices are found in Nanning (4.19 yuan/m3) and Guangxi provinces, while the lowest commercial price is found in Chengdu City at 1.71 yuan/m3 and the lowest industrial price is found in Lanzhou, Gansu Province at 1.25 yuan/m3 (Table 5-6). Residential gas prices also vary among provinces as shown in Figure 5-9. Residential prices in Guangxi (4.35 yuan/m3) and Guangdong (4.1 yuan/m3) provinces are more than 3 times higher than the lowest price in Qinghai Province (1.25 yuan/m3).

Table 5-5 Government-set City-gate Natural Gas Prices (December 26, 2005 onward)

Gas field	User type	Government-set city-gate gas price (Yuan/1,000m^3)	Government-set city-gate gas price ($/MMBtu)
Grade I			
Sichuan-Chongqing	City gas	920	3.03
	Fertilizer	690	2.27
	Industrial	875	2.88
Changqing	City gas	770	2.53
	Fertilizer	710	2.34
	Industrial	725	2.39
Qinghai	City gas	660	2.17
	Fertilizer	660	2.17
	Industrial	660	2.17
Xinjiang	City gas	560	1.84
	Fertilizer	560	1.84
	Industrial	585	1.93
Others (Daguang, Liaohe, Zhongyuan)	City gas	830	2.73
	Fertilizer	660	2.17
	Industrial	920	3.03
West-East	City gas	1,270	4.18
	Fertilizer	1,120	3.69
	Industrial	1,100	3.62
Grade II			
Excluding from Grade I	City gas	980	3.22
	Fertilizer	980	3.22
	Industrial	980	3.22

Source: Ni, Chun Chun (2007), *China's Natural Gas Industry and Gas to Power Generation*, IEEJ.

Figure 5-8 China's Ex-factory Natural Gas Price between January and October 2008, Compared to Selected International Prices



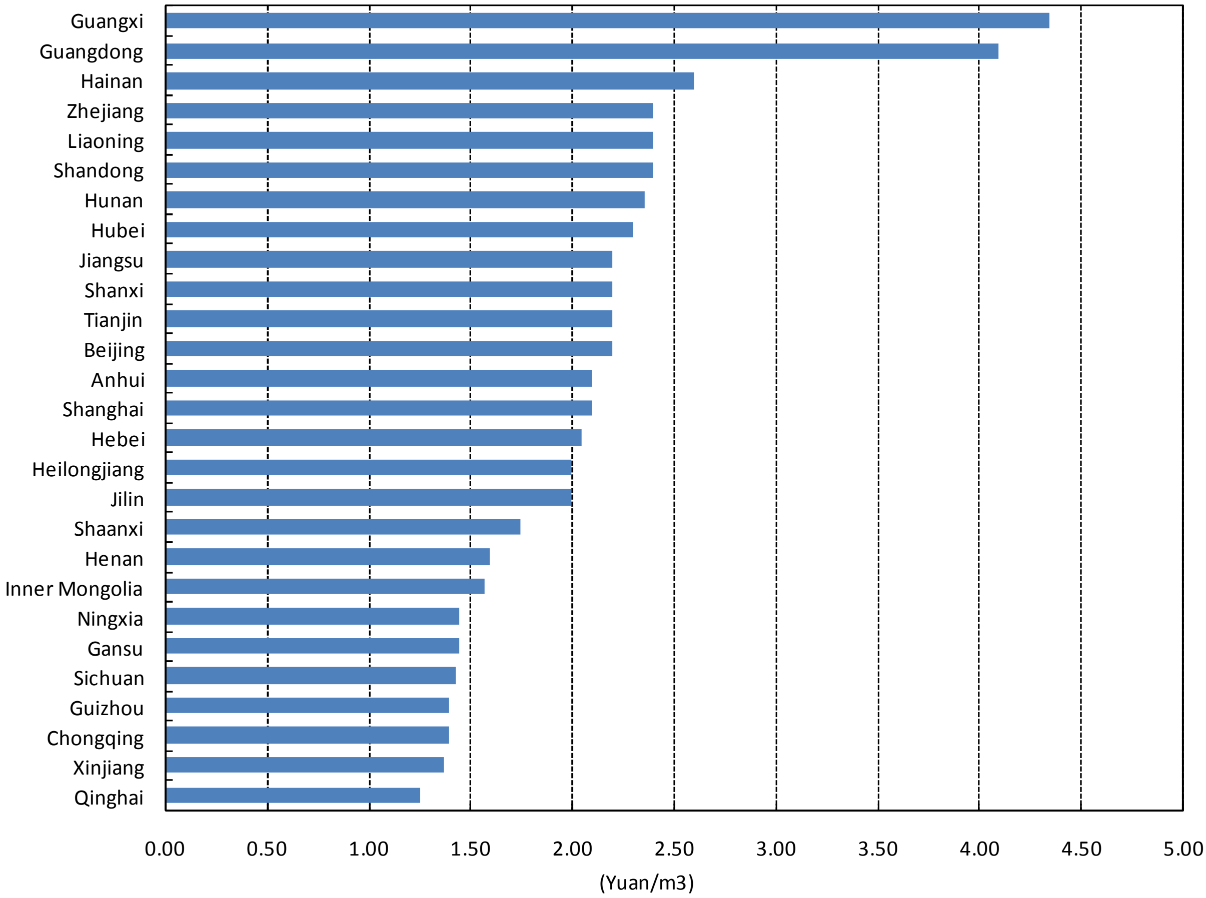
Source: Liu, Keyu (2008), *China's Natural Gas Market: Today and Tomorrow*, presentation paper on December 5, 2008 at IEEJ, Tokyo.

Table 5-6 Commercial and Industrial Gas Prices in Major Cities (2007-2008)

City/Province		Commercial (Yuan/m^3)		Industrial (Yuan/m^3)	
		Oct. 2007	Oct. 208	Oct. 2007	Oct. 208
Beijing		2.55	2.55	1.95	2.35
Tianjin		2.40	2.40	2.40	2.40
Shijiazhuang	Hebei	2.40	2.40	2.00	2.00
Hohhot	Inner Mongolia	1.92	1.92	1.27	1.67
Shenyang	Liaoning	3.60	3.60	3.00	3.00
Changchun	Jilin	1.80	1.80	1.80	1.80
Harbin	Heilongjiang	3.00	3.00	2.50	2.50
Shanghai		3.30	3.30	2.50	2.90
Nanjing	Jiangsu	3.00	3.00	3.30	2.75
Hanzhou	Zhejiang	2.40	2.40	2.35	2.35
Ninbo	Zhejiang	-	3.40		3.40
Hefei	Anhui	2.10	2.10	2.05	2.48
Jinan	Shandong	2.82	3.29	2.82	3.29
Qingdao	Shandong	3.60	3.60	2.88	3.60
Zhengzhou	Henan	2.40	2.40	2.10	2.50
Wuhan	Hubei	3.28	3.28	2.20	2.63
Changsha	Hunan	2.55	2.55	2.28	2.28
Nanning	Guangxi	4.19	4.19	4.19	4.19
Haikou	Hainan	3.10	3.73	2.35	3.30
Chongqing		2.21	2.21	1.24	1.67
Chengdu	Sichuan	1.71	1.71	1.23	1.66
Xian	Shaanxi	1.75	1.75	1.75	1.75
Lanzhou	Gansu	1.88	1.88	1.25	1.25
Xining	Qinghai	1.75	1.75	1.07	1.47
Yinchuan	Qinghai	1.98	1.98	1.38	1.38
Urumqi	Xinjiang	1.88	1.88	–	–
National Average		**2.54**	**2.62**	**2.16**	**2.42**

Source: Same as Figure 5-8.

Figure 5-9 Residential Gas Prices by Province
(As of the end of October 2008)

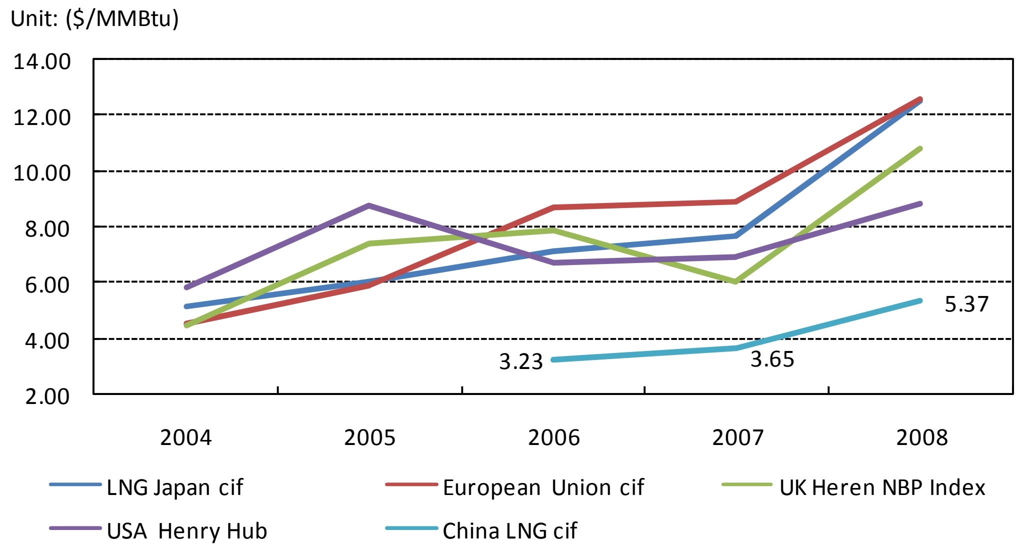


Source: Same as Figure 5-8.

To meet the domestic demand for natural gas, China has implemented a multi-channel natural gas (LNG) supply strategy since the early 2000's. The country's first LNG cargo arrived in May 2006 at CNOOC's Dapeng LNG terminal in Guangdong province, originating from Australia's North West Shelf Project. By the middle of 2009, China had two LNG terminals in operation. However, due to soaring international oil prices and the temporary lack of LNG refining infrastructure between 2005 and 2008, the increasing price gap between domestic and foreign LNG has slowed the country's LNG import schedule (Figure 5-10). The average annual LNG import price in 2006 and 2007 was \$3.23/MMBtu and \$3.65/MMBtu, but this jumped by 47.2% from the previous year to \$5.37/MMBtu in 2008 (Figure 5-11).

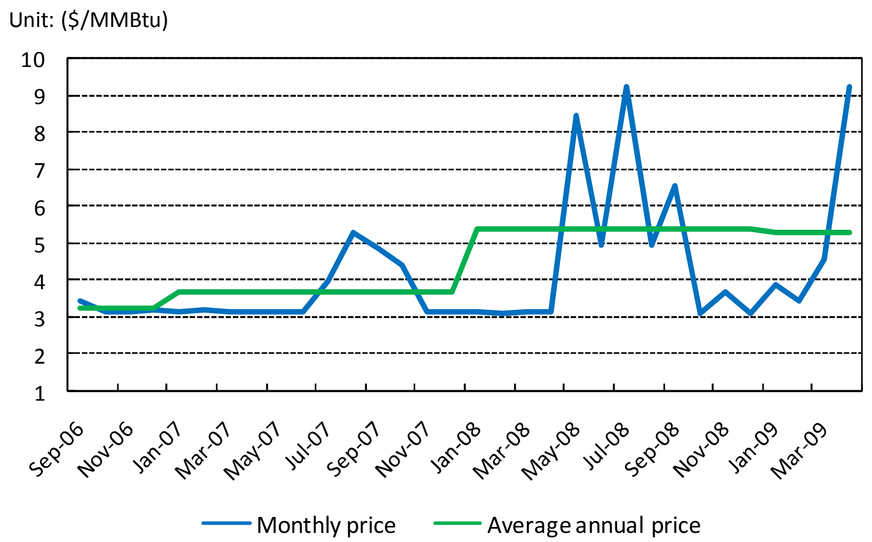
With China's increasing dependency on the international natural gas (LNG) market, addressing the causes of the lag in developing a better natural gas pricing mechanism is the next issue on the Chinese government's energy agenda.

Figure 5-10 Natural Gas (LNG) Price in Selected Countries (2004-2008)



Source: *BP Statistical Review of World Energy 2009*, and TEX Report.

Figure 5-11 LNG Import Price (2006-2009)



Source: TEX Report.

4. Electric Power Pricing

Unlike more developed electricity markets, until 1985 China did not have a wholesale price for power because the purchase price from power producers to transmission and distribution systems was internalized as a line-item in these vertically integrated SOEs' balance sheets. However, "to alleviate extreme shortages of electricity and encourage more generation from different sources, the State in 1985 implemented a 'diversified tariff for electricity produced outside the central economic plan'"[5].

In 1985, two types of power wholesale pricing arose, of which one was referred to as the "old plant-old price" or "catalog price" and the other as the "new plant-new price" or "guidance price". Power sale prices from virtually all power plants constructed before 1985 (primarily funded with government allocations) and from plants or shares of plants constructed with subsidized government loans between 1985 and 1992 were based on the catalog prices issued every year by the former Ministry of Electric Power. These prices covered direct operating costs such as labor, fuel, and maintenance costs, but not capital costs such as depreciation, interest, and a fair return on investment[6]. Conversely, generation prices for power plants not financed by the central government between 1986 and 1992 and all power plants built after 1992 were based on the "new plant-new price" policy.

Under this "new plant-new price" policy, prices for domestic joint venture power producers were calculated with a "cost-profit-tax" formula, whereas prices for publicly listed power producers was based on a rate of return formula. The rate of return on rate base was set at 13.5 per cent and the rate of return on equity financing was set at 15 per cent[7]. For Build-Operate-Transfer (BOT) producers, power prices were determined through an international bidding process. The investment return on such projects was estimated to be around 13% per year. For Transfer-Operate-Transfer (TOT) producers, power prices generally guaranteed a 10% to 15% annual investment return to investors[8].

In 1988, the central government started levying a two-cent construction fee for each kilowatt-hour of consumption. This was adopted to help local governments expand their financial sources for developing local generation capacity. The first price reform during the 1980s is one of the most important steps taken by the central government to encourage investment from other sources by ensuring revenue sufficient to repay the interest and principal on a construction loan.

The "new prices" for "new power plants", "old prices" for "old power plants" pricing system had accelerated the development of the power industry on one hand but established different wholesale prices for different power stations and even different wholesale prices for a power plant on the other hand. It also led to an intentional increase in power wholesale prices, escalated power generation costs, and resulted in haphazard power plant construction[9].

Since 1996, some fundamental changes have taken place regarding wholesale power price setting. The "new plant-new price" system was gradually replaced by a single pricing system based on power purchase agreements. In 1998, China introduced an "on-grid operational period" pricing formula, thereby shifting away from calculating costs based on a plant's loan repayment period towards a pricing mechanism based on a plant's expected lifetime. Units built after 1998 were based on the average market cost of "technically advanced power units".

As the generation sector was divested from the transmission and distribution sectors in 2003, the government issued the *Implementation Method of Separation of Generation and T&D (transmission and distribution) Costs*, which was an updated version of the "on-grid operational period" pricing mechanism and further specified the pricing methodology for plants that were divested from the old State Power Company and for those still held by the two grid companies. In addition, the government advocated a "same grid same price" principle and adopted a uniform on-grid power price benchmark for new plants. This has been subsequently expanded to all generators following the issuance of the *Provisional Regulation on On-grid Power Price* (issued in 2005) and other pricing reform rules.

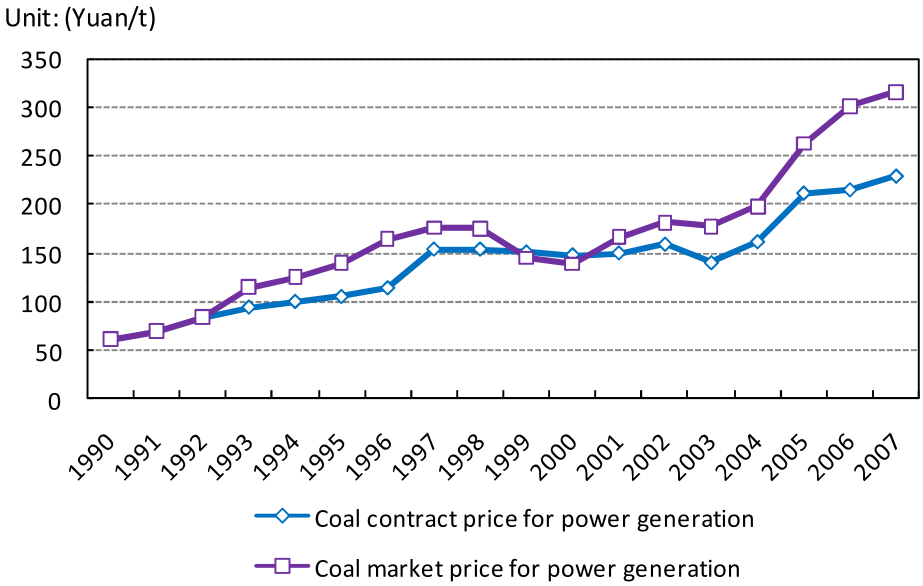
Due to soaring coal prices, in December 2005, the NDRC issued a notice establishing a mechanism to link coal and electricity prices. Under this mechanism, electricity prices could be adjusted if the average hike of the FOB price of coal for power generation rose by more than 5% in a six-month period. 70% of coal price increases would henceforth be paid for by electricity end-users, while power companies would absorb the remaining 30 percent.

Figure 5-12 Major Electricity Power Price Reforms (1980-present)

1985	• "Old price for old plant, new price for new plant" mechanism implemented
1998	• Cost-based pricing system replaced with an average cost-based system for new plants
2003	• *Reform Scheme for Power Price* issued • *Implementation Method of Separation of Generation and T&D Costs* issued • Uniform on-grid power price benchmark introduced for new plants
2005	• *Provisional Regulations on On-grid Power Price, T&D Price, and Retail Price* issued, respectively • Coal and power on-grid price peg system introduced • Average on-grid price increased by 0.0178 yuan/kWh, and average retail price increased by 0.0252 yuan/kWh
2006	• Surcharge for renewable energy power introduced • Average on-grid price increased by 0.01174 yuan/kWh, and average retail price increased by 0.02494 yuan/kWh
2008	• In July, average on-grid price increased by 0.0214 yuan/kWh, and average retail price increased by 0.0261 yuan/kWh • In August on-grid price for coal-fired generators increased by 0.02 yuan/kWh

Between 2005 and 2008, China adjusted electricity prices four times to help generators offset soaring coal prices (Figure 5-13). However, because the adjustments were insufficient and the government was more concerned about the inflationary effects of an electricity price hike than the profitability of the power companies, in 2008 China's big five state-owned power companies together posted losses of 32.25 billion yuan, while the entire coal-fired power generating sector suffered losses of 70 billion yuan, according to the National Bureau of Statistics. Due in part to a concurrent increase in conflicts between coal miners and power companies, the NDRC and the State Electricity Regulatory Commission (SERC) have pledged to further reform the electricity pricing system. However, the problem of on-grid power pricing is not that it is set too low but that it is not adjusted promptly to reflect generators' production costs. The system is inherently problematic in that power generators face market prices for their inputs but can only sell their generated electricity at government guidance prices. As long as there is a distortion between coal pricing and electric power pricing, conflicts between the two sectors are unlikely to be resolved.

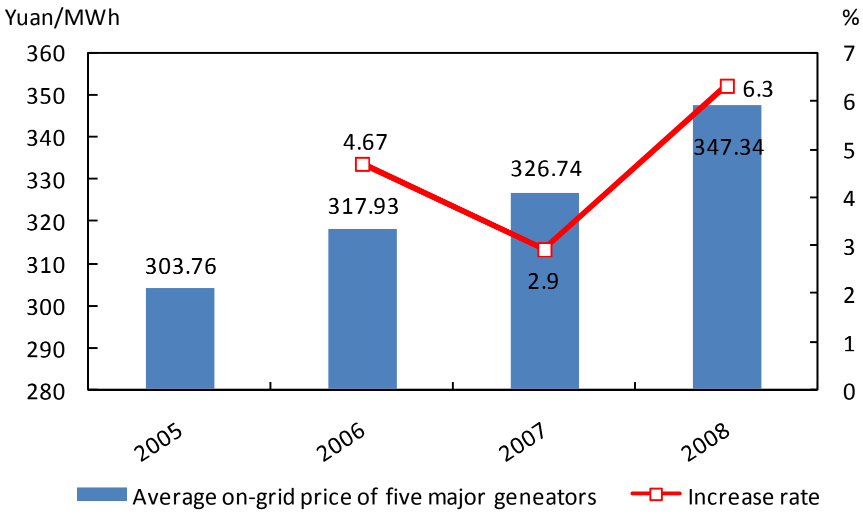
Figure 5-13 Coal Contract Price and Coal Market Price for Power Generation (1990-2007)



Note: Data for 2007 only includes data from the first half of the year.
Source: Xing,Ying (2008), "Change of Coal Pricing Mechanism in China", *Electricity Industry in Foreign Countries*, JEPIC, April 2008, p29.

The average on-grid price of the five major power companies increased by 43.58 yuan/MWh from 303.76 yuan/MWh in 2005 to 347.34 yuan/MWh in 2008 (Figure 5-14). However, it should be noted that price varies by province. In 2007, the lowest on-grid price was found in Qinghai, while the highest price was in Guangdong Province (Table 5-7).

Figure 5-14 Average On-grid Electricity Prices of the Five Major Power Companies (2005-2008)



Source: The State Electricity Regulatory Commission, *Electricity Regulatory Annual Report, 2006-2008*.

