Overview of the Chinese Electricity Industry and its Current Uses

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Overview of the Chinese Electricity Industry and Its Current Issues

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Abstract

In China, many ongoing problems in the electricity sector can be traced back to the old 'centrally planned' economy. Since the start of liberalization in the 1980s, the clash between a liberalized economy (excluding a few so-called strategic industries) and a centrally controlled electricity industry has gradually become more and more apparent. The Chinese electricity industry is in need of constructive restructuring. In the absence of a universal agreement on optimal industry design, the Chinese government should have a firm and clear understanding of the implications of electricity restructuring for long-term social welfare. Otherwise the electricity industry might, again, be locked into an inferior industry design which would be very costly to change.

JEL Classification: L22, L52, Q48

Key words: Chinese electricity industry, reform, electricity policy

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Section 1: Introduction

The Chinese electricity industry was born in the late half of the 19^{th} century, but for the next 60 years, frequent wars and government takeovers greatly damaged the national economy and the Chinese electricity industry grew very slowly. By 1949, when the People's Republic of China was founded, the country had a small electricity system with only 1.85 GW installed capacity, but over the succeeding five decades the industry expanded rapidly to fuel the country's massive industrialization.

Between 1949 and 1978 the Chinese economy was 'centrally planned' and the electricity industry was a vertically integrated state-owned utility. During this period, the government underlined the urgency of expanding access to electricity as quickly and widely as possible. This policy, together with the governments' preference for heavy industry, made a great contribution to the development of the electricity industry. However, the high inefficiency of the planning system also exhibited many problems.

In 1979, China started its market-oriented economic reform. Since then, the market mechanism has gradually surpassed the planning system in the national economy. In 1985, as a consequence of broader institution and market reforms, the government started to reform the electricity sector. However, unlike other sectors in which the market mechanism was playing a leading role after 20 years of economic reform, the electricity industry, probably the last bastion of the centrally planned economy, still kept its old development pattern largely unchanged. Clashes between a liberalized economy (excluding a couple of industries) and a centrally controlled electricity industry became more and more apparent. Just after 2000, various factors, including chronic problems inherited from central planning, and the explosion in electricity demand, etc., resulted in a nation-wide electricity crisis. In 2004, 26 out of 31 provinces experienced electricity shortages. Eventually, by aggressively rationing electricity and controlling demand to prevent spikes, China avoided the kind of massive, costly blackouts that affected millions of people in the northeast United States and in Canada in August 2003. However, power shortages, together with increasing environmental concerns, warned the Chinese government that a quick and suitable reform of the electricity industry was required.

This paper comprises eight sections. Section one is an introduction. Section two is an overview of the development of Chinese electricity industry. Section three outlines the ongoing electricity crises. Section four and five describe the main features of Chinese electricity industry under the former centrally planned economy from 1949 to 1978 and under economic reform after 1978 respectively. Section 6 explains reasons for electricity demand increase. Section 7 explores the strategies of how to way out the crises. Section 8 concludes the paper.

Section 2: Overview of Industry Development

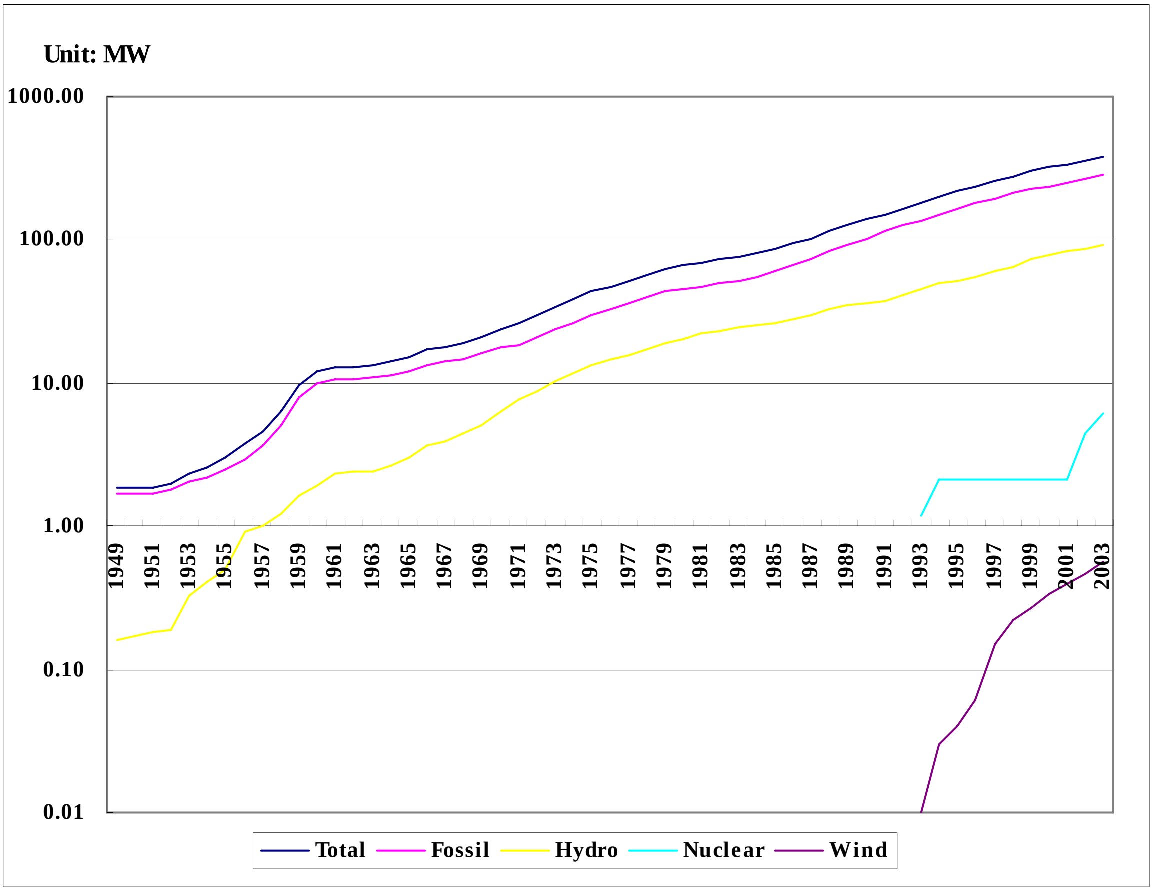
Electricity generation developed sporadically in the 1880s. In Shanghai, 1882 witnessed the installation of the first power plant by a British investor. Six years later, in Beijing, an electricity generator was installed to serve the royal family of Qing Dynasty (Zhou, 2003). Also in that year, the local administration of Qing Dynasty imported an electricity generator into Guangzhou city (Zhang and Heller, 2004). From then on, domestic and foreign private investors, and successive Chinese governments, gradually built more and more generators and primitive local grids to provide electricity in big cities, such as Shanghai, Tianjin, and Wuhan. These generators were mainly used to light the city streets and to serve rich urban residents. According to China Electric News, during this period, electricity assets were mainly held by foreign shareholders. For example, foreign investors owned 1.5 MW generating capacity out of a total of 2.7 MW in 1911. In 1936, foreign firms owned 79% of Shanghai's 2.66MW capacity (CEPN, 2002). Between the end of the 19th century and the first half of the 20th century, the frequent wars and regime changes made the country totally chaotic and greatly damaged the development of the national economy. As a result, the local electric systems grew very slowly and never extended into the countryside. In 1949, when the Chinese Communist Party came to power, the whole industry was rather primitive and installed generating capacity was only about 1.85 GW in total (CED, 2004) and 0.0034 kW per capita[1]. However, over the five decades from 1949, within a stable social environment the electricity industry rapidly expanded to fuel the country's massive industrialization effort.

2.1 Electricity Production

Between 1949 and 2003, installed capacity grew continuously at an average annual rate of 10.6 percent[2]. Growth was particularly significant after the mid 1980s because of surging demand for electricity and increased investment associated with market-based economic reforms. In 2003 the Chinese electricity system was the world's second largest, with about 380 GW installed capacity. Power generation in 2003 was about 1.9 trillion kilowatt-hours (CED, 2004; SPIN, 2004). Figure 1 shows the changing curve of the installed generating capacity in China from 1949 to 2003 (Date from (CED, 2004)).

[1] According to the statistics of the China Population & Development Research Center (CPDRC), by the end of 1949 the population in China was 542 millions.
[2] The raw data for the average annual increase rate are from SPIN (2004) and CED (2004).

Figure 1: Electricity Generation Capacity

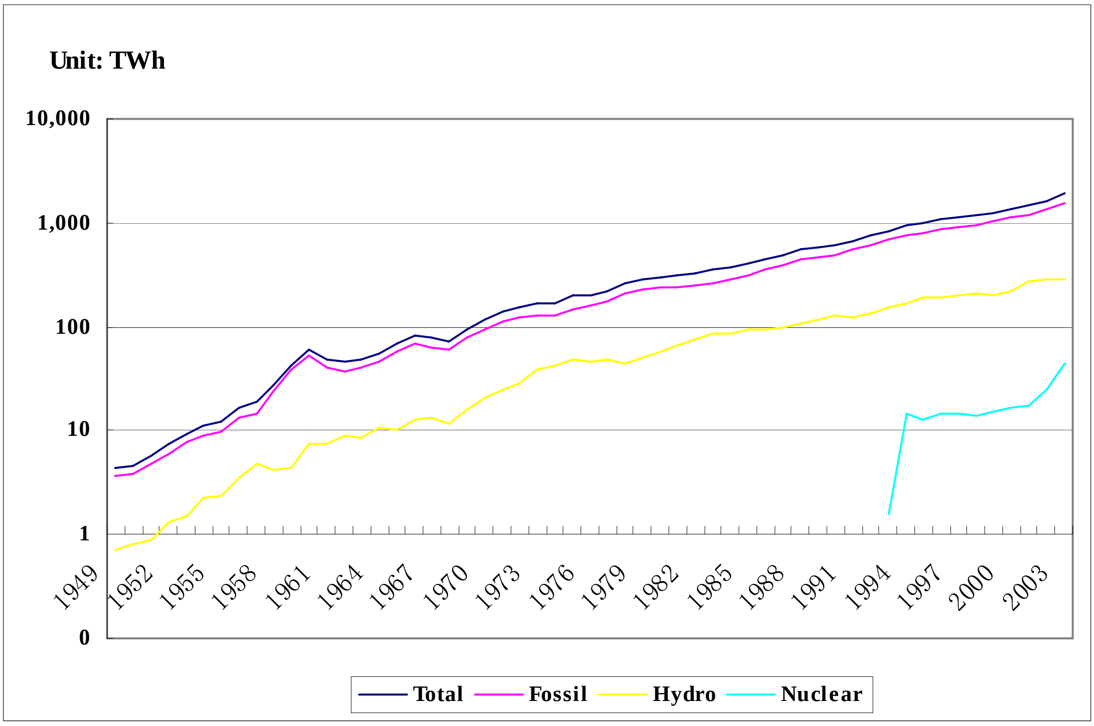


Data: (CED, 2004)

Structure of generating capacity

China's electricity generation relies heavily on fossil fuel. Within the installed generating capacity, fossil-fired (mainly coal-fired) facilities occupy about 74 percent and hydro power constitutes about 24 percent. Nuclear and other energy sources so far account for no more than 2 percent (CED, 2004; SPIN, 2004). Accordingly, the ratio of gross electricity by different generating modes in 2003 is fossil 82.9%, hydro 14.8% and nuclear and others 2.3% respectively. Figure 2 exhibits the changing curve of the gross electricity generation from 1949 to 2003 (Data from (CED, 2004)).

