Beijing Natural Gas Supply and Environment Protection

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Abstract: This paper analyses the main cause of pollution in Beijing city-the limiting of the pollution caused by coal burning has seen important progress, and natural gas is assuming an important role in China's energy strategy as the country actively seeks new and cleaner sources of energy, since 1997 to 2007, the gas supply for Beijing was given, compared with the air quality standard above II which set up by WHO(World Healthy Organization), as a result the important relationship between the environment and gas using was found, then the percent of SO_2, NO_2, PM10, CO, O_3 of air was shown from August 8th -24th 2006, Which it was verified that the quality of air will be perfect within the standard of WHO during the Olympic Game 2008 China.

Key words: Gas, Environment, Beijing

1 Introduction

Natural gas is assuming an important role in China's energy strategy as the country actively seeks new and cleaner sources of energy. Currently, about 70% of China's commercial energy comes from coal, which is a primary cause of the horrendous urban air quality that has made Chinese cities among the most polluted in the world. Coal will be difficult to unseat as it is locally abundant and inexpensive. Over the next few decades, cleaner fuels like natural gas will be essential to powering the growing Chinese economy.

This rapid growth is expected about to continue through 2020 to reach between 1,750 and 2,310 Mtoe (DRC2003). In the 10th Five-Year Plan (2001-2005) for the

energy sector, the central government for the first time began explicitly stressing "energy structure optimization, "hoping to diversify from coal to include cleaner energy sources like natural gas. To meet this goal, it adopted a new national energy strategy, which seeks to increase the share of natural gas in primary energy consumption from the current 3% to 9% by 2020. This implies a more than 10% annual growth rate for gas as compared to 5% total energy growth targeted for the same period. In volumetric terms, consumption would rise from 39 billion cubic meters (bcm) in 2004 to 200 bcm by 2020 (BP 2005, DRC 2003), and would make China the world's fourth largest gas market after the U.S., the twenty-five members of the E.U., and Russia.

The Beijing city government's efforts to expand the share for gas are found in supply networks and demand. In 2002, central government-owned companies began construction of the 4,000km West-East gas pipeline to connect gas resources in Xinjiang to demand centers in Shanghai. The pipeline began limited operations in 2004 and is expected to have an annual throughput of 12 bcm. China has also contracted for LNG supplies, and the first LNG terminal (in Guangdong) is expected to open in 2006. Central plans envision a more elaborate network of pipelines and LNG terminals, but it is unclear whether future infrastructure development projects will follow a central plan.

2 Beijing Gas Supply

2.1 Gas supply

From 1998 to 2006, Beijing invested 1,200 million RMB in environmental protection measures, a total of 3.24% of GDP. In 2006 alone, this number reached 250 million RMB.

Fig 2.1 the Pollution Control Monitoring Center

Pollution control has been carried out in thirteen stages, with more than 200 concrete steps. The limiting of the pollution caused by coal burning has seen important progress. In 2006, Beijing's natural gas usage reached 38 million cubic meters, 34 cubic meters greater than 1998; this year, experts believe that that figure will rise to 47 cubic meters. For large coal-burning equipment, including coal-fired power plants and coal-burning boilers in excess of 20 tons, there has been increased monitoring of desulphurization processes. Monitoring techniques will be changed for the 16 thousand coal-burning boilers below 20 tons, and small coal-fired burners are slowly being eradicated. In Dongcheng and Xicheng districts, the 30,000 single house residents are changing the way they use energy. Law enforcement officials constantly monitor small businesses to prevent them from using small coal-burning stoves, as residents' health is directly related this sort of pollution.

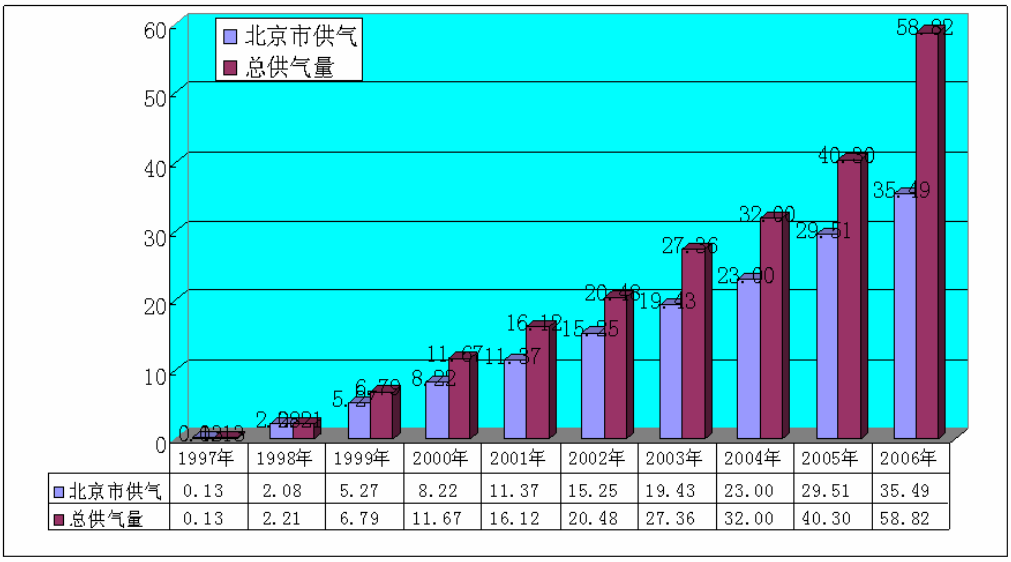

Fig 2.2 The Gas supply from shaan-jing gas pipeline

2.2 Beijing to replace coal with natural gas as major energy source

The Beijing capital will replace coal with natural gas as the major energy source for heating and power generation by 2008, when the Olympic Games take place, according to the city government.