Table 5-7 Average On-grid Power Price by Province (2007)

Region	Province	Average on-grid power price (Yuan/MWh)	% increase from previous year
North	Beijing	379.24	2.56%
	Tianjin	372.45	0.73%
	Hebei	345.33	2.61%
	Shandong	374.37	1.74%
	Shanxi	284.47	3.71%
	West Inner Mongolia	262.76	2.63%
Northeast	Liaoning	335.26	0.75%
	Jilin	323.34	3.89%
	Helongjiang	318.66	4.90%
	East Inner Mongolia	292.25	0.35%
Northwest	Shaanxi	286.86	1.31%
	Gansu	237.03	2.12%
	Ningxia	229.78	7.24%
	Qinghai	187.46	7.90%
	Xinjiang	241.87	4.41%

Region	Province	Average on-grid power price (Yuan/MWh)	% increase from previous year
East	Shanghai	434.80	10.82%
	Jiangsu	368.20	0.87%
	Zhejiang	436.83	0.38%
	Anhui	347.68	3.51%
	Fujian	365.05	1.22%
Central	Jiangxi	361.90	0.06%
	Henan	326.05	11.16%
	Hubei	297.80	0.03%
	Hunan	352.48	-0.44%
	Chongqing	322.17	2.28%
	Sichuan	290.25	0.34%
South	Guangdong	461.63	2.85%
	Guangxi	326.18	0.07%
	Yunnan	243.17	3.28%
	Guizhou	262.15	4.79%
	Hainan	380.48	6.16%

Source: Nakayama, Moto (2009), "China's Power Price in 2007", *Electricity Industry in Foreign Countries*, JEPIC, January 2009.

Generally, China's power transmission and distribution prices have simply been decided by the following equation.

T&D Price = average retail price of power-average wholesale price/(1-tranmission loss rate)

Attempting to implement a pilot program to develop more direct, bilateral power purchase agreements between generators and large power consumers, the NDRC has been publishing a T&D price benchmark based on the above equation for each province since 2006, as shown in Table 5-8. Evaluation of actual transmission and distribution costs has been carried out by both the NDRC and SERC since that time. Establishing a rate-base rate-return T&D pricing mechanism is the likely next goal of China's on-going power pricing reform.

Table 5-8 T&D Price Benchmark by Province (2006-2007)

Province	2006 (Yuan/MWh)	2007 (Yuan/MWh)	Province	2006 (Yuan/MWh)	2007 (Yuan/MWh)
Beijing	156.18	162.68	Sichun	147.08	167.56
Tianjin	156.18	136.32	Shaanxi	123.80	131.98
South Hebei	95.28	98.65	Gansu	129.22	131.48
Shanxi	123.47	126.13	Ningxia	130.83	128.17
West Inner Mongolia	97.68	83.04	Qinghai	108.75	105.41
Shandong	90.59	95.22	Xinjiang	193.58	187.52
Shanghai	196.76	195.14	Liaoning	151.05	153.65
Jiangsu	111.52	169.90	Jilin	136.24	161.00
Zhejiang	160.75	109.52	Heilongjiang	160.78	162.28
Anhui	126.54	129.50	Guangdong	180.93	181.02
Fujian	113.65	103.39	Guangxi	111.57	118.92
Hubei	154.25	165.09	Yunnan	140.36	140.21
Henan	82.70	80.76	Guizhou	95.01	108.78
Hunan	149.60	155.55	Hainan	215.44	206.82
Jiangxi	126.29	131.11	Tibet	-	169.68
Chongqing	173.80	181.72	**National Average**	**138.00**	**141.23**

Source: NDRC.

As shown in Table 5-8, the T&D price benchmark varies from province to province as well. The national average T&D price benchmark was 0.138yuan/kWh in 2006 and 0.141 yuan/kWh in 2007. The actual average T&D price charged by power grids in 2006 was 0.153 yuan/kWh, 0.015 yuan/kWh higher than the 2006 benchmark, and was 0.139 yuan/kWh in 2007, 0.002

yuan/kWh less than the 2007 benchmark. In 2007 and 2008, the lowest T&D price was found on the north power grid (except for the Inner Mongolia power grid), while the highest price was in the southern power grid. Share of the T&D price in the total retail power price dropped from 30.72% in 2006 to 26.67% in 2008, due to insufficient price adjustments in the retail sector (Table 5-9, Table 5-10).

Table 5-9 T&D Price by Province in 2006

Power Gid	T&D Price (including transmission loss) (Yuan/kWh)	% of T&D price in total retail price (%)
North Power Grid	0.126	28.67
Northeast Power Grid	0.177	37.59
Northwest Power Grid	0.121	34.20
East Power Grid	0.162	29.57
Central Power Grid	0.124	28.37
State Power Grid	0.141	29.94
Southern Power Grid	0.179	31.10
Nation-wide	**0.153**	**30.72**

Source: SERC (2006), *Electricity Regulatory Annual Report 2006*, SERC.

Table 5-10 T&D Price by Province (2007-2008)

Power Gid	2007		2008	
	T&D Price (excluding transmission loss) (Yuan/kWh)	% of T&D price in total retail price (%)	T&D Price (including transmission loss) (Yuan/kWh)	% of T&D price in total retail price (%)
North Power Grid	0.124	25.31	0.128	25.14
Northeast Power Grid	0.151	29.59	0.151	28.79
Northwest Power Grid	0.125	33.17	0.128	32.66
East Power Grid	0.129	23.17	0.132	22.93
Central Power Grid	0.133	27.91	0.141	28.38
State Power Grid	0.136	27.21	0.138	26.53
Southern Power Grid	0.151	26.57	0.155	26.81
Inner Mongolia Power Grid	-	-	0.077	22.13
Nation-wide	**0.139**	**27.01**	**0.131**	**26.67**

Source: SERC, *Electricity Regulatory Annual Report 2007 and 2008*.

China's retail power price is composed of an on-grid power price, T&D price including transmission loss, and arbitrary fees levied by both the central government and local governments. The retail price benchmark is issued by the

NDRC and varies among provinces, as shown in Table 5-11. Generally, a retail price schedule includes five classifications: power for residential use, general industry and non-industry (such as schools, hospitals, etc.), heavy (or, often, “large”) industry, commercial use, and agriculture including irrigation. Prices for each classified user vary according to voltage. The higher the voltage is, the cheaper the price.

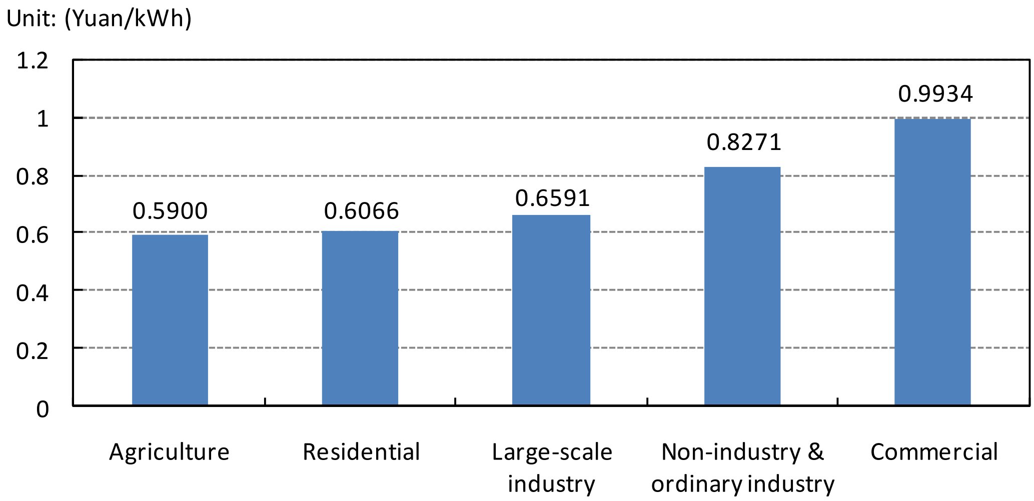
The ratio between the highest rate for commercial use and the lowest for irrigation in poor regions is almost 5 to 1 (Figure 5-15). Large industries in general pay lower prices. However, residential use power prices are about 15% cheaper than those charged to large industry. Conversely, in many developed countries, “electricity prices charged to households are more than 1.5 times the price charged to large industrial consumers; in the EU, on average, they are twice as high”[10].

Table 5-11 Retail Power Price Benchmarks by Province (2006-2007)

Province	2006 (Yuan/MWh)	2007 (Yuan/MWh)	Province	2006 (Yuan/MWh)	2007 (Yuan/MWh)
Beijing	523.32	625.03	Zhejiang	569.28	573.26
Tianjin	523.32	543.24	Jiangsu	590.13	594.86
Tangshan	523.32	543.24	Anhui	503.37	511.92
Hebei	440.92	459.25	Fujian	490.13	490.32
Shanxi	408.63	421.52	Hubei	516.75	532.00
Shandong	478.48	492.6	Henan	419.24	431.51
West Inner Mongolia	352.61	342.06	Hunan	496.41	510.55
Liaoning	508.55	522.31	Jiangxi	506.82	516.42
Jilin	485.62	527.05	Sichuan	465.76	487.43
Heilongjiang	482.22	516.91	Chongqing	507.04	526.35
Shaanxi	420.74	434.72	Guangdong	681.90	689.68
Gansu	356.65	371.93	Guangxi	449.70	457.04
Qinghai	291.43	306.16	Yunnan	392.33	392.13
Ningxia	358.72	381.57	Guizhou	377.29	386.82
Xinjiang	417.13	450.98	Hainan	615.23	614.69
Shanghai	649.60	663.12	**National Average**	**477.50**	**494.09**

Source: NDRC.

Figure 5-15 Retail Power Price by User in Guangdong Province (As of July 2008)



Source: NDRC.

Power prices can vary by as much as two or three times between regions, depending on the availability of power generation capacity in a province and its proximity to coal mines (Table 5-12, Table 5-13). For example, in 2008, the average retail price nationwide was 0.523 yuan/kWh (excluding funding, additional charge, and maintenance expenses for rural networks). Retail prices in Guangdong, Shanghai, and Beijing were 0.706 yuan, 0.680 yuan, and 0.650 yuan, respectively, far higher than the nationwide average price. On the other hand, retail prices in Qinghai, Inner Mongolia, and Gansu were 0.312 yuan, 0.338 yuan, 0.342 yuan, respectively, far lower than those in the coastal regions.

Table 5-12 Average Retail Power Price by Province (2007-2008)

Province	2007 (Yuan/kWh)	2008 (Yuan/kWh)	Province	2007 (Yuan/kWh)	2008 (Yuan/kWh)
Beijing	0.528	0.65	Zhejiang	0.579	0.592
Tianjin	0.528	0.561	Jiangsu	0.572	0.556
Tangshan	0.528	-	Anhui	0.487	0.522
Hebei	0.459	0.463	Fujian	0.483	0.502
Shanxi	0.395	0.415	Hubei	0.512	0.533
Shandong	0.505	0.520	Henan	0.419	0.433
West Inner Mongolia	0.317	0.334	Hunan	0.496	0.514
East Inner Mongolia	-	0.342	Jiangxi	0.504	0.547
Liaoning	0.520	0.54	Sichuan	0.459	0.483
Jilin	0.495	0.511	Chongqing	0.481	0.518
Heilongjiang	0.472	0.482	Guangdong	0.701	0.706
Shaanxi	0.417	0.431	Guangxi	0.438	0.451
Gansu	0.362	0.377	Yunnan	0.366	0.388
Qinghai	0.293	0.312	Guizhou	0.356	0.384
Ningxia	0.374	0.389	Hainan	0.615	0.646
Xinjiang	0.396	0.412	Tibet	-	0.502
Shanghai	0.657	0.68	**National Average**	**0.514**	**0.523**

Source: Same as Table 5-10.

Table 5-13 Average Residential Power Price by Province (2006-2008)

Province	2006 (Yuan/kWh)	2007 (Yuan/kWh)	2008 (Yuan/kWh)	Province	2006 (Yuan/kWh)	2007 (Yuan/kWh)	2008 (Yuan/kWh)
Beijing	0.454	0.439	0.475	Zhejiang	0.527	0.500	0.528
Tianjin	0.454	0.450	0.488	Jiangsu	0.499	0.337	0.504
Tangshan	0.454	–	-	Anhui	0.552	0.485	0.553
Hebei	0.456	0.420	0.488	Fujian	0.465	0.421	0.471
Shanxi	0.463	0.374	0.465	Hubei	0.523	0.500	0.559
Shandong	0.496	0.460	0.504	Henan	0.532	0.494	0.543
West Inner Mongolia	0.376	0.386	0.385	Hunan	0.504	0.445	0.528
East Inner Mongolia	-	0.411	0.455	Jiangxi	0.593	0.549	0.598
Liaoning	0.454	0.470	0.495	Sichuan	0.468	0.465	0.507
Jilin	0.489	0.478	0.521	Chongqing	0.493	0.460	0.517
Heilongjiang	0.446	0.446	0.463	Guangdong	0.611	0.607	0.628
Shaanxi	0.474	0.375	0.475	Guangxi	0.444	0.444	0.490
Gansu	0.473	0.457	0.483	Yunnan	0.391	0.422	0.452
Qinghai	0.354	0.338	0.349	Guizhou	0.402	0.406	0.434
Ningxia	0.451	0.434	0.448	Hainan	0.577	0.578	0.592
Xinjiang	0.459	0.485	0.494	Tibet	-	-	0.563
Shanghai	0.546	0.522	0.543	**National Average**	**0.508**	-	-

Source: Data for 2006 and 2007 are cited from the Annual Report of the SERC. 2007 data is cited from Nakayama, Moto (2009), "China's Power Price in 2007", *Electricity Industry in Foreign Countries*, JEPIC, January 2009.

In general, power prices exhibit a coastal-interior dichotomy. "In most coastal provinces, where new power capacity has expanded the fastest, electricity prices have been raised for cost-recovery purposes to levels approximating marginal production costs"[11]. In inland provinces, however, power prices are much lower partially due to a large proportion of electricity that "is still produced by plants built before 1980 that effectively have no capital costs since they were built with non-repayable central government funding"[12]. Distance from fuel sources is another reason for the substantially lower prices in the northwest regions. South China's coastal provinces such as Guangdong have consistently paid the highest prices in the country over the past two decades.

Starting from the severe power shortages in 2002, a two-part tariff system has been applied to industrial users and a time-of-use tariff system has been introduced into some energy thirsty regions for both large and residential customers. The following tables provided by Shanghai Power Company illustrate Shanghai's retail price schedules which include two-part and time-of-use tariffs (Table 5-14).

Table 5-14 Shanghai Municipality Retail Prices Schedule (As of June 2009) (Unit: Yuan/kWh)

User type		Off-summer						Summer					
		Energy charge				Demand charge		Energy charge				Demand charge	
		>1kV	10kV	35kV	<110kV	Yuan/kW	Yuan/kVA	>1kV	10kV	35kV	<110kV	Yuan/kW	Yuan/kVA
Industrial, commerical, and others	Peak	1.074	1.049	1.024	0.999	39	26	1.099	1.074	1.049	1.024	39	26
	Shoulder	0.671	0.646	0.621	0.596	39	26	0.696	0.671	0.646	0.621	39	26
	Off-peak	0.316	0.310	0.304	0.298	39	26	0.251	0.245	0.239	0.233	39	26
Agriculture (pilot)	Peak		0.730			33	22		0.730			33	22
	Shoulder		0.448			33	22		0.448			33	22
	Off-peak		0.242			33	22		0.242			33	22

Source: Shanghai Economy and Information Technology Commission.

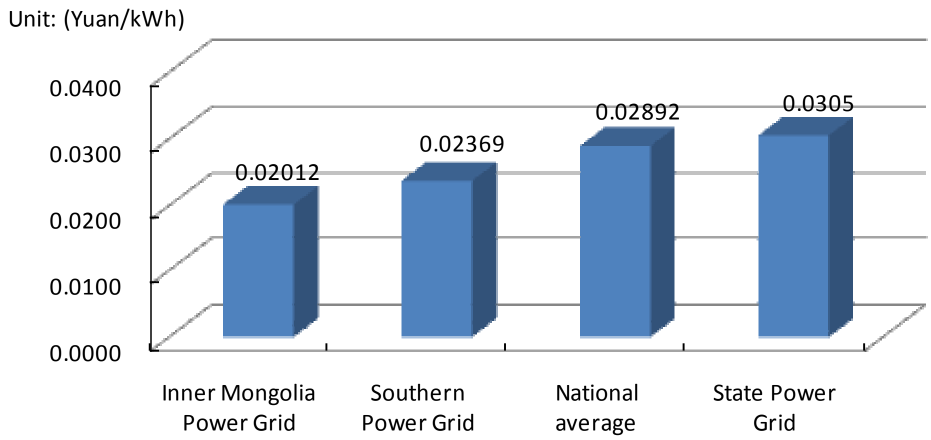
Major arbitrary government fees and surcharges added to retail power prices include a fund for construction of the Three Gorges Dam, migration subsidies for those populations affected by dam construction, funding for rural power grid maintenance, and arbitrary fees for urban public utility services and for renewable energy projects. The average arbitrary fees and surcharges totaled 0.03016 yuan/kWh in 2007, accounting for 5.6% of total retail price, and 0.02892 yuan/kWh in 2008, accounting for 5.5% of total retail price (Table 5-15, Figure 5-16).

Table 5-15 Surcharges and Fees by Province in 2007

Province	Average surcharges and fees (Yuan/kWh)	Province	Average surcharges and fees (Yuan/kWh)	Province	Average surcharges and fees (Yuan/kWh)
Beijing	0.03756	Guansu	0.0077	Henan	0.01966
Tianjin	0.03566	Ningxia	0.01191	Hunan	0.03265
South Hebei Grid	0.01596	Qinghai	0.00752	Jiangxi	0.01741
Shanxi	0.05028	Xinjiang	0.00912	Sichuan	0.02786
Shangdong	0.02031	Shanghai	0.05073	Chongqing	0.04196
West Inner Mongolia	0.02066	Jiangsu	0.0280	Guangdong	0.02855
Liaoning	0.01895	Zhejiang	0.02542	Guangxi	0.03255
Jilin	0.02922	Anhui	0.02081	Yunnan	0.01933
Heilongjiang	0.01025	Fujian	0.01976	Guizhou	0.00605
Shaanxi	0.04250	Hubei	0.04595	Hainan	0.02710

Source: Same as Table 5-7.

Figure 5-16 Total Surcharges and Fees by Province in 2008



Source: SERC, *Electricity Regulatory Annual Report 2008*.

In order to curb the chaotic expansion of high electricity consuming industries, the Chinese government decided to adopt a differentiated power pricing regime for six raw material production sectors in 2004, including the alumina, ferroalloy, calcium carbide, caustic soda, cement, and steel production sectors. In 2006, the phosphorus sector and the zinc processing sector were also incorporated into this regime. Punitive higher power prices (normal retail price plus a differentiated power price) have been applied to enterprises that fail to meet the requirements of the national industrial policy and the range of these differentiated prices has been increasing in recent years, as shown in Table 5-16. In 2007, differentiated power prices were applied to 2,204 large electricity consuming enterprises, of which enterprises that were targeted for elimination constituted 19.7% (435 companies) and enterprises that were targeted for restriction accounted for 80.3% (1,769 companies). Total differentiated prices levied on targeted enterprises reached 651.8 million yuan in that year (Table 5-17).

Table 5-16 Differentiated Power Price Benchmark (2006-2008)

(Unit: Yuan/kWh)

Industry	Category	Current differentiated power price benchmark	From Oct. 1 2006	From Jan.1 2007	From Jan.1 2008
Alumina, ferroalloy, calcium carbide, caustic soda, cement, steel, phosphorus, zinc processing	Enterprises that should be eliminated	0.05	0.10	0.15	0.20
	Enterprises that should be restricted	0.02	0.03	0.04	0.05

Source: State Council, *Notice Regarding to Improve Differentiated Power Price*, September 2006, State Council.

Table 5-17 Implementation of Differentiated Power Price by Sector in 2007

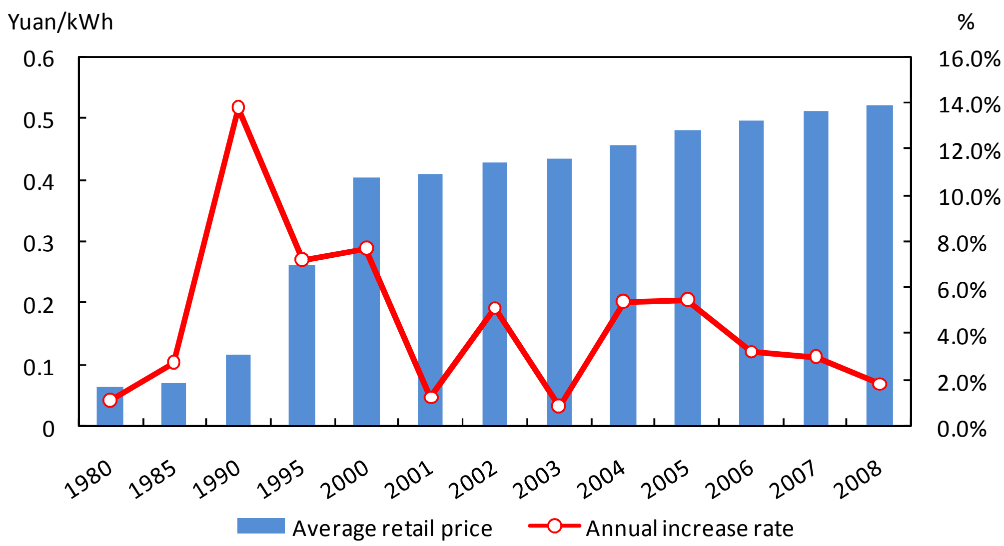
Industry	Targeted enterprises	Targeted power consumption (GWh)	Revenues increased by charging the differentiated price (Million Yuan)
Alumina	4	384.6	38
Ferroalloy	266	605.8	33.9
Calcium carbide	83	1,675.5	19.4
Caustic soda	0	0	0
Cement	425	970.5	81.2
Steel	1,374	4,822.5	505.4
Phosphorus	22	864.7	6.6
Zinc processing	30	33	1.5
Total	2,204	9,356.60	651.8

Source: Same as Table 5-7.

