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The Coal-powered Electricity Market in China

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Preface

This study was carried out as a final thesis at the Master Program in Energy Systems at the University of Gävle.

First of all we would like to thank our supervisor Stig-Inge Gustafsson, who gave us lots of advice and help during this thesis work, and commented our thesis several times.

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Abstract

China is rich in coal resources, possessing as much as 13 percent of world's coal reserves. With a vital role in domestic economic development, coal contributes to 70 percent of national energy needs. China's power industry mainly depends on thermal power plants, where the largest share of coal is consumed.

At present in China, generating and transmitting of electricity are completely 2 separated operating systems, particular different in monopoly level. For better communication between them and more effective and smooth working procedures, the State Grid Corporation of China (hereinafter referred to as SGCC) was established in 2002, under supervision of National Development and Reform Commission, which is in charge of making major policies concerning development. SGCC has multiple functions, both as governmental authority and as an individual company.

The electricity power market is experiencing a significant systematic reform which has been ongoing for over 10 years. Its main goal is to "Break monopoly, and introduce competition". In this reform, there are two big power grid companies and five major electricity generation groups established in the scheme of organization reform. These power grid companies are responsible for electricity transmission and the power generation groups are in charge of electricity production. One purpose of this thesis is to introduce deregulated market theory in China's electricity market. Only when generation, transmission and distribution are opened separately, can it achieve to reduce electrical energy cost and, as a result, lower electricity price. In the process of reform, several theory problems are discussed: Competition and monopoly, bidding for sale, the electric power system's big cycle and minor cycle.

Petroleum is regarded as a non-renewable resource and will be used up someday. Meanwhile, oil prices surge gradually, and with human society's full-scale development, new demand as well as new energy technology are stepping onto the historical stage. These factors are major reasons that the utilization efficiency for petroleum is lower than for any other energy. In order to ease the contradiction between energy supply and demand, we must minimize the share of un-renewable resources such as fossil fuels, and increase the new and renewable energy shares in the current energy structure. In one word, the long-term objective is to establish a sustainable-developing energy system.

New energy for electric power industry in China has two aspects: First, utilization of clean coal technology for electricity generation, and second, the renewable energy resource for electricity generation mainly consists of hydropower, wind power, biomass electricity generation, tidal power, and solar power generation and so on. The industry is still in its infancy and there's still a long way to go. The Chinese government will progressively increase the ratio of consumption of the high-quality, clean and renewable energy in the gross energy consumption from 7 percent in 2005 to 13 percent in 2020.

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1 Introduction of Chinese coal

1.1 Background of Chinese coal

1.1.1 Coal reserves

China possesses 13 percent of the world's proven coal reserves, 3rd in the ranking just behind United States and Russia. The north and north-west part of China own the main coal reserves, especially in Shanxi, Shaanxi¹ province and Inner Mongolia, which are called "Three-west" place noted in Figure 1.1, centered on 60 percent of the coal reserves. Six percent of coal reserves come from Sichuan, Guizhou, Yunnan province, and Chongqing City. Those places are mountainous regions far away from industrial centers. Therefore, the basic pattern of transferring north coal to southern areas and west coal to the east coastal region has been going on a long time. Approximately 70 percent of the coal output is transported by rail; the average transportation distance is 560 kilometers. These shipping charges increase the industry's costs.

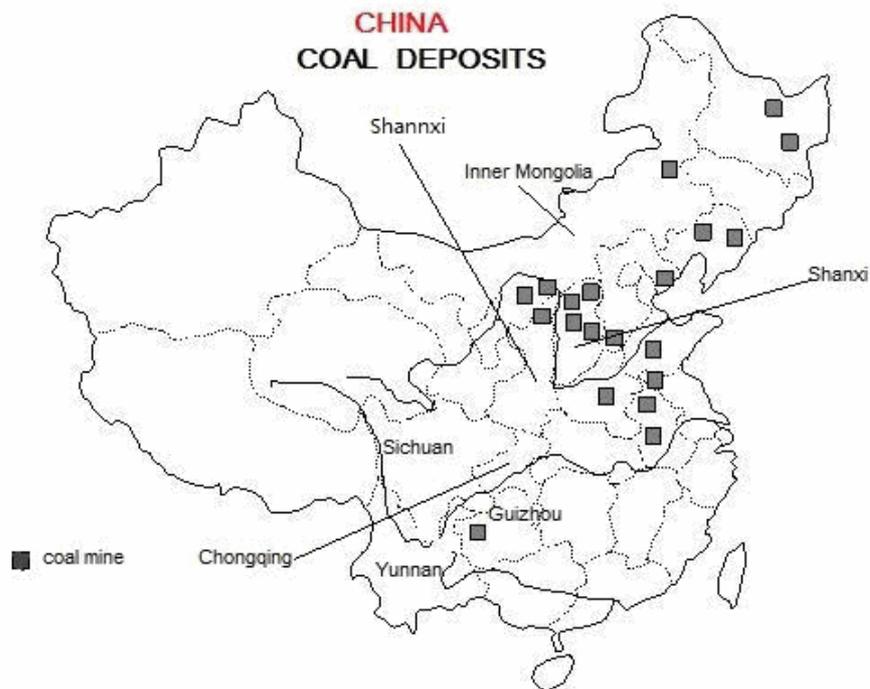


Figure 1.1, The coal deposits in China

China's coal includes two grades: coking coal which accounts for 28 percent and non-coking coal or steam coal, which accounts for 72 percent. Although China has rich coal reserves, the actual areas fit for opening exploitation are small, only 7 percent of the total reserves. Seventy percent are lignite coal. The main locations are Inner Magnolia, Xinjiang province, and Yunnan province.

¹ Shanxi and Shaanxi are two different provinces in China. They are both coal-producing provinces.

The majority of coal resources are buried deep in the earth, the coal bed distribution is complex and is unfit for exploitation, and different exploitation methods and scales are needed for different geological conditions.

1.1.2 Coal production and consumption

According to the Energy Information Administration (hereinafter referred to as the EIA), the gross amount of production and consumption of China's coal has grown fast during the last 20 years, which can be seen in Figure 1.2. Although demands for coal as fuel are declining in the world, China is an exception. Its large coal reserves and limited gas and oil reserves lead to increasing coal output and coal consumption in this large country. With the high output, consumption has increased at the same speed.

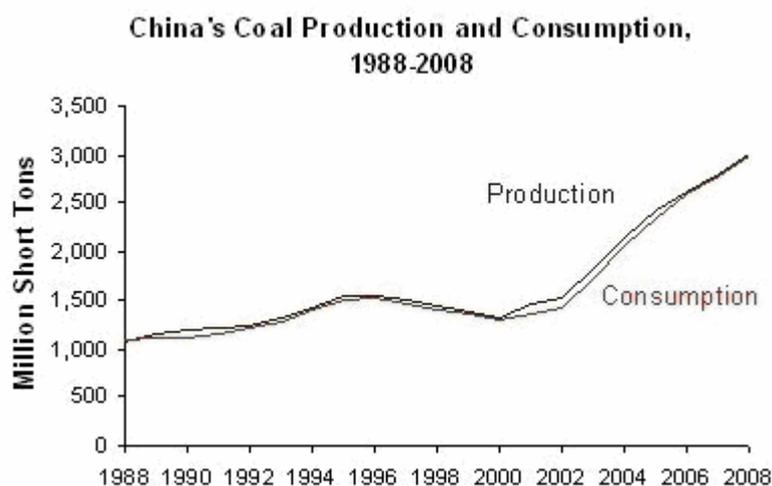


Figure 1.2, The coal production and consumption in China².

It is known that coal-exporting countries mainly have large reserves and production output exceeding their own domestic demand requirements.

China is the third top exporter of steam coal in 2005 behind Australia and Indonesia. Output rose 8.1 percent in 2006 over the previous year, reaching 2.38 billion tons, and the nation's largest coal enterprises saw their profits exceed 7 million SEK, 1 million dollars. Its output rose 8.1 percent in 2006 reaching 2.38 billion tons. However, with the continuing increased coal consumption, China is projected to constrain its export expansion. China became a net importer for the first time for 2007. Vietnam is the largest supplier of coal to China at 24.6 million tons for 2007. Australia exported 4.52 million tons for 2007.

Coal applies widely in our daily life. According to China's classification, coal has two main uses: steaming and coking coal.

1.1.2.1 Steam coal

Steam coal is used as the power for electricity generation, boiler combustion, and transportation, and so on.

The output for steam coal accounts for 80 percent of the total coal output in the world wide. Ten largest coal companies in the world are mainly produce steam coal. China's steam coal

² Short ton equals to 2000 pounds.

capacity takes up over 80 percent of the total coal production. In other countries, steam coal is mainly used for electricity generation, and industrial boilers also share a certain portion. About 55 percent of the coal consumption is classified into this aspect. However, in China, every field all needs coal as power.

1.1.2.2 Coking coal

Coking coal is used in iron and steel industry.

Compared with steam coal, the percentage of coking coal is relatively small. It takes up 10 percent of total coal in the world. The distribution of coking coal is 50 percent in Asian countries, 25 percent in North America, and 25 percent in other regions of the world. In China, coking coal takes about 13 percent in the world.

1.2 Coal industry in China

Coal continues to dominate fuel markets in China. The proportion remains steady at 70 percent of the energy resources. The situation can not be changed within a short time.

1.2.1 The process history of coal industry

As the most important primary energy in China, coal has significant influence on national economic development. After the Communist Party was established in 1949, the coal industry has experienced approximately three phases.

1.2.1.1 The planned economy phase (from 1949s to 1980s)

Like other industries, the coal industry in China also ran in the planned economy environment. That is, all the productive tasks were regulated by the state-owned companies. The companies' construction and development all depended on state investment. The production, sales, and price setting obeyed a government plan. Against this background, the country was in charge or in command of people's lives and works.