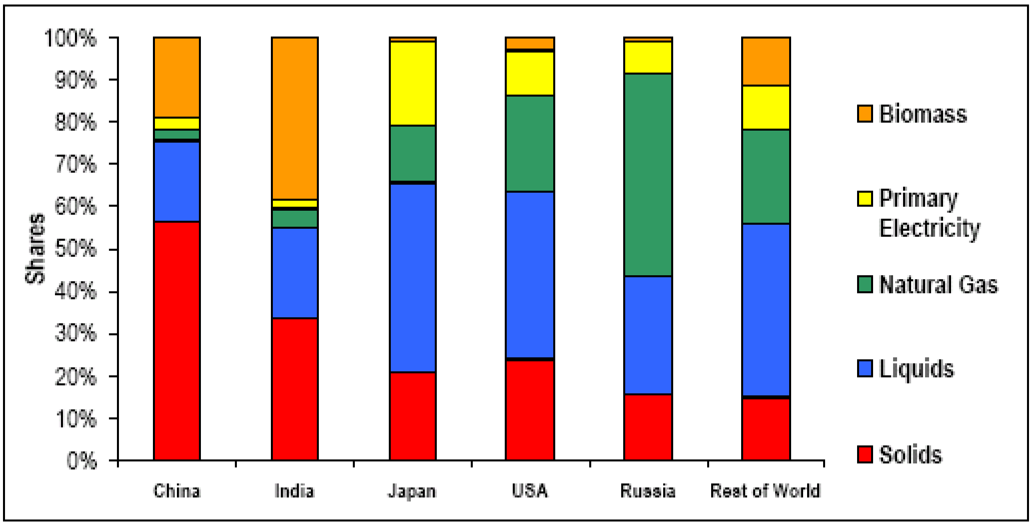
Figure 2: Gross Electricity Generation



Data: (CED, 2004)

Given the abundance of coal and the relative scarcity of gas and oil, coal is the main fossil fuel used for power generation in China. Statistics shows that China is now the largest coal consuming country in the world. In 2001, the ratio of coal consumption in China to world total was about 27% (CED, 2004). No other large country relies so heavily on coal to meet its primary energy demand (Figure 3).

Figure 3: Shares of Energy Consumption by Energy Type, Selected Countries



Data: (CED, 2004)

Coal has fuelled the Chinese economy for the past several decades. However, as sustainable development gradually becomes a key concern, hydropower, nuclear and non-hydro renewable energy gradually become a higher investment priority.

Hydropower has been utilized in China for long time. The largest project under construction, by far, is the Three Gorges Dam, which, when fully complete in 2009, will include 26 separate 700-MW generators, totalling 18.2 GW. The reservoir created by the dam began filling in June 2003 and the first electric turbine started to generate electricity on August 2003. Another large hydropower project involves a series of dams on the upper portion of the Yellow River. Shanxi, Qinghai, and Gansu provinces have jointly created the Yellow River Hydroelectric Development Corporation, with plans for the eventual construction of 25 generating stations with a combined installed capacity of 15.8 GW (GENI, 2004). Transmission adds tremendous costs to electricity supply. This is particularly the case in the already expensive hydropower development. The high cost mean that almost 80% of exploitable hydro capacity remains undeveloped[3].

The first use of nuclear power came from two 300 MW generating units in Qinshan, Zhejiang Province in 1992. Since then, several units of 600MW or 1GW capacity have come into use. By 2003, the installed capacity for nuclear power was 5.4 GW in total (CED, 2004), and many more are now at the design stage.

Wind energy is starting to be used. In 2003, the total wind farm installed capacity was about 567 MW. Wind patterns limit its use and most of the best wind sites are in the north part or along the southeast coast. The four provinces with biggest installed capacity of wind farm are Inner Mongolia (North China), Liaoning (North China), Xinjiang (Northwest China) and Guangdong (coastal area). Installed capacity in these four provinces is some 405 MW, about 71% of national total (CED, 2004). Therefore, in a sense, the distribution feature of wind energy constrains its extensive usage in China.

2.2 Electricity Consumption

Since 1995 China has become the world’s second largest electricity consumer. In 2000, the total installed capacity of electric equipment for final use was more than twice the total generating capacity (Zhou, 2001). In 2003, total electricity consumption was about 1,906.7 terawatt-hours (CED, 2004). However, on a per capita basis, the annual electricity consumption is still very low. In 2002, it was roughly 1000 kWh. Compared with 12183 kWh for the US and 5618 kWh for the UK in the same year, China is clearly still in the category of a developing country (World Bank, 2002). It is expected that rapid economic growth and an improving standard of living will spur higher and higher levels of electricity consumption. Therefore, Chinese policy makers have to take actions to ensure the future power demand is met.

[3] China’s exploitable hydropower resources are estimated at 378.5 GW (CED, 2004).

For many years the industrial sector has been the largest electricity-consuming sector in China. In 2002, electricity consumed by industry accounted for about 70% of total power consumption. Proportions used by agriculture, transportation, construction, commercial, residential, and other sectors can be seen in the Table 1 (CED, 2004).

Table 1: Sectoral Electricity Consumption, Selected years

Item	2002	2001	2001-02 Annual Growth Rate	Consumption Structure
	（TWH）	（TWH）	（%）	（%）
Sectoral Electricity Consumption	**1422**	**1284.3**	**10.7**	**100.00**
1、Agriculture	78	76.2	2.4	4.81
2、Industry	1167	1049	11.2	72.04
(1)Light industry	252	221.1	14.0	15.56
(2)Heavy industry	915	827.8	10.5	56.48
3、Exploration	1	1	0	0.06
4、Construction	16	14.5	10.3	0.99
5、Transportation	33	29.3	12.6	2.04
6、Commercial	52	45.6	14.0	3.21
7、Residential	198	183.9	7.7	12.22
8、Other	75	68.8	9.0	4.63

Data: (SPIN, 2004).

2.3 Electricity Transmission and Distribution

China’s energy resources distribute highly unevenly. Coal mines are mainly sited in the north of the country, and hydro power is predominantly located in the west. However, the large economic and load centres are in the east and south. This means it is impossible to fuel national economic development by using only local energy resources. Transmitting electricity is cheaper and more environmentally attractive than transporting coal.

As generating capacity increased, the electricity transmission network grew. The development of the power grid has entered a new era. Long high voltage transmission lines were built to increase transmission efficiency. China built its first 330 KV transmission line in 1972 and first 500 kV AC transmission line in 1981. The length of transmission and distribution line (35 kV and above) built by 2000 is listed in Table 2 (SPIN, 2004).

Table 2: Transmission Line in Use in 2000

Item	Length (km)	Percent (%)
500 kv	25,910	3.7
330 kv	8,524	1.2
220 kv	122,597	17.3
110 kv	195,001	27.6
66 kv	46,054	6.5
35 kv	309,056	43.7
Total	707,142	100

In 2003, the total length of the electricity transmission line of 220 kilovolt and above exceeded 200,000 kilometers, and power transforming capacity was close to 600 million kilovolt-ampere (Yin, 2004).

2.4 Rural electrification

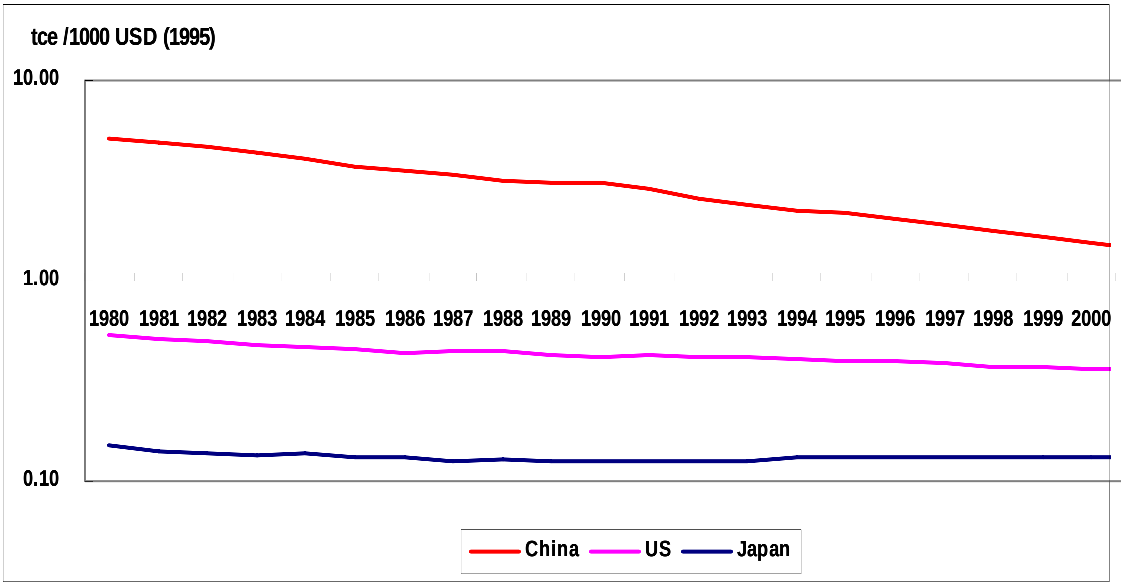
Rural electricification in China lags far behind the development of the electricity industry in general. The reasons for this are multilevel, but the most notable reason is the lack of investment. Because of limited state revenue and the government's preference for heavy industries and urban grids, rural electrification was entirely ignored before economic reform (Xu, 2002). Rural electrification became the burden of rural residents themselves. They had to raise funds, build and manage their own electricity facilities. In 1979, the year when the economic reform started, there were about 37.4% rural households still without access to electricity (CED, 2004).

Since 1980 rural electrification has been improved significantly. In order to support economic development, the former Ministry of Electric Power Industry (MEP) started to build the new rural transmission line and upgrade the primitive electricity network. By the year of 1996, the percentage of rural households without electricity was reduced to about 5%. In 1998 the government launched a big project to construct and upgrade the networks of 2,400 counties. The total investment for this project was 23 billion US dollars (Zhou, 2001). In 2001, when the project was completed, the percentage of rural households without electricity access was reduced to about 1.5% (CED, 2004). These households normally live in remote, isolated places where it is very uneconomical to build a transmission line. In this case, the government provides financial support to encourage them to use renewable energy, such as micro hydropower, solar energy, wind energy and biomass energy.

2.5 Efficiency of Electricity generation

For a long time, the efficiency of energy utilization has been very low. For example, historical data shows that in 1980 China's energy intensity[4] was 5.18 tce/1000 USD[5]. Compared with 0.15 in Japan and 0.54 in the US at the time, it resulted in enormous waste of energy. In order to solve this problem, China launched its energy conservation program in the early 1980s. This program has made a substantial progress. From 1980 to 2001, China's energy intensity drastically declined 72% from 5.18 to 1.46 (CED, 2004). This resulted from a number of factors. Firstly, it was caused by efficiency improvement due to technological innovation, secondly, by changes in product mix and quality, and thirdly, by structural shifts in China's economy (EIA, 2004). However, compared to the developed countries, China's energy intensity is still too high. Figure 4 shows the curves of energy intensity trends for selected countries between 1980 and 2001.

Figure 4: Energy Intensity Trends, Selected Countries (CED, 2004)



Data: (CED, 2004)

Within the electricity industry, efficiency improvement is even clearer. Many new large generating units with higher technical parameters and efficiency have gradually become the main power sources of China's power industry. More and more inefficient smaller units were just used to meet short-term peak demand. The number of large scale units increased significantly. By the end of 2000, in the field of thermal power, there were 22 units each with a capacity of 600MW or more, 246 units each with a capacity of

[4] Energy intensity, according to the definition of American Department of Energy, refers to 'the amount of energy used in producing a given level of output or activity….. It is expressed as energy per unit of output or activity measure of service'. Office of Energy Efficiency and Renewable Energy (OERE) (2004) Terminology & Definitions. U. S. Department of Energy. Access on 18 October 2004 at http://intensityindicators.pnl.gov/terminology.html#intensity.

[5] tce/1000 USD (1995) refers to tones of coal equivalent (tce) per thousand 1995 USD.

300 MW - 600 MW, and 376 units each with a capacity of 100MW – 200 MW. The total number of generating units with higher technical parameters and generating efficiency were 179.9 GW in capacity, occupying about 75% of the generating capacity of thermal power (CED, 2004). As a result, technical and economic efficiency has been distinctly improved.

Section 3: Ongoing Electricity Crisis

China is facing a severe electricity crisis. Like a mirror, this crisis reflects some inherent problems in the Chinese electricity industry. Examining the current electricity crisis in detail, we find that the current problems are caused by various economic, political, and technical factors. They can be roughly categorized as following: (1) shortage of generating capacity; (2) transmission and distribution network; (3) lack of an effective price mechanism; (4) shortage of fuel; and (5) environmental problems.