In addition, since October 2007, the NDRC has called for prohibiting local governments from granting favorable power prices to some industrial consumers. However, when the economy slows down, local governments tend to give priority to economic development, job creation, and tax revenues, seeing environmental concerns as secondary. Very often, waivers are given to energy intensive industries.

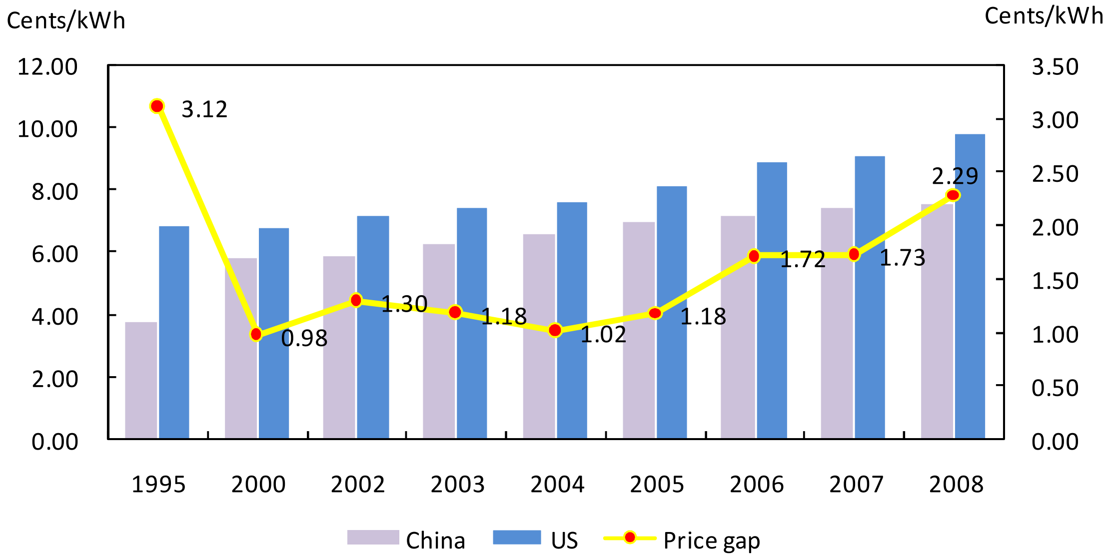
China's national average retail electricity price increased from 0.06547 yuan/kWh in 1980 to 0.52348 yuan/kWh in 2008, increasing annually by 7.7% (Figure 5-17). However, it is notable that in 2008, the average retail electricity price in China was US2.29 cents/kWh cheaper than in the United States. Still, prices in some of China's coastal cities such as Guangdong and Shanghai are higher than in some cities in the United States, as shown in Figure 5-18, Figure 5-19.

Figure 5-17 Average Retail Power Price (1980-2008)



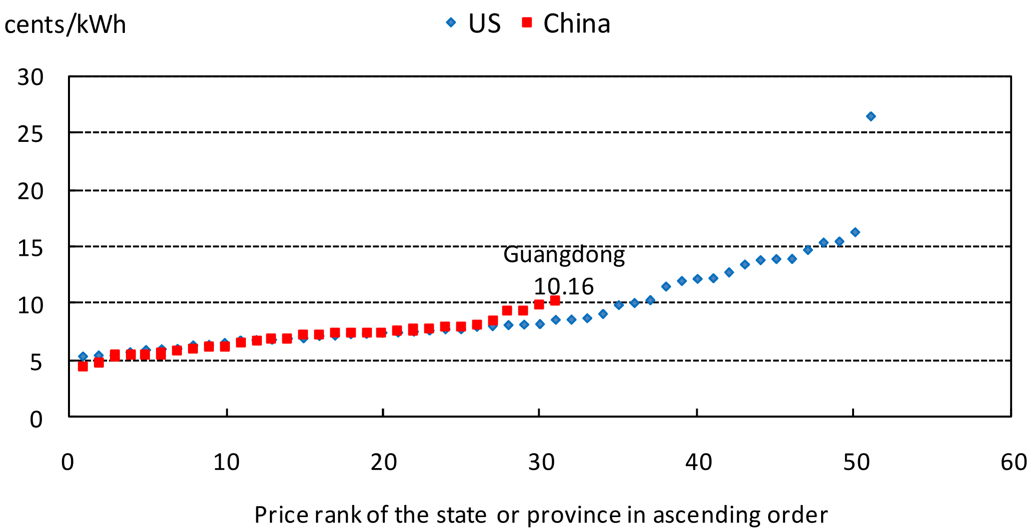
Source: Xing,Ying (2006), "Power Tariff in China's Major Cities", *Electricity Industry in Foreign Countries*, JEPIC, December 2006, p.36; SERC, *Electricity Regulatory Annual Report 2007-2008*.

Figure 5-18 Comparison of Retail Power Prices between China and US (1995-2008)



Note: 1 US Dollar = 6.947922 Yuan.
Source: Data of China from Figure 5-17, Data of the US from EIA.

Figure 5-19 Comparison of Retail Power Price between China and US in 2008



Source: Same as Figure 5-18.

5. Renewable Energy Pricing

China's landmark *Renewable Energy Law* took effect on January 1, 2006, prompting the government to issue a number of pertinent new rules and technical criteria. One of them - *The Provisional Administrative Measures on Pricing and Cost Sharing for Renewable Energy Power Generation* provides for calculating prices and share costs for renewable energy power generation as approved by the government in and after January 2006.

The *Measures* stipulate two forms of renewable pricing: a government-set price and a government guidance price.

Under the *Measures*, prices for biomass power projects are determined by the government based on the provincial or local 2005 on-grid price of desulfurized coal plants plus a 0.25 yuan/kWh government subsidy. The subsidy will no longer be available once a biomass project has been in operation for 15 years. For all renewable power projects approved after 2010, the amount of subsidy provided per kilowatt-hour generated will decrease at an annual rate of 2 percent. If a biomass project is approved through a competitive bidding process, the bid-winning price will be implemented and it should not exceed the local benchmark for on-grid coal-fired price.

The price for any given wind power project is guided by the government based on the bid-winning price. Table 5-18 shows bid prices for central government-led wind power development projects. In order to standardize wind power pricing and to boost the use of wind energy, in July 2009, the NDRC set benchmark prices for on-grid wind farm-generated electricity and abandoned the public bidding systems that helped to facilitate initial investment in the wind power sector. The new benchmark system set onshore on-grid wind power rates to between 0.51 yuan/kWh to 0.61 yuan/kWh in four regions and eliminated the downward pressure on on-grid prices exerted by bid competition (Table 5-19). All newly-built onshore projects will receive the benchmark price from their output starting from August 1, while the prices paid for the electricity produced by offshore wind power projects will be determined separately.

Table 5-18 Successful Bid Prices for Wind Power Concession Projects (2003-2007)

Year	Project	Proposed capacity (MW)	Accepted capacity (MW)	Successful bid price (Yuan/kWh)	Lowest bid price (Yuan/kWh)	Highest bid price (Yuan/kWh)
2003	Jiangsu Rudong I	100	100	0.4365	0.4365	0.7191
	Guangdong Huilai	100	100	0.5013	0.5013	0.7179
2004	Jiangsu Rudong II	100	150	0.5190	0.5190	0.5660
	Jilin Tongyu	100	2×200	0.5090	0.5090	0.5096
	Inner Mongolia	100	2×100	0.3820	0.3820	0.4260
2005	Jiangsu Dongtai	200	2×200	0.5190	0.4600	0.5460
	Gansu	100	100	0.4616	0.4616	0.5560
	Shandong Jimo	100	150	0.6000	0.7261	0.7261
2006	Inner Mongolia Ximeng	300	2×300	0.4056	0.4058	0.5651
	Inner Mongolia Baotou	200	200	0.4656	0.4566	0.5550
	Hebei Zhangbei Danjing	200	200	0.5006	0.5006	0.6010
2007	Inner Mongolia Niaolan	300	300	0.4680	Unknown	Unknown
	Inner Mongolia Tongliao	300	300	0.5216	Unknown	Unknown
	Hebei Shangde	150	150	0.5510	Unknown	Unknown
	Gansu Yumenchangma	200	200	0.5206	Unknown	Unknown

Source: Ni, Chun Chun (2008), *China's Wind-Power Generation Policy and Market Developments*, IEEJ.

Table 5-19 On-grid Wind Power Price Benchmarks (August 1, 2009 onward)

Category	Benchmark price (Yuan/kWh)	Region
I	0.51	Inner Mongolia: Regions except Chifeng, Tongliao, Xinganmeng, Hulunbeier cities; Xinjiang: Urumqi, Yilihasake, Cangjie, Kelamayi, Shihezi
II	0.54	Heibei: Zhangjiakou, Chengde; Inner Mongolia: Chifeng, Tongliao, Xingan, Hulunbeier; Gansu: Zhangye, Jiayuguan, Jiuquan
III	0.58	Jilin: Baicheng, Songyuan; Heilongjiang: Jixi, Shuangyashan, Qitaihe, Suihua, Yichun, Daxinganling; Gansu: Regions except Zhangye, Jiayuguan, Jiuquan; Xinjiang: Regions except Urumqi, Yilihasake, Cangjie, Kelamayi, Shihezi; Ningxia
IV	0.61	Regions except from the above

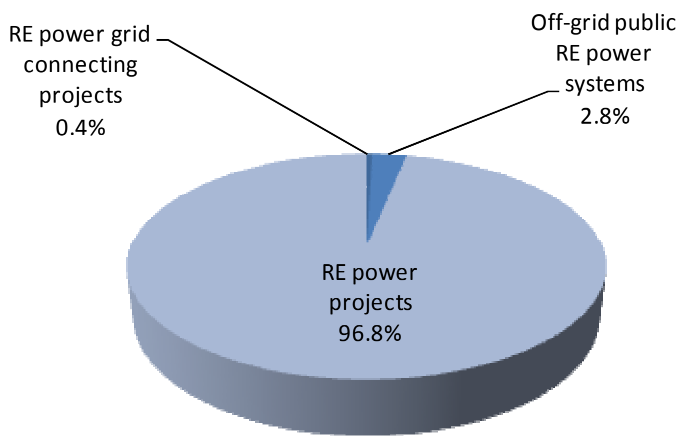
Source: NDRC.

Meanwhile, prices for solar, ocean, and geothermal power projects are determined by the government and are based on the principle of cost plus reasonable profits.

The cost difference between on-grid renewable power and power from on-grid desulfurized coal plants is compensated for by levying an additional surcharge on electricity end users at the national level. This surcharge also subsidizes off-grid public renewable energy power systems and also subsidies grid interlinks for renewable energy projects, until a rational T&D pricing mechanism is established. Again, it is important to note that for all renewable power projects approved after 2010, the amount of subsidy provided per kilowatt-hour generated will decrease at an annual rate of 2 percent.

This Renewable Energy Power Surcharge is and will continue to be included in power companies' retail electricity prices. In June 2006, the government raised retail power prices by 0.01 yuan/kWh to fund the renewable energy subsidies. In 2006, a total of RMB 260 million yuan was levied through this Renewable Energy Surcharge. Thirty eight power projects with 14.14 GW of capacity, 5 off-grid public renewable energy power systems, and 5 renewable energy power grid connection projects were subsidized by the surcharges.

Figure 5-20 Allocation of RE Surcharge in 2006



Source: SERC.

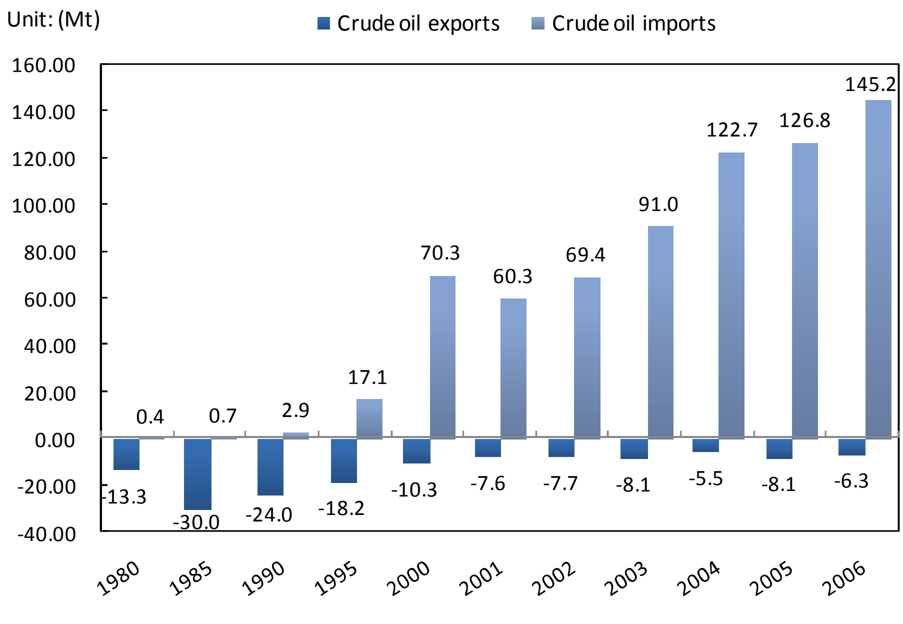
[1] These higher prices were restricted within certain ranges of planned prices.
[2] The eight major coal producing provinces are Shanxi, Inner Mongolia, Heilongjiang, Anhui, Shandong, Henan, Guizhou and Shaanxi.
[3] Due to the complexity of the coal distribution chain, water freight contract prices for coal increased from 40-50 yuan per ton before 2007 to 70-100 yuan per ton in 2008.
[4] *State Council Notice on Implementation of Oil Product Prices and Taxes Reform*, December 2008, NDRC, http://www.gov.cn/zwgk/2008-12/19/content_1182128.htm. *Administration Measurement of Oil Prices*, May 2009, NDRC, http://www.ndrc.gov.cn/zcfb/zcfbtz/2009tz/t20090508_277522.htm.
[5] Zeng, M. (1999), *Theory of the Electricity Market and Its Application*, Beijing: China Electric Power Publishing, p.138.
[6] The price setting for domestic joint venture power producers is: (operating cost + profits + tax)/power generation.
[7] Zeng, M. (1999), *Theory of the Electricity Market and Its Application*, Beijing: China Electric Power Publishing, p.141-143.
[8] Same as Note 7.
[9] Asia Pacific Energy Research Center & Institute of Energy Economics Japan (2009), *Understand Energy in China*, Tokyo: Asia Pacific Energy Research Center & Institute of Energy Economics Japan.
[10] Stern, J. and J. R. Davis (1998), "Economic Reform of the Electricity Industries of Central and Eastern Europe," *Economics of Transition*, Vol.6, pp.443.
[11] Johnson, T. (1995), "Development of China's Energy Sector: Reform, Efficiency, and Environmental Impacts," *Oxford Review of Economic Policy*, Vol.11, p.126.
[12] Nakajima, S. (1993), "Price Reforms in China," *China Newsletter*, Tokyo: JETRO, No.102, pp.6-15.

Chapter 6 Energy Imports and Exports

1. Oil and Oil Products

With dynamic domestic economic growth, limited crude oil resources and the late development of domestic oil fields, China's dependence on foreign oil has gradually increased since 1990. In 1993, total imports of petroleum surpassed exports by 9.7 million tons, making China a net oil importer for the first time. In 2004, China's crude oil imports exceeded 100 million tons at 122.7 million tons for the first time with imports hitting a record high of 145.2 million tons in 2006, which was an increase of 14.5% from the previous year or an average increase rate of 25.9% per annum between 1980 and 2006. Share of imported crude oil in total crude oil supply increased from 0.4% in 1980 to 45% in 2006. Meanwhile, crude oil exports have dropped constantly since 1985 as shown in Figure 6-1.

Figure 6-1 Crude Oil Imports and Exports (1980-2006)

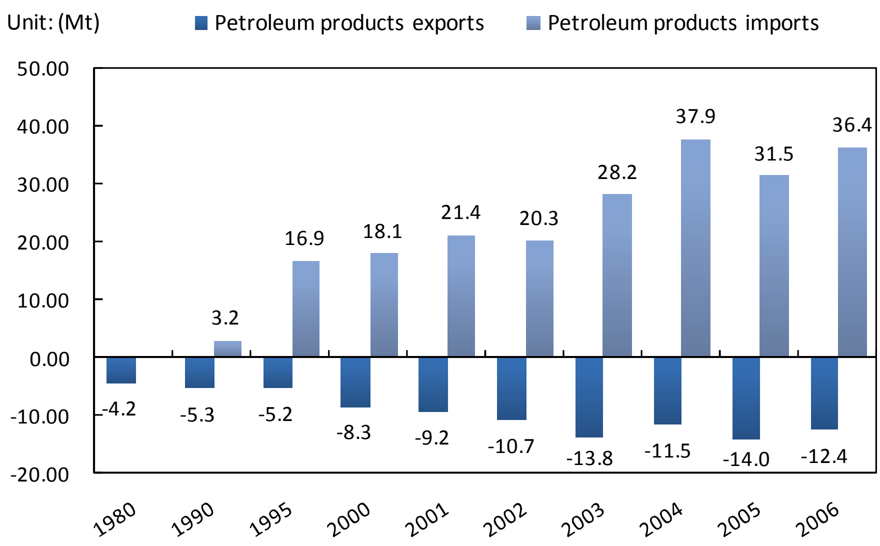


Source: *China Energy Databook, V.7.0.*, Table 7A.1.1..

Imports of petroleum products increased from 0.07 million tons in 1985 to a record high of 37.9 million tons in 2004, dropping slightly to 36.4 million tons in 2006 with an average rate of increase of 34.8% per annum. Exports increased about 3 times from 4.2 million tons in 1980 to 12.4 million tons in 2006 (Figure

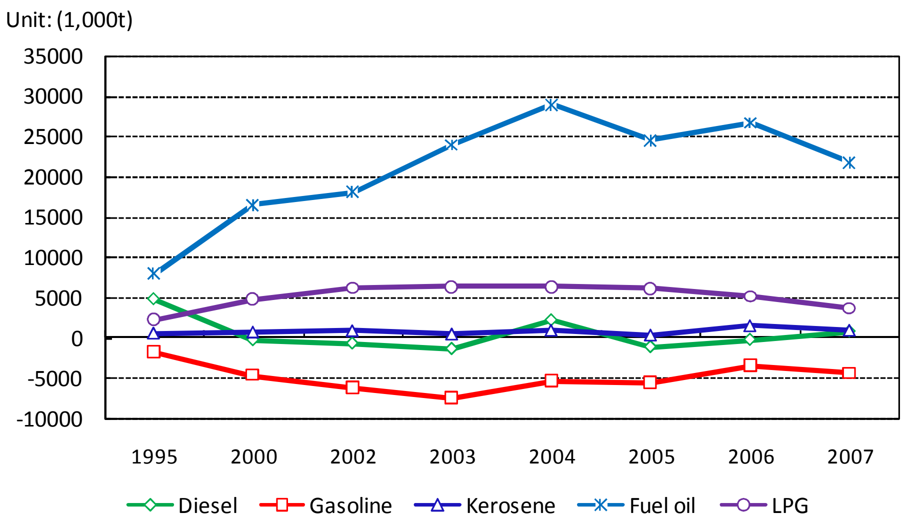
6-2). Generally, fuel oil is the largest component of imports, while gasoline and kerosene are the major components of exports. However, the net volume of exported gasoline has decreased and the net volume of imported kerosene has increased since 2003 (Figure 6-3).

Figure 6-2 Petroleum Products Imports and Exports (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 7A.1.1..

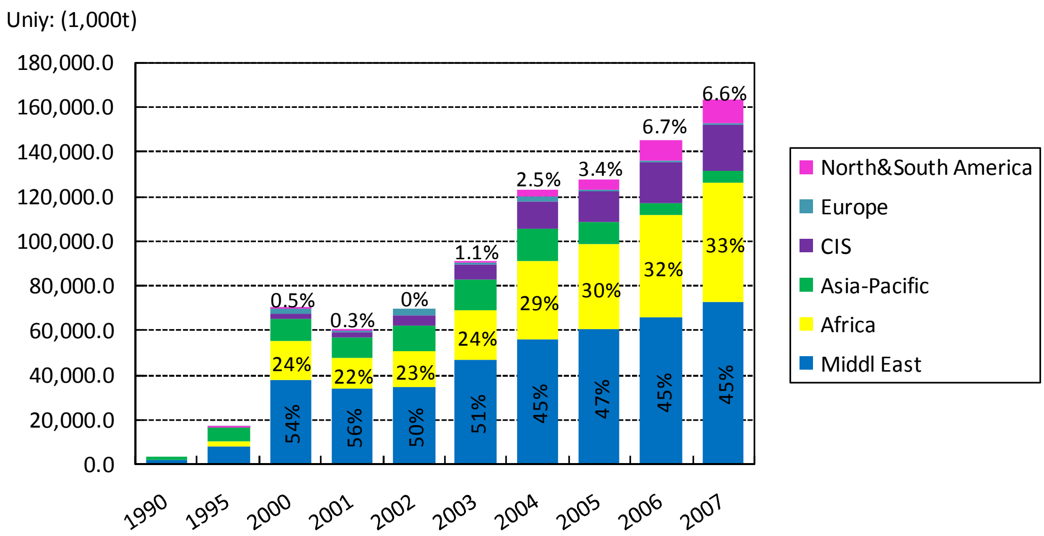
Figure 6-3 Net Import of Petroleum Products (1995-2007)



Note: Data in positive values indicate net imports.
Source: National Bureau of Statistic of China, *China Energy Statistical Yearbook 2008*.