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The Beijing city has approved a group of electricity-generating projects fueled by natural gas, not coal, to ensure cleaner and bluer skies in the capital, which the plan designed by Beijing Municipal Commission of Development and Reform.

The Beijing city plans to build a large gas-fueled power station in the Taiyanggong area, which is about 4-5 kilometers from the Olympics Green in the northern suburbs of the capital. The electricity generating facility will replace about 40 heating supply stations which currently burn coal.

Statistics indicate that 26.7 percent of China's total energy consumption takes place in houses and buildings. This ratio is two or three times higher than in other countries at the same latitude, said the English-language newspaper.

3. Environment changed for Olympic Games

Air quality Beijing has implemented a number of initiatives to improve its air quality and reduce its air pollution. From the relocation and refitting of major polluting industries, to the conversion of coal burning boilers to cleaner fuels and the implementation of vehicle emission standards, the city can boast significant achievements. Most of these initiatives will benefit the citizens of Beijing long after the Games have closed, provided that the impetus brought about by hosting the Olympics is continued, with Games-related measures being adopted and implemented on a long-term basis by the authorities.

	Goal	Key word
1	Construction of the second Shan-Jing natural gas pipeline with a transport capacity of 4-5 billion m^3/year, by 2007.	Energy
2	Conversion of coal burning boilers in the urban area, increased use of clean fuels and energy structure readjustment.	Energy
3	District heating supply to over 50% of the urban civil residential area. Electricity and geothermal heating coverage up to 16 million m^2.	Energy
4	Improvement of transport infrastructure and construction of key roads.	Transport
5	Improvement of the public transportation system. Use of clean fuels in 90% of public buses and 70% of taxis.	Transport / energy / air quality
6	Implementation of a vehicle emissions standard equal to Euro II for light vehicles by 2004.	Transport / air quality
7	Improvement of the management of flying dust in building sites and road construction. Prohibition of any kind of open air incineration. Coverage of outdoor storage areas of waste and other materials.	Air quality
8	Protection of Miyun and Huairou reservoirs (sources of drinking water) and improvement of their water quality. Implementation of the silt elimination and water clarification project in Guanting reservoir.	Water
9	Technical transformation and renovation of the Jingmi canal to improve water quality and flow.	Water
10	Readjustment of the agricultural structure to promote development of high quality, high efficiency and water saving agriculture. Strengthened efforts to reduce flying dust in the agricultural sector.	Water / air quality
11	Improvement of the city sewage network and wastewater treatment system. Achievement of a 2,8 million m^3/day total wastewater treatment capacity by 2007.	Water
12	Construction of hazardous waste disposal facilities for a total capacity of almost 10,000 tons/year (including medical and radioactive waste processing and disposal plants).	Waste

13	Implementation of a safe urban domestic waste disposal system by 2007. Establishment of processing facilities for non-hazardous urban waste in the Beijing suburban area.	Waste
14	Reduction and control of industrial pollution. Implementation of industry pollution registration, monitoring and licensing system. Closing down of heavy polluting, high energy consuming and resource-wasteful enterprises.	Industrial sector / waste / water / air quality / energy
15	Relocation of more than 200 industrial enterprises from within the Beijing Fourth Ring Road. Readjustment of industrial structure. Relocation, closure or renovation of heavy polluting and energy consuming plants in the Beijing southeast area and Shijingshan district. Phase-out of old technologies. Improvement of environment quality in the southeast suburb and Shijingshan district.	Industrial sector / waste / water / air quality / energy
16	Achievement of 40% of green cover in the urban area. Establishment of a green belt alongside the Fourth Ring Road (100 m wide green belt on both sides of the road except for those sections running through already built up areas).	Ecosystem
17	Realization of the Five River Ten Road green belt. Accomplishment of nearly 50% of forest coverage rate. Realization of three green ecological belts in the mountain, plain and urban areas respectively.	Ecosystem
18	Strengthening of natural preservation zones and establishment and management of key conservation areas (such as wetlands, forests and bird habitats). Establishment of natural protection areas over 8% of the municipal area.	Ecosystem / protected areas
19	Formulation and implementation of an action plan to phase out Ozone-depleting Substances (ODS). Achievement of the target by 2005.	Air quality / ozone
20	Implementation of cutting-edge environmental technologies in the design of Olympic venues. Use of natural resource-efficient, non-polluting and recyclable materials for facilities and equipment. Preservation during the construction of Olympic venues of indigenous vegetation and ecological ecosystems. Protection of cultural relics. Improvement of green coverage. Promotion of public transportation and clean fuel vehicles in the Olympic transport system.	Venues design / natural resources / forestation / transport