1.2.1.2 Extensive economy phase (from 1980s to first half of 1990s)

In the early 1980s, with the implementation of reform and opening-up policy, all business trend to be active. The coal, as the basic energy source, was in great demand. The nation's supply of coal was in jeopardy, which restricted the national economy. In this case, the government framed management policy for the coal industry. The state-owned companies are sped up their development, as well as encouraging small mines to be set up. On April 1983, the State Council issued a decreed "Eight measures with regard to speeding up the mines in villages and towns". In this document, the government proposed a policy of increasing local state-owned mines and small-scale mines, and at the same time advocating every kind of mines development simultaneously. The consequence was rapidly increased mines and low industrialization. At the end of 1997, the state has sixty-four thousands mines; there were small mines of sixty-one which approximately account for 94 percent of total production.

1.2.1.3 The improvement and rectification phase (from 1997-now)

Due to the extensive management policy, the coal industry increased rapidly but with low quality. With slow development in industry, chaos occurred in supply and demand market, which led to irregular competition and abnormal price. All the coal industry is in a bad situation. In the second quarter of 1996, it occurs the coal oversupply which lasts to the year

2000. The state large-scale mines were hardly able to operate. Under these circumstances, the state discontinued Ministry of Coal Industry. And the local government received the right to regulate the local coal enterprise.

The mainly decreed industry policies within three years currently included: "Opinions of promoting healthy development of coal industry by State Council" in June 2005, "Opinions of picking up structural adjustment in coal industry and dealing with overcapacity" in April 2006, "The eleventh Five-year plan for coal industry" on January 2007, and "Coal industry policy" in December 2007³. The above mentioned policies had revolutionary consequences for the future coal industry.

The raised market access: "Coal industry policy" figured on the market access, within the "eleventh five-year plan" period, the government said no to new mine projects whose annual production is less than 300 thousand tons, and made strict standards on the aspects of safety, environmental protection, and energy conservation. This restricted the small-scale coal-mines' development and promote large-scale ones.

Large-scale enterprises: "Coal industry policy" demanded that in the large-scaled coal-mine, one mining area was exploited by one company in principle, and this company could exploit several mining areas. In energy rich area, the large-scale modernized mines are prior constructed. With the implement of the "Coal industry policy", some large-scaled companies would have advanced opportunity for preferential growth and merge with other regional small-scale coal-mines and mining of advanced equipment. This will be a trend in the future days for the coal industry.

Coal industrialization: With the development of upsizing of coal companies, some large scale industry has coal and transportation through purchase and merger. At the same time, those companies also extended the downstream section of the industry chain, especially the chemical business which depended on coal and electricity as its basic material.

Raised industry concentration ratio and capacity to set price for the companies: In the period of the eleventh Five-year plan, the coal output for large-scale mines increased to 14.5 billion tons and the large-scale coal basement output was 22.4 billion tons which account for 56 percent of national output. Approximately 6 to 8 hundred-million-ton and 8 to 10 fifteen-million-ton coal companies were formed and took up more than 50 percent of national coal output. This result would improve the coal market order and the price setting capacity for the coal industry would increase and the cost will be easily passed on to the downstream industry.

1.2.2 Coal supply and demand

1.2.2.1 Steadily increased output

The coal output has increased steadily in the last 7 years. With the coal market demand and supply from state policies, the growth rate per annum for coal output is 11 percent. In the year 2005, coal output is up to 2.2 billion tons, an increase of 69.7 percent compared with 2000. Projected by the energy bureau of Development and Reform Commission, the national coal output will be approximately 2 billion tons in 2010.

(1) Stock for coal

³ The documents come from State council informatization office.

The nation's social stock for coal is very stable on a relatively low level, around 23 days or 24 days. When a snowstorm happened, the coal of the southern part of China was in short supply in January 2008. As a result, many places faced power cuts because of the shortage of coal supply for electricity.

(2) Industry concentration ratio⁴

Coal industry faces a contrary situation: demand exceeds supply, and long-run loss before 1996. At the end of 1996, the coal is oversupply. Until the end of 2000, with the state's macro-control policy, coal industry begins to go through recession. Some experts believe that reasons for downturn are great burden for coal industry. The actual cause of poor economic performance is the disorder of management and development as well as low industry concentration ratio, the second being very important.

The raw coal yield is 1.3 billion tons in 1998 with 50,000 production companies of coal; the average coal output for each company is 25,000 tons. The number of mines is 72,100; the average raw coal output for each mine is only 17,000 tons. The number of state-owned coal mine enterprises is 111, each enterprise sells 4.22 million tons coal on average, and the market share is less than 0.4 percent for each. In spite of the corporate reorganization to close mines and reduce output, the state still has 41,100 mines, the average output for raw coal is only 25,500 tons.

After a period of renovation, at the end of 10th five-year plan, that is 2005, the industry concentration ratio is gradually increased, the small-scaled mines are 20,000 in all, the amount for ten million ton coal enterprise is up to 31, over 30 million ton coal enterprise is 10 among this and 50 million ton one reaches 5, as well as 2 oversized enterprises for 100 million tons. The coal output for large and medium sized enterprises occupies 54 percent of the total amount, which is far below other coal production powers.

Table 1, The coal owners in China

Year	National total	State-owned coal mines	Locally-owned coal mines		
			Total	State-owned but locally administered	Private enterprises
2000	125	53.6	71.4	19.4	52
2001	108.9	61.8	47.1	22.5	24.6
2002	141.5	71.5	70	26.7	43.4
2003	172.8	81.4	91.3	28	63.4
2004	199.7	93.9	106	29.7	76.2
2005	210.7	101	109.8	29.6	80.2

⁴ concentration ratio namely in other words is market concentration rate.

1.2.2.2 Coal demand

Coal is the most important energy resource which accounts for 70 percent of national primary energy sources and performs a vital role in our economic development. It is a logical necessity that the development of national economic aggregate will lead growth in coal demand. In general, the GDP (gross domestic product) probably increases of 1 percent this year will fuel coal demand increase by 0.5 percent or 0.6 percent. Projections by the Jianshe Security Research Institute in China suggest that, the GDP rise will be 11.2 percent for the next year, and the coal demand will be increased by 5.5 percent or 6.5 percent around. The most important consumers of the coal industry are the power industry, steel industry, building materials industry and coal-chemical industry. The coal consumption for those four fields occupies nearly 80 percent of the total coal consumption. It is estimated the increase of coal consumption for the power industry is approximately 11.8 million tons, the steel industry uses 2.9 million tons, and building materials industry is 2 million tons and for the coal-chemical industry is nearly 1 million tons. The total social coal consumption will reach 27.28 billion tons.

(1) Power industry

The power industry mainly depends on thermal power plants, and takes up the largest share of coal consumption. The amount is more than half of the total social coal consumption. In 2001, coal consumption for power industry was 646 million tons, accounting for 46.78 percent of total coal production at that time. During the year of 2002 and 2005, the annual increase of coal consumption for the power industry was 100 million tons. At the year of 2006, the amount was up to 1.202 billion tons which was increased 148 billion over the previous year, which occupied 50.47 percent of coal output of that year. Within six years, the amount of coal consumption in power industry is increased 86 percent.

Compared with other electricity generation form, coal-powered technology is mature; the construction cycle is relatively short and has quick returns. On the aspect of new generating capacity, the absolute increase of thermal power plants is higher than any other generation forms. The total new generating capacity is 65.4 billion kilowatts; eight of this is billion kilowatt hydroelectric powers, thermal power plants share 54 billion kilowatts, and the nuclear power is 2 billion kilowatts.

For quite some time in the future, the structure of power industry mainly based on thermal power plants will not be changed much. The coal demand will increase more or less. It is believed that the thermal power plants field will increase by 12 percent in 2008, the relatively coal demand will increase by 9 percent, that is 118 million tons.

(2) Steel industry

As the second coal consumption field, the steel industry is still maintaining the trend of rapid growth. The raw steel output in 2006 was 419 million tons and 490 million tons in 2007, the incremental speed was more than 16 percent. The increment speed of coal consumption is slower than the steel output because of improved technology; unit consumption can produce more products than before. The coal consumption increased 13.8 percent, which is 420 million tons.

(3) Building materials industry

The coal consumption for building materials industry is mainly in the process of concrete manufacture. With the development of construction field, the building materials industry is

booming, especially for the yield of concrete and plate glass. The nation's total concrete output was 1.3 billion tons in the year 2007.

(4) Coal-chemical industry

In the coal consumption field, the chemical industry share is the smallest amount. However it will be the new growth area in the future. The raw oil price plummets. Some chemical projects have to change their material to coal. Coal-to-liquid projects have substantial progress. On the other hand, the government gives policy support to the coal-chemical industry.

2 Coal market

In Chinese coal market, there are two distribution systems: planned coal and market coal. Just as the name implies, planned coal is supervised by the Chinese government, and market coal is following the market theory. The Taiyuan coal trade center was set up in May 2007; it became the national coal trade center. The aim was to form a uniform market price. Some experts believed that this was the first step for the Chinese government to cancel their planned economic model on the coal field and promote the formation of a uniform market. The coal market follows the market economy.

2.1 Market-driven price mechanism

The coal price-forming mechanism has experienced a series of changes, and has finally moved towards marketization.

In planned economy phase, coal production and sales should obey the government's plan. The coal price was regulated by the government. At that time, the government gave the gross target for coal production to the coal industry each year. The coal companies had to produce the given amount. They had no choice for the coal output and the price.

After the reform and opening-up policy, small-scale mines were emerging. In this period, the coal price began to split apart, and although the state controlled most of the coal selling price, some medium and small sized mines set the price on their own according to the market demand. The coal price policy became flexible.

Coal price reform began in 1993. The government gradually decontrolled the coal price. The coal price started to get liberation. Take the coal for electricity for example, there were two price mechanisms: the planned coal and market coal which coexisted for a long time.

The coal price set by the State Development Reform Commission is called the "guiding price". The buyer and seller negotiate on the basis of "guiding price", when a dispute happens between two parties, the final price will be set with the government's coordination.

Beginning on January 1st 2001, the state gave up regulating the price of coal for electricity in principle, canceled the "guiding price" and decontrolled the price of coal for electricity, which was then set by the negotiation of the two parties with the government's coordination in principle. However, the government still gave the "guiding price" to the coal for electricity in reality in order to smooth the transition period of electrical power reform. During this period, the price of coal for electricity was far lower than the market coal price.