3.1 Shortage of generating capacity

China's generating capacity has been expanded very rapidly over the last five decades, but the growth of electricity demand has increased even faster. Just after a short period of relatively sufficient electricity supply in the late 1990s, supply again became extremely tight. In 2002, generating capacity increased about 4.3%, but demand grew about 12% (China Daily, 2003). In 2003, total generating capacity increased by 8% compared to 2002 to reach 385 GW. However, the demand for electricity increased more than 15% (SPIN, 2004). In 2003, supply shortages caused blackouts in 19 provinces (including municipalities and autonomous regions). In 2004, 45 GW of new capacity was installed, and the national total exceeded 430 GW. But, as in 2003, demand increase easily surpassed capacity increase. The latest investigation showed that there was a shortage of about 35 GW capacity in 2004 (SFO, 2004; SGCC, 2004; Xu, 2004). Problems of electricity shortage grew and this time blackouts occurred in 26 provinces out of 31 (Xu, 2004). Factories were forced to move production to nights and weekends, while office and shopping complexes cut back on heating and switched to power-saving light bulbs. Eventually, by aggressively rationing electricity and controlling demand to prevent spikes, China avoided the kind of massive, costly blackouts that affected millions of people in the northeast United States and Canada in August 2003. However, power shortages are a warning to the Chinese government that a rapid and appropriate reform of the electricity market is an urgent necessity.

Experts predict that the current demand-supply imbalance will last far into 2006 (SGCC, 2004). Shortage of generating capacity is the main cause of the ongoing electricity crisis in China. According to the International Energy Agency, to meet rapidly-growing electricity demand, China needs to invest a total of nearly 2 trillion U.S. dollars in electricity infrastructure between 2001 and 2030, about one fifth of the estimated world total investment in the electricity industry during this period (Toh, 2003).

3.2 Transmission and Distribution Bottlenecks

Long-term lack of investment caused serious transmission and distribution bottlenecks in electricity delivery: there has been insufficient investment in electricity industry as a whole and inappropriate distribution of investment funds between generator installation and grid construction. For a long time electricity policy was biased towards the construction of generating capacity, and the transmission and distribution network was neglected. Although since 1980 the transmission grid has been upgraded greatly, investment in the delivery network is still far from adequate (China Daily, 2005). Transmission bottlenecks limited the use of rich energy resources in western China to satisfy soaring demand in eastern regions. Lagging development of the grid aggravates the shortage of electricity. In 2003 when big cities, such as Shanghai and Guangzhou, faced serious shortage of electricity, some western provinces, such as Yunnan and Inner Mongolia, still had about 30% reserve capacity (Song, 2003).

3.3 Lack of an effective price mechanism

A good price mechanism can effectively allocate market resources. However, there is no market mechanism for setting electricity prices in China. Historically, the electricity price was set by administrative organs and did not reflect supply-and-demand conditions. The price setting system is opaque and economically irrational. This is because, on the generation side, the electricity purchasing price varies greatly according to different power plants costs (DRC, 2002). On the supply side, the final electricity price is made up of 'grid selling price', which is set differently for different categories of consumers, and various charges and fees. Charges and fees[6] usually reflect policy priorities of different regions and vary across consumers and regions. Table 3 gives an example of the price structure in urban areas of Guangdong Province (GETRC, 1999).

Table 3: Electricity Prices in Guangdong Urban Areas[7]

[6] This part of pricing is often subject to local government abuses. As SPC (2001) points out, a huge pricing problem is that provincial and local governments often change the electricity pricing and form their own pricing policy within their controlled areas, without permission, after the State Development Planning Commission set the price for them (p.111). *Summary Of The Electricity Industry Performance During The 9th Five-year Plan*. China Electric Power Press, Beijing, pp.29 - 174.

[7] The power construction fee is collected for new electricity projects. The Three Gorges Fund is specially for the construction of the Three Gorges Hydropower project. The extra local fuel fees are used to compensate for the difference between the purchasing price from local power plants and the main grid selling price. City fees are primarily for building and maintaining city streetlights.

$/MWh

End-users	Grid selling price	Power Construction Fee	Three Gorges Fund	Extra Local Fuel Fees	City Fees	Total
Large manufacturing	65.46	2.42	0.85	13.77	1.69	84.18
Other manufacturing	79.35	2.42	0.85	14.37	1.69	98.67
Commercial	110.87	2.42	0.85	15.10	1.69	130.92
Residential	72.46	2.42	0.85	3.62	0.00	79.35
Agricultural irrigation	37.44	2.42	0.85	0.00	0.00	40.70

Source: GETRC (1999)

In the late of 1990s, after several years' huge investment, the supply shortage was temporarily alleviated. In 2000 six provinces (Liaoning, Jilin, Heilongjiang, Zhejiang, Shanghai and Shandong) were selected to experiment with wholesale market competition. However, this was suspended when the electricity supply became tighter again in 2001.

3.4 Shortage of Coal Supply

Another outcome of the unsound price system can be seen in conflicts between the coal and electricity industries. As mentioned in the earlier section, China is a coal-fired economy. Up to 1992, the coal price was set under the planning system. In 1993, except coal for electricity, the coal market was liberalized. Between 1993 and 2001, the price of coal for electricity was set in two steps – the State Planning Committee (SPC) first preset a guide price, and then based on this, coal mines and power plants negotiated the final price and contracted the coal supply. In this process the guide price played a major role and functioned like an anchor for the floating coal price. Because normally the market price of coal was much higher than the guide price set by the SPC, coal mines were eager to raise the coal price for the electricity sector. However, this intention was not realized until 2002.

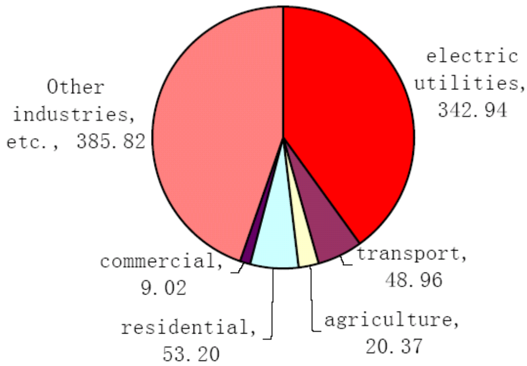
Since 2002 the government has liberalized the price of coal for electricity; it is now totally decided by the market. In late 2002, coal producers started to raise the coal price. Because the cost of coal is about 70% of total cost of electricity production in coal-fired power plants, generators' profits are very sensitive to fluctuations in coal prices. Since the electricity price is still under administrative control, the increase of coal price drove down the profits of power plants. This caused many power plants, including some independent power providers (IPP), to fall into financial difficulties. Also, after 1985 power plants, as independent enterprises, must repay their investment loans so they insisted on bargaining with coal providers and governments. A report showed that the coal supply agreements for 2003 signed at the end of 2002 only covered about 40% of the total coal demand (CRI, 2003). This conflict finally caused coal reserves in many power plants to fall below the safe level, and sometimes forced the plants to stop generating due to lack of fuel. Although generation companies kept asking the government to allow the electricity price to float, this was not permitted until 2005 (Yang, 2005).

3.5 Environmental Consequences

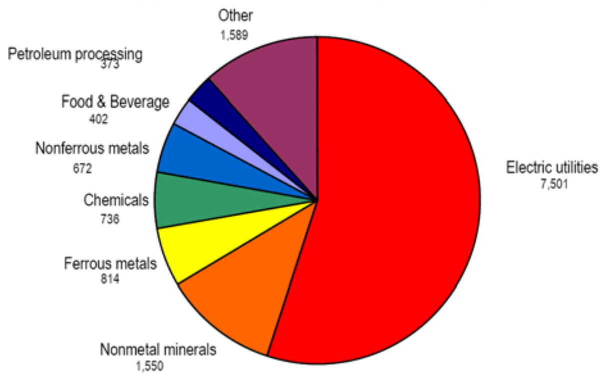
Chinese electricity generation heavily relies on coal. However, coal is a very dirty energy resource. The prevailing coal-fired electricity generating method is now a major source of greenhouse gases (including CO_2), NO_x, SO_2, and particulate emissions. Statistics shows that in 2002 about 40% of CO_2, 55% of SO_2 and 23% of particulate emissions were from electricity industry. On the average, generating 1000 kWh electricity produced approximately 0.21 ton of CO_2, 4.6 kg of SO_2 and 2 kg of particulate respectively in China[8]. Below are figures for CO_2 (Figure 5a), SO_2 (Figure 5b) and particulate emissions (Figure 5c) (CED, 2004).

Figure 5: CO_2, SO_2 and Emissions in China

(a) CO_2 Emissions (unit: million ton)

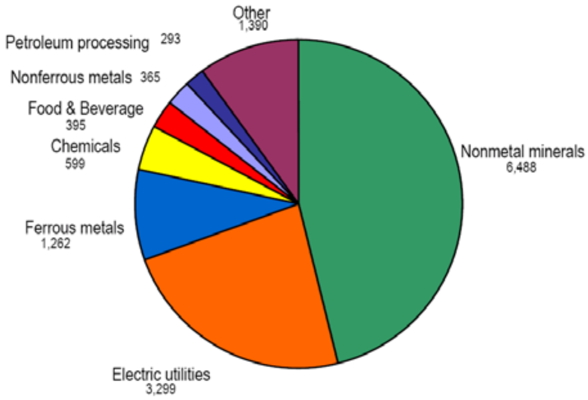


(b) SO_2 Emissions (Unit: kt)



(c) Particulate Emissions (unit: kt)

[8] In order to keep the consistency between data presented in this paper, the raw data for calculating CO_2 emission are also derived from CED (2004). Therefore, the estimate of CO_2 emission presented here may be different from figures published in other places.



With the rapid increase in coal-fired generating capacity, pollution from electricity generation has caused enormous environmental damages and social economic costs. For example, a world bank study estimated the total costs of regional air pollution damage in China was $48 billion in 1995 (7% of GDP). Also, each year an estimated 178,000 Chinese in major cities suffer early deaths because of air pollution in excess of standards (World Bank, 1997). As a consequence, how to balance the development of electricity industry and the environmental protection has become a challenge to sustainable economic growth.

In practice, China has its environmental levies, but the effectiveness of levies in promoting environmental technology diffusion is often criticized – the average annual emission fee paid by each assessed enterprise is 10,500 Yuan (US $1,270), which represents less than 0.1% of the average output value of a Chinese State-owned firm (Watson *et al*, 2000). Thus, it is hard to believe that such a low levy could stimulate investment in cleaner technologies.

Generally speaking, the ongoing electricity crises display their political, economic, and technical features, some of which are chronic problems dating back to China's 'centrally planned' era. The later parts of this article will explain this in more detail. International practices tend to allow the electricity wholesale market to determine the tariffs on the generation side while an independent regulator regulates transmission and distribution price. To achieve this objective, China has to undertake in-depth electricity reform. In order to mitigate the ongoing crises, China has to reexamine its past electricity policy and industrial governance.

Section 4: Electricity Industry under Planned Economy

Electricity industry is an inseparable part of any economy and inevitably affected by the broad national economic environment. Therefore, in order to clearly illustrate what has happened, or is happening, in the electricity industry, it is necessary and helpful to look at the broad picture of the national economy. The post-1949 Chinese economy could be roughly divided into two stages: From 1949 to 1978 a 'centrally planned economy' (or command economy) was created, but after more than two decades, general economic difficulties forced China to launch its economic reform. This starts the '*reform stage*', begun in 1979 and still ongoing. The planned economy has been gradually dismantled and the market economy has been built up step be step. Given its widely acknowledged importance, many accounts, both on China's planned economy and economic reform, are currently available (e.g. Prybyla, 1978; Perkins, 1988; Naughton, 1995; Bramall, 2000). Therefore, only some of the key and related developments are mentioned here as background information to help us understand the focus of the following section – what has happened and is happening in China's electricity sector.