Source: BOCOG

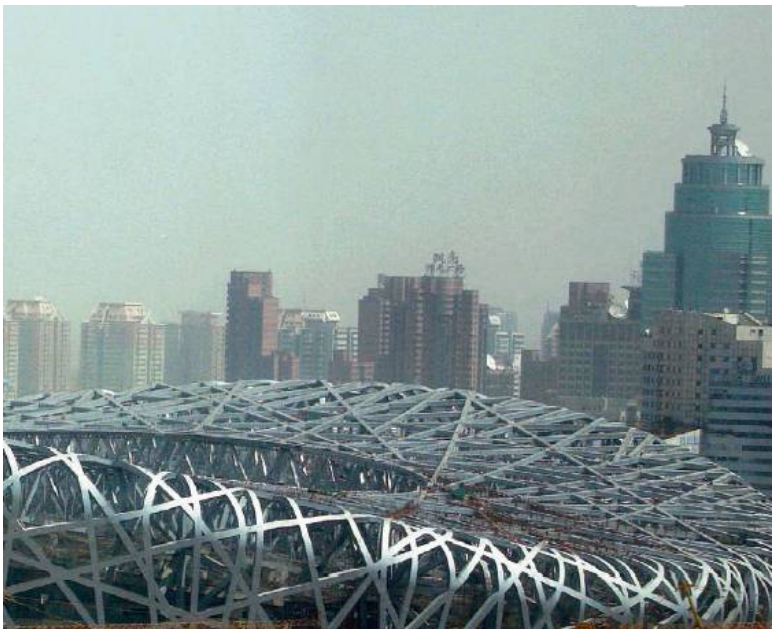

Fig 3.1 The Olympic National Gymnasium (“Bird’s Nest”)

Fig 3.2 The Olympic Swimming Natatorium (“Water Cube”)

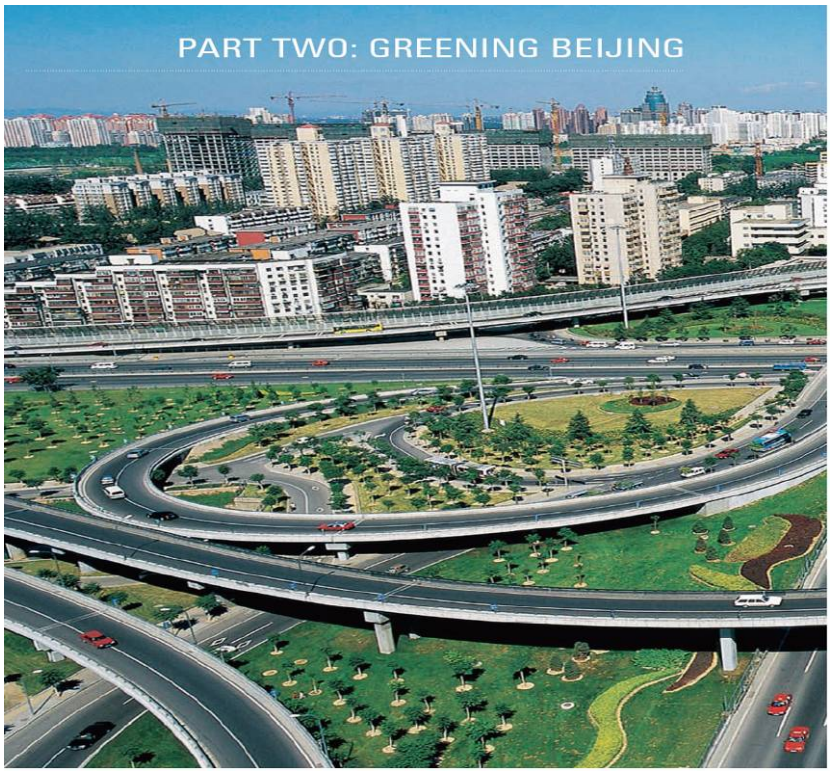

Fig 3.3 The Green Beijing

Fig 3.4 The Purified Beijing

4. Analysis of Air Quality in Beijing

4.1 Greening Beijing

As the IOC Evaluation Commission noted in 2000, Beijing "has an ambitious set of plans and actions designed and comprehensive enough to greatly improve overall environmental conditions. These plans and actions will require a significant effort and financial investment.

The result would be a major environmental legacy for Beijing from the Olympic Games, which includes increased environmental awareness among the population."

"Although many of the plans are not Olympic specific, the bid has provided, and a Beijing Games would provide, an impetus and a catalyst for many measures, and their timing.

The Beijing Municipal Government is committed to greatly reducing the pollution levels of Beijing, increasing environmental areas and protection, introducing environmental technology and controls, such as transport emission measures, and increasing sewerage treatment."

Beijing's variable air quality has been the subject of considerable media attention in the run-up to the Games Still Pictures.

Air quality is one of the major concerns of the Beijing Games' stakeholders, from the international media to the athletes who will compete there in August 2008. The IOC president, Jacques Rogge, was quoted in the media in August 2007 saying he "could not be happier" about the state of preparations in Beijing. "Since I've been involved in Games preparations, which is since Sydney, they are the best prepared of all." Nonetheless, Rogge has echoed the widespread concern about the city's air pollution, even floating the possibility of rescheduling some events. "Sports with short durations would not be a problem, but endurance sports like cycling are examples of competitions that might be postponed or delayed," he said.