In 2004, the government felt sufficient confidence to release the price of coal for electricity, and proposed the "coal-electricity corporation" program. After adjusting electricity price, the price of coal for electricity is totally negotiated by both sides. In fact, the relative price did not move towards marketization, the pattern of coal for electricity and market coal, planned and unscheduled coal contracts still exist. However, the double-track prices existing for a long time gradually split apart.

At the end of 2007, the "Coal trade fair" was replaced by "Coal supply and demand fair". It was a symbol that the product of planned economy formed in 1965 finally bowed out of the coal price formation mechanism. In the "Coal supply and demand fair", the coal trade price was fixed by two sides without interference; finally the guild collected all the coal trading contracts. It shows that the coal price is moving toward to perfect marketization.

2.2 Coal price

In recent years, coal price raised sharply abroad. The domestic coal price increased 10 to 15 percent approximately.

The Australia BJ⁵ coal spot price was 51.2 dollars per ton on January 4, 2007; the price rose steadily and reached 98.6 dollars per ton on December 30, an increase of 92.5 percent. One reason was the international oil price wandering at a high price for a long time. This pushed up the price of coal. The other reason is the China's export rebate leads the coal export amount reduces sharply. Japan, Korea as well as other countries begin to import coal from Australia.

The domestic coal price increased rapidly in 2007. In intermediate transit point Qinhuangdao, the steam coal price fluctuated in the first part of the year: the price increased a little bit at the beginning of the year and fell with a little range in a long term, until the third quarter, when the price began to shoot up. Take the excellent mixed coal in Datong for example, the price was 550 SEK per ton on January 5, 2007, the lowest price in this month was 500 SEK per ton. At the end of July, the price was 470 SEK per ton. Then the price rebounded and reached 600 SEK per ton on Dec 3, 2007. At that time, the price for Shanxi excellent mixed coal, Shanxi mixed coal and common mixed coal were 530SEK, 470 SEK and 380 SEK respectively.

2.2.1 Coal tax

China has adjusted the coal import duty from the earlier 5 percent taxes to zero, which promotes the southern coastal areas importing coal from Indonesia, Vietnam, and Australia. At the same time, the Chinese government cancelled the export rebates in September 2005, and then taxed 5 percent on coking coal in the following month. The result was that the price of import coal is far cheaper than the domestic coal, it is believed that the difference is 144 SEK per ton cheaper than the Chinese domestic coal price. It is a good choice to use imported coal. According to IEC⁶ 2007, the export amount has lowered to 46 million tons (1.1 trillion Btu) in 2007 which is equivalent to one-half of China's steam coal exports in 2003. China's coal imports are projected to total 3.2 trillion Btu in 2030, while its exports are projected to total 1.1 trillion Btu.

2.2.2 Production Cost

The total costs for the coal production price including: resource cost, environment cost, safety cost, labor cost, and sustainable development cost.

2.2.2.1 Resource cost

This includes the resource tax, resource compensation fee, and mining right fee, etc.

Resource tax: In order to strength macroeconomic control, the state gradually raised the imposition standard of the coal resource tax in recent years. It varies from place to place. Generally speaking, the standard is around 3 to 5 SEK per ton.

Resource compensation fee: Relying on the mineral resource property rights, the country levies a resource compensation fee for mining rights. It is in favor of coal mine recovery

⁵ The Australia BJ is the price index of coal in Asian market. The price is published every week.

⁶ IEC is International Electrotechnical Commission.

ratio⁷ and promotes the formation of reasonable energy use mechanisms. The recovery ration is set to one percent. The formula is calculated as follows:

Resource compensation fee = Sales income × recovery ratio

If the coal income is 400 SEK per ton, the resource compensation fee is 4 SEK.

Mining rights fee (including property rights and exploitation rights): The mineral resource belongs to the nation. Mining rights of new mineral resource can only be gained competitively by bidding and action.

2.2.2.2 Environment cost

The government gradually established the accountability mechanism of environmental pollution improvement and ecology recovery from 2006. A company which engages in mineral resource mining must deposit the environment cost and fulfill the duty of ecology recovery and adds it to the coal price. The government supervises and makes sure that the money is used for environmental pollution improvement. The standard for the environment cost is various. It is set as a percentage of sales income. In Shanxi province with the largest coal output, the environment cost is 8 SEK per ton.

2.2.2.3 Safety cost

The standard for safety cost: large and medium size coal mines pay more than 3 to 8 RMB per ton, and the small size coal mines pay less than 6 to 10 RMB per ton.

2.2.2.4 Labor cost

All the companies should assure employees' basic income and allowances. The allowances are gradually increased to 22 to 52 SEK per day especially for underground workers. It is estimated that the increased labor cost is 10 SEK per ton.

2.2.2.5 Sustainable development cost

The sustainable development cost was first experienced in Shanxi province and was popularized in the other parts of China later. The standard price is 25 SEK per ton basically, the price varying for different types of coal. Coal corporations are charged according to different coal category and coal consumption amount. The payment can be used to solve regional ecological environmental problems.

2.3 Coal transportation

The distribution of coal resource is not in an equilibrium state. The west and north areas have the most coal reserves. East and southern areas share little. The "three west" places are Shannxi and Shanxi provinces and Inner Mongolia, containing 60 percent of the coal reserves. In this circumstance, the coal transportation structure is characterized as "transport coal from northern part to southern part, transport coal from west to east coastal places".

There are three main options for coal transportation, waterway transportation, railway, and highway. Since the north part of China lacks great rivers, it is difficult to ship via water. Highways are suitable for short distance transportation. The most economic and high- speed

⁷ It refers to the ratio of coal output to coal reserves in a certain area.

method is railway transportation, which is the main option for coal transportation and accounts for 70 percent.

The coal demand is also influenced by seasons. The peak periods happen in summer and winter in southern part of China. In winter, the market is in need of coal. Due to weather variations, coal variations and handling capacity etc, the coal cannot be transported on time. Numerous motor lorries are kept long in the wharf waiting for the coal. However, the coal demand falls in spring and autumn. The number of lorries reduces rapidly, and quay share and operation is low.

In considering product attribution, coal is bulk cargo production goods with large amount, and the unit production value is relatively low, whatever transportation forms are taken, and transportation cost tends to dominate all other considerations.

The average one kilometer transportation cost for railway is 0.1 SEK per ton, for highway is 0.25 SEK per ton. The state now is making an effort to control the overload. It is forbidden to load more goods than the standard weight, and the highway cost has increased to 0.35 SEK per ton. Waterway transportation has the lowest price with 0.06 SEK per ton.

For a typical continent country, the best method for coal transportation is to combine railway and waterway transportation. The distance between energy resource regions and a harbor should be rational, not too long or too short. However China's excellent quality coal comes from the north-west part of China, and it is not economical since the highway distance is around 1000 kilometers.

Transporting coal through pipelines can ease the pressure on railway transportation. The medium in the pipeline is liquid; liquid is added to the coal forming slurry before it enters into pipelines. After reaching destination, the slurry will be made into power coal containing 15 percent water through dehydration equipment, and then the power coal can be used for electricity generation. The pipeline is buried under frozen earth. It is estimated the cost for one kilometer is 0.048 SEK per ton.

The first underground coal slurry pipeline runs from coal base Shanxi province to coastal cities of Qingdao and Weifang in Shandong province. Shanxi province is abundant in coal resources, and some coal cannot be shipped out on time. On the other hand, Jiaodong Peninsula in Shandong province is a booming region in recent years, demanding more coal for economic development. The pipeline plays a significant role in coal transportation and demand for electricity generation.

China has vigorously developed the railway in recent years for advances in transport capacity. The coal transport by railway was over 990 million tons in 2004, and the transport by waterway was over 54 million tons in 2002.

Table 2, The coal transportation in China

Mode of transportation	1997	1998	1999	2000	2001	2002
Railway(Million ton)	703	630	649	685	766	818
Waterway(Million ton)	39	37	41	49	49	54

2.4 Coal reforms

As a dominant fuel for economic growth, coal has a high place in China's energy resource market. However, coal is non-renewable energy resource. Since its formation needs long time and China has limited energy options, rational use of coal can be the most important thing. At the same time, the existing system is blocking the economic development; some reforms have been taken to improve the current situation.

2.4.1 Coal-to-liquids plant

The reserves of petroleum and natural gas in China are limited. Petroleum reserves account for 2.3 percent of the world total quantity. The exploitation age is only 20.6 years which is much lower than 42.8 years of the world level. In recent years, oil prices increased rapidly. The natural gas reserves are relatively low, accounting for 2 percent of the world total quantity.

Under this circumstance, China is promoting a large coal-to-liquid industry. The first coal-to-liquids plant was located in Inner Mongolia. It was built by the Shenhua Coal Liquefaction Corporation and will have an initial capacity of approximately 20,000 barrels per day, tentatively scheduled to be increased to 100,000 barrels per day by 2010.

However experts also point out the risks including huge capital investments and its complex technology.

2.4.2 Coal systems

Unlike western countries carrying out market economy from the start, China's economic system has experienced some phases. In 1949, the country was poor and faced resource shortages. Almost all the production, distribution and consumption affairs were planned by the country.

The government had the right to settle those issues. Most of the resources were controlled by the government which directed all the economic affairs without relying on the market. After the Third Session of the Eleventh Central Committee of the Party, China began to practice reform and opening-up policy. The former Chinese leader Deng Xiaoping pointed out that planned economy and market economy did not conflict. The aim of the government for today is to establish a complete market economic system.

For the reform in the coal field, the mines are mainly divided into two parts: one is the state-owned mines representing 45 percent of nationwide coal production, the other falls into local mines which are mainly private investments. Both are managed by the Ministry of Coal Industry which distributes national coal production and coordinates production activities.

The State Power Grid Corporation (SGCC) supervises power from coal; it is the largest electric power provider in the world, formerly known as "SGCC" which includes both the electric grid and power plants all over mainland China. It's headquarter is in Beijing. After the "Plant - Grid Separation" reform since early 2000s, State Grid Corp. operates power transmission, distribution and other assets of power grid. The power plants separated from State Power Co. were divided by five "power generation groups".