4.1 Ownership Structure

When the Communist Party came to power in 1949, it was ideologically opposed to capitalism and a system based on the profit motive, so with the founding of the People's Republic of China, collectivization and central planning were introduced with the aim of maximizing social welfare. The Chinese version of a 'centrally planned economy,' like those in east European countries, was a highly centralized hierarchy and quantity based supply-and-demand balancing mechanism. In a sense it was an imitation of the economic system of the Soviet Union. Under this system, most productive assets, including land, were taken into state or collective ownership. In comparison, private ownership was trivial.

State assets concentrated in more modern, capital-intensive industries and mainly came from nationalization[9]. Soon after the Chinese Communist Party came to power, electricity assets, which has been looked on as assets with 'strategic importance'[10], were confiscated from the defeated regime and put into the 'central planning' system. These assets became the earliest state-owned enterprises (SOE) in the electricity sector. After 1949, within a stable social environment, the electricity industry made rapid progress. From 1949 to 1978, the installed generating capacity increased from 1.85 GW to 57.12 GW (SPIN, 2004). During this period, the Chinese electricity industry had a sole state ownership structure.

4.2 Industrial Governance

Although the ownership structure is important, 'operational control over assets and the

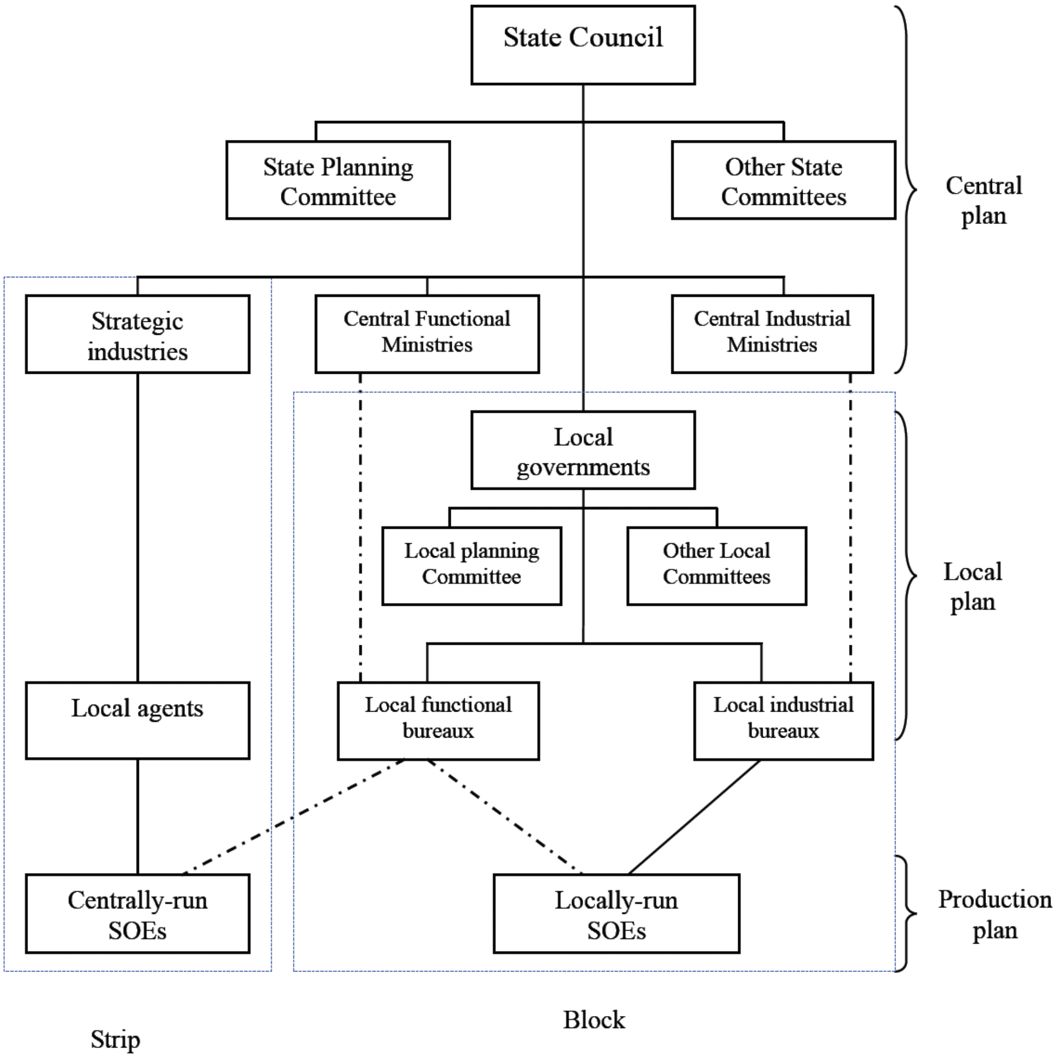
[9] In terms of different ownerships of assets, the government adopted different nationalizing strategies. For assets controlled by the defeated former regime and its high bureaucratic governors (called '*bureaucratic capitalist assets*'), the new government directly confiscated and put them into the 'central planning' system. For general private assets (called '*nationalist capitalist assets*'), the new government took a strategy of buying out the private ownership. From 1949 to 1952 nationalization was first launched in the industries with strategic importance, such as banking, steel, electricity and international trade, and then from 1953 to 1956 the nationalization was extended to other relatively less important industries, for example, commercial and service (Wu, 2003).

[10] Whether an industry is of 'strategic importance' is normally judged by its 'strategic heights' of the economy (the Leninist notion), which usually mean '*(a) size in terms of employment and/or output; (b) technological level; (c) importance for national defense; (d) dependence on imports of capital equipment from abroad and importance for exports; (e) strategic position in the national economy as a producer of key capital goods; and partly as a consequence of all these, (f) dependence on investment allocations from the central state budget*' (Henle, 1974).

extent of that control granted to the actual holder of the assets are economically more significant' (Prybyla, 1978). In order to achieve its economic goals, the state devised a complicated pyramid hierarchy of industrial governance, within which centralized methods (strips) and decentralized methods (blocks) were simultaneously used.

So-called 'strips' and 'blocks' are in fact two different kinds of command channels. 'Strips' represent direct control of SOEs by central government. Traditionally, it is used to control industries with 'strategic importance'. 'Blocks' refers to a way of directing the economic operations of SOEs in term of the administrative regions in which they are located (Figure 6). The ranges of both 'strips' and 'blocks' were not fixed. After 1957, aside from a relatively few SOEs entirely owned by central government, control of the majority of SOEs passed to provincial governments (Child, 1994). Although there were many institutional changes between 1949 and 1978, the basic structure of this hierarchy changed little before 1978.

Figure 6: Hierarchy of the Centrally Planned Economy



Note: Real line - an administrative relationship.
Broken line - (1) a regulatory relationship
or (2) a technical and advisory relationship

Under the central planning system, the electricity industry was structured as one 'strip'. The industrial governance of electricity could be roughly divided into three levels: *central, local and enterprise.*

- *Central level*

At the highest level of government, the State Council has sole power to legislate detailed economic rules for the implementation of laws passed by the People's Congress.

The State Planning Committee (SPC) is the major department of economic management under the State Council and its main function was to control the macroeconomic balance, make middle-term and long-term plans (for example, the five-year plans) for national economic development, and propose policies for national economy, scientific and technological innovation, and social welfare. Plans for electricity development were only one part of the national development plans. The SPC was made up of ministers from various related ministries, such as the Ministry of Finance, the Ministry of Materials, the Ministry of Labour, the Bureau of Price, the Bureau of Statistics and the National bank (Zhang, 1993). Its cross-ministry character ensured its planning authority.

The Ministry of Electric Power (MEP) was the functional government organ under the State Council to manage all national electric assets[11]. In principle, it was responsible for:

- Working with the SPC to determine electricity policies and development strategies.
- Developing rules and regulations in the electricity industry.
- Proposing development plans for the industry.
- Managing the electricity generation and supply.
- Working with the SPC to approve generation, transmission & distribution projects.
- Distributing investment funds received from the central government appropriations to specific power projects (Sambeek, 2001).

- *Local level*

At the provincial level, the Bureau of Electric Power (BEP) was the local agent of the MEP and supervised generation and distribution SOEs in designated geographical areas. The provincial bureaux proposed industrial development and operation plans and had authority to directly control electricity generation, transmission, and distribution in designated regions.

- *Enterprise level*

At the base of the hierarchy were a huge number of SOEs. Each SOE, either power plants or transmission and distribution utilities, was only treated as the production unit, or the elongating arm of the provincial BEP. It did not have responsibility to increase assets or make profits. Its role was to implement directives from higher levels on a day-to-day basis. For electricity SOEs, their profits were remitted directly to the central fiscal authorities.

Within the pyramid hierarchy, the relationship between administrative office and SOEs

[11] Before 1988, it was the Ministry of Electric Power and Water Resources Utilisation under the State Council that controlled the electricity assets. In 1988, the Ministry was split up in two – the Ministry of Electric Power (MEP) and the Ministry of Water Resources Utilisation (MWRU). The MWRU has since then managed and operated small and medium hydropower plants and small grids in about 600 counties (Sambeek, 2001). Other electricity assets, including grids, fossil-fuel power plants, and large hydropower stations, are subordinated to the management of the MEP. For simplification here and after the author just mentioned the MEP.

was complicated. All of the enterprise managers were selected and designated by the higher-level office and had corresponding ranks in the governmental hierarchy. They could manage a SOE and be a bureau officer at the same time, so administrative office and enterprise, economic activity and political directive, were never clearly separated.

4.3 Planning For Electricity Development

Under the above hierarchy, planning represented more than just economic behaviour. Prybrla (1978) summed up four major principles of Chinese planning, but we consider just two of them. First, politics. Economic planning must work for the political objectives and social goals of the Communist Party and the State. Economic growth may be preferred, but not at the expense of the system's moral and political philosophy. Second, the relationship between the whole and its parts. For any unit of state, self-interest must at all times be moderated by the larger interest of the state as a whole. The plan targets, once set, could not be changed without the permission of the planning authorities; central plans were the starting point for local plans. Local plans should not contradict central plans. SOEs, both those locally and centrally controlled (Figure 6), organized their production based on plan indices directed to them. They could make production plans to guide their daily operation. In general, plans made by the lower levels had to be approved by the higher level planning authorities before they went into effect.

4.3.1 Functions of Planning

Plans had two main functions: First, to allocate resources between current consumption and investment for the future. Given China's poor economic endowment in the 1950s and its ambition to industrialize the national economy, the only way for planners to accumulate resources was by depressing social consumption. During this period, a unitary government finance system was constructed to ensure the redistribution of economic resources.

Second, to balance inputs and outputs for each industry and firm. Since the objective of developing heavy industries was paramount, a material balance system that guaranteed control of resources best suited the planners. The system as least had three interlocking components (Naughton, 1995: 29):

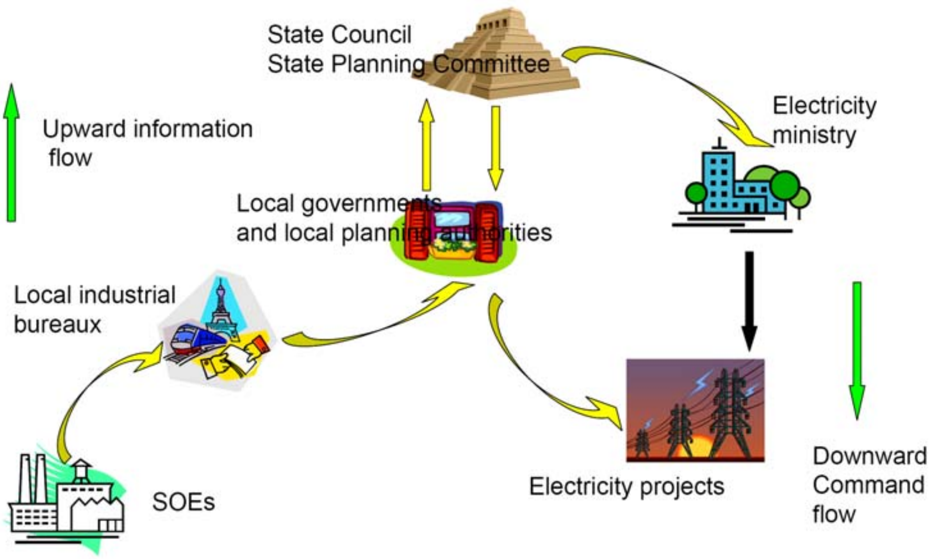
> *an output plan for individual producers, a supply plan that transfers resources among producers, and a schedule of material usage coefficients or norms that links inputs and outputs for individual producers.*

In other words, the material balance system treated the planning of society's output as an elaborate arithmetical exercise. At the microeconomic level, planners had to match up the inputs and outputs for each industry and even each SOE. For example, planners had to arrange coal supply, labour, generation, transmission, etc., for a coal fired power plant.