The main causes of air pollution in Beijing include the presence of many polluting industries and the large number of new vehicles registered daily in the city. The city's geographical position further exacerbates poor air quality. Beijing is surrounded by mountains that don't allow pollutants to disperse and the area is subject to severe

sandstorms.

To fulfill its bid commitments, the Beijing Municipal Government began working to improve air quality in 2008. The prevention and abatement of air pollution has been reinforced, with a specific focus on vehicle emissions, industrial pollution, energy use and the construction sector.

Air quality has improved for some of the monitored pollutants. However, it takes years to determine significant changes in air quality. Relevant progress may be evident only in the medium- to long-term. International attention on this issue is increasing with the approach of the Games. While this review lists several initiatives undertaken by the Beijing authorities and Games organizers to improve air quality, it would appear that more effort may be needed to address the legitimate concerns of the International Olympic Committee and other stakeholders.

4.2 National Air Quality Standards

In terms of air quality standards, the city of Beijing is subject to the Standard II National Ambient Air Quality Standards (GB 3095–96). These regulations set limits for major air pollutants such as sulphur dioxide (SO_2), carbon monoxide (CO_2), nitrogen dioxide (NO_2) and particulate matter (PM10). Ozone (O_3), which is generated through a photochemical reaction that takes place when nitrogen dioxide and volatile organic compounds are exposed in the sun (UV) radiation, is not among the parameters currently monitored by the city of Beijing. Ozone is produced in higher quantities during the summer months because of the reaction involving UV radiation and this is of particular concern because the Games will be staged in the month of August 2008. Further investigation into ozone levels is necessary.

According to data released by the Beijing Environmental Protection Bureau (EPB) from measurements from 27 monitoring stations in the municipal area, the number of days with air quality equal to or above the National Standard increased each year from 1998 to 2006.

Table 4.1 Standard II National Air Quality Standards

Pollutant	Mean Level	Upper Limit of Standard II	WHO standards
SO_2	Annual Mean	60 μg/m³	
	24-hour Mean	150 μg/m³	20 μg/m³
	Hour Mean	500 μg/m³	
PM_{10}	Annual Mean	100 μg/m³	20 μg/m³
	24-hour Mean	150 μg/m³	50 μg/m³
NO_2	Annual Mean	80 μg/m³	40 μg/m³
	24-hour Mean	120 μg/m³	
	Hour Mean	240 μg/m³	200 μg/m³
CO	24-hour Mean	4,000 μg/m³	
	Hour Mean	10,000 μg/m³	

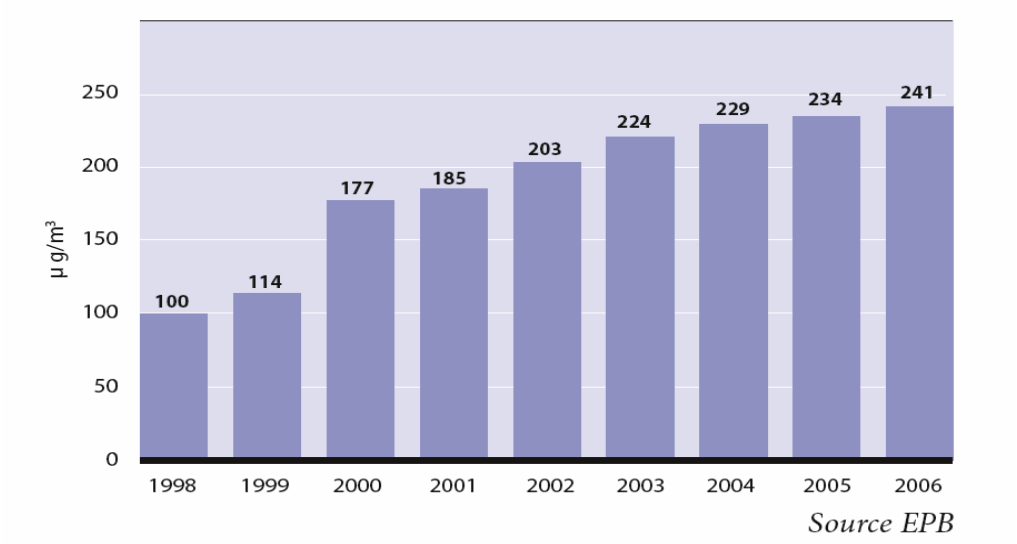

Fig. 4.1 Days with Air Quality Equal or above National Standard, 1998-2006

4.2 Annual Concentrations of Air Pollutants in Beijing

The tables below show the annual average concentration of major air pollutants in Beijing. The Environmental Monitoring Centre, managed by the Beijing Environmental Protection Bureau, collected and disseminated the data.