In order to have further development in the world market, China entered the World Trade Organization (WTO) on November 2001. As one of China's commitments for entry, the

Chinese market is gradually opening up to the outside. The Chinese government is working hard to create bilateral benefit to China and its partners.

Recently, there has been an underground coal slurry pipeline construction which runs from coal base Shanxi province to coastal cities of Qingdao and Weifang in Shandong province. This program is conducted with the cooperation of foreign investments.

However attracting foreign investments also causes some controversies. The Asian American Coal, Inc, AACI short for, is the first foreign-invested coal exploitation enterprise in China. It got the coal production license for 4 million tons from Shanxi Coal Industry Bureau on July 10, 2007. It is the first production license issued to Sino-foreign joint coal venture since China has always restricted the foreign investment entering the coal exploiting field.

Although the designed annual capacity is 4 million tons, their long-term plan is for 6 million tons and will gradually be increased to 8 million tons. The fact generates people's worry about over exploitation. This case is an exception. China still limits the foreign investment in the exploitation field. On the other hand, the coal chemical industry still welcomes the foreign investment to bring their advanced technology.

3 Thermal power generation

Thermal power generation is a method of converting heat into electric energy. The heat energy is formed in the combustion process of coal, petroleum, natural gas and so on. When these fuels are burning, the generated heat energy is routed through power plants and converted into electric energy. It includes power plant boilers, steam turbines, generators and auxiliary units. Of all electricity generation forms, thermal power generation has the longest history and is regarded as one of the most important methods.

A thermal power plant is a factory for thermal power generation. There are several classification methods for thermal power plants. According to the fuel category, it may be divided into coal-fired thermal power plants, petroleum-fired thermal power plants, and gas-fired thermal power plants and so on.

According to the function, it can be divided into power plants and thermal power plants. The power plants only produce electricity and supply electric energy for end users, thermal power plants also supply heat energy to end users besides electric energy. The other classification method is according to the service scale: regional power plants and local power plants. The installed capacity for regional power plants is bigger than other power plants. There are often built near the fuel bases. For example, the power plants are built next to large coal mines. Regional power plants are also called pithead power plants.

The electric power is supplied to end users through long distance transmission lines. Local power plants are often under constructed near the load center. These need long distance transportation of fuel to power plants, and the electric power is supplied to the relatively centralized users which are living together.

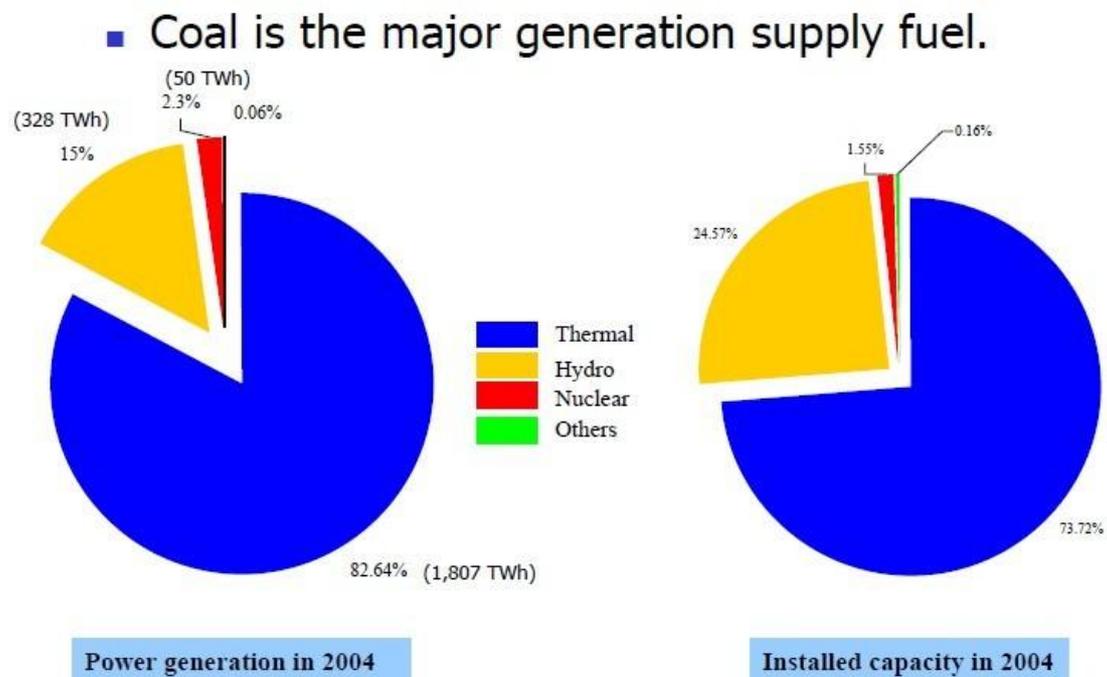


Figure 3.1 The proportion of major energy resource in China

3.1 Coal-fired thermal power plants

The fuel used by thermal power plants is mainly decided by the national resources situation and the energy policy. After 1980s, the Chinese thermal power plants mainly use coal as fuel. Thus coal-fired thermal power plants are widely used in China.

3.1.1 The procedure of coal power

Coal is delivered to the power plants, and is unloaded there. Then it will be transferred on a conveyor belt to the coal transfer station. Part of the coal is stored in the coal storage yard from transfer station. Another part of the coal is delivered to the coal storage can. In this process, the coal quantity is controlled. When the coal is sent to the coal breaker, the coal becomes small and easy to use. At this time, the coal will achieve complete combustion relatively easy. Finally, the coal will be sent to the boiler. In the boiler, the coal forces air and high pressure steam through the turbine, condenser and generator to get the electricity. When electricity is generated, the transformer increases the voltage so electricity can be carried on through transmission lines. When it enters substations at the destination, the voltage will be reduced. When electricity is transported to the end-users, the voltage will be reduced again.

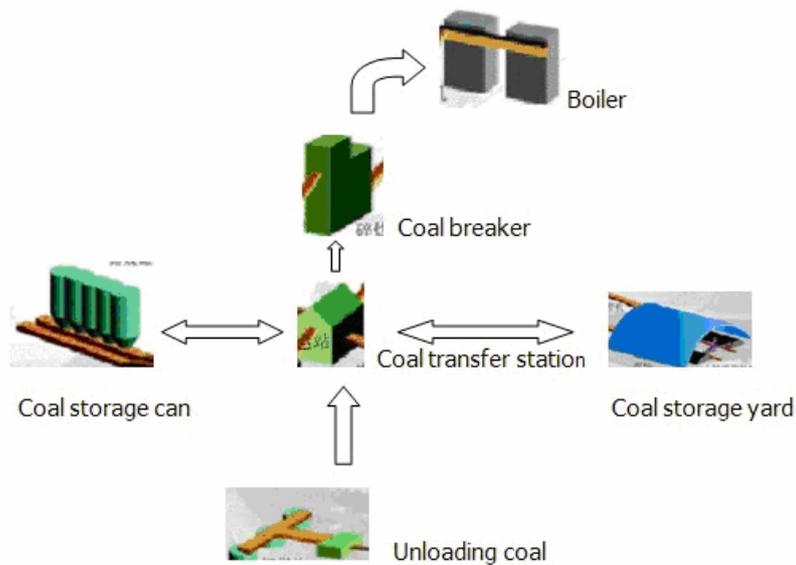


Figure 3.2, The sketch of the coal storage and usage

The emissions produced from coal burning, mainly carbon dioxide, sulfur dioxide and nitrogen oxides, are vented from the boiler through a stack. The ash left at the bottom of the boiler will be removed which is usually made into cement for building construction. A water treatment plant is used for purifying water in the pipelines for the purpose of preventing corrosion.

3.2 Environmental issues

The coal burning process produces several types of sulfur emissions that affect the environment, mainly sulfur dioxide, nitrogen oxides, particulates, carbon dioxide, and mercury. These emissions have raised environmental issues. Since the main fossil fuel in

China is coal, it is widely used in every field. In China, the trend to coal consumption is continuing increasing.

China is believed to be responsible for 13 percent of the world's carbon dioxide emissions. Sulfur dioxide and particulates are related to acid rain and increase illness; nitrogen oxides link to the formation of acid rain and they damage the Earth's ozone layer; carbon dioxide is related to the global warming, and mercury is poison for fish and animals when it meets water and forms methyl mercury.

3.3 The power transmission from west to east in China

“The power transmission from west to east” is an important decision and a significant project of the Development of the West Regions which is also a large project in China. “The power transmission from west to east” means that the west provincial electric power resources are transported to east provinces which lack electricity. In this project, west provinces are Guizhou, Yunnan, Guangxi, Sichuan, Inner Mongolia, Shaanxi and Shanxi. East provinces are Guangdong, Shanghai, Zhejiang, Beijing and Tianjin.

This project will transport the rich resources in the western area to the east area. It uses the natural conditions in the western area. This project will provide safe, high quality, reliable, inexpensive electric power for the eastern area, and it will promote economic development of western area.

Designed by the government, “The power transmission from west to east” project has three passage ways.