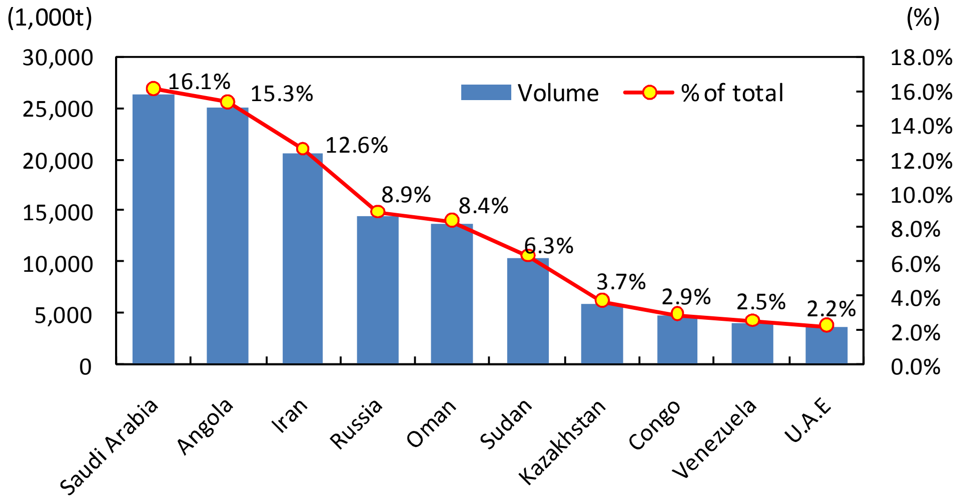
Although the Middle East has become the largest region exporting crude oil to China since 1993, the share of total imports originating in South America and Africa has increased significantly as China increasingly invests in the two regions (Figure 6-4). In 2007, Saudi Arabia was the largest exporter of crude oil to China, followed by Angola, Iran, Russia, and others as shown in Figure 6-5.

Figure 6-4 Crude Oil Imports by Source (1990-2007)



Source: *China Energy Databook, V.7.0.*, Table 7B.5., and *China Oil, Gas and Petrochemicals*, February 1, 2008.

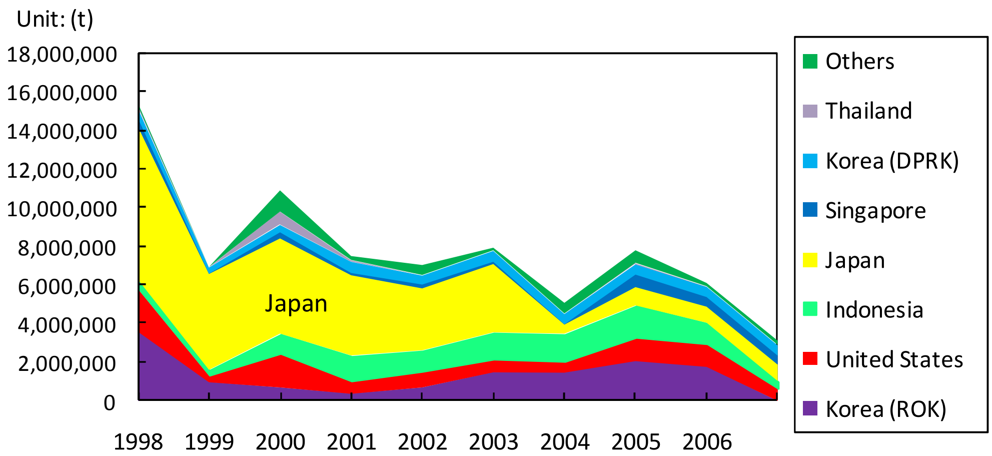
Figure 6-5 Top Ten Crude Oil Imports by Source (2007)



Source: Same as Figure 6-4.

Currently, China is still exporting a small quantity of crude oil mainly to abide by its long-term trade agreements with other countries such as Japan[1]. Up until 2003, nearly half of China's exported crude oil went to Japan; however, the volume dropped significantly in 2004, due to the decline in production at the Daqing oil field and the Chinese government's new policy on export tax rebates as discussed below[2] (Figure 6-6).

Figure 6-6 Crude Oil Exports by Destination (1998-2007)

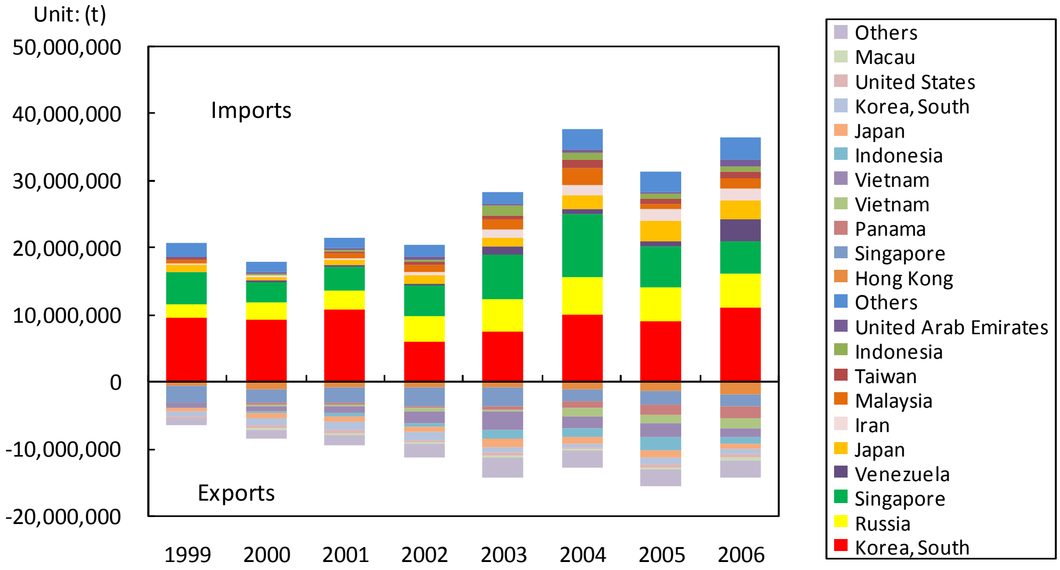


Source: Same as Figure 6-4.

China trade in oil products with more than 50 countries and oil product exports are mainly related to processing. Major sources of imports are the Republic of Korea, ASEAN (Association of South-East Asian Nations) members and Russia, while leading target markets for exports are ASEAN members (Figure 6-7).

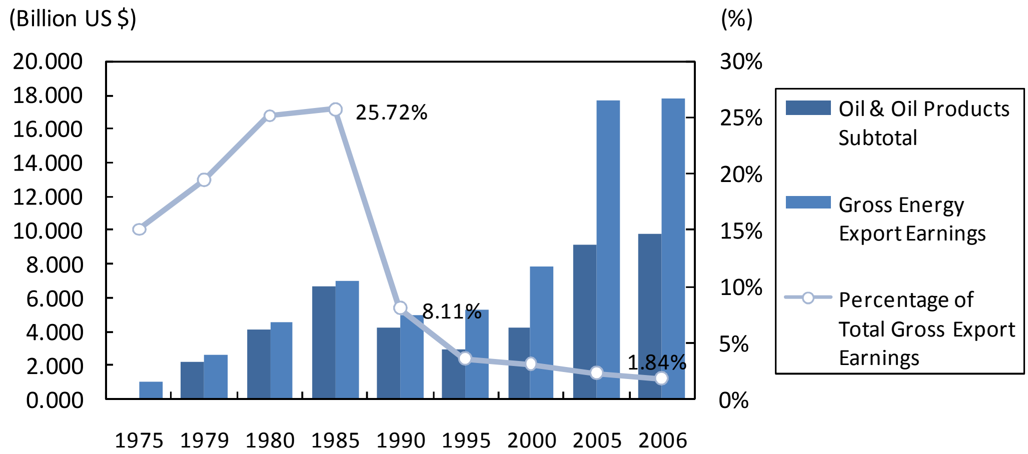
Before the 1990s, crude oil exports had been a key source of foreign exchange earnings. At the time 26% of gross export earnings came from energy products; oil and oil products accounted for about 90% of total energy export earnings (Figure 6-8). However, with increasing amounts of oil demanded for economic development, oil imports have been continuously expanded and imports of oil products, together with other fuels have become the biggest source of outgoing foreign exchange and have somewhat offset China's huge trade surpluses.

Figure 6-7 Oil Products Imports and Exports (1999-2006)



Source: *China Energy Databook, V.7.0.*, Table 7B.6.

Figure 6-8 Oil and Oil Products Exports Earnings (1975-2006)



Source: *China Energy Databook, V.7.0.*, Table 7B.3.

In order to appropriately limit exports of energy resources and encourage energy resource imports, the government has also adjusted export and import tax policies for different types of energy products[3]. In January 2004, China abolished export tax rebates for both crude oil and refined oil exports, except gasoline. The export tax rebate for gasoline was reduced from 13% to 11% at the same time, and abolished completely in September 2005. In January 2007, China reduced import value-added taxes of oil products from a range of 3% to 6% to a range of 0% to 3%, and started to levy a 5% export tax on crude oil at the same time (Table 6-1).

Table 6-1 China's Oil Import and Export Tax Policy

Year	Tax rebate on exports	
	Crude Oil	Oil Products
Jan-04	Export tax rebate reduced from 13% to 0%	·Export tax rebate reduced from 13% to 0% except Gasoline ·Export tax rebate for Gasoline reduced from 13% to 11%
Sep-05	-	Export tax rebate for gasoline was ceased
Year	**Tax on exports**	
	Crude Oil	**Oil Products**
Jan-07	Export tax for crude oil increased from 0% to 5%	-

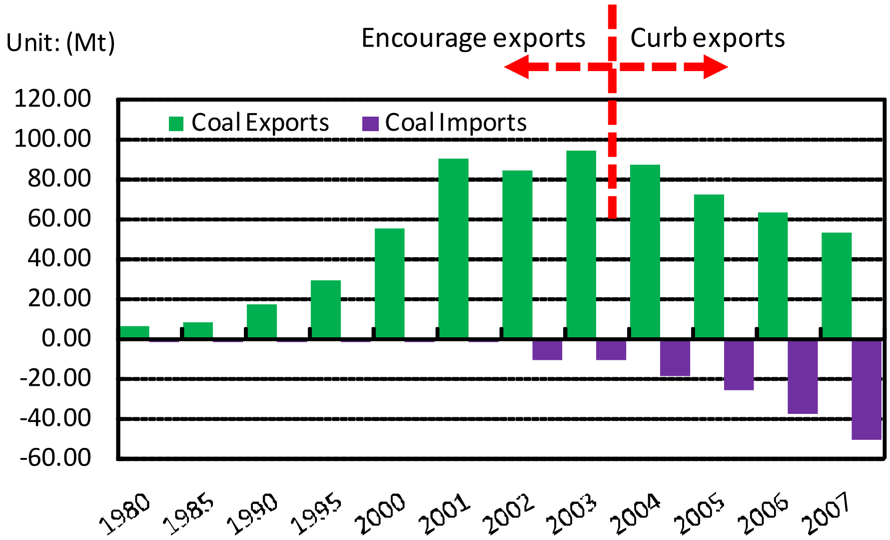
Year	Value-added tax on import	
	Crude Oil	Oil Products
Jan-07	-	Value-added import tax reduced from a 3% to 6% range to a 0% to 3% range

Source: Ministry of Finance, China.

2. Coal and Coal Products

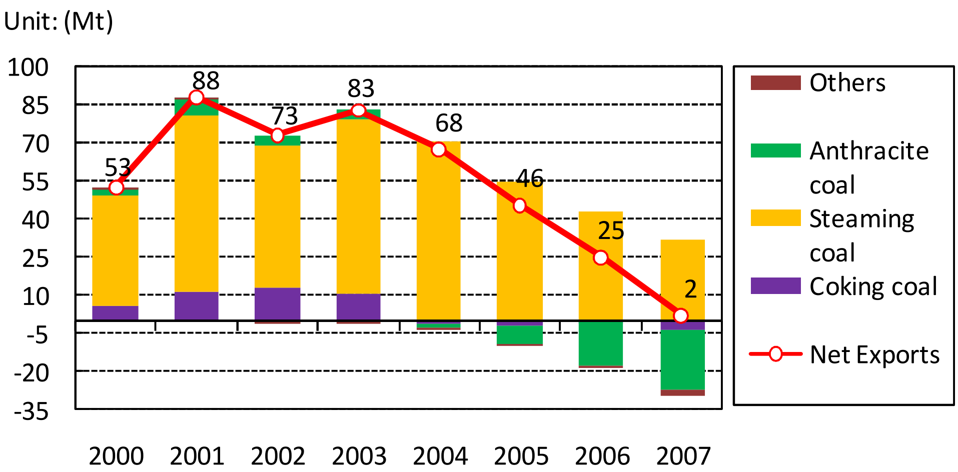
China has a long history of exporting coal, dating back to 1950. From 1960 up until 2001, coal imports ranged between 1 million tons and 2.5 million tons per year. Exports jumped from 2.12 million tons in 1960 to 90.12 million tons over the same period. However, this modern trend (stable imports, increasing exports) has fluctuated substantially since 2002. After coal exports hit a record high of 93.93 million tons in 2003, they dropped sharply by about 10 million tons per year to 53.17 million tons in 2007 due to the tight domestic demand and supply situation. Meanwhile, coal imports increased almost five times from 10.76 million tons in 2003 to 51 million tons in 2007 as international coal prices became more affordable for domestic users, especially for power companies (Figure 6-9). In 2007, net exports declined by 23 million tons from the previous year to 2.16 million tons. Generally, steaming coal is the major exported coal product and anthracite coal is the major imported coal product. In 2004, China became a net importer of both anthracite coal and coking coal, while remaining a net steaming coal exporter, although the volume of exports has been gradually cut to less than half of the 2003 peak since then.

Figure 6-9 Coal Imports and Exports (1980-2007)



Source: *China Energy Databook, V.7.0.*, Table 7B.1., and Sagawa, A. and K. Kizumi (2008), *Trends of Exports and Imports of Coal by China and Its Influence on Asian Markets*, IEEJ.

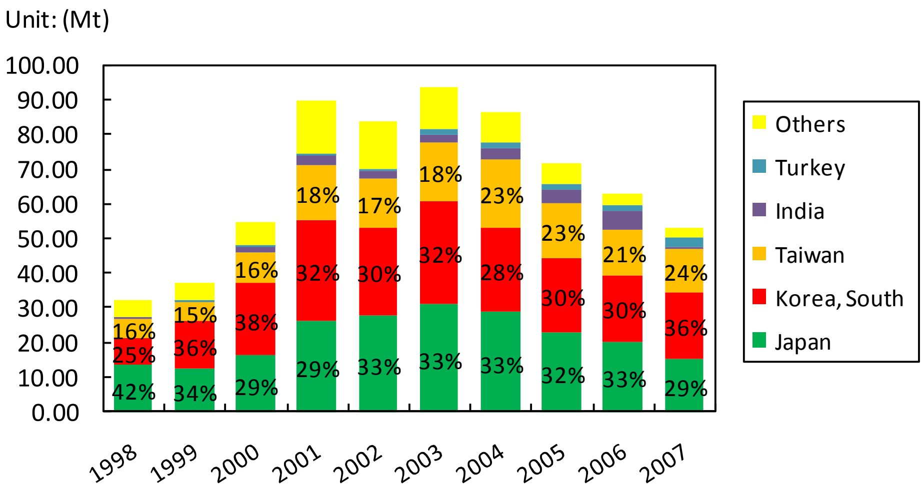
Figure 6-10 Coal Net Exports (2000-2007)



Source: Sagawa, A. and K. Kizumi.

Most of China's coal exports go to East Asian countries, of which, Japan has been the most important buyer, followed by South Korea and Taiwan. Overall exports to those countries declined in line with China's total coal exports in 2004. In contrast to the declining share of exports to Japan, the share of South Korea has remained at 30%, while the share exported to Taiwan has increased from 16% in 1998 to 24% in 2007 (Figure 6-11).

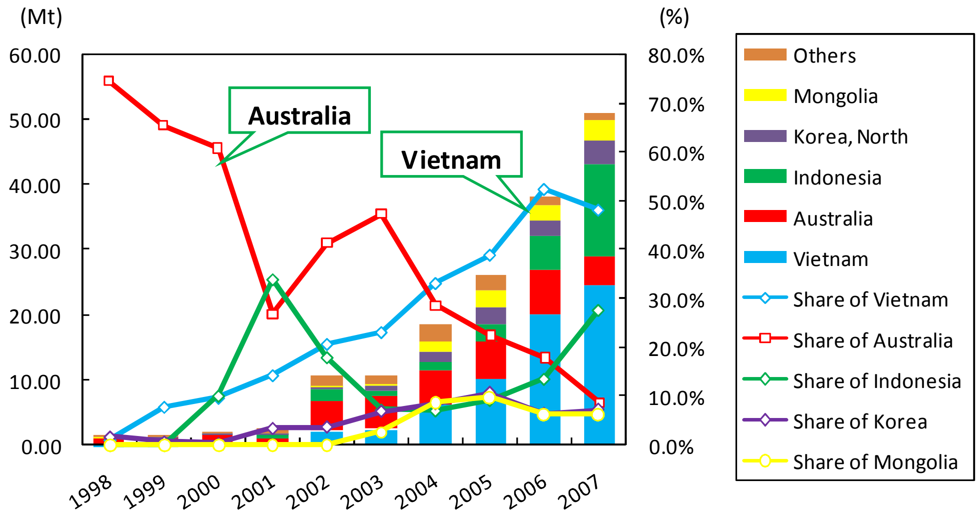
Figure 6-11 Coal Exports by Destination (1998-2007)



Source: Same as Figure 6-9.

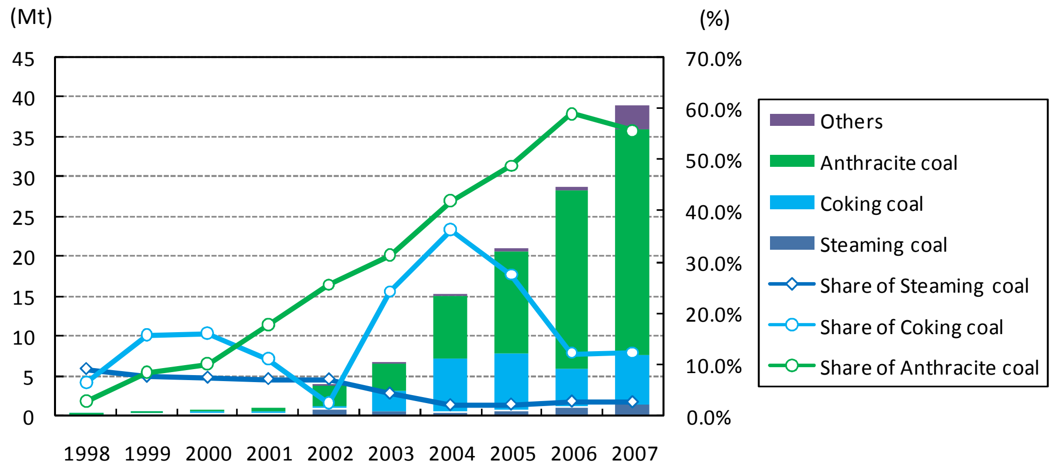
China's coal imports generally come from Australia, Vietnam, Indonesia, Mongolia, North Korea, Russia and Canada. Although the volume of coal imports from major supplying countries has increased, the share from Australia has dropped from its peak high of 74.6% in 1998 to only 8.9% in 2007, while the shares from Vietnam and Indonesia have increased sharply over the same period (Figure 6-12). The share of anthracite coal in total coal imports has increased markedly since 1998. Although the volume of imported steaming coal has increased, its share has declined. Coking coal, both in terms of volume and share of total imports, shows sharp fluctuation over the same period (Figure 6-13). Generally, anthracite coal imports come from Vietnam and North Korea, steaming coal comes from Australia and Indonesia, and coking coal is mainly imported from Australia and Mongolia.

Figure 6-12 Coal Imports by Source (1998-2007)



Source: Same as Figure 6-9.

Figure 6-13 Coal Imports by Type of Coal (1998-2007)



Source: Same as Figure 6-9.

The Chinese government encouraged coal exports during the period between 1998 and 2003. However, after being faced with a domestic shortage in 2003, the government implemented the *Coal Export Allotment Control Law* in July 2004 in order to adjust export volumes depending on domestic demand and supply needs. Since then, the annual coal export volume has been announced and regulated through licensing by the government based upon this law. Table 6-2 illustrates that the government has decreased allowed coal export volumes since 2004, and the actual volume of coal exports by licensed coal exporters has evened out under the government-controlled system since 2005.