4.3.2 Balancing Procedures for Electricity Supply and Development

In any economy, electricity supply and development are based on the prediction of the future electricity demand. In a market system, decisions are collectively made by independent market entities, including power plants, utilities, consumers and, probably, a regulator. However, the balancing procedure for electricity under China's centrally planned economy was a two-way process, 'an upward information flow' and 'a downward command flow' (Figure 7).

Figure 7: Centrally Planned Balancing Procedure For Electricity



In practice, upon receipt of the plan indices directed to them, SOEs had some operational discretion in making their production plans. Based on production factors (for instance, production capacity, labour skills, technical innovations, etc.), SOEs broke down the plan indices into various input factors and then fixed their production plans. In this process, the figure for electricity consumption was estimated. The consumption figures from different SOEs were pooled at their supervisory industrial bureaux, summed up at the local planning organs, and finally gathered in the Central Planning Committee. This was the 'upward information flow'.

To determine electricity demand, planning committees compared available generating capacity with current and future electricity demand. Based on these results, the SPC directed the MEP and local governments to build new power plants to meet future electricity demand. This is a process of 'downward command', within which various flows of commands were sent from the top of the hierarchy down to the bottom electricity SOEs.

For new electricity projects, the SPC had ultimate authority for project approval, budget allocations, arrangements for fuel suppliers, equipment, construction force and construction time, etc. The MEP was in charge of construction; it worked with local governments to carry out the detail building plan. Once completed, new power plants were brought into the planning system as production units.

Within this system, issues of electricity demand and supply, location of new projects, and personnel arrangement, etc., were examined, discussed, and reconciled in a series of meetings at various levels. When electricity was in short supply, the administrative authority also allocated consumption quotas among different regions and consumers. Frequently in the past, quotas of electricity supply and consumption were balanced by political bargaining power.

It is worthy of note that the electricity demand of collectively owned enterprises (COE) and the residential sector are not mentioned above. This is because, before economic reform, COEs mainly worked as subcontractors of big SOEs or produced daily consumables for neighbourhoods. They largely distributed in more traditional, labour-intensive, semi-mechanized industries, either in urban or rural areas. The number of COEs was enormous, but their function in the whole economy was supplementary (Bettelheim, 1974). Therefore, given their small scales, a certain percentage of leeway could easily cover their demand for electricity. So did the electricity consumption in residential sector.

4.4 Electricity Pricing Under Central Planning

The price system was strictly controlled by the planning system. Unlike prices in a market economy, prices in a planned economy were not expected to play an autonomous guiding function. It had the following characteristics:

Prices were set by the central or local price bureau. They reflected the pricing intentions of planners rather than the demand-supply relation in the market.

Prices were used to depress consumption. Except for goods judged by the state to be ‘essential’ (e.g. food and medicines), they were set at high levels relative to average money earnings (Prybyla, 1978).

Prices served as a tool to redistribute social resources. ‘Profits’ on final industrial products were set very high. SOEs’ profits remitted to the state fiscal authorities accumulated a very large state share of national income. This funded the state’s ambitious investment programs.

As in the rest of the economy, electricity prices within this period were set by the governmental price organs and did not reflect the real demand-and-supply situation.

The electricity price setting system was opaque and economically irrational in terms of market concepts.

4.5 Problems of the 'Centrally Planned' System

The planning system was initially designed to meet the requirement of large-scale production. However, in practice, this system displayed numerous problems.

Firstly, separation of 'strips' and 'blocks' caused low management efficiency. In practice, contrary to planners' intentions, control of 'strips' and 'blocks' impeded each other. Both 'strips' and 'blocks' actually represented two different administrative channels. The main feature of administrative relationship was through the top-down hierarchy using administrative commands. As a result, relationships between SOEs within 'blocks' and those within 'strips' were cut. This damaged economic collaboration between SOEs. In order to solve this problem, from 1970 to 1974 the planners passed more controlling power to provincial administrations (Donnithorne, 1974). Despite great efforts, the problem was not solved. In the electricity sector, this separation created many difficulties for electricity enterprises in getting real information about demand.

Secondly, the relationship between the central and provincial governments was not always smooth. This relationship had two sides. On one side, if the central government maintained tight control over the national economy, provincial government lost their incentives to adapt central directives to local conditions. Because China is a huge country with an unevenly developed economy in different regions, it is impossible for central government to grasp all the economic details necessary for an overall panacea-like economic plan for all regions. Therefore, loss of provincial government incentives to some extent implied a failure of central directives in that part of country. On the other side, if the central government loosened control and gave more freedom to provincial governments, although local incentives and working efficiency could improve, it always caused loss of uniform order. Sometimes the variances in different provinces could make the whole planning process chaotic. Therefore, in order to avoid the error of 'commandism' or arbitrary 'planning from above' and its opposite, unapproved 'spontaneousness', time and effort were spent on consultation (if not 'bargaining') between planning bodies at different levels (Prybyla, 1978). This was, and still is, a regular cycle of 'tight control' and 'loose control' in Chinese national economic life. In the electricity sector, because for a long time central government had not solved the annoying electricity shortage, local governments generally had the incentives to develop electricity projects in their regions. However, given the 'centrally controlled' feature of the electricity industry, local governments' incentives were constrained.

Thirdly, manipulation of price reduced the vigour of the national economy. On the one hand, because all the income streams were artifacts of controlled prices, sources of any particular income stream were not emphasized (Naughton, 1995). This hit SOEs' enthusiasm to improve their working efficiency. This is also the case in the electricity sector. On the other hand, the controlled electricity price, relative to low income, depressed the consumption of electricity. This created a slow increase of electricity demand in residential and commercial sectors.

Fourthly, there were many social burdens on SOEs. Guided by the ideology – 'Socialist production is not for profit, but for people's welfare', SOEs, including those in electricity sector, took on a lot of social responsibilities. Above all, given the large population of China, SOEs generally had surplus low-skilled workers. This unfavorable situation became even worse when dismissal in both state-owned and collectively owned firms was not allowed. For instance, statistics showed that in 1979 there were only a little more than 20,000 quits and dismissals, approximately 0.03% of the total labour force in the state sector (China Labor Statistics, 1990: 218). Permanent employment not only caused extensive potential unemployment, but also prevented SOEs from adopting high-quality human resources. All of the above reasons caused per capita productivity, which was originally very low, to become even lower. Additionally, SOEs had other social responsibilities. For example, they had to build schools, hospitals and houses, and provide retirement pension, medical insurance and other benefits, for their employees free of charge. A series of rules and regulations were set up to ensure these burdens were implemented under the planned system. The heavy social burdens further constrained the economic vigour of SOEs.

The 'planned economy' was largely disturbed during the Cultural Revolution and it was restored during the period 1976 to 1978, before China embarked on its economic reform. It is this reform, together with those structural characteristics inherited from the former centrally planned regime, that has shaped the present pattern of China's economy.

Historically, the 'centrally planned' development pattern made a great contribution to both the electricity industry and the whole national economy. It made it possible for China to use limited resources to build a relatively advanced electricity industry in a rather short period. However, the high inefficiency of this system would never meet the soaring demand for electricity in the country. This appeared even clearer after the Chinese government began to liberalize its economy in 1979.

Section 5: Electricity Industry under Economic Reform

China's economic reform was both an immediate reaction to restore a national economy largely damaged by the Cultural Revolution, and a desire to transcend the limitations of the 'Centrally planned' system (Child, 1994). The reform, as officially announced, was started in December 1978 at the Third Plenum of the Eleventh Central Committee meeting of the Communist Party of China. When it was launched, there were no successful precedents for reformers to imitate. The reform, therefore, was designed cautiously and evolutionarily to improve economic efficiency and increase the scope of the market for resource allocation. The Chinese old metaphor – 'groping for stones to cross the river' – vividly describes this stepwise learning process. In so doing, many of elements of reforms have inescapably been time dependent (Naughton, 1995). Due to its great importance to the stability of the national economy, electricity reform was not started until 1985. Since then, a series of reforms have occurred in this sector.

5.1 Chinese Economic Reform

In retrospect, Chinese economic reform can be divided into two stages. The watershed was 1993 when the Chinese Communist Party historically decided to give up the 'Centrally Planned economy' and to embrace the market economy[12]. Earlier, reforms were designed to respond to particular constraints in the planning system, but since 1994, reform innovations have displayed clear market-oriented characteristics. The government started to 'retreat by means of privatisation, corporatization, and securization' (Qian, 2001: 297). Up to 1993, the main focus of economic reform was to invigorate the old economic system, but since 1994, the main focus has been to build a new institutional structure to serve the 'socialist market economy'.

5.1.1 Reforms in Industrial Governance

Reform of industrial governance is a process to restructure the relationship between government and enterprises. Under the old 'central planning' system, the planning committee made plans for both the macroeconomic environment and microeconomic units. SOEs were merely production units and not true business entities. In 1984, on the basis of substantial progress achieved in a number of areas of reform, the government decided to deepen industrial reforms, focusing on increasing SOEs' autonomy (CPC, 1984). Since then, a series of policies have been issued to enhance the role of the market in the national economy. SOEs gained more freedom to plan their own production, pricing and marketing in tune with market changes. The role of governments' organs was also redefined as 'service provider' and required not to interfere in enterprise management. According to Child (1994:39), these policies have mainly involved:

- *Changing the distribution of property rights (in the sense of a right to use assets) away from the state through the de-collectivization of agriculture, the deregulation of the economy (including easing of the right to establish collective and private firms) and decentralization of much remaining regulation, and the easing of access by firms to the factors of production;*

[12] The milestone for this was the November 1993 decision of the Chinese Communist Party – 'Decision on Issues Concerning the Establishment of a Socialist Market Economic Structure'.

- *Shifting from the hierarchical administrative regulation of economic transactions towards a system of market regulation guided by the state;*

- *Strengthening the management system within producing units through an enhancement of managerial competence and discretion;*

- *Improving incentives by linking remuneration and responsibility to performance through incentive payment schemes and responsibility systems.*

With the development of a market mechanism, the role of planning gradually faded from the centre of the national economy, and a new relationship between government and enterprises was built up. This change could be measured in terms of the number of commodities subject to 'output planning'. For example, in 1988 the number of products subject to output planning was 45 and the number of inputs distributed by the central government was 27, compared to 316 and 256 respectively in 1979 (Beijing Review, 1989). This clearly displays a retreat of government's intervention on SOEs' operation.

As SOEs were gradually transformed from production units into market entities, private firms and foreign-invested ventures also gained legal recognition and expanded rapidly. Deregulation of industrial governance since 1984 has directly stimulated a rapid development of the national economy. The new relationship between government and enterprises could also be seen from changes in ownership structure.

5.1.2 Price Reforms

In order to ensure stability and guarantee the attainment of some key government priorities (primarily assets in energy and infrastructure), the old pricing system was not dismantled immediately.

Initially, a 'dual-track pricing system' ('shuang gui zhi'), was introduced, i.e. 'the coexistence of a traditional plan and a market channel' for the allocation of certain goods (Hussain, 1990, 1992; Naughton, 1995). Under the plan track, economic agents are required to produce fixed quantities of goods at fixed plan prices as specified in the pre-existing plan; provided that economic agents fulfill their output quotas, they can sell their extra goods at free market prices. This was obviously a cautious way to move forward – introducing market transactions at the margin whilst maintaining administrative planning (Hussain, 1992). For agricultural commodities, the market track emerged in 1978-1979 when government lifted restrictions on the private trading of rural residents. For manufactured goods, the market track dates back to 1984 when SOEs were permitted to sell their above-plan output at negotiated prices. In the electricity sector, we also can find this 'dual-track pricing system'. As explained in section 3.4, in 1993, apart from coal for electricity, the coal price was marketized.