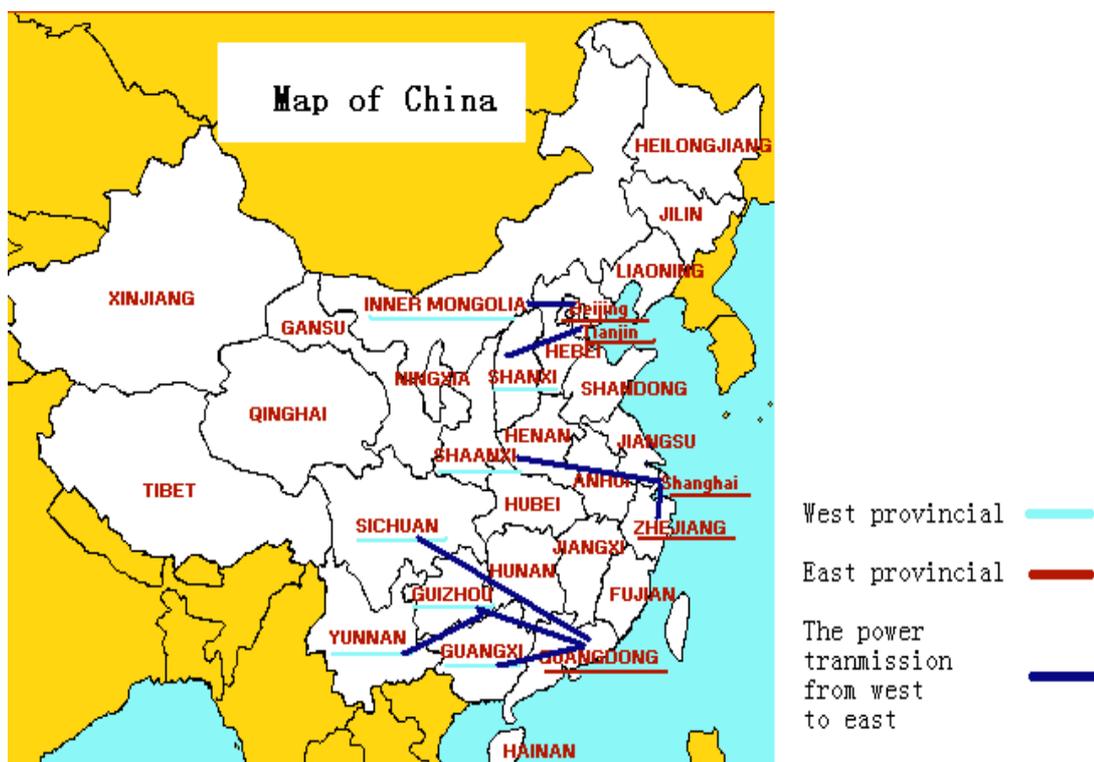


Figure 3.3, Coal transmission in China

The south passage-way: The hydropower resources from five rivers as follow: Guizhou Wu River, Yunnan Lancang River, Nanpan River, Beipan River, and Hongshui River as well as mine power plants from Guizhou and Yunnan provinces are sent to Guangzhou province.

The middle passage-way: The hydropower resources from Three Gorges Region of Yangtzi River as well as main and tributary of Jinsha River are sent to East China.

The north passage-way: The hydropower resources from the upstream of Yellow River as well as mine power plants from Shanxi and Inner Mongolia are sent to Beijing-Tianjin-Tangshan Area.



Figure 3.4, Coal fired power station in ZOU Xian. It is the biggest generation station in Asia.

It is planned that till the year 2020, the scope of power transmission from west to east will be 29,700 MW for the south passage-way, 52,800 MW for the middle passage-way and 66,700 MW for the north passage-way. The interconnection of regional power grids shall be actively carried forward. China will make major efforts to develop hydropower, optimize development of coal-fired power, actively expand nuclear power, moderately expand natural gas-fired power, and speed up electricity generation with new energy resources.

4 Electricity market

At present, many of the countries' electric power industries are carrying on electric power system reform by state. The state main aims are to break monopoly, deregulate the market, and introduce competition for the purpose of disposing resources rationally and improving resource efficiency.

With the development of electric power industries, the electric power system reform is also increasingly thorough. The electric generation part has already introduced competition mechanisms and the government has deregulated the generation market. The power generation companies are bidding for sale in the electricity network.

4.1 *Electric power industries enter into electric power market*

4.1.1 Diversified property rights of power plants

With the development of the electric power industry, different investments are used in this field: foreign capital, joint capital, stock system, raising funds from local area and so on. This situation creates friction with the electric power supply and demand. On the other hand, property rights of power plants become diversified and principal interests arising from it diversified.

How to coordinate the economic benefits of different investments becomes a sensitive question. Without a good market system and supervision system, the attitude of power plants has two trends: one trend is to adopt a protective policy to power plants within the system and restrict competition, the other one is to attract foreign capital in an appropriate way, give overly favorable conditions to foreign capital power plants without considering investment risk and other environmental issues. These two practices are not right. A sound electric market is needed to create a fair competitive environment and allow investors gain a profit with a certain risk.

4.1.2 Supply and demand conditions

With the development of electric power industry and adjustments of national economic structure, large projects have been constructed and installed capacity has increased rapidly. Power supply and demand condition has transferred from former shortages to the current basic balance, even surplus. Electricity production is beginning to transition from a seller market to a buyer market. This change has caused power supply companies sales to decline, and has impacted the power supply companies' management. Their role has been changing from managers of electric power production and consumption into electric power operator and end-users' service provider. In this case, the guiding principle also changed into satisfying electricity demand, strengthening the load forecast, and encouraging electricity use. They can not play the same role as before, for example distribute electric power, and limit electricity use.

In order to promote electric power sale, some power supply enterprises have started to explore their working pattern under the market economy condition. The administrators of power enterprise's change the ideas, strengthen management of the electric power dispatch and the overhaul work according to the market economy rule's request, speed up the city and

countryside electrical network's construction and transformation, and raise the service level. This kind of promotional behavior sped up the steps to enter the electric power market.

4.2 Electric power market operation mechanism

In China, the electric power market operation mechanism can be divided into three parts: supply and demand mechanism, price mechanism and competition mechanism.

4.2.1 Price mechanism

The present price mechanism is fixed by the state, and is known as the guiding price. The electric power enterprises are unable to carry on fair competition according to the market price mechanism, resulting in deviation of enterprise efficiency and benefit, and the investors could not get reasonable repayment. It is necessary to reform the electric power market price. The electric power price policy-making is as follows:

(1)The state controls the electrical network selling price, the ceiling price is set considering average cost, reasonable profit and the end-users' economic affordability. Under the ceiling price, the electricity price can be adjusted in the electric power market.

(2)The state deregulates the electricity price in the network. Most of the electricity enters the national electric network. The network price, or the electricity supply, transmission and distribution price within the network, can be competitive. The state only gives some advice without instructional commands.

4.2.2 Supply and demand mechanism

Now, the SGCC is manages the electric affairs. Two big power grid companies and five big electricity generation groups have been established. Power grid companies are responsible for electricity transmission and electricity generation groups are in charge of electricity generation.

All the property rights of power plants should obey the entire electric network's unified plan, with reasonable arrangement for the network and the centralized dispatch.

The price mechanism and competition mechanism are used to promote the commercial operation of the power plants. All the property rights of power plants should operate through network competition.

The power grid companies implement the peak and valley electricity according to electric network's load demand situation. They transmit more electricity in peak time and less in valley time to balance supply and demand. The power grid companies can adjust electricity price as the demand varies. When supply exceeds demand, the price will be down-regulated; otherwise when short supply happens, an up-regulated price will be used.

4.2.3 Competition mechanism

All the power plants have separated from grid power companies. The generated electricity all enters into electric networks and companies compete. The end users have options to choose electricity supply. The generation groups are working hard to improve efficiency and reduce the cost.

In the consideration of protect the environmental, the state has closed small and polluting power plants and promotes new energy sources for electricity generation. These factors force

electricity generation group to enlarge the power source structure adjustment, increase the supply of renewable energy sources, and close down medium and small scale coal-fire power plants. For new power construction projects, generation companies are carefully selected in order to reduce the cost and strengthen competition.

4.3 Electricity price

The electricity pricing mechanism is a very complex question. Along with the development of market economy, the state has already freed the coal price which is decided by the market. However, electricity as a special commodity, also relates to the national economy and people's daily life, therefore, the country adopts the electricity price in a state-fixed price manner.

At present the electricity price has different categories according to the different divisions: the production and the circulation division divided into the network price, mutually supplied price, transmission and distribution price and the sales price. Also according to category of electricity usage: the residential electricity price, the non-residential electricity price, the commercial electricity price, and the agricultural production electricity price.

4.3.1 The network electricity price

The National Electric Power Company used to control the rights of electricity generation and transmission. In April, 2002, the National Development and Reform Commission started up the electric power system reform project, with the aim of breaking up monopolies and enforcing a competitive environment, which divided the National Electric Power Company into 11 companies. The established competitive companies included the state owned National Electricity Company, Southern China Da Tang, China Hua Electricity, China National Electricity, China Electricity Investment, and four affiliated companies as well.

4.3.1.1 The management of network electricity price

The generation company sells electricity as it is produced to an electricity network company in a guiding price.

(1) After the implementation of electricity price bidding, the power generation enterprise will participate in the competition. Therefore, power plants must improve their competitive ability to suit the reform of electricity market.

The capacity electricity price for regional electric power market and the established electric power dispatch transaction center is formulated by the State Council Price Department.

(2) For those generation companies who do not participate in the electric power market competition, their network electricity price is set by the provincial level government price department.

(3) The state price department and administration department of electric power carry on the supervision and the management according to the respective responsibility on the operational price in electric power market. The electric power supervisory department puts forward the adjustment electricity price proposal to the state price department according to the law, the administrative rules, and regulations.

With the progress of China's electric power system reform, particularly since the separation of generation from the transmission functions, every generation company has been paying more attention to the profit-making capability, the majority of which comes from the coal

purchasing and transportation. As the coal price maintains at a high level, the cost of coal accounts for 80% to 85% of a power plant's total cost.

Under this circumstance, the network electricity price per coal-fired unit dispatched above the national provincial level has been suitably raised since January 1, 2004. It is increased 0.07 SEK per kilowatt-hour (including tax) in order to solve increased electricity price cost influenced by the raising coal price.

4.3.2 Mutually supplied price

The mutually supplied price is formed between the electrical networks and exchanges electrical energy mutually. Both sides propose the plan and report to the price administration department to approve it. The mutually supplied electricity method can gain the power transmission electric quantity and the mutual support networking benefit.

4.3.3 Transmission and distribution price

Transmission and distribution price refers to the total price of the electrical network companies including the turning on system, the networking, the electrical energy transportation and the sales service. The price is formulated by the state and implemented under unification policy with hierarchical management.

There are three types of transmission and distribution price: price of shared network distribution and transmission service, the special service price and the auxiliary service price. For the shared network distribution and transmission service price, the electricity network companies provide the service of electricity transmission and distribution as well as sales for power consumers who access to the shared network. After separating the function of distribution and transmission, the distribution price and transmission price are formulated respectively.