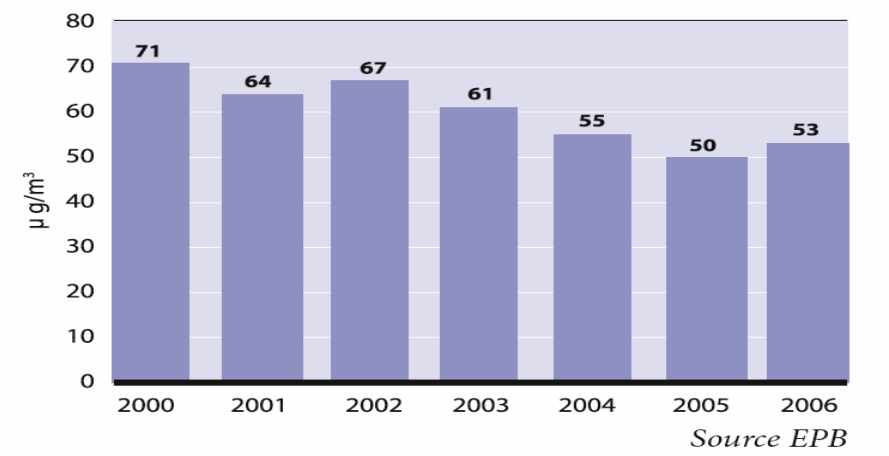

Fig. 4.2 Annual Concentrations of Air Pollutants in Beijing

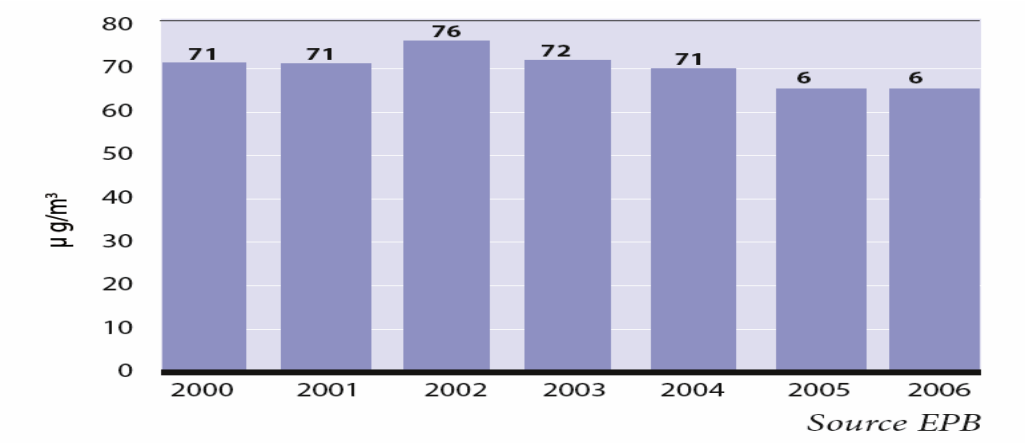

Fig. 4.3 Annual Mean for NO_2 Concentrations in Beijing, 2000-2006

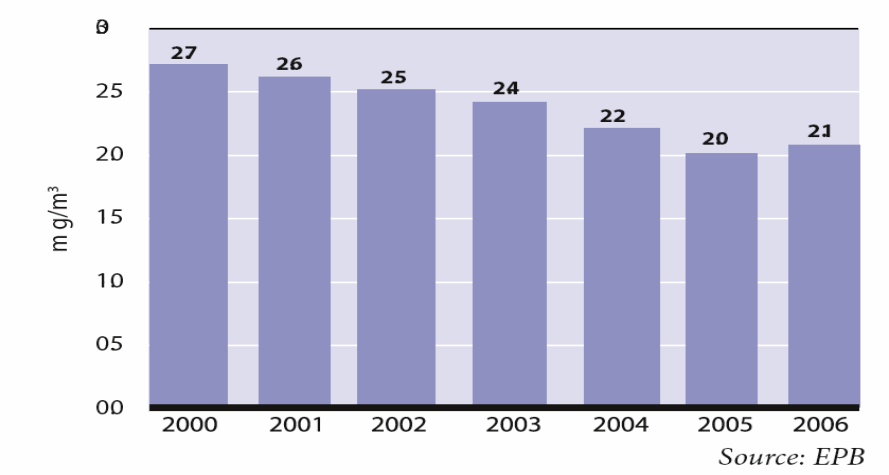

Fig. 4.4 Annual Mean for CO Concentrations in Beijing (Milligrams), 2000-2006

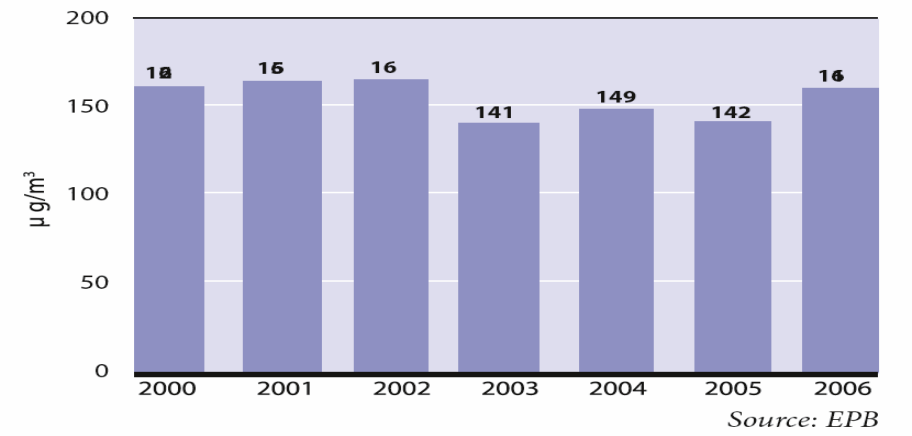

Fig. 4.5 Annual Mean for PM_{10} Concentrations in Beijing, 2000-2006

The official figures of concentration levels appear to show that from 2000 to 2006 the percentages of SO_2 , CO and NO_2 in the atmosphere have predominantly declined.