However, in the electricity coal sector, between 1993 and 2001 a guided coal price set by the SPC still functioned like an anchor constraining the price increase of coal.

One desirable feature of the dual-track approach is its minimal requirements for new information and institutions. Compared to the ‘big bang’ style of full liberalization strategy, this approach provided a useful way to implement a reform with minimum political opposition and social chaos (Lau *et al*, 2005). However, as the economic reform went deeper and wider, the dual-track system became increasingly untenable. In practice, market prices were seldom in tandem with, and invariably higher than, plan prices. The dual-track displayed two harmful effects: firstly, with the increase of SOEs’ autonomy, they tended to sell more industrial goods at market prices which adversely affected the implementation of output plans; secondly, it ‘[segmented] the market and [gave] rise to a bewildering multiplicity of prices for the same manufactured good’ and further ‘[spurred] large-scale ‘rent seeking’ by officials and Party cadres (buying goods at the lower plan prices for sale at the higher market prices)’ (Hussain, 1992: 25). In retrospect, this consequence does not seem surprising – although the dual-track system had favourable effects on minimizing the political opposition and stabilizing the process of economic reform, it was in fact, an attempt to combine two incompatible pricing mechanisms. Therefore, there was no doubt that the dual-track pricing system would fade out of national economic life. After more than a decade’s economic reform, the market situation was greatly changed. By 1993, more than 90% commodity prices had already been decided by market mechanism (Naughton, 1995).

What is worthy of note is that price reform and the dual-track system was strictly confined to the SOEs’ sector. Most collective, private, and foreign-invested enterprises have been predominantly market-oriented from the beginning (Naughton, 1995).

5.1.3 Changes in Ownership Structure

There are three factors that could be seen as major contributors to ownership transformation. Above all, the shift of investment funds from the government budget to bank loans made it possible for non-state enterprises to use the limited social resources. Under the planning system, the government budget was the major resource of investment funds but, after reform, the function of investment allocations from the government budge decreased (Hussain, 1990; Naughton, 1995). Since 1984, like other SOEs, banks have been allowed financial and operational autonomy and gained the power to control their lending operations. Although it is still difficult for small non-state enterprises to get bank loans, this shift of investment funds has considerably weakened government control over investment and diversified the final usage of social resources.

Secondly, there has been a ‘tide’ of retreating state assets from the industrial area. After more than 10 years’ reform, the government began to understand that there could be more than one pattern of state ownership. In 1991, two milestones in ownership change were reached: In 1991 two stock markets were opened, one in Shanghai and the other in Shenzhen Special Economic City. Shares of selected large SOEs have been sold to various investors since then. Although government remains overwhelmingly the largest shareholder, it indicates a move towards diversifying the ownership of state assets. And since 1991, local governments have been permitted to deal with the small and medium-size, less profitable SOEs. Many of them were sold to private investors. In a sense, 'the traditional state-owned sector is being nibbled away from both ends' (Naughton, 1995).

Thirdly, the 'open-door policy' attracted a flood of foreign investment. Before economic reform, there was little foreign investment in China's national economy. However, after reform, particularly after the legal recognition of foreign property rights, the huge undeveloped Chinese market becomes a 'gold mine' for foreign investors. Statistics show that the amount of foreign capital invested in Chinese market between 1979 and 2002 was a massive 623.42 billion USD (NBSC, 2003).

Last, the growth of non-state enterprises is much faster than state enterprises. Under the planning system, SOEs played a major role in the national economy. Both rural and urban collectives, by virtue of their smaller size, had not been emphasized too much and only treated as complementary capacity to SOEs. Compared with SOEs, they were less subject to economic regulations and generally operated more flexibly and efficiently. Therefore, when the government allowed the non-state sectors to flourish, these collectives, together with emerging private firms, quickly responded to market changes and grew much faster than SOEs.

Generally speaking, reforms in industrial governance, price system, and ownership structure greatly changed the economic 'ecosystem' in China. In so doing, the national economy has made a long-term rapid progress and also exhibits a trend of 'growing out of the plan' (Naughton, 1995).

5.2 Electricity reform

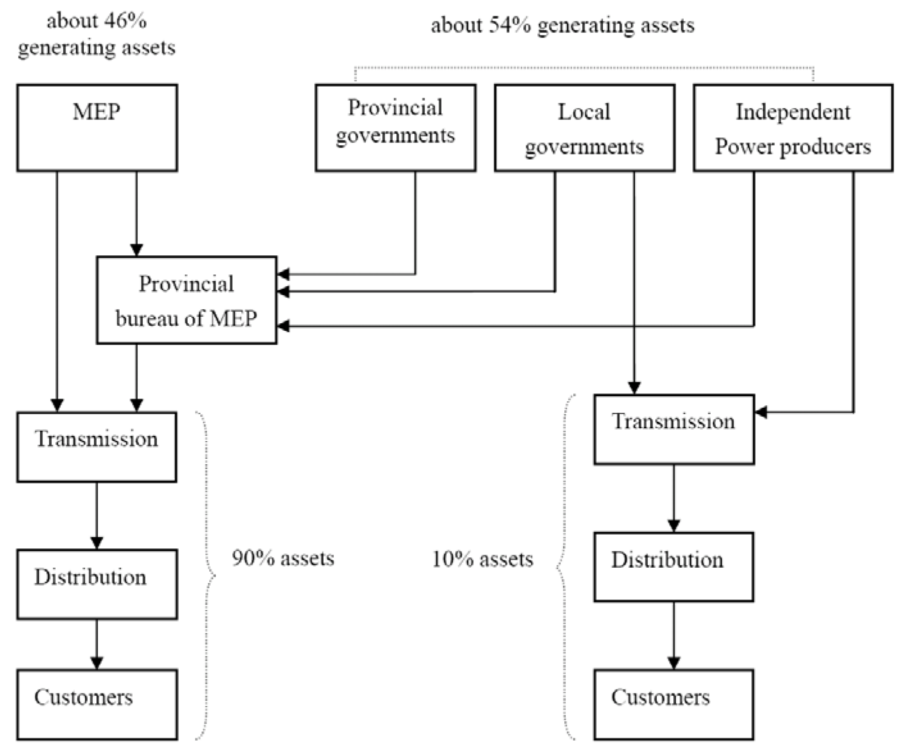
Reform in the Chinese electricity sector is a continuous process as a consequence of broader government and market reforms. Since 1985, a series of reforms have happened in this sector. Many of them are interrelated and processed more or less in parallel to each other. To understand the changes during this transition, as well as the factors driving the reform, this section will concentrate on describing reforms on the investment mechanism, industrial governance and introduction of competition.

5.2.1 Reforms on the Investment Mechanism

The highly centralised hierarchy of the electricity industry impeded the rapid expansion of the power sector needed to sustain high-speed economic growth. For decades, the electricity industry had relied on state investments. However, after 1979, constraints on enterprises were gradually reduced and China’s annual economic growth rate often reached 9%, or higher. In line with this, the demand for electricity increased very fast and supply shortages became more serious than ever. Reports showed that in the mid-1980s, supply shortages often forced factories to shut down their production line four days out of every week (GETRC, 1999). The serious shortage of supply forced central government to decentralize some of the decision-making authority concerning power development to local governments.

In 1986, in order to raise more investment funds for electricity development, central government started to allow local governments, enterprises and foreign companies to invest in the power sector. Firstly, central government adopted a policy of ‘anyone who invests in power plants, will have preferential use of electricity, and then will enjoy the profits’. Higher prices and long-term buying contracts for electricity were permitted. Typically, a 15% rate of return was guaranteed to investors. At the same time central government changed the rules for investment approval. Much of the decision-making authority for electricity projects with 50MW generating capacity or less was decentralized to local governments. Because local governments generally had strong incentives to rapidly expand the local economy and improve the local infrastructure, these reforms yielded a rapid expansion of the Chinese electricity industry. By the end of the 1990s, the proportion of generating capacity controlled by central government was reduced to less than 50%, although transmission and distribution remained under control of central government (Sambeek, 2001; Wang, 2002; Zhang and Heller, 2004) (Figure 8).

Figure 8: Electricity System after Early Reforms



Note: 1. This figure is modified from Figure 8: Electricity System After Early Reforms (Zhang and Heller, 2005).
2. Percentages represent shares of assets.

Secondly, the government allowed selected firms to raise funds, initially from the international stock market, and then later from domestic stock markets after their creation in 1992. Statistics showed that by 2002 at least three generating firms floated on foreign stock markets[13] and another 39 on the domestic stock markets (Wang, 2002).

All these measures relieved financial pressure on central government. For example, between 1996 and 2000 the proportion of investment funds from central government was reduced to about 44.6% of total construction capital. However, if we take both central and local government into consideration, they provided approximately 64% of total electricity investment. Therefore, the situation of electricity investment coming mainly from the government resources has not changed (Table 4).

Table 4: Construction Capital between 1996 and 2000

Capital raised (By Source)	US $ billion	Percent (%)
Total Construction Capital	70.4	100
Central government sources	31.4	44.6
Local government sources	13.6	19.4
Enterprise internal funds	9.2	13.1

[13] By 2002 they raised about $1.65 billion US dollars from the foreign stock markets in total.

Foreign investment	12.2	17.3
Other sources	4.0	5.6

Note: (Wang and Chai, 2001:266)

5.2.2 Reforms of the Industrial Governance

Reform of industrial governance should inevitably go hand in hand with changes to the investment mechanism. With the progress in reform achieved after 1985, central government increasingly recognized that combining administrative and business functions in the one government unit could not lead to effective implementation of electricity policies and did not benefit the development of the industry. In 1988, central government decided to separate administrative functions from management. Provincial electric power companies were gradually built up alongside provincial electricity bureaux. However, functional separation of resources, responsibilities, and personnel lagged far behind (Sambeek, 2001).

In 1995, China passed its first national electricity law, a milestone in the development of the industry. For the first time the law recognised investor's property rights and their protection. Also, for the first time state-owned power plants and transmission and distribution utilities became independent market entities. Prior to this, electricity enterprises' legal status came from other related laws. Thirdly, it legally established the separation of administrative and business management functions. Fourthly, for the first time the balance between environment and electricity development was emphasised; electricity enterprises were required to use new and renewable technology to reduce emissions and protect the environment. Last, but not the least, it left enough space for the government to launch further reform policies, for example, competition in the generating sector and electricity price reform (ELC, 1995).

5.2.3 Introduction of Competition

Since 1997 the Chinese government has started a new round of electricity reform. The objectives during this period focused on how to build an effective electricity market and introduce competition into the industry.

In 1997 the State Council created the State Power Company to take over production assets of the MEP, as well as its business management functions. In 1998, the MEP was finally removed from the administrative hierarchy and its administrative and policy making responsibilities were transferred to the State Economic and Trade Commission. Since then the administrative authority and business management function have been fully separated (Wang, 2002).

In 1999 the SPC selected five provinces and a municipality (Shanghai, Zhejiang, Shangdong, Liaoning, Heilongjiang and Jilin) to experiment with a competitive power generation market based on a single buyer system. The experiment followed a very crude English pool model, as noted by Zhang and Heller (2004: 34), for example,

> *Liaoning Province designed a '1 + n' model, that is, one grid and n generators. The province decided that certain power plants – including co-gen plants, hydropower, and a single unit with capacity less than 10 megawatts – would not participate in the experiment. Essentially, the power generators forced to participate were the twelve largest IPPs. For each, the total power capacity was divided into a contractual amount was dispatched as usual every day at the politically set price. The 10 percent beyond the contractual amount was bid into the grid at market price. The IPPs were free to make their own decisions whether to compete or not on a daily basis.*

The experiment of wholesale market competition began in July 2000 and suspended in 2001. The failure of this experiment was caused by various factors, one being the rapid growth of electricity demand in 2001. Other factors were more or less related to the inappropriate institutional structure of the Chinese electricity industry, including unfair competition, government initiatives for newer reform models, etc.