Electricity network companies charge a special service fee when they supply a special service for particular users, such as access fee, specialized project transmission price and interconnection price.

4.3.4 Sales price

The sales price is made up of purchase cost, transmission and distribution losses, and transmission and distribution price and government fund.

Purchase cost refers to the bill of electricity network enterprises or other electricity networks that buy electricity from electricity generation enterprises, the electricity capacity bill, kilowatt-hour electrical bill and taxes are included. The government fund refers to the fund and attachments imposed along with sold electricity quantity under the national relevant laws, the administrative rules and regulations authorized by the State Council.

The sales price is also fixed by the state and implemented under the unification policy with hierarchical management.

The classification of the sales electricity price is divided into residential electricity consumption, industry electricity consumption, agricultural production electricity consumption, and commercial electricity consumption.

4.3.4.1 Valuation mode of sales price

Sole electricity price

The sole system electricity price is the actual electricity consumption which is calculated every month by the customer's electricity instrument for the cost basis. The electric bill is not related to its plant capacity or the time electricity is used. It only takes the actual electricity consumption as the electrical bill with unique price. At present residential electricity consumption and agricultural production electricity consumption implement the sole system electricity price.

Composite electricity price

Along with the opening of the electricity market at the generation side, a single electricity price cannot meet the need, coordinated and sustainable development of the electricity market, and it is the general trend to establish a composite electricity pricing system which accords with the law of market economy.

The composite electricity price is divided into two parts: the basic electricity price and the kilowatt-hour electricity price. Thus the formula for total electricity price is:

$$\text{Electricity price} = \text{electricity capacity} \times \text{basic electricity price} + \text{electricity quantity} \times \text{kilowatt-hour electricity price}$$

The industry electricity consumption is often implemented by this kind of sales price.

Electric Price in the Period of Peak and Valley

The peak and valley electricity price is one kind price of time-dependent electricity price. The cost of electricity in peak time interval, valley time interval and common time interval in one day varies.

Electric power can not be stored. Moreover, balancing the electric power supply with electricity demand in real-time is an engineering factor for the electrical network's safe operation. The peak time interval needs high electricity production. It is the main reason for the frequently opening new electricity generation plants. This causes the generating cost to increase, therefore within different time intervals, the generating cost is different, and the corresponding electricity price should also be different. The implementation of a peak and valley electricity price urges the customers to use electricity more in the valley time interval. Reducing electricity usage in the peak time interval achieves the reduction of the generating cost, customer electricity consumption cost, and enhancing the energy efficiency.

In the areas of experimenting Peak and Valley electricity price, the Peak time intervals are 8:30-11:30, 14:30-17:30, 19:00-21:00. The electricity price standard for peak times is 0.4883 Yuan/kilowatt-hour. The Valley time interval is 23:00-7:00, and the electricity price standard is 0.30 Yuan/kilowatt-hour. The other time intervals are called common intervals. In the experiment site, the user may voluntarily choose between the Peak-Valley electricity price and the sole electricity price way.

The regional electricity price can vary based on their different situations. In Beijing for example, residential electricity bill increases 0.0083 SEK each degree for the supportive fund of reservoir immigrations. Thus, the electricity price for Beijing residents who use electricity less than 1 kilovolt is adjusted from the original 0.55SEK to 0.56SEK. For usage over 1 kilovolt, the price is increased to 0.552SEK from the original 0.54 SEK.

4.3.4.2 The sales price adjustments

Regular price adjustment

The state price department carries out an examination of the sales electricity price every year, if the cost level change is not obvious. The sales electricity price should remain stable as far as possible. Otherwise, the state will give some advice about the price.

Linkage of price adjustment

This refers to the linkage with the network electricity price which is fit for industry and commercial users. After the government price department checks the sales electricity price, the price difference between actual purchased electricity price and the original fixed price is handled by the electricity price equilibrium account. When the purchased electricity price raises or drops to a certain level, the sales price will relatively raise or drop. The adjustment interval is at least one month.

The management of sales price

After the separation of transmission and distribution, the sales electricity price is set by the provincial-level price department, the cross-province reports to the State Council price department to examine and approve.

When it formulates and adjusts the price, the state price department should fully listen to the electric power supervisory department, the electric associations and the related market main body's opinion.

The sales price for residential electricity consumption should be formulated after the hearing carried by the state.

4.4 The coal-electricity debate

The contradiction rises between mine enterprises and electricity companies. The Chinese government has closed the polluting and unsafe mines and merged some enterprises to increase the competition in the world market. In this case, the coal consumption exceeds the production.

The coal price increases since the government has no rights to control the coal price. The coal market is an almost deregulated market; its price varies with the market demand. When the coal price increases, the coal-powered electricity price should increase at the same time.

However, the electricity companies do not have the final decision for electricity price.

Majority of them are state-owned and are executed by the State Development and Reform Commission which has the final decision for the electricity price. It thinks it's not the right time to increase the electricity price since the electricity cost is still lower than the electricity sales price at a reasonable level. In this case, the electricity companies' profit decreases than before, they are facing a bad situation. Especially after the snow disaster on January 2008, the large-scale electricity failure gives much inconvenience of daily life.

From another point of view, when the electricity demand decreases, the coal enterprises have to bear the economic loss due to the price drop and overstocked products. Some experts believe that the coal and electricity price linkage mechanism can solve this problem. If the coal price increases five percent or more in a certain period, thirty percent of its increased cost for electricity generation will be solved by power stations themselves. For example, through

improve utilization rate, the other seventy percent will be solved through electricity price adjustment by the state in order to make up the increased cost.

5 National power market reform

"Break monopoly, introduce competition" is the main goal of electric power system reform started from 1998. It split electric power enterprises into two parts: power grid companies and power generation groups. Electricity generation and transmission were separated. Power grid companies are responsible for electricity transmission and power generation groups are in charge of electricity generation. Two big power grid companies, five big electricity generation groups were established in the national stratification plane which can be seen in Table5.1.

Table 5.1, The power companies in China

Power grid companies	Power generation groups
<ul style="list-style-type: none"> ·State Grid Corporation ·China Southern Power Grid Corporation Ltd 	<ul style="list-style-type: none"> ·The state owned National Electricity Company ·Southern China Da Tang ·China Hua Electricity ·China National Electricity ·China Electricity Investment

The SGCC was founded in the original Ministry of Electric Power government's management function of electric power was executed by national and every provincial committee of economy and trade.

5.1 *Electric power system reform*

With the implement of "Separation of generation and transmission" for the purpose of creating a deregulated market, the transmission part is opened in the electric power market. Under this kind of circumstance, not only the electricity generation enterprise needs to act according to the fair competition in the electricity network, moreover allows the big power consumers to purchase from electricity generation enterprise in a lower price and transport through unified electricity-network or interconnected power network. This causes the network public, enables the electricity generation enterprise, the power distribution enterprise, the big users to involve in the electric transmission network.

At the same time, it causes the electrical network acting as the carrier of electric power commodity and entering to the commercialization operation; the electrical network transmits electricity between the producer and the user and promotes electricity into retail market. (i.e. distribution network to be open, power distribution and user separate pattern), thus achieves the reduced electrical energy cost and electricity price. At the same time, after the independence of power transmission network, the electrical network's construction cost and the expansion funds can be included in the electricity price by the electric transmission expense. Thus this money can be reused for network construction and accumulated capital, a positive cycle is formed.

Therefore, the separation of generation and transmission is only the preliminary stage for entering the deregulated electricity market. The separation of power distribution and transmission realized can bring huge economic efficiency.

5.2 Theory problems

There are some theory problems in the reform, at present these are being discussed.

5.2.1 A deregulated market

The word "Deregulation", defined in Wikipedia is a term which gained widespread currency in the period 1970-2000. It can be seen as a process by which governments remove, reduce, or simplify restrictions on business and individuals with the intent of encouraging the efficient operation of markets.

The electricity market is free from regulations especially from governmental regulations. The state still owns the grid, with many electricity producers competing in the market. End-users have options to choose electricity producers. The market price is formed by competition instead of regulations. The main aim is to improve efficiency and lower electricity price. Electricity production varies from time to time according to electricity demand.

The power company and power supply station are responsible for the users' power supply separately. The power supply load must have the guaranteed generating capacity and necessary reserve capacity. The generating capacity consists of four parts: the company power plant, bilateral contracts, spot market and futures market.

In order to ensure everything work properly, the state has to supply necessary service for the market, proposes an electric transmission plan and carries on the dispatch to the power plant, provides trading markets etc.

5.2.2 Electricity certificates

The electricity certificate system was first implemented in Sweden in the year 2003. The main purpose of this system is to increase the share of renewable energy sources in the electricity production. The renewable energy resources mainly include wind power, solar power, wave energy, geothermal energy, biofuel, hydro power and CHP and so on.

Demand for certificates is created by the fact that all electricity suppliers - i.e. resellers delivering electricity to end users - and also certain electricity users are required to purchase certificates corresponding to a certain proportion (quota) of their electricity sales or electricity use.

Through the sales of their certificates, producers of electricity from renewable energy sources receive additional revenue from and for their production of electricity. In this way, the system encourages the expansion of electricity production from renewable sources and new technologies.

The electricity suppliers should buy a number of electricity certificates which is calculated by the percentage of their sales, also called quota obligation. The quota obligation is around 12 percent which will be gradually increased in the following years. There were 1093 companies and persons that joined this system in the year 2006.

The electricity certificates can be traded in the market. The price is related to supply and demand. The number of electricity certificates issued by the state is uncertain, thus influences the demand amount.

5.2.3 Competition and monopoly

This used to be the most disputed problem existing in the SGCC. It occupied more than half of the nation's installed capacity and generated electricity which was not useful for competition. It owned five power corporations: North Power Corp., Northwest Power Corp., North China Power Corp., East China Power Corp., and Central China Power Corp. It becomes a question: is maintaining five big groups to be good or cancels five big groups, constructing various provincial companies under the SGCC? Since under the third-stage legal person system⁸, the SGCC and five big groups are impossible to exist together. Therefore SGCC proposed clearly viewpoints: separate enterprises from government management and set the province as an entity. This brings many disputes. If the country has one electric power corporation, can it move toward monopoly again? Or five big groups might as well promote competition and break monopoly pattern? Some experts believe that five big group patterns are the establishment in the equilibrium theory foundation. But the uneven theory is the foundation for the SGCC exists.