However, the concentration of PM_{10} has not decreased. The reasons for this include dust generated by the huge number of construction sites, emissions from the coal burning boilers in Beijing and dust storms. For example, in the spring of 2006, the city was hit with 18 sandstorms.

According to the Beijing municipal Government, the increase in airborne dust and sand is the most likely reason for the raise in the levels of Pm10 for 2006. However, this appears to be contradicted by the SO_2 and Pm10 data for August 2006. As they correlate closely it would appear that emissions from coal burning are largely responsible.

It is also significant that after three years of downward trend, levels of all the measured airborne pollutants in the graphs (SO_2, CO and NO_2, as well as Pm_{10}) rose or ceased to decline in 2006.

4.3 WHO Air Quality Guidelines

The World Health Organization (WHO) develops globally recognized standards for air quality. WHO sets concentration guidelines for major pollutants on the basis of the health hazards they can cause to human beings.

In 2006, WHO published the 'Air Quality Guidelines: Global Update 2005',

superseding the previous edition completed in 1997 (published by WHO in 2000).

The limits for some major pollutants were revised and below are the values currently in force:

Table 4.2 . WHO Published the Air Quality Guidelines

SO_2 20μg/m3 24-hour mean 500μg/m3 10-minute mean	NO_2 40μg/m3 annual mean 200μg/m3 1-hour mean
CO 30mg/m3 1-hour mean 30mg/m3 2-hour mean	PM_{10} 20μg/m3 annual mean 50μg/m3 24-hour mean
O_3 100μg/m3 daily maximum 8-hours mean	

Fig. 4.6 the Buses with Gas Fuel

4.4 Natural Gas Consumption

The Beijing Gas Group Ltd. is a state owned company responsible for supplying natural gas and liquefied petroleum gas (LPG) to Beijing. Beijing Gas Group Ltd. Is the largest company operating in the gas sector in China? Other smaller companies also supply natural gas to Beijing, but this portion of the chapter will only discuss Beijing Gas Group activities. Since Beijing began importing natural gas from Shanxi, Gansu and Ningxia Provinces in 1997, natural gas consumption in Beijing has increased by 300-450 million m^3 annually. The number of customers has increased by 250,000-300,000 households annually.

In 1997, the Beijing Gas Group purchased 180 million m^3 of natural gas. By 2006,

their purchase had increased to 3.53 billion m^3 and the number of households benefiting from the service reached 3.22 million.

According to official data, the ratio of natural gas consumption to total energy consumption in Beijing increased from 0.5 per cent in 1997 to 6.4 percent in 2004.

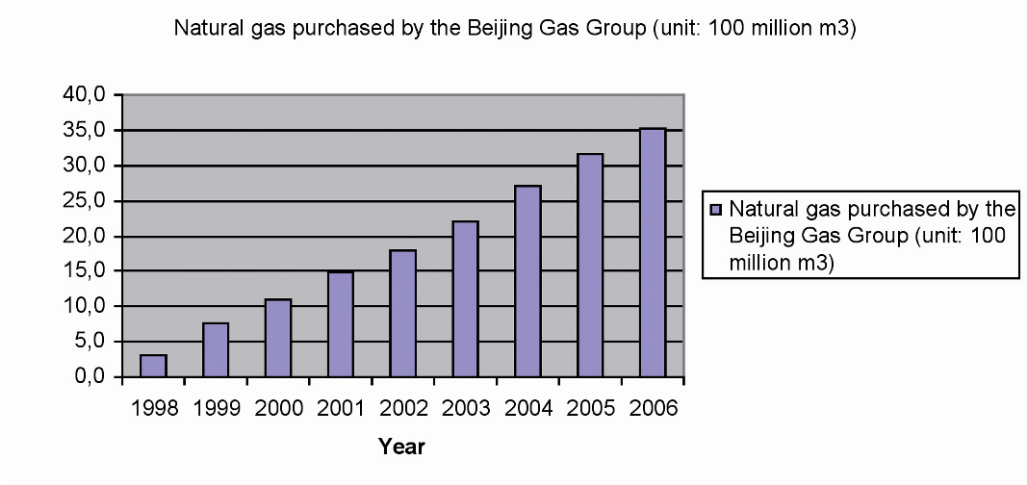

Fig. 4.7: Natural Gas Purchased by the Beijing Gas Group for Distribution (1998-2006)

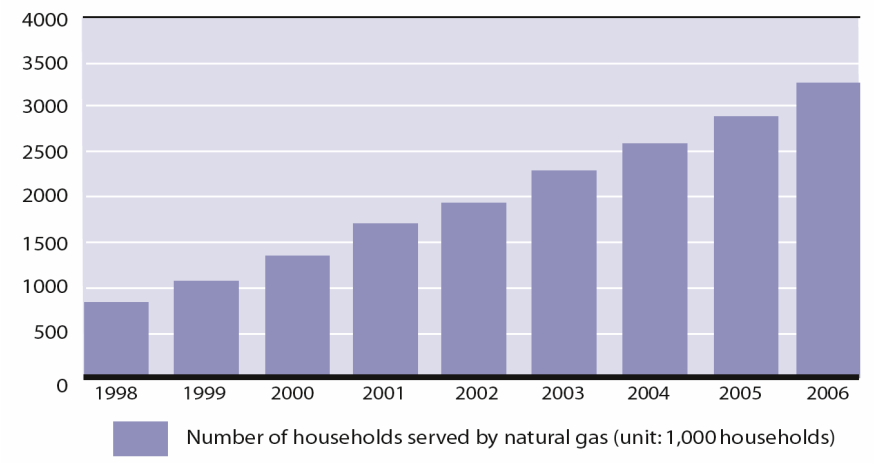

Fig 4.8 Numbers of Households Served by Natural Gas (1998-2006)