In 2002, based on international practices of deregulation, new electricity reform was launched to build a competitive electricity market. The reform reflected central government's intention to replace 'the central planning system' with the market. The State Power Company was dismantled. Its generating assets were reallocated into five generating companies (China Hua-neng, China Da-tang, China Hua-dian, China National Power, and China Power Investment, called 'the big five' below). Transmission and distribution (T&D) assets were split into two grid companies: a new State Grid Company, which manages the T&D assets in the north part of China, and a new China Southern Grid Company, which is jointly owned by the central government and Guangdong provincial government and covers five provinces (Guangdong, Hainan, Guangxi, Yunnan and Guizhou). After the 2002's restructuring, other IPPs previously outside the SPC are continuously expected to compete with the big five generators.

In tandem with the 2002 restructuring, an independent electricity regulator, the Electric Power Regulatory Commission (SERC) was established by the State Council in 2003, which was also the first supervisory body for China's infrastructure industries. The SERC is expected to carry out ongoing electricity reform, speed up the construction of laws and regulations, and most importantly, develop a successful electricity wholesale market. In the same year, China started trial operation of regional electricity markets. The pricing system of the regional market is set as a two-tier mechanism – about 80% of the demand is covered by the long-term annual bilateral contracts and the remaining is traded in the monthly and daily markets. The goal of restructuring the electricity industry, by the SERC, is to build six competitive regional markets across provinces. However, at present the provincial electricity market is temporarily allowed in some cases as an interim measure.

Electricity reform in China is still ongoing. Many plans about the wholesale market are still on paper, and its future has not yet been clearly seen.

5.3 Necessity of Market-oriented Electricity Reform

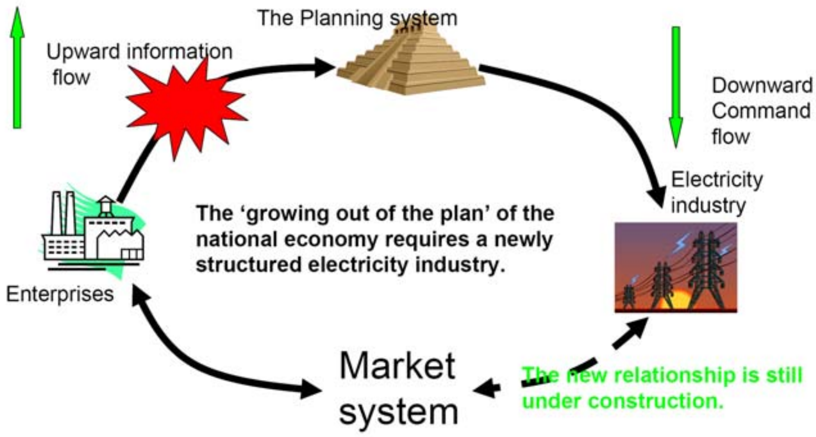
There has been a trend of ‘growing out of the plan’ since economic reform started (Naughton, 1995). This is because, on the one side, as the government reduced its intervention in SOEs' economic operation, SOEs gained autonomy to manage their operation according to market changes; on the other side, non-state firms, which were real market entities from the beginning, achieved a rapid growth. Both factors enhance the vigour of the national economy. As shown in the Table 8, after 1993 industrial output of non-state sectors has exceeded that of the state sector (Naughton, 1995; Story, 2003). Below is table for the industrial production under different types of ownership between 1978 and 1993 (Table 5) (Naughton, 1995).

Table 5: Ownership Structure of Industrial Production in 1993

Year / Ownership type	1978	1985	1988	1990	1993
State	78%	65%	57%	55%	42%
Collective	22%	32%	36%	36%	40%
Private	Neg.	2%	4%	5%	9%
Foreign	Neg.	Neg.	1%	2%	7%

‘Growing out the plan’ directly results in breaking ‘the upward information flow’, which is illustrated in Figure 7. Therefore, it is impossible for the planning committee to make an accurate prediction on electricity consumption as it did under the ‘central planning system’. There are two pieces of evidence for this argument. Firstly, in 1997 when serious electricity shortage had been temporarily removed, the state council arbitrarily decided to stop large investment in the electricity industry from 1998 to 2000. However, contrary to planners’ prediction, soon after 2000 the electricity supply became unprecedentedly tight. The above decision is now extensively blamed as one of the major faults causing the present shortage. Secondly, in the 10th Five-Years Plan of 2000, the SPC predicts the power demand growth at 6% over five years, but the actual increase is about 12% -15%. Evidence of this sort questions the existence of the old ‘central planning’ decision-making style in electricity industry. However, up to recent times, due to the slow reform steps in this area, the basic ‘centrally planned’ features of Chinese electricity industry, as described in the former sections, have not been substantially changed. Figure 9 shows the status quo of Chinese electricity industry.

Figure 9: Status quo of Chinese electricity



Section 6: Reasons for Electricity Demand Increase

In a modern society, electricity is a necessary input in the production process and in people's daily activities. Therefore, any factor with economic influence on the production process and people's daily activities will probably have an important impact on electricity consumption. In China, the soaring increase of power demand is closely related to the country's economic growth and its impact on living standards.

6.1 Economic Growth

It is generally accepted that there is a significant and stable positive correlation between economic growth and electricity consumption. This has particularly been the case in the industrial sector, which has been China's largest electricity-consuming sector for many years. In 2002, it accounted for about 70% of total power consumption (Table 1). Since 2002, the unexpected demand increase from energy-intensive industries was the main reason for the soaring increase of electricity consumption.

6.2 Burst of depressed electricity consumption

As mentioned before, electricity consumption was depressed under the planning system but after reform got under way and as GDP grew, the increase in people's living standards drove up electricity consumption in both urban and rural areas.

In urban area, residents' living standards have achieved a steady increase, and more and more households can now afford electricity-consuming luxuries, for example, air conditioning. This intensifies the shortage of supply, particularly in hot weather.

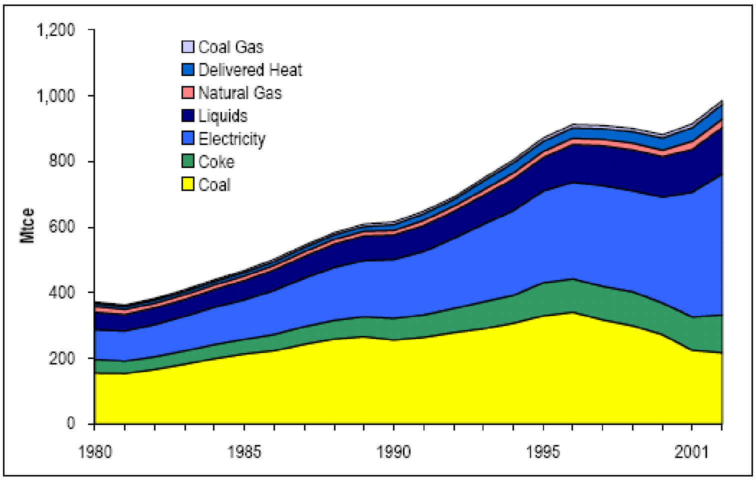
In rural areas electricity consumption growth was caused by two factors. With the progress of rural electrification it is now much easier for rural residents to access the electricity distribution network; as mentioned above, by 2001 there were only about 1.5% rural residents without electricity access (CED, 2004). The second factor concerns income effects; electricity price is an important factor affecting electricity consumption. For a long time electricity prices in China had been set administratively according to the supply cost, including generating, operating and maintenance costs, construction costs and a certain percentage of profit. Therefore, given the long distance and relatively low efficiency of the rural network, rural residents had to pay a higher price for electricity than urban residents. With the upgrade of the rural distribution network, by 2004 the rural electricity price has been lowered to the urban level. The decrease in the rural electricity price directly drives the growth of rural electricity consumption.

6.3 Changes in energy consumption paradigm

(1) Industrial sector

There was a decline in coal consumption after 1996, particularly by the industrial sector, the biggest coal consuming sector in China (Figure 10) (CED, 2004). There is a trend to replace coal with electricity to fuel production.

Figure 10: Industry Energy End Use by Energy Type



For example, between 1996 and 2001, coal consumption in the industrial sector decreased about 36.4% and during the same period electricity consumption increased by about 46% (CED, 2004) (Table 6).

Table 6: Industrial End-Use Energy Consumption by Energy Type, Selected years

Year	Energy Type (unit: Mtce)						
	Coal	Coke	Electricity	Petroleum	Gas	Other	Total

1996	339.90	101.41	293.92	114.72	19.49	41.89	911.33
2002	216.22	114.97	429.23	140.92	26.33	56.44	984.10

Apparently, coal consumption in the industrial sector decreased both in absolute terms and proportionally. Given the small increase in consumption of other fuels, it seems clear that there is a trend for industrial players to switch from coal to electricity.

(2) Residential and commercial sector

There is a similar trend of switching from coal to electricity in the residential and commercial sectors. It is the direct result of environmental protection efforts by local government. For example, in big cities, numerous small coal-fired boilers and stoves for private and commercial use were shut down for both energy conservation and environmental protection reasons. This also increased the electricity consumption.

Generally speaking, the increase in electricity demand is caused by various factors, which are more or less related to the country's economic growth. And the decline of coal consumption to some extent intensifies the ongoing electricity shortage. However, it does bring benefits, such as a reduction of CO_2 emissions and energy conservation.

Section 7: Way out Current Crises

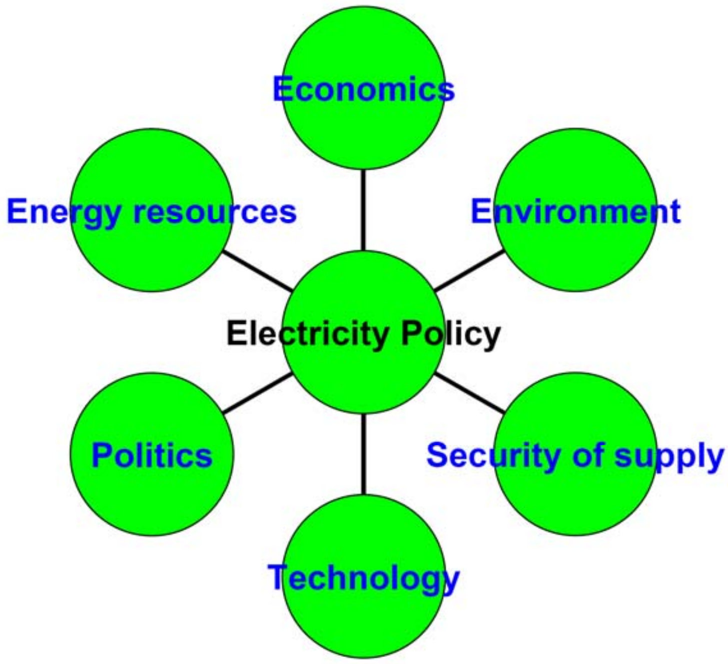
From the above analysis, we can see that the causes of ongoing electricity crises are multilevel. Some of them are inherited from the old institutional structure of the Chinese 'planning system'. Some of them are triggered by soaring electricity consumption along with rapid economic growth. However, whatever the real cause, the Chinese government has to re-examine its past practices in this sector. So the question is if past practice was unsuitable for the Chinese electricity industry, what should the new paradigm be? In order to cope with this issue, a new way of thinking about electricity is necessary.

7.1 An Integrated Model for Electricity Policy

In order to describe a suitable framework for electricity policy, the authors presuppose that a proper development strategy for electricity should at least consider the following aspects. Above all, despite some anomalies, the correlation between energy demand and economic development is widely accepted, therefore the electricity industry, which provides one of the most important energies in modern society, should be developed synchronously with the development of the national economy. Secondly, in order to advance overall socio-economic development, the development of the electricity industry should ensure the best use of scarce national resources. Thirdly, electricity policy should focus on achieving long-term welfare maximization. That is, development of the electricity industry should not be at the expense of the environment. Fourthly, electricity policy should encourage technological innovation and effective use of limited resources. This might mean a combination of energy-efficient technologies powered by a range of renewable and fossil fuels (Wilkins, 2002). Last, but not the least, a better designed electricity policy package should include a mechanism within which electricity enterprises are pushed to pursue a higher productive efficiency.