The equilibrium is demonstrated in two aspects. One is electric power supply and demand is balanced. The second aspect is the electric power management system is balanced. Although the SGCC shares more than half of the electricity generation capacity, the electricity generation is balanced within five big groups as well as in the region and seven provincial companies. This balance is fit for China's national condition and conforms to the market economy's moderate competition principle. This pattern should continue at least after the Three Gorges Power plant production in 2010.

On the contrary, the SGCC exists in the foundation of uneven theory. It believes that the electric power balance is only surface appearance which deeply covers the uneven essence. First is the structure is unreasonable.

With high energy consumption and serious pollution, the small units are not eliminated, the Chinese power source level is very difficult to enhance. Second is the low level electricity supply. Now China's average electricity consumption per person only accounts for one third of the world level. People's use of electricity is constrained by urban and countryside distribution networks which can only maintain the basic demand.

Third is the unreasonable electricity price. Now the electricity price is a very serious issue, it varies greatly in different regions, between the city and countryside. Moreover, some provinces are seeking for electricity balance by place protection and monopolies. It is hard to realize competition and structural adjustment. Finally are the resources distribution and the electricity consumption regions? The west part is rich in hydro power and the southwest of China is the most developed region. Thus, the "Transmission Electricity Power from the West to the East" pattern is formed.

Therefore a national network is needed which is the foundation for the construction of the electricity market. On the aspect of electricity consumption, there are two time differences.

The peak-valley period, in which price varies by the time of day, and wet-dry season, in which the price differs from season to season.

⁸ The system is found at provincial, cities and county level.

Therefore the national networking can fully use the west and the northern resources. That is, only when national networking is implemented under the uneven theory's support, can the value of SGCC's existence be confirmed. Because of unbalance, the national network is needed for centralized dispatcher.

5.2.4 Bidding for sale

Before 1993, many power plants completely depended on loans, later most depended on loans, some on foreign capital loans. These loans' cost were relatively high, therefore the high electricity price is connected with loans. Although the introduction of foreign capital can promote electric power development, the electric power price are various, has several hundred kinds.

The electricity price is set according to the demands of debt service and development maintenance. On one hand, the entire society all needs electricity, on the other hand the electricity price is too high to afford, and many countrysides cannot use electricity. The restriction of structural adjustment lies in the unreasonable electricity price structure.

Bidding for sale is generally means that any electricity power company can transmit the electricity into nation network for electricity supply and make profit only as it provides electricity at a lower price. Take Inner Mongolia for example, this region takes ten percent of its electricity capacity that is 120 million degree to bid in the network. It buys electricity from power plants at the price of 0.18 SEK and sales to Beijing at the price of 0.28 SEK. In this case, the Northeast Power Corporation gains 0.08 SEK for each degree.

It had gained one hundred million last year. Unlike foreign countries' bidding, they can quote price ahead of half of the day, China cannot achieve now, and it is ahead of 3 months and can only put out 10% percent of electricity capacity.

5.2.5 Electric power system's big cycle and minor cycle

Under obligation to local interests, some Local authority is not willing to use other provinces' low price electricity. Instead, they desperately request local power plants, which are local-owned or loan guaranteed to generate electricity to increase their supply, and then impose the high price electricity on the user.

This kind of high cost protection of local power plants in a minor cycle act leads to electric unit cost rising and the profit is dropping. It is not only harmful for the electricity user but also for the local financial revenue. Moreover since the city and countryside resident are compelled to use the high price electricity, there are many complaints to the Local authority and the electric power management department. In fact, the minor cycle is in vogue in the present especially in the oversupply situation. It creates energy waste and sacrifices benefits to the consumer.

Along with the serious electric power supply and demand situation, the emphases are the electrical network connections across provincial areas for electric power system reform. At the same time, it is important to break down the protection barrier between provinces and construct an orderly competition, opening the electric power market.

5.2.6 The modernization of power grid in China

The power grid construction has entered its fastest development. Mainly power grids cover all the cities and most rural areas. 500 kilovolt grids are beginning to replace 220 kilovolt grids for inter-region transmission.

Now, power industry in China has entered a new period of large generating units, large power plants, large power grids, ultra-high voltage and automation.

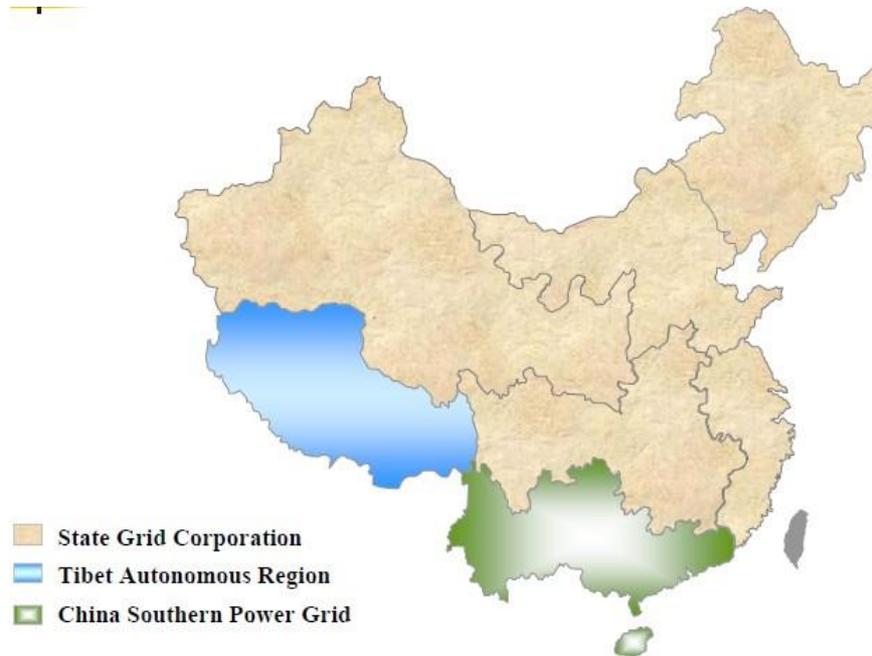


Figure 5.2, The owner of power grid in China

6 New Energy

The electric power industry may be divided into the traditional electric power industry and the new energy electric power industry. The former one mainly refers to the thermal power using traditional powdered coal stove units and diesel units. The new energy electric power industry mainly includes two aspects: First, utilization of clean coal technology for electricity generation. Second, to relieve the shortage of energy supplies that fetters China's economic growth, China is developing new energy resources, such as wind, solar, geothermal, and tidal power. The renewable energy source for electricity generation mainly includes hydropower, wind power, biomass electricity generation, and solar power generation and so on.

According to the latest "Annual report of new energy industry in China," the main change for energy supply is, coal share by present approximately 70 percent reduces to 40 percent in 2050, the petroleum is 20 percent, the natural gas accounts for 10 percent, other supplemented by the non-hydro energy's renewable energy sources which are increased in a large scale. The wind power generation will become the second main electricity generation source at that time, forming 350,000,000 kilowatt generating capacities. According to this new plan, in the next 15 years and even 50 years the wind power will be the generation's gold development times.

6.1 Clean coal technology for electricity generation

Coal is the main primary energy with rich resource. Since the coal price is much lower than petroleum, it has rapidly expanded in recent years. Several unmodifiable facts are: Coal is now and will be the country's main energy source. The proportion of coal in electricity generating is getting to be bigger and bigger, from present 50 percent to more than 70 percent. Coal-burning has caused serious environmental pollution which also makes it very difficult to solve the greenhouse gas problem.

Since coal resources are limited, they should be used in a reasonable way to maintain the foundational function for a longer time. Its total quantity should be maintained within the scope of the strict environmental protection and the climatic change permit. When coal output increases to approximately 30 hundred million tons per years later, it should be maintained roughly stable. The "Clean coal project" should be continued, the standard of coal consumption for newly built coal-burning power plants should be less than 300 gram standard coal per degree.

Most of the Chinese coal mining is exploited in the open and the coal is used in direct combustion way. These characteristics have determined that the clean-coal technology is quite different from foreign countries. While the foreign countries focus on the combustion for power technology, Chinese clean-coal technology covers all the process from exploitation to utilization. Its purpose is to reduce pollution in the process of exploitation and utilization, raise the efficiency of coal processing, the combustion, and transformation. It includes four fields:

Coal processing fields: Coal dressing, water-coal-slurry; highly-effective coal combustion and advanced power technology field: IGCC (Integrated Gasification Combined Cycle); An Integrated Gasification Combined Cycle, or IGCC, is a power plant using synthetic gas (syngas). This gas is often used to power a gas turbine generator whose waste heat is passed to a steam turbine system (Combined cycle gas turbine). Coal transformation field: Gasified,

liquefied, and fuel cell; Pollution emission control and reject processing field: emission purified, multi-purpose utilization of pulverized fuel ash in the power plants, coal gangue. The mines every year withdraw 150 million to 200 million tons coal gangue, it is mainly used for electricity generation, the cement production, and baking bricks. However the using amount is few. The pulverized fuel ash is mainly used as materials of road and bridge building.

6.2 Present situation of electricity generation from new energy

The fossil energy is non-renewable; sooner or later it will dry up. Renewable energy sources are in rich quantity, recyclable with less pollution, will certainly substitute fossil energy, and will become the main body of energy supply. Secondly, the western area is rich in renewable energy resources, accounting for the 70 percent of the total national resources.

It will certainly lead the economical development and ecological environmental protection in western area. The last point, at present, our country countryside still has approximately 300,000,000 tons of biomass energy which can be used for 70 percent of farmers' daily life energy; the remote area still has 7,000,000 peasant households which do not have electricity supply. The development of local renewable energy resources can provide electric power and clean energy for the people and promote local economic development. It still plays a role to ecological environment improvement.