At the end of 2006, the total purchasing volume of the Beijing Gas Group was 3.53 billion m^3, while the overall sales volume was 3.47 billion m^3. The total length of the company's transportation network was 7,295 km, including super-high pressure, high pressure, medium pressure and low pressure pipes 348 km, 466km, 2357 km and, 4125km respectively. In 2006, a total of 646 natural gas pressure regulating stations were operating with a storage capacity of 700,000 m^3, divided between four different storage facilities.

Beijing relies on both national and Russian gas fields for its supply. It has been estimated that nearly 20 billion m of natural gas will be imported from Russia in 2015. The Russian gas fields are connected to the city by several long-distance transportation pipelines, such as the Shaan-Jing Lines No.1 (built in 1997 with a transportation capacity of 3.3 billion m^3/y) and No.2 (built in 2005 with a transportation capacity of 12 billion m^3 / year).

The Beijing Gas Group is currently working to:

- Strengthen the development of high quality energy sources, such as natural gas.
- Increase import levels of natural gas from international natural gas sources, to supplement extraction from national natural gas fields, such as Changqing and Huabei Gas Fields.
- Preferentially satisfy the natural gas demand of residents.
- Encourage, in cooperation with the Municipal Government, the replacement of polluting industries and electricity power plants.
- Support the development of gas-powered co-generation plants.

The table below shows the forecast for natural gas demand in Beijing with a breakdown for different end-user sectors. While the conversion to natural gas is a positive trend, it is hard to currently gauge its significance as data has not been presented to relate it to other energy sectors, for example to calculate how much less coal is being used as a result of increased natural gas use.

Table 4.3 Natural Gas Consumption Forecast, Beijing, 2006-2020

Sector	2006	2008	2010	2020
Residents	7.9	8.6	9.1	14_17
Public Service	3.4	4.6	3.7	6_7
Industry	1.6	5.3	3.9	9.1
Heating	17.7	24.3	33	42
Cooling	0.6	1.0	2.3	3.3
Electricity Generation	2.8	6.6	14.5	32_38
Others	1.3	2.2	1.3	1.6

Source: Beijing Gas Group Ltd.

4.5 Air Quality in Beijing in August of 2006

The tables below show air quality data released by the Beijing EPB for the month of August 2006, compared to the 2005 WHO Air Quality Guidelines recommendations.

The data refer to the daily SO_2 concentration, the NO_2 hour concentration and the daily PM10 concentration. They are particularly relevant for the Olympic Games, which will be staged from August 8 to 24，2008.

While NO_2 concentrations are consistently and significantly below the WHO threshold, and SO_2 levels are predominantly within safe limits, levels of PM_{10} are well above recommended safe levels, often by as much as 200 per cent and sometimes more.