Table 6-2 Volume of Coal Export Licenses and Actual Exports (2004-2008) (Unit: 1,000 tons)

Year	Volume of export permit			Result			Difference		
	Steaming coal	Coking coal	Total	Steaming coal	Coking coal	Total	Steaming coal	Coking coal	Total
2004	74,300	5,700	80,000	80,920	5690	86,610	-6,620	10	-6,610
2005	73,970	6,030	80,000	66,460	5260	71,720	7,510	770	8,280
2006	n.a.	n.a.	80,000	58,930	4370	63,300	n.a.	n.a.	16,700
2007	64,000	6,000	70,000	50,630	2540	53,170	13,370	3,460	16,830
2008	48,400	4,600	53,000	41,980	3460	45,430	6420	1,140	7,570

Source: Sagawa, A. and K. Koizumi.

Coal as an energy product is not exempted from to the government's policy changes on energy exports and imports. Tax rebates for coal exports were gradually reduced from 2004 and were completely abolished in 2006. In addition, the government levied an export tax of 5% on coking coal in November 2006 and increased this to 10% in August 2008. Meanwhile, taxes on imported coal were gradually reduced and finally abolished in 2007.

Table 6-3 Tax Policy Changed for Coal Imports and Exports

Year	Tax rebate on coal exports	
	Coking coal	Steaming coal, Anthracite coal, others
1-Jan-04	13% → 5%	13% → 11%
24-May-04	5% → 0%	-
1-May-05	-	11% → 8%
15-Sep-06	-	8% → 0%

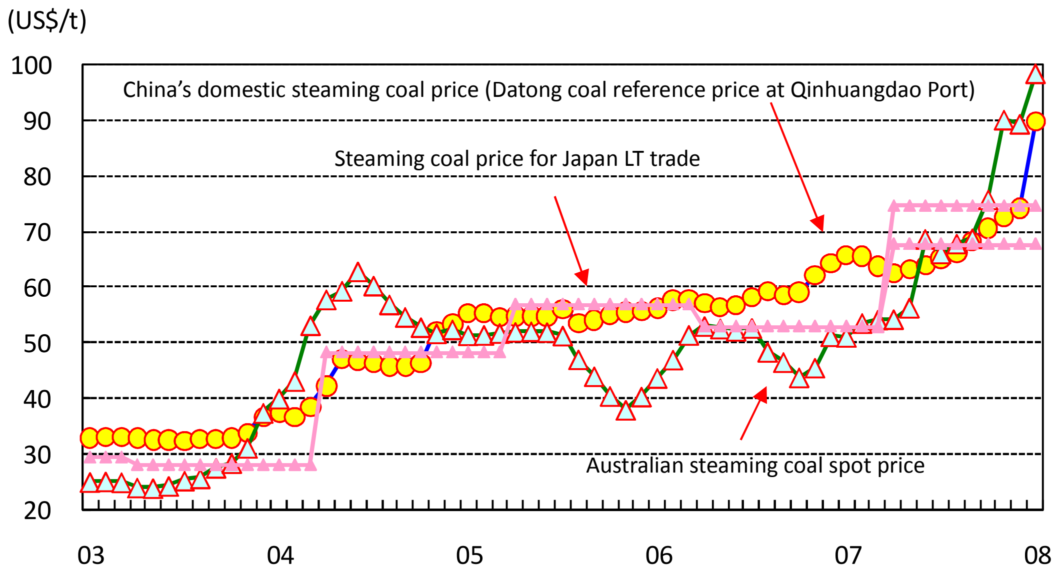
Year	Tax on coal exports	
	Coking coal	Steaming coal, Anthracite coal, others
1-Nov-06	0% → 5%	-
20-Aug-08	5% →10%	0% → 10%

Year	Value-added tax on coal imports			
	Staming coal	Coking coal	Anthracite coal	Others
1-Jan-05	-	6% → 3%	-	-
1-Apr-05	6% → 3%	-	-	-
1-Nov-06	3% → 1%	-	3% → 1%	5% → 1%
1-Jun-07	1% → 0%	-	1% → 0%	1% → 0%

Source: Sagawa, A. and K. Kizumi.

Higher domestic coal prices and the elimination of tax rebates on coal exports are the major reasons behind China's declining coal exports, while cheaper international coal prices and short domestic supply have driven major coal users to increasingly import coal. As Figure 6-14 shows, between late 2004 and May 2007, China's domestic steaming coal price was higher than that of international markets and this reduced the incentive to export coal and kept foreign buyers away. Meanwhile, imports soared to a record high with coal importers and major power companies taking advantage of the price differences between domestic and international steaming coal markets. However, China's exports have increased again after international prices surpassed the Chinese domestic price in the latter half of 2007, while import volume dropped as CIF prices increased.

Figure 6-14 Comparison of Coal Prices in China's Domestic Market and International Markets (2003-January 2008)



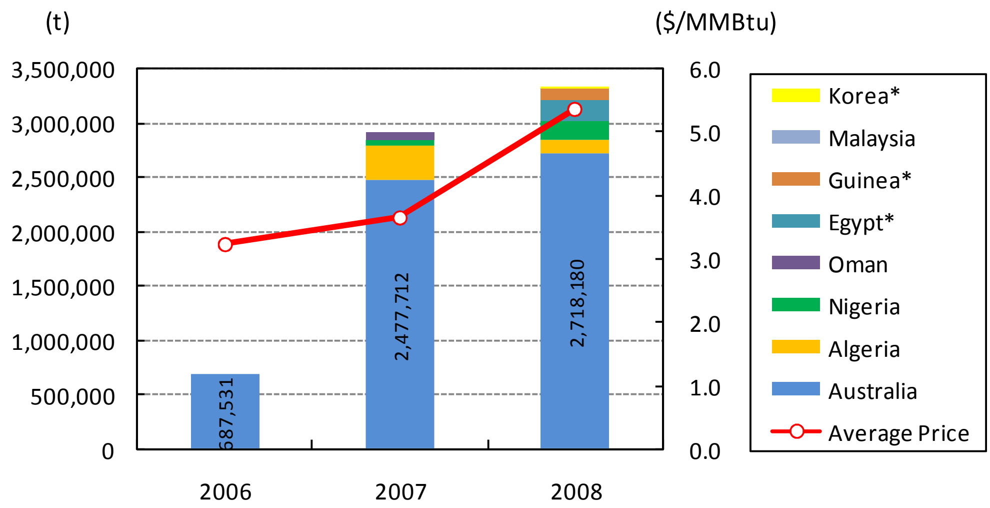
Source: Sagawa, A. and K. Kizumi.

It seems likely that the volume of China's coal exports will stay at their current level or even fall further mainly due to the government policy on restraining energy product exports. However, whether China will be a net coal importer in the near further will fundamentally be based on price differences between China's domestic market and the international market, that is, lower international coal prices drives China's increases in coal imports and vice versa.

3. Natural Gas

China did not start importing liquefied natural gas until June 2006 after the Dapeng (Guangdong Province) LNG terminal, China's first LNG project, went into operation. The terminal imports LNG from Australia under a long-term contract signed between CNOOC and the North West Shelf Australia LNG. Since then, LNG imports have increased year-on-year from 687,531 tons in 2006 to 3.3 million tons in 2008 including spot LNG imports. China has purchased spot LNG since April 2007 when CNOOC bought its first cargo from Oman at a spot price of US $8.4/MMBtu, but it temporarily halted spot purchases between December 2007 and April 2008 due to soaring prices in the European market. With increasing spot LNG purchases, the average LNG import price has increased from US $3.23/MMBtu in 2006 to $5.37/MMBtu in 2008 with an average increase rate of 28.9% per annum (Figure 6-15).

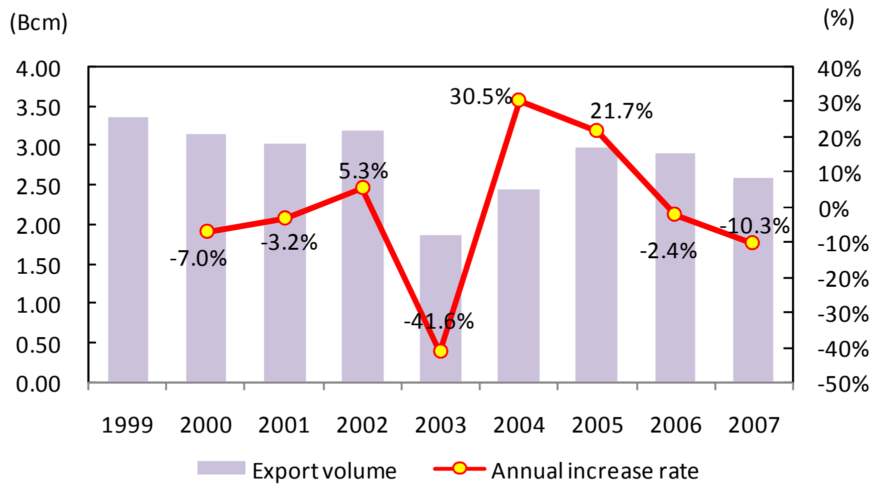
Figure 6-15 LNG Imports by Source (2006-2008)



Note: *are non LNG producer cargoes.
Source: TEX Report.

Although China is expected to start importing natural gas from central Asia through its first cross-country gas pipeline in 2010, the mainland has exported natural gas from the Yacheng 13-1 gas field in the South China Sea to Hong Kong since 1996. Natural gas exports dropped by 0.54 Bcm from 3.14 Bcm in 2000 to 2.6 Bcm in 2007 due to strong demand from the domestic market, specifically from Hainan Province (Figure 6-16).

Figure 6-16 Natural Gas Exports (2003-2008)



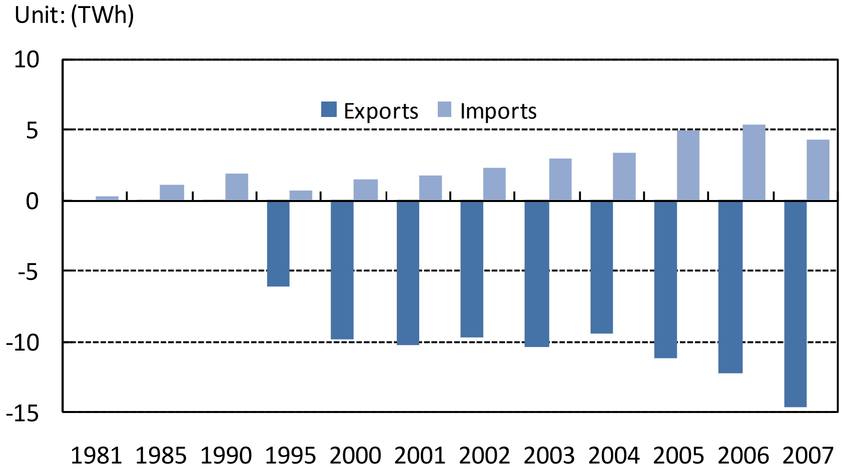
Source: *China Energy Databook, V.7.0.*, Table 7A.1.1., and *China Energy Statistical Yearbook 2008.*

4. Electricity

Despite a chronic domestic power shortage, China's power exports have increased significantly, especially since 2000, due to improvements in cross-border transmission networks. In 2007, China exported 14.57 TWh electricity to its neighboring countries, up by 2.3 TWh from the previous year. Most power exports are sold to Southeast Asian countries such as Vietnam, Myanmar, and Laos, and non-mainland Chinese territories, including Hong Kong and Macau. China also sells a small amount of electricity to its Northern neighbors, such as North Korea and Mongolia.

Meanwhile, China's electricity imports also increased steadily from 0.3 TWh in 1981 to 4.25 TWh in 2007. In addition to its role as a key provider of crude oil and natural gas, Russia has become China's crucial external supplier of electricity. Preparation for the expansion of electric power transfers from Russia's Far East region to China's north region has been underway since the State Grid Corporation of China signed an agreement with the Russian electricity monopoly Unified Energy System in April 2006.

Figure 6-17 Electricity Imports and Exports (1981-2007)

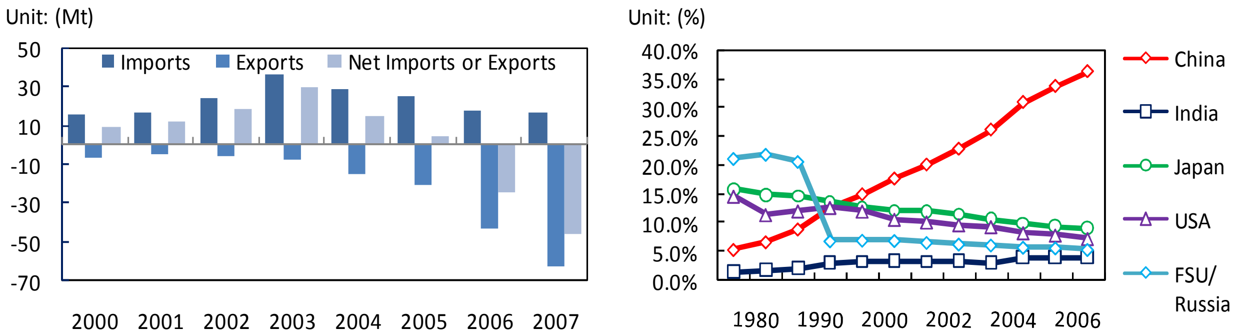


Source: *China Energy Databook, V.7.0.*, Table 7A.1.1., and *China Energy Statistical Yearbook 2008.*

5. Energy-intensive Products

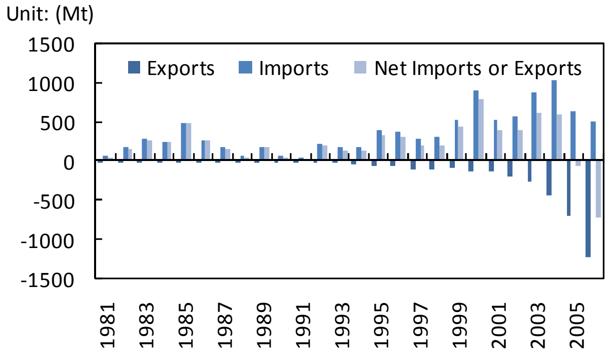
China's exports of energy intensive products have soared since 2000. In 2000, China imported 15.96 million tons of steel products, while exports were only 6.21 million tons. In 2006, steel product exports not only jumped by 36.8 million tons to 43.01 million tons, but China's share of global crude steel production increased from 15% to 36.4%, making China the world largest steel producer (Figure 6-18). A similar trend has emerged in the aluminum sector as well (Figure 6-19).

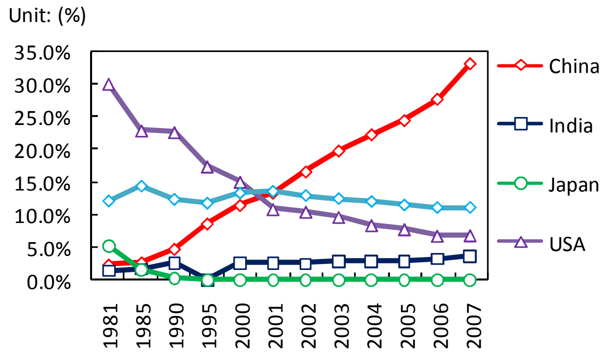
Figure 6-18 Steel Products Imports and Exports and Share of Global Crude Steel Production



Source: *China Energy Databook, V.7.0.*, Table 9B.13., and *China Energy Statistical Yearbook 2008.*

Figure 6-19 Rolled Aluminum Imports and Exports and Their Share of Global Primary Aluminum Production

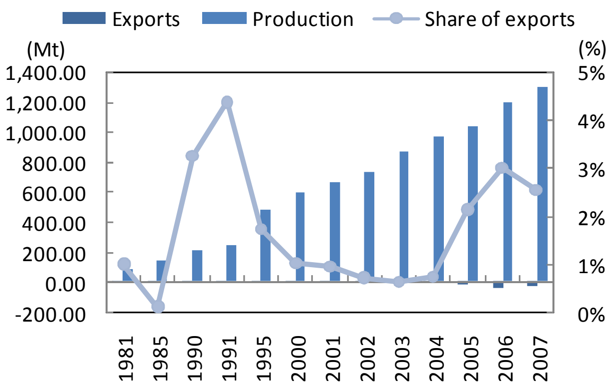


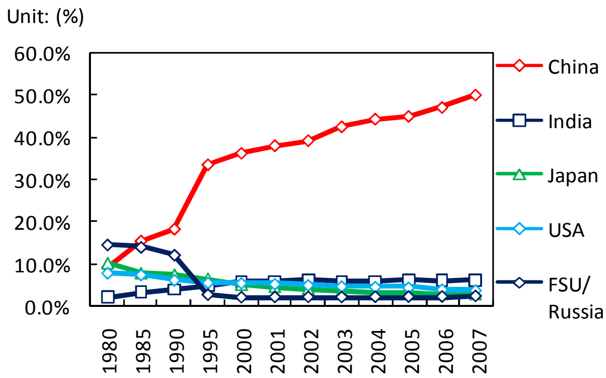


Source: Same as Figure 6-18.

In 2007, China produced 1,300 million tons of cement, which accounted for half of the world's cement production. Although cement exports only account for a small amount of total production (3% of China's total cement supply), the volume of exports has increased by more than 5 times since 2000 (Figure 6-20).

Figure 6-20 Cement Exports and Share of Global Cement Production





Source: Same as Figure 6-18.

To curb the country's soaring trade surplus and to preserve energy, China has adjusted its export and import tariffs on energy-intensive, high-polluting and resource-rich products as well. In April 2007, China scrapped export tax rebates on a number of steel products and substantially lowered export tax rebates on more than 70 other steel products. In June 2007, China increased export tariffs on primary steel products, including steel billets, steel ingots and pig iron, from 10 to 15 percent. In addition, 10 percent export tariffs were imposed on a range of commodities including natural graphite, rare earth metals, refined lead, dysprosium oxide, terbium oxide, and waste and scraps of certain non-ferrous metals. Five to fifteen percent export tariffs were levied on products including ammonium metatungstate, molybdenum oxide, ammonium molybdate, sodium molybdate, magnesite and burned magnesia. Export tariffs were raised from 10 percent to 15 percent on raw ores of nickel, chrome, tungsten, manganese, molybdenum, and from 5-10 percent to 10-15 percent on coal tar, certain ferroalloys, unwrought zinc, fluorites and non-coniferous wood chips. In July 2009, the NDRC announced regulations designed to cut costs of raw material imports by subsidizing interest on loans used for import purchases. The imports covered by the favorable loan program include concentrates and ores of metals such as copper, nickel, zinc, uranium and chromium, as well as clean energy equipment such as solar and nuclear power components.

There is no doubt that China will increase its influence on the global energy market due to constantly growing energy consumption. Having quickly and dramatically shifted from a net energy products exporter to the world's largest energy importer, China is in a dilemma. Its unpredictable energy imports have caused volatility in the international energy commodities markets as well as in upstream energy investments, and severe fluctuations in world energy prices have forced China to raise its domestic energy prices, which the government has been reluctant to do. The correlation between the international energy markets and China's domestic energy market has become stronger due to a number of interrelated factors: the need to reduce the extent to which negative influences impact both sides; the international demand for China to be more transparent on its energy policies including energy pricing, the international demand for China to complement and publish energy data such as oil and coal inventory data; and the international demand for China to be more cooperative with international energy bodies such as the International Energy Association.

[1] In 1962, China and Japan signed the *Memorandum on Comprehensive Trade*, which is also referred as LT Trade from the initials of its signatories, the then Chinese Premier Zhou Enlai and the former Japanese minister of International Trade and Industry Tatsunosuke Takasaki.

[2] China started to export Daqing crude to Japan since 1978 under a long-term government-to-government agreement to promote bilateral trade.

[3] China levies value-added tax on most products, but refunds varying amounts of that tax on goods that are exported. The government usually adjusts the size of export tax rebates for different types of goods when it is trying to encourage or discourage growth in particular industries.

Chapter 7 Energy and Environment

China's rapid economic growth has had benefits and costs for both the Chinese people and the wider international community. While this growth has provided something of an engine for the growth of economies across the globe, rapid industrialization in China has meant increased pollution, smog, and the degradation of natural resources, and these environmental consequences are felt at home and abroad. The country's polluted environment is in large part a result of the large increase in its consumption of fossil fuels, primarily the inefficient combustion of coal.

Nevertheless, the Chinese government has made remarkable efforts to improve its deteriorating environment. The government has expanded its monetary support for energy efficiency and environmental protection since 2006. In the 11th Five-year Plan, the government aimed to reduce total emissions by 10% by 2010 and to bring China's energy efficiency up by 20% in the same period. As part of its 4,000 billion yuan economic stimulus package of November 2008, the government plans to enhance sewage and rubbish treatment facilities and prevent water pollution, accelerate green belt and natural forest planting programs and increase energy conservation initiatives and pollution control projects[1].