Based on the above, six interrelated factors can be defined as dimensions of electricity policy, namely, economics, energy resources, environment, security of supply, technology and politics (Yang, 2004). Thus, an integrated model for electricity can be illustrated as figure 11.

Figure 11: An Integrated Electricity Policy Framework



Starting from the above framework, some useful policy implications can be generated.

7.2 Way out the crises

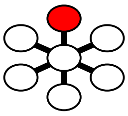
The history of Chinese the electricity industry is a story of how to expand generating capacity as quickly as possible. Under the long-term pressure of supply shortages, electricity policy displayed time-dependent and pragmatic features and does not take long-term social welfare into consideration. Therefore, the Chinese electricity industry has to be restructured. To ensure a successful outcome, a few of questions addressed by Murray (1998) could be adapted to the Chinese case:

- *What new structures should be put in place to foster competition and who should own and control the assets?*

- *What market conditions and mechanisms need to be put in place to support the new structure?*
- *How will the security of the power system and supplies be maintained?*
- *How will optimum levels of investment be encouraged and financed?*

Based on these questions, some suggestions are made as follows.

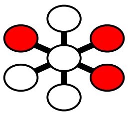
<u>Economics</u>



The driving force behind the restructuring of the Chinese electricity industry is the need to open the electricity generation market to all private participants. However, in a competitive market excluding the central planning, there is no guarantee on the investment return. Therefore, the real challenge in the restructuring process is how to ensure the market rules designed can send the right signals to attract sufficient investment to finance the development of the industry (Wu and Fu, 2005).

Facing the above challenge, some suggestions can be made. Firstly, the Chinese government has to make the policy framework more transparent and show potential investors that the growing power market still has a profitable prospect. Some constraints inheriting from the old central planning system, such as unpredictable legal and regulatory framework, still create an investment impediment (Sambeek, 2001; Zhang, 2003; SFO, 2004). These constraints have to be moved. Secondly, market design should exhibit some extent of policy consistency and compatibility. Lessons from the California Electricity Crisis in 2000 indicated how harmful an inconsistent electricity market design can be (Sweeney, 2002; Yang, 2004). Different aspects of market design should mutually complement each other to fulfill the ultimate objective of maximizing the long-term social welfare. Thirdly, although it is believed that a properly designed electricity market can promote efficient investment, it is too risky to rely solely on this untested theoretical approach. Some forms of approaches guaranteeing a high investment return might still be worthy of maintaining as a way to attract capital in a certain period.

<u>Energy resources, environment and technology</u>

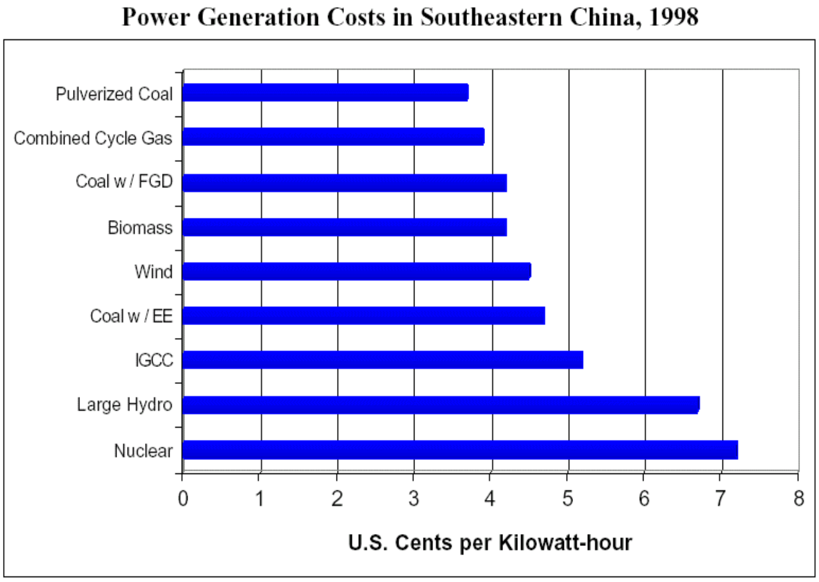


Energy consumption is closely related to the environment. Depending on the types of emissions you consider, some energy sources will appear cleaner than others. Today environmental concerns in electricity sector mainly concentrate on SO_2, NO_x, CO_2, and particulate emissions. Therefore, a good market design should provide the correct incentives for individuals to make choices consistent with society’s best interest. To do so, it is necessary to make individuals bear all the external costs of their choices. Contrary to this, to date in China building coal-fired power plants exhibits the features of market failure.

- The future of coal-fired power plants in China

For several reasons, coal will be the main fuel for electricity generation in the foreseeable future. Above all, China is a country with abundant coal and relatively scarce oil and gas resources. In the near future, if the Chinese government does not want to rely overly on energy imports, demand for electricity will continue to drive demand for coal. Also, coal-fired electricity is much cheaper than other alternatives in China, even if desulphurization is mandated. Below figure 12 is the comparison of power generation costs in Southern China in 1998 (Chandler *et al*, 1998)[14].

Figure 12: Power Generation Cost in Southern China, 1998



Note: Coal w/ FGD is pulverized coal power generation with flue gas desulphurization (dry scrubbers); Coal w/ EE is pulverized coal power generation with environmental externality; IGCC is integrated gasification combined cycle[15].

In order to reduce the negative environmental consequence of burning coal, it is necessary to develop clean-coal technology. So far these technologies are expensive compared to old coal-fired facilities. In a competitive market, private investors are often uninterested in social benefits and more concerned about how to avoid short-term financial risks. Therefore, an ill-designed electricity market will give the old coal-fired technology some competitive advantages because of their lower operating and construction costs. Then, in a competitive wholesale market, these old-style coal-fired

[14] As mentioned in section 2.3, in China coal mines are mainly sited in the north part. Generally speaking, coal price is cheaper in the north than in the south. So, comparison of power generation costs in this figure is also true in the northern China.

[15] Research assumptions used: externality fee of SO2 is $965 per ton; coal cost is $35 per ton for pulverized coal plants and $30 per ton for lowergrade coal in all other coal-burning plants; natural gas cost is $2.50 per gigajoule; transmission costs are not included (Chandler *et al*, 1998).

power plants could be more fully utilized (Parker, 2002). So, in order to break the ‘lock-in’ effects of coal-fired technology, governments need to step in and play an active role to promote the usage of potentially superior technologies.

- Environmental concerns

Coal is a very dirty energy resource. Burning coal for electricity results in many serious environmental and social consequences. Firstly, the extensive use of coal damages the sustainability of the Chinese economy. A World Bank study estimated the total costs of local/regional air pollution damage in China at $48 billion in 1995 (7% of GDP), including the impact of acid deposition and negative health effects from air pollution (World Bank, 1997). It could be expected that such costs will rise more quickly in the future if this situation remains unchanged. These negative effects absolutely oppose the government’s efforts to improve social welfare. Also, the Chinese government might be under diplomatic pressure from the international community in the future. So far, all possible consequences of CO_2 emission are subject to profound uncertainty (Hope, 2003). At present, the Chinese government tends to be more concerned with local environmental problems, such as particulate matters and SO_2 emissions (CCAB, 2003). However, in the future, countries which desire a reduction of CO_2 emission according to the Kyoto Protocol, might not find much comfort in China’s enormous coal consumption (Cragg, 2002).

- Emissions tax

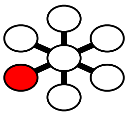
Consider the actual situation of burning coal for electricity in China – using coal does not reflect its external social costs. So, when building generating capacity, investors tend to build more coal-fired power plants than society desires. This tendency worsens the situation.

The electricity market is a defined mechanism. If the externalities of burning coal can be internalized into the market price of coal, then electricity sector investors will voluntarily act according to the new market rules. Therefore, a proper ‘emission tax’ added to coal price might help lower coal use and make the cleaner technologies more economical.

- Efficiency improvement

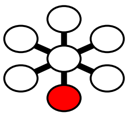
As emphasized above, market design should advance technological innovation and the increase of enterprise’s productive efficiency. In order to reduce the energy waste, the Chinese government launched its energy conservation program in the early 1980s. As small, wasteful generating units were replaced by larger, more energy efficient facilities, technical efficiency in enterprises, both inside and outside the electricity industry, achieved an apparent increase (Chandler *et al*, 1998). However, when compared with the advanced levels of productive efficiency in the world, existing facilities still have scope for progress (Yu, 1999). Therefore, for China, continuing its efforts to conserve energy and increase energy efficiency is a cheaper choice than adding new power plants.

Security of supply



Electricity is a very special commodity. Security of supply depends on a network infrastructure that must be maintained with system coordination (Parker, 2002). Coordination can be reflected in two aspects: (1) within a system, such as spinning reserves, voltage stability and system synchronization; and (2) between neighbouring systems, for example, managing congestion and avoiding system overloads. Both of the two aspects need more investment in transmission and distribution grids. Therefore, if China wants to use the extra reserve capacity in the west to meet the soaring demand increase in the east/south cities, transmission and distribution grids must be upgraded. Also, compatible models of dispatching electricity have to be unified between different regions.

Politics



Markets are always imperfect and may fail. Therefore, a healthy public policy system requires impartial evaluation and frequent monitoring of market performance under different rules and institutions (Chao and Huntington, 1998). International practice is to appoint an independent regulator to supervise the operation of the electricity market. As explained before, the present strict supervision system, which is inherited from the old ‘centrally planned regime’, has constrained the development of the electricity industry. However, a slack supervision system might also put the industry at risk of higher prices if power plants collude to escape regulation. So far electricity reform in China has only split the former State Power Company into five smaller firms. They remain state-owned. In a chess-like market game, the extent to which these generating companies will accept price competition remains questionable. The hope of competition and price reduction might not be realistic and a failure in supervision will jeopardize the whole reform. A watchdog, the State Electricity Regulatory Commission (SERC), has been established, but its capacity to oversee the industry has been widely questioned. The State Development and Planning Commission (SDPC) still retains the most powerful administrative functions for setting prices and approving new power plants. Such a competing and diffuse administrative structure will dampen the authority of the commission (PTAC, 2003). In order to build a healthy electricity market, the government still needs to improve the supervision mechanism, including improved regulatory structures and clearly defined transparent regulations.

In a word, a proper design for the electricity industry should consider the above factors and provide a consistent policy framework. In order to successfully complete the electricity reform, a wise strategy for Chinese policy makers would be to incorporate international ‘best practice’ of competitive electricity markets.

Section 8: Conclusion

The electricity industry is an integrated part of the national economy. Analysing electricity issues could not succeed without taking the broader economic environment into consideration. In China’s case, many ongoing problems in the electricity sector can be traced back to the old ‘centrally planned’ economy. In the reform era, the Chinese electricity industry needs a constructive reform.

Throughout the world, although there is no universal agreement on how to achieve the optimal arrangements for the electricity industry, the underlying theme of the reform is to replace government monopoly with competition (Murray, 1998). Following the international trend, there seem two merits in doing this: firstly, a market mechanism could effectively allocate social resources, for example, attracting more private investment funds into this sector; and secondly, market competition can help the Chinese electricity industry improve their low productive efficiency. However, so far electricity reform appears limited to symbolic institutional changes, rather than a real renovation of its former outdated ‘centrally planned’ management style. Further new market-oriented electricity reforms are necessary.

Research on international blackouts shows that simply liberalizing the electricity industry does not necessarily guarantee a successful electricity market (Yang, 2004). The market may fail. The wise strategy for governments might be to let the market work where it can do so properly, and where it might fail, government should create new incentives by redefining market rules to guide the future development of the industry. In doing this, the government needs a firm and clear understanding of the implications of electricity restructuring for long term social welfare. In China’s case, the final decision on restructuring should at least include the six aspects of consideration explained in the section 7. Otherwise, the electricity industry might inadvertently be locked into an inferior industry design again. This will be more costly to change in the future than it is to set up now.

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