6.2.1 Wind power

20 percent of the country has relatively rich wind energy resources, its main distribution regions are southeast coast and islands, northwest, North China and northeast areas, especially Xingjiang Province and Inner Mongolia. Its abundant wind energy resources give China the potential for mass-produced wind power. It is estimated that land potential wind electricity generating capacity is approximately 250,000,000 kilowatts; the amount of marine wind energy resource is bigger, amounting to 750,000,000 kilowatts. Thus the total electricity generating capacity is 1,000,000,000 kilowatts in potential. At present, the increased air blower unit capacity leads to reduced power plant construction cost, so that the wind electricity price might competes with petroleum, coal, natural gas electricity generation as well as the nuclear power network price. It will be a trend for wind power generation in worldwide. It is estimated that up to the year 2020, wind power generation might provide the 10 percent of world's electricity demand.

Between 2001 and 2005, the government invested 1.5 billion yuan in the wind power industry. The largest wind power station in Asia, with an investment of 12 billion SEK and a capacity of one million kW, will be completed in Inner Mongolia before 2008.



Figure 6.1, the wind power resource in China. Potential wind power resource > 3000 GW

6.2.2 Solar power

The technology of solar electrical energy generation is widely used in Tibet but the cost is expensive. The area of hunger is 1.08 million cubic meters, which is mainly located in the northwest part with rich sunlight. And in the north coast, the sunshine amount is up to 2000 hours per year. However the solar energy is not widely used over the country. Since high purity polysilicon, the raw material to produce crystalline silicon solar cells, is great shortage, China needs to import it from foreign countries.

Take the year 2005 for example, China's requirement for polysilicon was 3800 tons, of which photovoltaic industry needed is 2916 tons. The fact is the output of this material was only 60 tons; all the rest needed to be imported. Under this circumstance, when enjoying the warm sunshine, and look on plenty of energy loses. Asia's largest demonstration base for solar heating technology in Yuzhong, Gansu Province, has become the training center of applied solar technologies for developing countries.

6.2.3 Biomass electricity generation

Biomass energy mainly includes agriculture, forest production, and processing of industrial waste water, municipal solid wasteland so on. Since China is a large agricultural nation, the agricultural waste resource is widespread, and the annual output of crops straw surpasses 600 million tons, of which approximately 350 million tons can be used as energy resource. This is equivalent to 150 million tons standard coal.

Biomass energy is still at the beginning stage in China. Combustion of biogases and rice husks for electricity generation, rice husks gasification and methane electricity generation have been taken into practice, with a generating capacity of approximately 800MW. Shenzhen Trash Power plant, operated for seven years, has conducted certain experiments in the waste electricity generation. This brings the new hope for the garbage disposal problem.

6.3 Government support

The development of new energy is greatly restricted by its resource distribution. Most of the resources are mainly distributed in the west part of China. However, the main electricity consumption areas are in the east coastal cities. The electricity generation from new energy is also influenced by climate and season changes. Thus, the industry's overall scale is very small. Moreover, the country's new energy technology level is relatively low, generating cost is high, and generally the network electricity price is higher than the thermal power network electricity price which lacks competitive advantage. The hydro power's generation cost is approximately 1.2 times greater than coal power, biomass power (methane electricity generation) is 1.5 times and solar power is more than 10 times higher than coal power. So the new energy industry is in the early establishment period with great uncertainty. Its development to a great extent relies on government's support.

In February 2005, the Standing Committee of the National People's Congress discussed and passed the China Renewable Energy Law. It stipulated the responsibilities and duties of government, enterprises and users in the development and exploitation of renewable energy and establishing a series of policies and measures including systems for overall objectives, special funding and preferential taxes and levies. The Chinese government will progressively increase the ratio of consumption of the high-quality, clean and renewable energy in the gross energy consumption from 7 percent in 2005 to 13 percent in 2020.

The Swedish government has already taken sustainable development as the goal of energy industry from the 1970s. Sweden experienced especially heavy losses from the 70s world oil crisis. In order to make sure that Sweden's economic development is no longer restrained by the fast-growing petroleum price, as well as for the national energy security, the Swedish Government formulated energy development targets, and has established the energy strategy guiding principle in 1997: Speed up sustainable energy system development in order to get rid of the dependence on oil resources, realize renewable energy sources comprehensively. Its primary intentions are: Sweden's electric power and other energy supply is ensured, the price must be competitive in the world market; the sustainable development with high efficiency and low cost will emit less pollution and promote ecological equilibrium.

It is stipulated that either electric power producers or the electric power supplier must have the certain proportion of electric quantity in its electric power production or the electric power supply from renewable energy sources, "Electricity certificates" and "Trade systems of electricity certificates" to realize its goal. The proportion is around 10 percent and will be increased year by year. In the same way, in order to encourage the enterprises to use the biological and other new energy, the Swedish Government gives preferential tax benefits to the enterprises using electricity generated from new energy and it can be accounted for the proportion of total electricity usage. The government has paid out massive funds every year from the government budget to support new energy technology since 1975. It gives the subsidy mainly to technical research and development projects.

These effective economic means play a positive role on the aspects of changing energy consumption structure and promoting environmental protection.

Although new energy technology is relatively mature in Sweden, it is still an emergent industry. How profits from the overseas experience are the question which urgently waits to be solved. In view of China's actual situation, some experts put forward some proposals.

The government can set up special expansion funds for the new energy, suppresses polluted fossil energy, and promote new energy development. The fund is used to safeguard the implementation of the fiscal subsidy, the price subsidy, the interest-paid loan, and the research and development investment and so on other renewable energy source policy. The special fund can include three parts: withdraw 1-3 cent money from the electricity end users; get some from the present coal resources use fee as development fund; collection of fossil fuel tax. In view of the finiteness of fossil energy resources and pollution in the combustion process, the state can use overseas' experience for reference: tax CO₂ emissions and levy fossil fuel methods.

The new energy industry also is small and weak at present. It depends on the market spontaneity and development is very difficult. Its realization of commercialization advancement needs the government's support. The state can use administrative means to carry out the quota system; a certain share of new energy electricity generation must be included in the total energy production, and consumption. On the other hand, the company's benefit should be considered. The state must guide the new energy technology development and enlarge the new-energy domain research and development investment, as well as through the form of tender to attack and capture the new energy key technologies. It is also important to sign new energy technology interflow and cooperation agreement with the advanced countries. In this case, the state creates a good international cooperation environment for new energy technology introduction. The import duty for the new energy technology introduction is reduced at present to support its development. It is still long way to go before China has its own new energy technology.

7 Conclusions

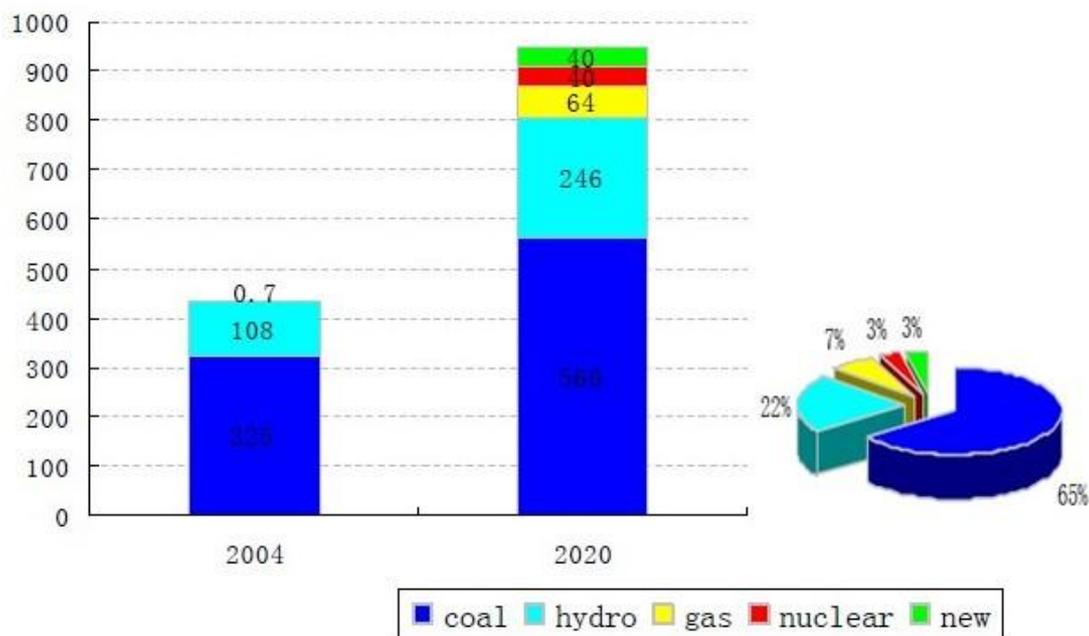
China's energy market is in a transformation phase. Despite the fact that economic growth in their planned economy did contribute to an increased standard of living, government intervention only creates a marketplace that contracts. To achieve the final goal of providing better service and products to market, the energy industry faces imminent reform and must seek to introduce the competitive mechanisms are needed.

In the initial period of Reform, the government compulsorily controlled every economic development and comprehensively arranged economy growth, which at certain point, did improve people's living standard. However, with whole society's gradual development and proceeding of Reform, planned economy has become a burden to social development and government's interference has been an obstacle standing in development.

After continuously reforming and opening up, the full-scaled development in society has pushed government-controlled market off historical stage.

Opening up market and introducing competition mechanism are required as a necessity for further development.

Installed capacity(GW)



Target generation mix in 2020

Figure 7.1, The long-term target generation mix in China in 2020

In the foreseeable future, coal will be seen as major energy source for China, despite the poisonous gas it emits. Several standards and regulations on gas emissions have been made that companies must adhere to. Protecting the environment has already increased the production cost for coal mining and electricity companies. Countries in Europe that have signed the Kyoto Protocol, have already begun the process of reducing the amount of carbon they release into the atmosphere--something China should take note of.

At the same time, it's also important to educate people about being reasonable about energy conservation, both in industries and individual households--for example, power saving fluorescent lamps can help. Mechanisms are in place to regulate the energy industry, by reducing costs and providing better products and service to the market. Information on how to achieve energy efficiency is available for all business startups.

Though national policies and sponsorship matter a lot in the initial development of energy reform. China's energy market must breakup of monopoly and open the markets.

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