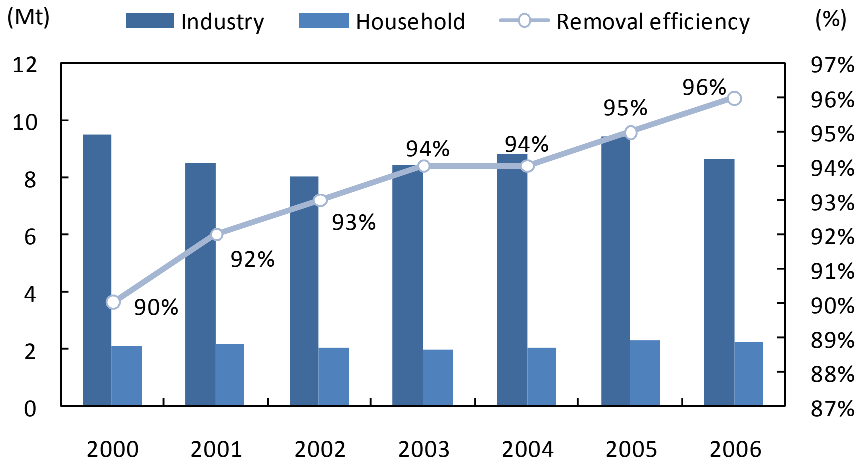
1. Particulate Emissions

Particulate emissions in China remained relatively unchanged between 1980 and 1998, and have gradually fallen since 1999, despite steadily increasing coal consumption. Improved system controls in the industrial sector have resulted in a wider penetration of particulate abatement systems and consequently, particulate removal efficiency on average has increased steadily from 90% in 2000 to 96% in 2006.

Generally, about 80% of China's particulate emissions come from industry, particularly the power, cement and building sectors, while non-industrial users, mainly households, still account for about one-quarter of total emissions.

Geographically, those regions with concentrated industries and a cold winter season have high particulate emissions densities. Shanghai has the highest levels of particulate emissions in the country, followed by Beijing and Tianjin.

Figure 7-1 Particulate Emissions by Sector and Total Removal Efficiency (2000-2006)



Source: *China Energy Databook, V.7.0.*, Table 8B.2., and *China Statistical Yearbook of Environment 2007.*

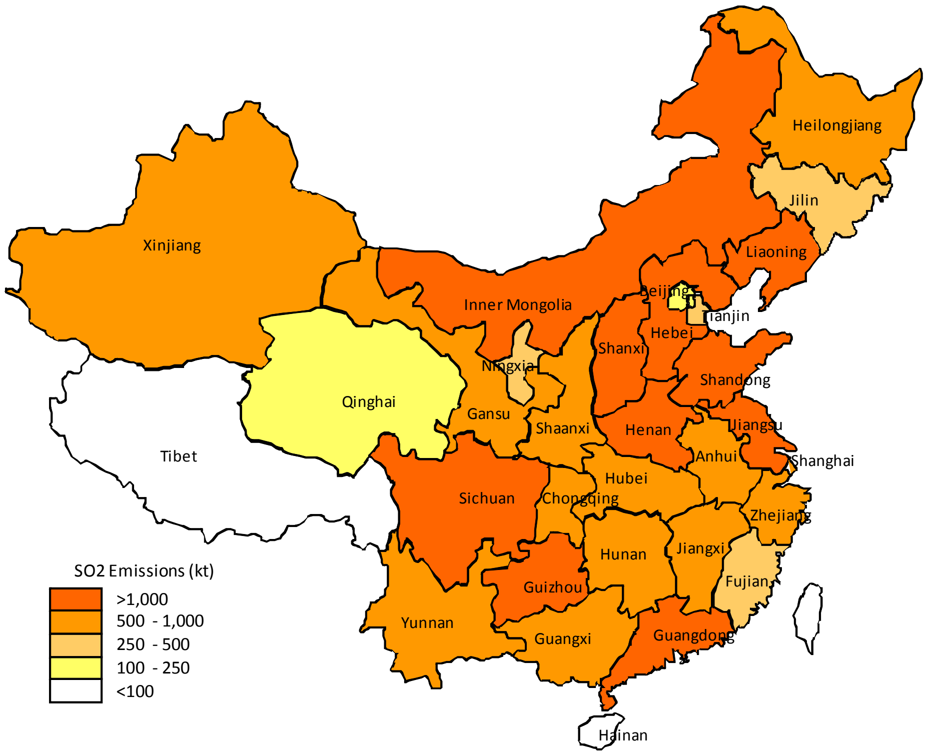
2. Sulfur Dioxide Emissions

In contrast to particulate emissions, SO_2 emissions have increased roughly parallel to massive increases in coal consumption. In 2006, SO_2 emissions reached 25.89 million tons, up by 9.49 million tons from the 1980 figure. More than half of this increase came from electricity sector emissions.

The northern half of China is the country's largest source of SO_2 emissions, followed by the eastern region and Guangdong Province, where high-sulfur coals are more common (Figure 7-2). Although Shanghai's SO_2 emissions are far below the national average level, the Municipality has the highest sulfur dioxide emissions density, followed by the Municipality of Tianjin (Figure 7-3).

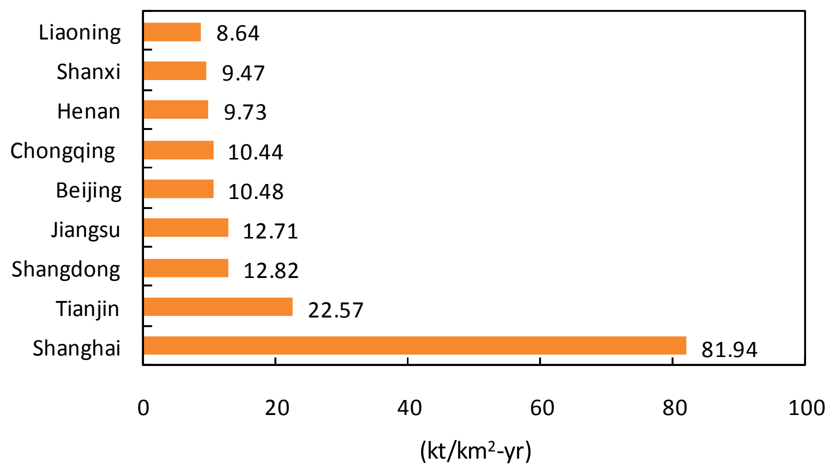
Despite SO_2 emission increases, the average efficiency of SO_2 removal has steadily improved since 2000, and the speed of improvement has even accelerated since 2006 due to the promotion of flue gas desulphurization (FGD) equipment installations in the largest source of China's SO2 emissions: the power sector. The country's total SO2 removal efficiency jumped 14% from 22% in 2000 to 36% in 2006.

Figure 7-2 SO2 Emissions by Province (2006)



Source: *China Statistical Yearbook of Environment, 2007.*

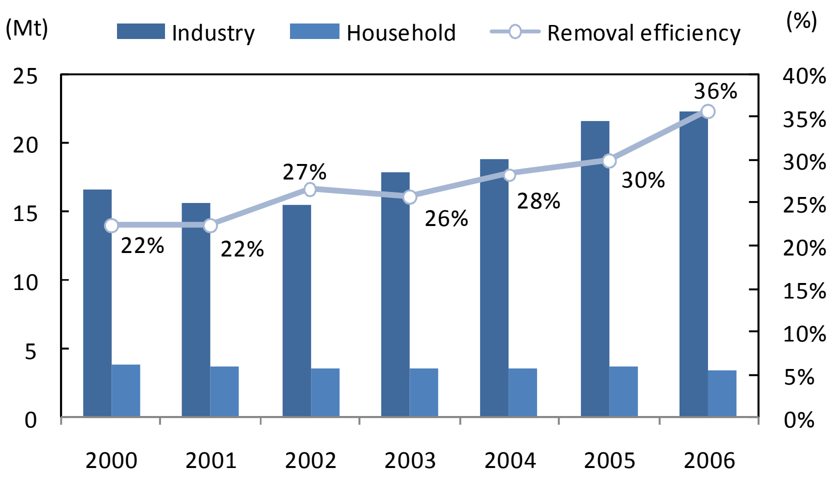
Figure 7-3 Top Ten High SO2 Emissions Density Cities (2006)



Source: Same as Figure 7-2.

China's first limestone-gypsum wet FGD device, operated by Huaneng Group, went into operation in 1991, however, FGD devices did not become widely installed until the government strengthened its efforts to control SO2 emissions by implementing strict regulations during the 11th Five-year Plan Period beginning in 2006. All new coal-fired power plants built from 2006 onward are required to install FGD equipment and dust removal facilities. To control SO2 emissions from existing coal-fired power plants, in March 2007, the government issued the *11th Five-Year Plan for SO2 Pollution Control of Existing Coal-fired Power Plants* which required existing coal-fired power units to cut their SO2 emission by 61.4% compared to 2005 levels, and to install FGD units with a total capacity of 1.37 GW by 2010. To achieve these targets, the government specified 221 major projects, of which, the State Grid and the five state-owned power groups account for 55.9%, and local government-owned and other power companies account for 44.1% of total projects, as shown in Table 7-1.

Figure 7-4 SO2 Emissions by Sector and Total Removal Efficiency (2000-2006)



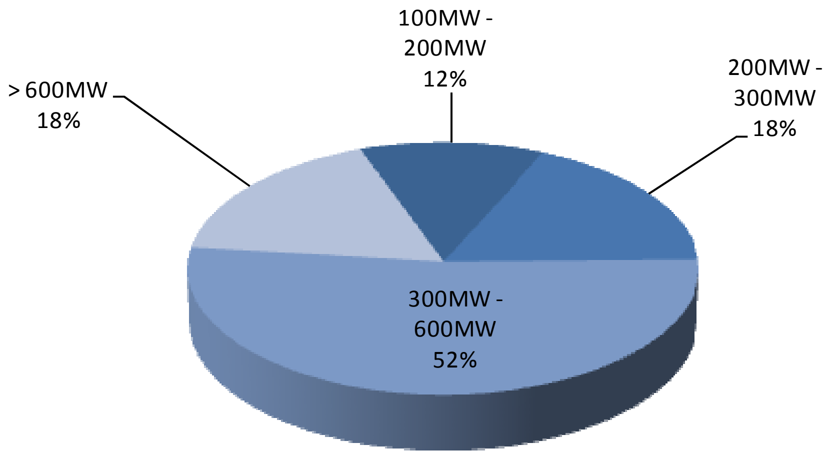
Source: *China Energy Databook, V.7.0.*, Table 8B.2., and *China Environment Yearbook 2007*.

Table 7-1 Major SO2 Projects for Existing Coal-fired Power Plants by Generator (2006-2010)

Power generator	2006	2007	2008	2009	2010	Total	% of total
State Grid	2.24	1.84	2.47	0.82	0	7.37	5.4%
Huaneng	7.80	3.09	5.03	1.70	0	17.62	12.9%
Datang	9.78	4.34	2.47	1.53	0	18.12	13.3%
Huadian	5.57	0.96	1.82	0.99	0	9.34	6.8%
Guodian	5.17	3.12	1.67	3.60	0	13.56	9.9%
China Power Investment	4.78	3.03	1.52	1.00	0	10.33	7.6%
Local power companies and others	22.27	21.09	13.77	3.14	0	60.27	44.1%
Total	57.61	37.47	28.75	12.78	0	136.61	100%

Source: The "11th Five-year Plan for SO2 Pollution Control of Existing Coal-fired Power Plants", March 2007, NDRC and Ministry of Environmental Protection.

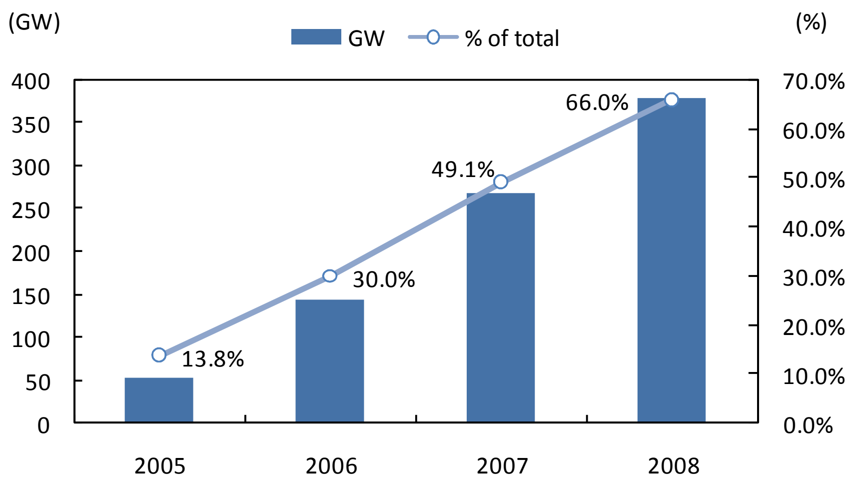
Figure 7-5 Major SO2 Projects for Existing Coal-fired Power Plants by Capacity



Source: Same as Table 7-1.

In addition, new economic incentives have prompted the power companies to invest in FGD devices. Electricity generated by power plants with FGD systems is sold at higher prices (the region's on-grid benchmark price plus an additional 0.015 yuan/kWh) to offset operating costs, and these plants are given grid feed-in priority over coal-fired plants without FGD systems[2]. As a result, the power sector's FGD capacity jumped from 5.3 GW in 2005 to 37.9 GW in 2008 with an average rate of increase of 92.7% per annum and consequently, the share of FGD-installed capacity increased significantly from 13.8% of total installed coal-fired capacity in 2005 to 66% in 2008, a 52.2% increase over the period.

Figure 7-6 FGD Capacity and Its Share (2005-2008)



Source: China Electricity Council and SERC.

However, to ensure the appropriate operation of FGD installed power plants the government needs to further enhance its regulation and monitoring systems regarding power generators and their environmental reports so as to prevent electricity generators from selling their power at higher prices without running their FGD systems.

3. Carbon Dioxide

According to the Carbon Dioxide Information Analysis Center of the Department of Energy of the United States (CDIAC), in 2006, China surpassed the United States as the world's largest CO2 emitter, due mainly to growing fossil-fuel use and cement production (Table 7-2). China's 1,665 million tons of carbon accounted for 20.2% of worldwide emissions in 2006, a jump of 11.6% from China's 1990 share of world totals. From 1980 to 2006, China's CO2 emissions grew at an annual rate of 5.5%; however, the increase rate between 2000 and 2006 was remarkable at an average of 9% per annum.

Coal combustion is the largest contributor to China's CO_2 emissions, accounting for 72.9% in 2006, followed by liquid fuel-related emissions, which accounted for 15.7% in the same year. The share of emissions from cement production increased by 7.2% from 2.6% in 1980 to 9.8% of total domestic CO_2 emissions in 2006 (Figure 7-7).

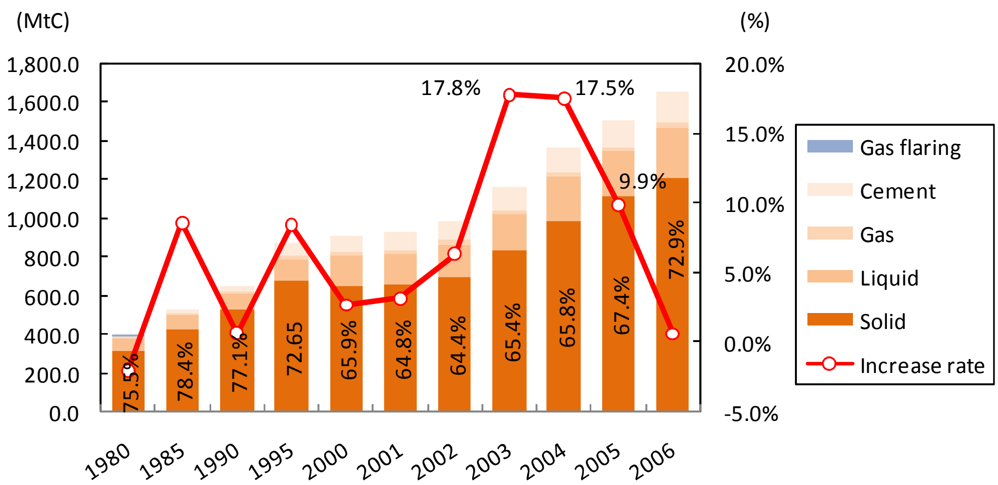
Per capita emissions increased steadily from 0.41 metric tons of carbon in 1980 to 1.27 metric tons of carbon in 2006 with an average rate of increase of 4.4% per annum (Figure 7-8). In 2006, China's per capita emissions (1.27 metric tons of carbon) exceeded the world average rate (1.25 metric tons of carbon) for the first time (Figure 7-9).

Table 7-2 Top 20 Emitting Countries by Total Fossil-Fuel CO_2 Emissions for 2006

Rank	Nation	2006 (Million tons of carbon)	% of total
1	China	1,665	20.2%
2	US	1,569	19.1%
3	Russia	426	5.2%
4	India	412	5.0%
5	Japan	353	4.3%
6	Germany	220	2.7%
7	UK	155	1.9%
8	Canada	149	1.8%
9	South Korea	130	1.6%
10	Italy	129	1.6%
11	Iran	127	1.5%
12	Mexico	119	1.4%
13	South Africa	113	1.4%
14	France	104.5	1.3%
15	Saudi Arabia	104.1	1.3%
16	Australia	101	1.2%
17	Brazil	96.14	1.2%
18	Spain	96.06	1.2%
19	Indonesia	91	1.1%
20	Ukraine	87	1.1%
Global		**8,230**	**100%**

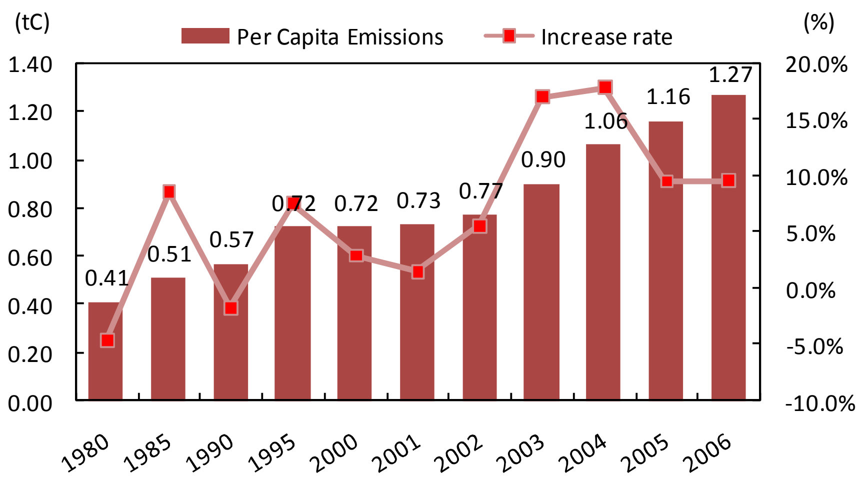
Source: CDIAC.

Figure 7-7 Carbon Dioxide Emissions by Source (1980-2006)



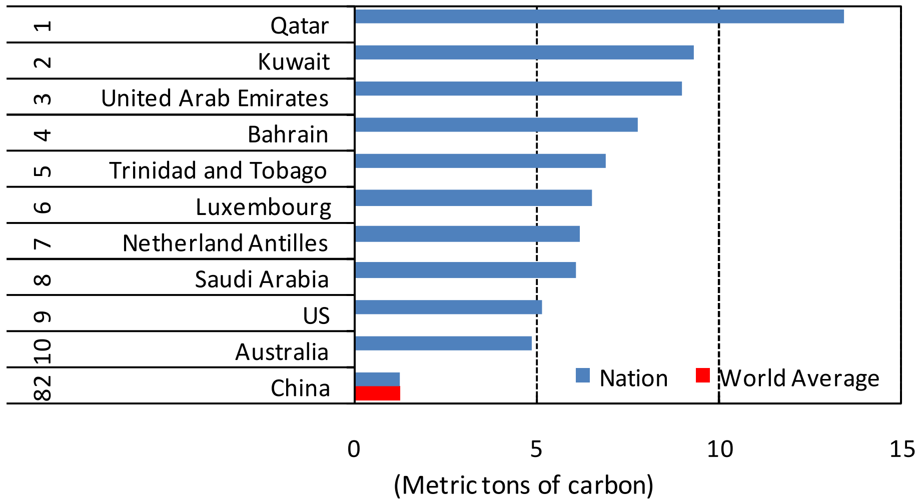
Source: *China Energy Databook, V.7.0.*, Table 8B.1., and CDIAC.

Figure 7-8 Per Capita Emissions (1980-2006)



Source: *China Energy Databook, V.7.0.*, Table 8B.1., and CDIAC.

Figure 7-9 Per Capita CO2 Emissions by Selected Countries for 2006



Source: CDIAC.

4. Ambient Pollution in Urban Areas

Although air quality in Chinese cities has improved since 2000, it is still extremely serious by world standards. Consequently, metropolitan areas experience high death rates from acute and chronic respiratory illnesses. Health-damaging air pollutants include sulfur dioxide, particulate matter and nitrogen dioxide, which together are responsible for the majority of China's air pollution-related illnesses.

China's first air quality standard – *China's Ambient Air Quality Standards* – went into effect in October 1996 and were revised in 2000. The Standards establish three air quality classes, and most areas are required to meet Class II. They are not as tight as most World Health Organization (WHO) guidelines but are stricter than many of the U.S. rules[3] (Table 7-3).

Table 7-3 China's Ambient Air Quality Standards, Compared Internationally

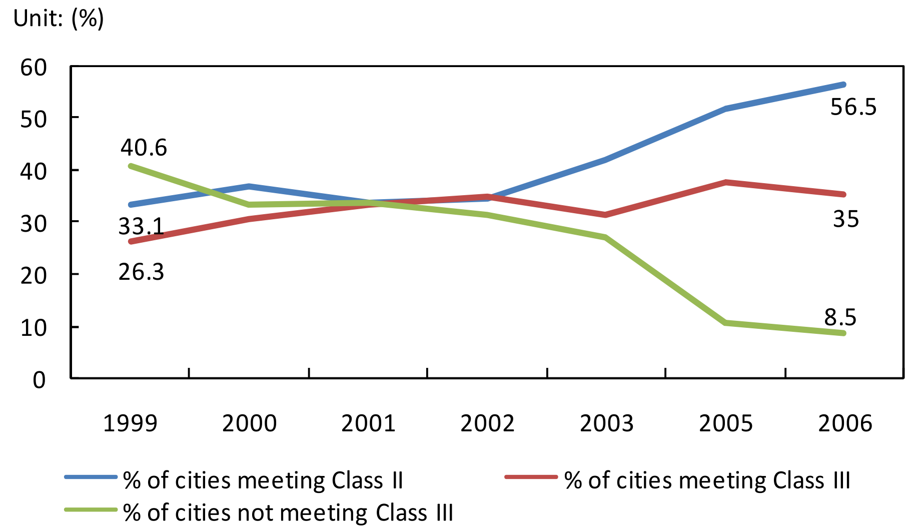
Pollutant	Averaging Time	China			USA	WHO
		Class I	Class II	Class III		
		Nature reserves, Scenic areas	Residential, Commercial, Regular Industry	Designated industrial areas		
SO2 (mg/m^3)	1 year	0.02	0.06	0.1	0.078	
	24 hours	0.05	0.15	0.25	0.37	0.2
	1 hour	0.15	0.5	0.7		
	10 minutes					0.5
TSP (mg/m^3)	1 year	0.08	0.2	0.3		
	24 hours	0.12	0.3	0.5		
PM10 (mg/m^3)	1 year	0.04	0.1	0.15	0.05	0.02
	24 hours	0.05	0.15	0.25	0.15	0.05
NO2 (mg/m^3)	1 year	0.04	0.08	0.08		
	24 hours	0.08	0.12	0.12		
	1 hour	0.12	0.24	0.24		0.2
CO (mg/m^3)	24 hours	4	4	6		
	1 hour	10	10	20	40	
O3 (mg/m^3)	8 hours					
	1 hour	0.16	0.2	0.2	0.24	
LEAD (mg/m^3)	3 months	1.5			1.5	

Source: Asia Pacific Energy Research Center & Institute of Energy Economics Japan (2008), *Understanding Energy in China*, Tokyo: Asia Pacific Energy Research Center & Institute of Energy Economics Japan.

The proportion of cities achieving a Class II rating in the *Ambient Air Quality Standards* system increased from 33.1% in 1999 to 56.5% in 2006, while the proportion of cities not meeting the minimum Class III standard dropped sharply from 40.6% in 1999 to 8.5% in 2006, as shown in Figure 7-10.

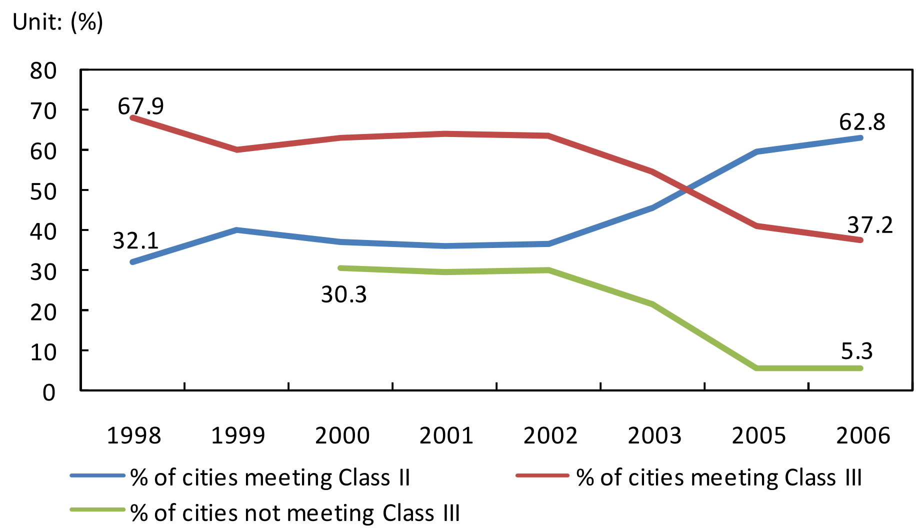
China has made significant achievements in the control of total suspended particulate (TSP) emissions since 1998. The results are evident in steadily declining levels of TSP and consequently, the proportion of cities meeting Class II standards jumped 30.7% from 1998 to 62.8% in 2006. Meanwhile, the proportion of cities which did not meet the Class III standard for TSP declined from 30.3% in 2000 to only 5.3% in 2006.

Figure 7-10 Ambient Air Quality Achievement by City (1999-2006)



Source: Same as Table 7-3.

Figure 7-11 Ambient TSP Achievement by City (1998-2006)

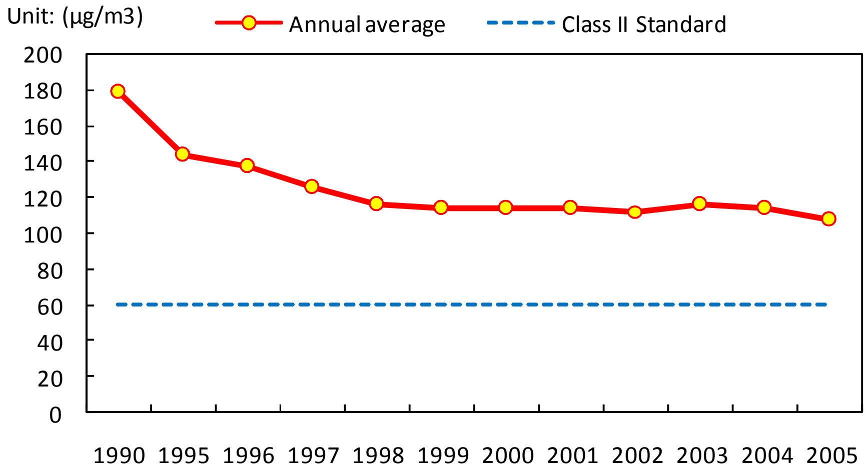


Source: Same as Table 7-2.

Conversely, up until the present, improvements in ambient sulfur dioxide and aid rain have been much less impressive, yet positive results are apparent. The national annual average levels of sulfur dioxide in monitored cities dropped from 179 μg/m3 in 1990 to 107μg/m3 in 2005, but remain significantly higher than the relevant Class II standard for annual average levels of 60μg/m3 (Figure 7-12). To combat increasing emissions of SO2, the government designated the

Two Control Zones for Sulphur Pollution in 1998, targeting SO2 emissions in Northern China and acid rain in Southern China. By 2005, the proportion of cities in SO2 control zones that met Class II standards increased from 32.8% in 1998 to 45.1%, while the proportion of cities below the Class III standard declined from 37.5% to 21% over the same period. The worst cities, mainly in Shanxi Province, the country's main coal production region, have the highest emission levels, while cities in several provinces such as Heilongjiang, Anhui and Hainan experience ambient concentrations well under the standard.

Figure 7-12 Ambient Sulfur Dioxide Levels (1990-2005)



Source: *China Energy Databook, V.7.0.*, Table 8B.7..

Table 7-4 SO2 Pollution in Control Zones (1998-2005)

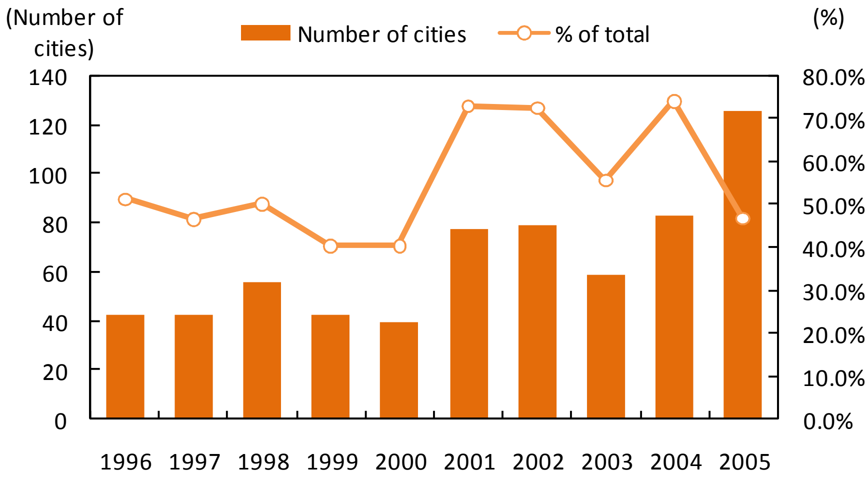
	1998	2000	2001	2002	2003	2004	2005
% of cities meeting Class II	32.8	47.7	48.4	40.6	39.1	40.6	45.1
% of cities meeting Class III	29.7	24.6		31.3	25	29.7	33.9
% of cities not meeting Class III	37.5	27.7		28.1	35.9	29.7	21

Source: Same as Table 7-3.

The distribution of acid rain across areas in China has been basically stable; however, the pollution has likewise remained stubbornly unchanged. In 2005, among the 269 cities within acid rain control zones, there were 126 cities with annual average precipitation PH values lower than 5.6, accounting for 46.8% of total in-zone cities. This share dropped from its peak at 74.1% in 2004 to 46.8% in 2005.

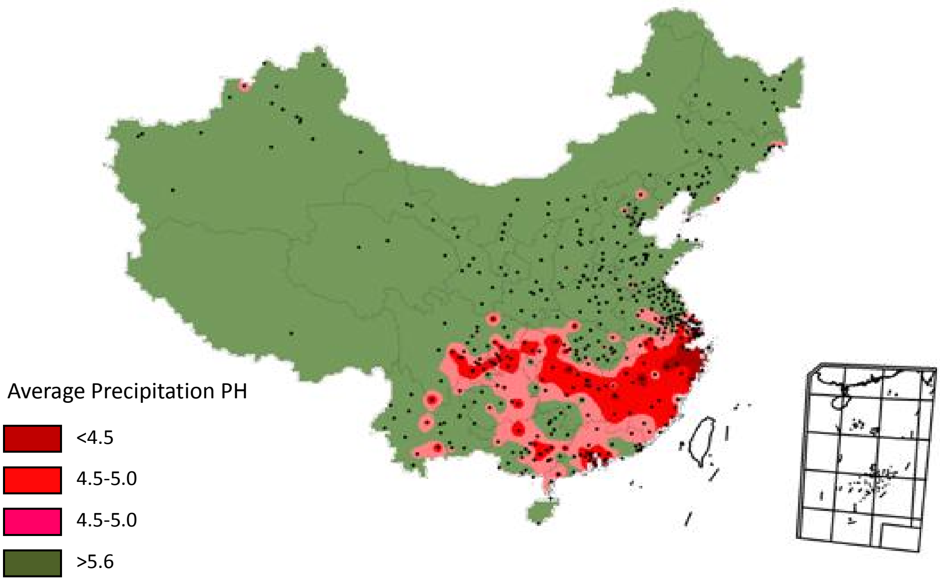
Generally, acid rain has mainly been distributed in areas to the south of Yangtze River and to the east of Yunnan and Sichuan provinces including Zhejiang, Fujian, Jiangxi, and Hunan provinces, most parts of Chongqing, and the Yangtze River and the Pearl River Deltas.

Figure 7-13 Cities with Annual Average Precipitation PH Values Lower than 5.6 and Their Share of In-zone Cities (1996-2006)



Source: *China Energy Databook, V.7.0.*, Table 8B.10..

Figure 7-14 Map of Regional Distribution of Acid Rain in China in 2006



Source: Ministry of Environmental Protection, China.

Nitrogen oxide levels are usually higher in China's large cities, which contain a relatively higher and rising number of motor vehicles, as more than 40% of NO2 emissions are contributed by motor vehicles[4]. Although all cities met Class II standards for annual ambient NO2 emissions levels in 2006, efforts to control NO2 have lagged behind those for SO2 control. Compared to developed countries, the quality of China's motor fuel is much lower, and stringent vehicle emission standards have been implemented only in major cities (EU IV-equivalent standards have been enforced for new vehicles sold in Beijing and Shanghai since 2008). The installation of NO2 removal equipment in power plants is not required by government regulation and such technologies have not yet been used beyond a government run pilot program.

China is a signatory to the Kyoto Protocol, however, it is not bound to reduce its carbon emissions target. It has also been an active participant in the climate change talks and other multilateral environmental negotiations and claims to take environmental challenges seriously based on the principle of "Common but differentiated responsibility." It has been advocating for the developed world to help developing countries to a greater extent in reducing their carbon emissions. It is a vast and ever vexatious task for the Chinese government to achieve harmonious development within its own community on one hand and cooperate with the international community in mitigating climate change on the other hand. Whether the COP15 Copenhagen meeting will be a milestone in world climate change mitigation cooperation will largely depend on how developed and developing countries agree to work together on key factors such as technology and capital transfers.

[1] "NDRC Explains Components of RMB 4,000 Billion Yuan Stimulus Plan", Caijing Net, November 27, 2008.
[2] Asia Pacific Energy Research Center & Institute of Energy Economics Japan (2008), *Understanding Energy in China*, Tokyo: Asia Pacific Energy Research Center & Institute of Energy Economics Japan.
[3] "China's Air Pollution Standards", Reuters, July 31, 2008.
[4] Minato, K. (2008), *Motor Vehicle Demand and Air Pollution in China*, a paper presented on January 19, 2008 in Shanghai, Japan Automobile Research Institute.

Chapter 8 Energy Industry Investment

1. Investment in Energy Supply

Investment plays a significant role in determining the success of China's energy policies and it has steadily grown as the government increasingly supports efforts to enhance energy security. Total investment in the energy industry increased from 326 billion yuan in 1997 to 1,100 billion yuan in 2006, an annual rate of increase of 14.5% per annum (Table 8-1).

Table 8-1 Total Investment by Ownership of Enterprise (1983-2006)

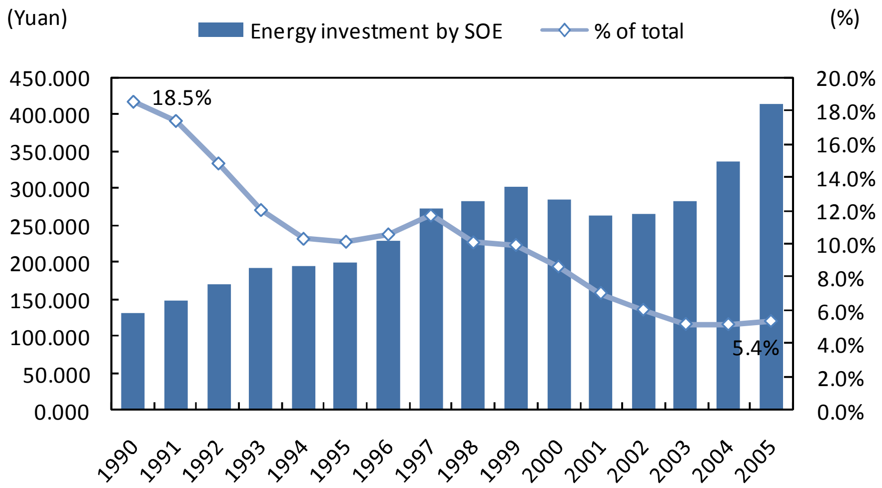
(Unit: Billion Constant 2000 Yuan)

Year	State-Owned Enterprises	Collective-Owned Enterprises			Individual Investment			Joint Venture & Other	Total	of which: Total Energy Industry Investment	
		Urban	Rural	Subtotal	Urban	Rural	Subtotal			Amount	% of Total
1983	207.291	9.940	24.101	34.041	3.641	66.425	70.066	0.000	**311.397**		
1990	464.523	26.003	58.267	84.271	19.847	139.497	159.343	0.000	**708.136**		
1995	1,076.105	91.010	233.790	324.800	54.535	198.263	252.798	323.033	**1,976.737**		
1996	1,130.137	79.935	263.779	343.714	62.803	239.465	302.269	380.726	**2,156.845**		
1997	1,226.990	74.528	286.379	360.917	69.186	252.227	321.413	428.229	**2,337.548**	326.287	
1998	1,518.053	94.712	319.359	414.071	104.985	264.857	369.841	503.766	**2,805.732**	359.821	
1999	1,621.591	101.216	339.934	441.150	143.992	282.633	426.625	546.304	**3,035.669**		
2000	1,650.444	100.983	379.162	480.145	180.510	290.426	470.936	690.248	**3,291.773**	398.361	12.1%
2001	1,757.541	104.098	422.813	526.911	244.861	297.122	541.984	888.243	**3,714.679**		0.0%
2002	1,904.052	110.902	493.016	603.918	342.531	315.023	657.554	1,222.067	**4,387.591**	427.417	9.7%
2003	2,126.514	142.890	643.422	786.313	443.651	314.250	757.901	1,784.383	**5,455.111**	788.978	14.5%
2004	2,308.513	173.326	745.897	919.223	601.203	310.171	911.374	2,361.633	**6,500.743**	1,028.259	15.8%
2005	2,577.981	193.929	846.200	1,040.129	864.631	342.429	1,207.059	2,889.040	**7,714.209**	1,300.064	16.9%
2006	2,734.714	2,990.038	62.819	43.115	2,179.042	678.149	1,598.448	629.566	**9,125.685**	1100.418	12.1%

Note: NBS reorganized the categories for investment data in 2006.
Source: *China Energy Databook, V.7.0.*, Table 3B.1..

Total energy sector investments by state-owned enterprises in 2005 amounted to 414 billion yuan, three times higher than in 1990, however, the percentage of total national investment dedicated to the energy sector has declined sharply from its peak high in 1990 to 5.4% over the same period (Figure 8-1) (Hereafter "total investment" refers only to investment in state-owned enterprises unless otherwise noted).

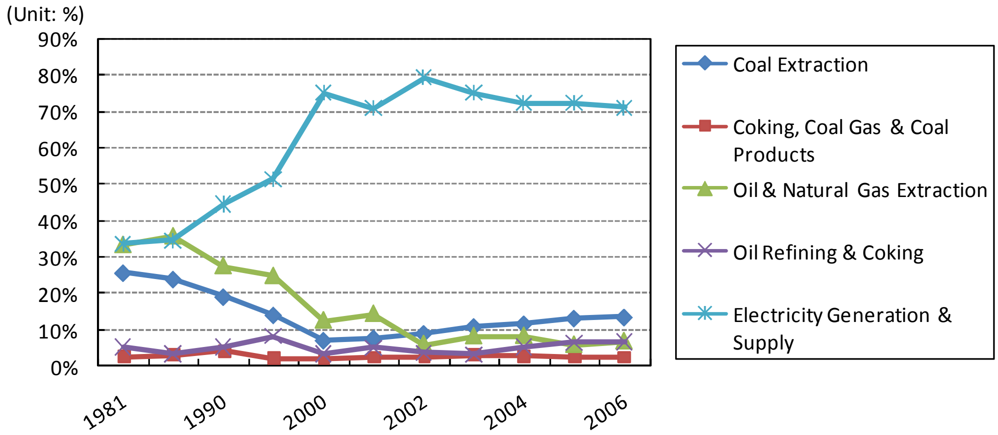
Figure 8-1 Energy Investment by SOEs and Its Share of Total Energy Sector Investment (1990-2005)



Note: Energy investment data of SOE is not available after NBS changed data categories in 2006.
Source: Same as Table 8-1.

In the early 1980s oil and natural gas extraction and refining accounted for the largest share (between 38% and 40% in the 1981-1985 period) of total domestic investment in the state-owned energy sector, followed by the electric power and coal subsectors. However, the share of total investment dedicated to the power and water utility subsector has increased dramatically, mainly due to the country's chronic power shortages. The share of total domestic state-owned energy sector investments in this subsector increased 36% from 34% in 1981 to 71% in 2006. Meanwhile, the share of investments dedicated to oil and natural gas extraction has dropped sharply from 33% in 1981 to 7% in 2006 due to a decrease in exploration in domestic fields and the expansion of investment in overseas ones. The share of coal investment has been maintained at a relatively stable level because of coal's status as China's primary energy source (Figure 8-2).

Figure 8-2 Share of Total Energy Industry Investment by Subsector (1997-2005)

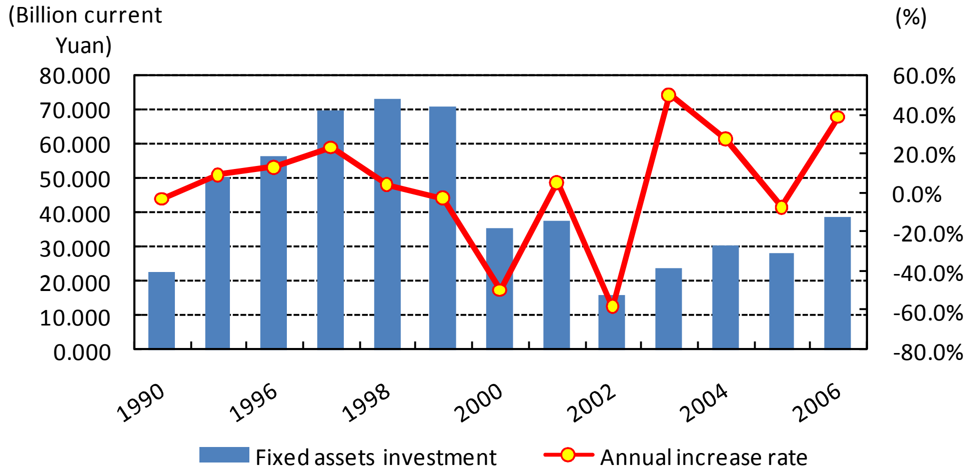


Source: *China Energy Databook, V.7.0.*, Table 3B.2..

In recent years, China's fixed assets investments in the coal industry have increased rapidly. During the period between 2000 and 2006, investment by state-owned enterprises grew at a rate of 25% per annum[1]. Consequently, China has had an average annual increase in coal production capacity of over 117 million tons over the same period[2]. Due to the increased regulation of coal extraction, it is expected that investment in coal mining (with the exception of the utilization of coal-bed methane) will slow or even be reduced but mergers and acquisitions among coal producers and the integration of assets in the coal industry will account for a significant amount of investment in the future. Updating production equipment, safety enhancements, and environment improvement will also be major areas of future investment for Chinese coal producers.

Investment in fixed assets in oil and natural gas extraction has recovered slightly after it dropped sharply from its peak in 1998. The main reasons behind this are: 1) the rising cost of production from old oil fields in the north and northeast; 2) the recent increase in the use of advanced drilling and recovery techniques; 3) an increases in natural gas exploration.

Figure 8-3 Fix Assets Investment in Oil and Natural Gas Extraction by SOEs (1990-2006)



Source: *China Energy Databook, V.7.0.*, Table 3B.4..

As a result, gains in oil production capacity in recent years have been modest, while gains in natural gas production capacity have increased markedly as shown in Table 8- 2.

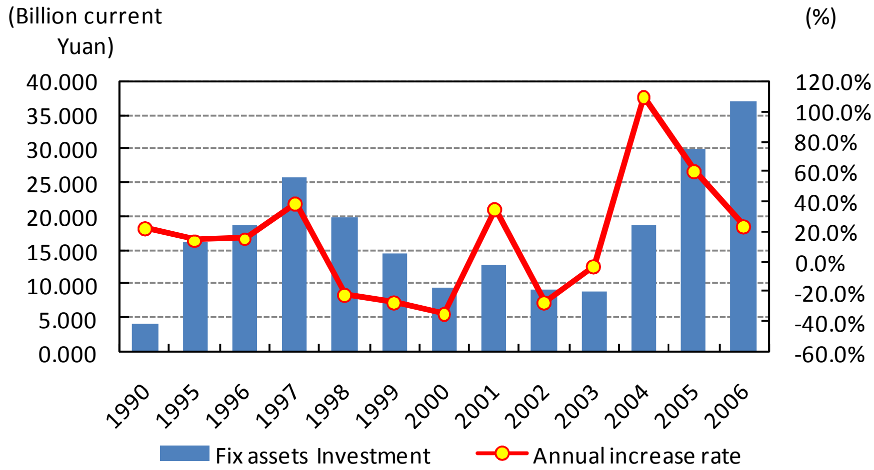
Table 8- 2 Newly Increased Oil and Natural Gas Production Capacity (2001-2006)

Year	Petroleum Extraction (Mt/yr)	Natural Gas Extraction (Bcm/yr)
2001	19.31	1.8
2002	25.41	16.4
2003	17.16	5.4
2004	24.68	11.400
2005	23.88	12.900
2006	16.02	7.600

Source: *China Energy Databook, V.7.0.*, Table 3B.9..

Meanwhile fixed asset investments in oil refining have increased significantly with a surge of investment in refinery capacity and secondary processing plants to meet growing demand for light and middle distillates.

Figure 8-4 Fix Asset Investments in Oil Refining by SOEs (1990-2006)



Source: *China Energy Databook, V.7.0.*, Table 3B.4..

As described above, the electric power sector currently accounts for more than 70% of total energy industry investments. Investment in coal-fired power plants has outpaced that in hydropower plants due to thermal power plants having a comparatively short construction lead-time and therefore shorter pay back periods. There is little doubt that this component of China's power generation will remain unchanged for a considerable time. However investment in coal-fired power plants will eventually slow down or decline mainly due to environment concerns and instead, investment in nuclear power, wind power, and hydropower is expected to accelerate. Where there is continued investment in coal generation, it will focus on large-scale, advanced thermal power plants such as those utilizing 600 MW and above supercritical and ultra-supercritical power plants. The NDRC recently revised its nuclear target from 4% to 5% of total installed electric power capacity by 2020. In practice this will mean that between 2009 and 2020, China will build five to six 1 GW nuclear power plants per annum. Although the government's official target for wind power is 30 GW installed by 2020, the wind power industry plans to reach a target of 150 GW generation capacity by 2020. In 2008 China's installed wind power capacity had reached 12.2 GW, two years ahead of the government goal of 10 GW by 2010.

Until the 11th Five-year Plan, investments in power networks had long lagged behind those in power generation. During the 8th, 9th and 10th Five-year Plan periods, investments in power grids accounted for only 13.7%, 37.3% and 30% of total investments by the power sector[3]. In an effort to find a way to ease the country's power shortages and in a bid to upgrade power transmission facilities, the country's two grid operators have invested heavily in high-voltage power grids since 2006 and have hammered out respective investment plans of 1,178 billion yuan and 206 billion yuan for the remaining years of the 11th Five-year Plan period (Table 8-3). In 2008, investment in power networks for the first time exceeded those for power generation, exceeding 50% of total investments in the power sector (Figure 8-5). In the middle of 2009, the SGCC also announced an ambitious plan to develop a national smart-grid by 2020, a project that is estimated to require investments totaling about 4,000 billion yuan. A pilot study is expected to be completed in 2010 and to be followed by an implementation phase by 2015, and rollout by 2020.

It is expected that China will continually increase its investment in power transmission and distribution areas to raise the quantity of power grid assets in the future. In coming years, the two grid operators will focus on the construction of inter-provincial and cross-regional power grids, and high as well as ultra-high voltage transmission power grids. Additionally, it is expected that the power sector will also focus on upgrading urban power grids and completing rural ones.

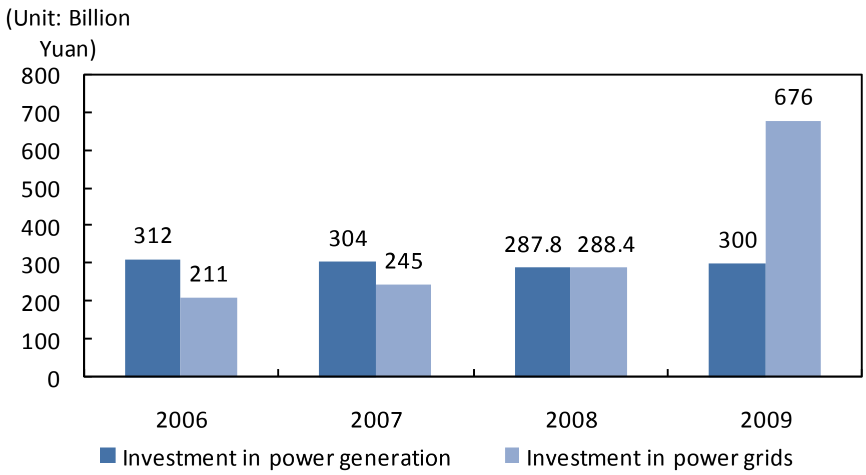
Table 8-3 Power Grid Investment Plans by Power Grid Operator (2006-2010)

(Unit: Billion Yuan)

Year	The State Grid Corp of China (SGCC) (Original plan)	China Southern Power Grid Corp (CSG) (Original plan)	Subtotal	SGCC (Newly increased)	CSG (Newly increased)	Total
2006	189.3	19.9	209.2			
2007	225.4	19.7	245.1			
2008	252	48.0	300			
2009E	280	66.0	346	300	30	676
2010E	268.3	80.4	348.7	330	30	708.7
Total (06-10)	1,215	234.0	1,449	630	60	2,139

Source: Press release of the SGCC and CSG.

Figure 8-5 Investment in Power Generation and Power Grids (2006-2009)



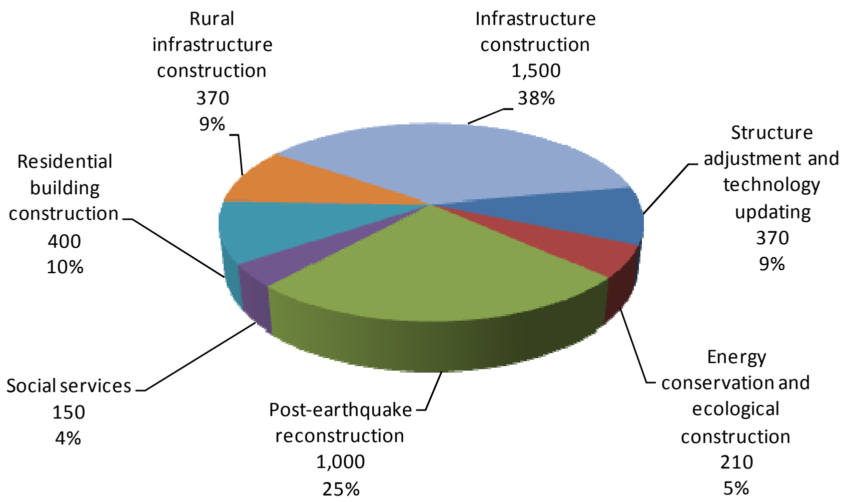
Source: China Electricity Council.

2. Investments in Energy Conservation

Investment in energy conservation increased from the early 1980s to the middle of the 1990s, and then dropped sharply in 1996 due to a shift in the emphasis of the country's economic policies from a centrally-planned economy to a market-based economy. In 1981, investments in energy conservation totaled about 1 billion yuan, but this figure had jumped to 14 billion yuan by 1995. Although investment levels have rebounded since 1996 and grew to 23.5 billion yuan in 2003, the share of energy conservation investments in total investment in the energy sector has been reduced from 13% at its highest level in 1983 to only 4% in 2003[4]. After the declining commitments in both policy and financial support between 1996 and 2005, the Chinese government has recently dramatically increased its investment in energy conservation and environmental protection since 2006 to achieve its new energy efficiency and pollutant emission reduction goals.

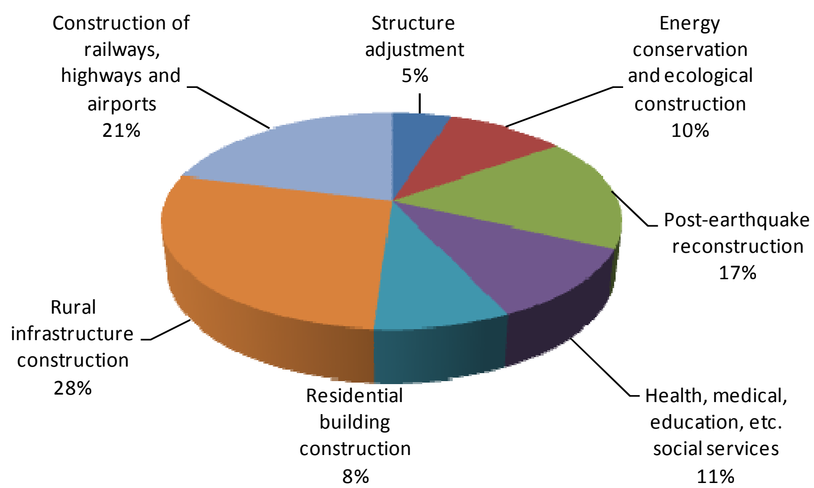
According to a NDRC press release in August 2009, between 2006 and 2008, the government provided 84 billion yuan for major energy efficiency projects and in the fourth quarter of 2008, the government devoted 23 billion yuan to energy conservation, emissions controls, and environmental protection as a part of its 4,000 billion yuan stimulus plan (Figure 8-6). Of this amount, 13 billion yuan is for waste water facilities and waste water pipe construction, 4 billion yuan is for pollution controls on major rivers such as the Huaihe, Songhuajiang, and Danjiangkou rivers, 3.5 billion yuan is dedicated to forest resource protection, and 2.5 billion yuan is dedicated to ten major energy saving projects and supporting the recycling economy (Figure 8-7).

Figure 8-6 Components of the Adjusted 4,000 Billion Yuan Stimulus Plan (Unit: Billion Yuan)



Source: NDRC press release.

Figure 8-7 Components of the 120 Billion Yuan Central Government Investment Plan in the Fourth Quarter of 2008



Source: NERC press release.

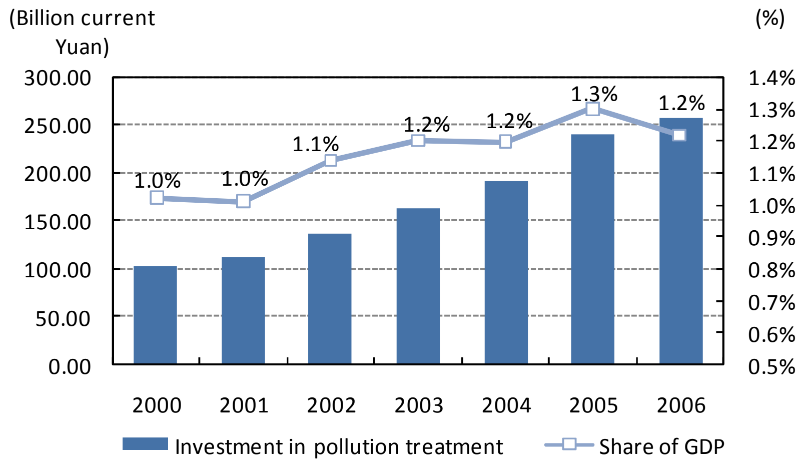
These investments demonstrate that while stimulating domestic demand and promoting economic development, the central government is also placing an increasing emphasis on energy efficiency and environment protection in accordance to its “scientific concept of development” principle.

3. Investment in Pollution Treatment

As pollution has grown worse with the rapid growth of the national economy, the government has attached increasing importance to environmental protection. The total investment put into environmental pollution control in 2006 was 256.6 billion yuan, an increase of 7.5% over 2005, accounting for 1.2% of GDP.

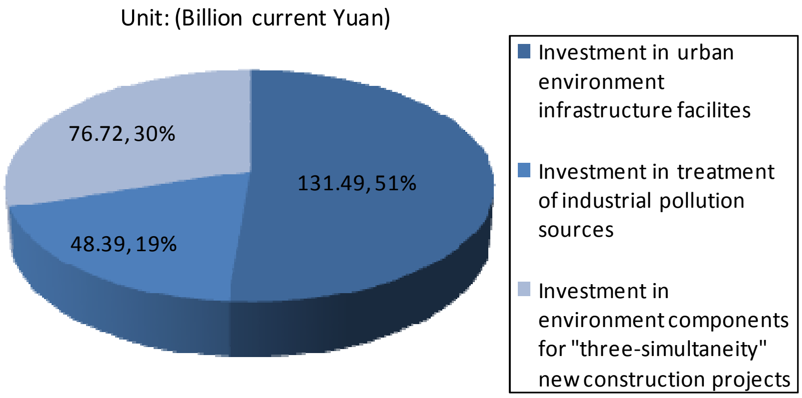
In the same year investments in the control of industrial polluting sources was 48.57 billion yuan, an increase of 5.6% over 2005. Investment in environmental protection related to new construction projects was 76.72 billion yuan, an increase of 19.8%. The outlay in urban environment infrastructure facilities was 131.1 billion yuan that year, an increase of 2.0%.

Figure 8-8 Investment in Pollution Treatment (2000-2006)



Source: *China Energy Databook, V.7.0.*, Table 3B.4., and Table 10B.1..

Figure 8-9 Components of Investment in Pollution Treatment in 2006



Note: "Three-Simultaneity" refers to simultaneously designing, constructing and putting projects into production and operation.
Source: *China Energy Databook, V.7.0.*, Table 3B.4..

As mentioned above, in the fourth quarter of 2008, the government arranged for 23 billion yuan in investments for energy conservation, emission controls and environmental protection. In July 2009, the NDRC reformed urban water prices in a bid to promote water saving and sewage and waste water treatment.

The environmental pollution consequences of economic growth and development have raised serious domestic and international concern and interest. It is now inevitable that the Chinese government will have to continue to make huge investments in controlling the country's pollution. Undoubtedly, China's environment protection industry is booming but the industry must invest in breakthrough technologies to further protect the country's vulnerable environment.

[1] *China Energy Databook, V.7.0.*, Table 3B.4..
[2] *China Energy Databook, V.7.0.*, Table 3B.9..
[3] The average power grid investment percentage in developed countries is above 50%.
[4] Lin, Jiang (2007), "Energy Conservation Investments: A Comparison between China and the US," *Energy Policy*, 35 (2007) 916-924.

Abbreviation

Technical Term

APWR	advanced pressurized water reactor
BOT	building-operation-transfer
CBM	coal bed methane
CCS	CO2 capture and storage
CDM	clean development mechanism
CFR price	cost and freight price
CIF price	cost, insurance and freight price
DSM	demand side management
EPR	European pressurized reactor
FGD	fuel gas desulfurization
FOB price	freight on board price
FOR	freight on road
IPO	initial public offering
LNG	liquefied natural gas
NG	natural gas
NPP	nuclear power plant
PFI	private finance initiative
PV	photovoltaic
PWR	pressurized water reactor
RMB	Renminbi
T&D	transmission and distribution
TOT	transfer-operation-transfer
TOU	time of use
TSP	total suspended particulates
TVOM	township and village owned mines

Institutions/Organizations

AQSIQ	State Administration of Quality, Supervision, Inspection and Quarantine
ASEAN	Association of South-East Asian Nations
BP	British Petroleum
CCC	China Compulsory Certification
CCQC	China Quality Certification Center
CDIAC	Carbon Dioxide Information Analysis Center of the Department of Energy
CECP	China Certification Center for Energy Conservation Products
CGNPC	China Guangdong Nuclear Power Holding Co., Ltd.
CNCA	Certification and Accreditation Administration of China
CNIS	China National Institute of Standardization
CNNC	China National Nuclear Corporation
CNOOC	China National Offshore Oil Corporation
CNPC	China National Petroleum Corporation
CSC	China Standard Certification Center
CSPGC	China Southern Power Grid Corporation
DERC	Department of Environment and Resource Conservation
ESPO	East Siberia-Pacific Ocean
FIDC	Fujian Investment and Development Corporation
IEEJ	The Institute of Energy Economics, Japan
JGIG	Jiangsu Guoxin Investment Group
MIIT	Ministry of Industry and Information Technology
MOA	Ministry of Agriculture
MOC	Ministry of Commerce
MOEP	Ministry of Environmental Protection
MOF	Ministry of Finance
MOHURD	Ministry of Housing and Urban-Rural Development
MOLR	Ministry of Land and Resources
MOR	Ministry of Railway
MOST	Ministry of Science and Technology
MOT	Ministry of Transportation
MOWR	Ministry of Water Resources
NDRC	National Development and Reform Commission

Institutions/Organizations

NEA	National Energy Administration
NEC	National Energy Commission
NEPD	Ningbo Electric Power Development Co., Ltd.
NPC	National People's Congress
NWS	North West Shelf LNG
POG	Pacific Oil and Gas
SAC	The Standardization Administration of China
SAOT	State Administration of Taxation
SAOWS	State Administration of Work Safety
SERC	State Electricity Regulatory Commission
SETC	State Economic and Trade Commission
SGCC	State Grid Corporation of China
Sinopec	China Petroleum and Chemical Corporation
SOASA	State-owned Assets Supervision and Administration
SPCC	State Power Corporation of China
UNEP	United Nations Environment Program
ZEG	Zhejiang Energy Group CO., Ltd.

Unit

b passenger-km	billion passenger-kilometers
b t-km	billion tonne-kilometers
b US$	billion current US$
b yuan	billion current yuan
bcm	billion cubic meters
bcm/yr	billion cubic meters/year
gce/kWh	grams of coal equivalent/kilowatt-hour
Gt	gigatonnes
Gt-km	gigatonne-kilometers
GW	gigawatts
GWh (M kWh)	gigawatt-hours
kb/d	thousand barrels/day
kg	kilogram
kg/cap	kilogram/capita
kg/t	kilogram/tonne
kg/yr	kilogram/year
kgce	kilogram of coal equivalent
kgce/kt-km	kilogram of coal equivalent/kilotonne-kilometers
kl	kiloliter
km	kilometer
kt	kilotonne
Kt/km^2-yr	kilotonne/kilo square meters-year
kt/yr	kilotonne/year
kV	kilovolts
kW	kilowatt
kWh	kilowatt-hour
M^2	square meter
m^3	cubic meter
m^3/t	cubic meter/tonne
Mcf/d	million cubic feet/day
mg/m^3	milligram/cubic meters
MJ	megajoule
mm	millimeter
Mm^2	million square meters

Unit

Mm^3	million cubic meters
Mm^3/day	million cubic meters/day
Mmbbl/d	million barrels/day
mpg	miles per gallon
Mt	million tonnes
MtC	Million tones of carbon
Mtpa	Million tonnes per annum
Mt/yr	million tonnes/year
Mtce	million tonnes of standard coal equivalent
Mtce/yr	million tonnes of coal equivalent/year
Mt-km	million tonne-kilometers
MW	megawatts
MWh (1000 kWh)	megawatt-hour
MWh/yr	megawatt-hour/year
t	tonne (metric ton)
tC	tonne of carbon
t/Mt-km	tonne/million tonne-kilometers
t/yr	tonne/year
tce/yr	tonnes of coal equivalent/year
Tcm	trillion cubic meters
TWh(b kWh)	terawatt-hours
TWh/year	terawatt-hours/year
ug/m^3	micrograms/cubic meter of air
US$/t	US$/tonne
yuan	yuan
yuan/(tce/yr)	yuan/(tonne of coal equivalent/year)
yuan/kWh	yuan/kilowatt-hour
yuan/MWh	yuan/megawatt-hour
yuan/t	yuan/tonne
yuan/yr	yuan/year

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