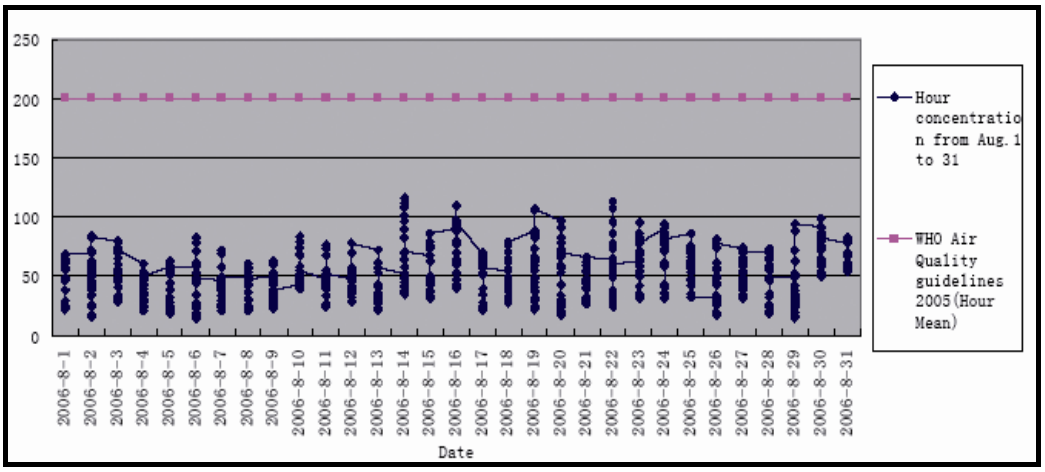

Fig 4.9: NO_2 Concentration in August, 2006, Compared with WHO Guidelines

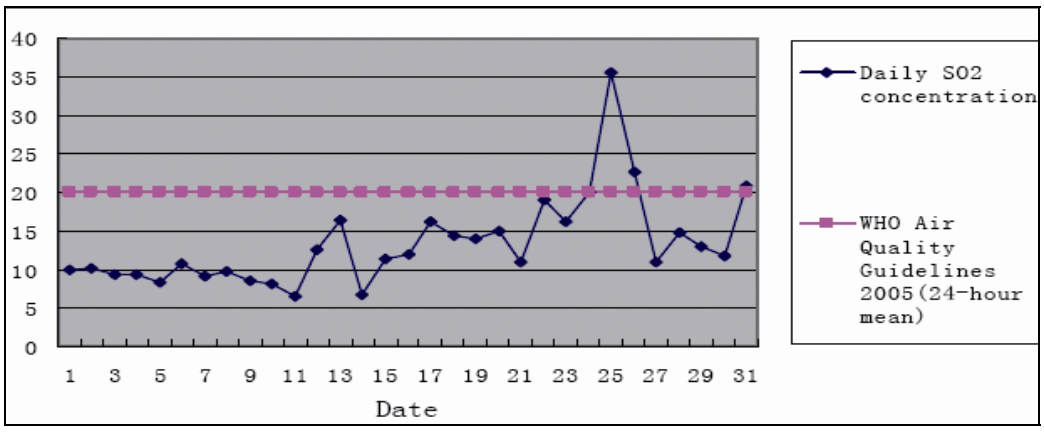

Fig 4.10 SO_2 Concentration in August, 2006, Compared with WHO Guidelines

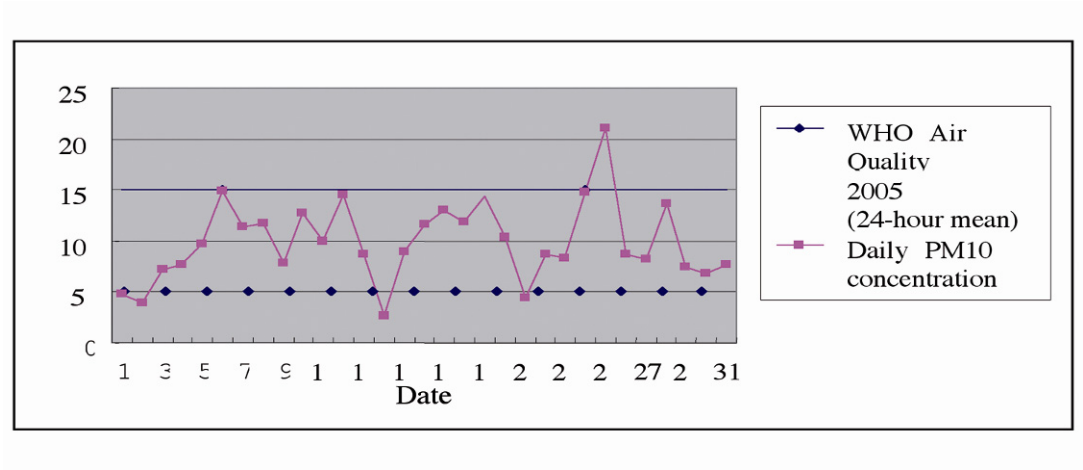

Fig 4.11 Daily PM10 Concentration in August, 2006, Compared with WHO Guidelines

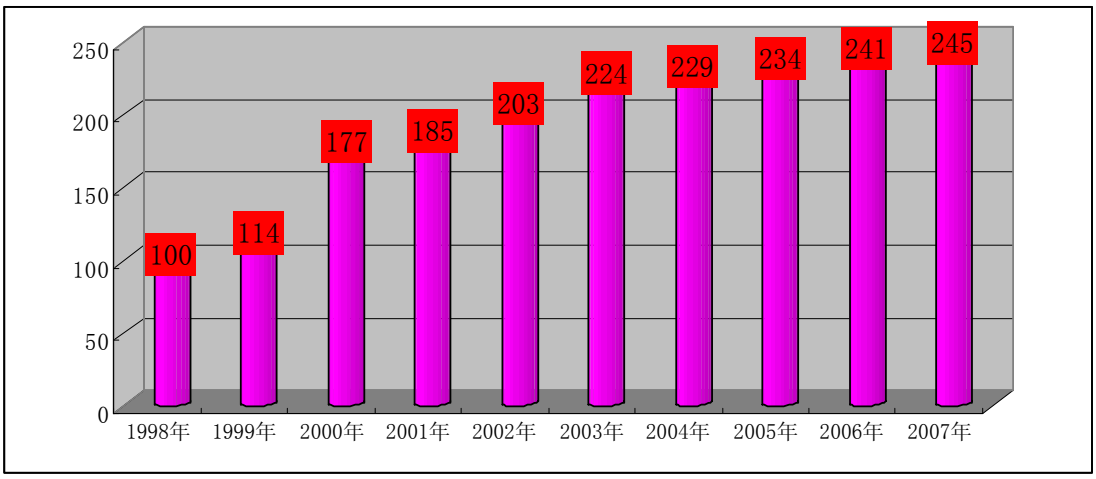

Fig. 4.12 the Annual Day Number of Blue Sky in Beijing

5. Conclusion

Before 2000, the coal using was 28 millions tons in Beijing, which is the 75 percent of total energy, the CO_2 was produced by coal, the condensity of which is the 3.5 times than usual time, the 2/3 suspend grain of air was due to soot. In 2007, the 4 billion natural gas was supplied by PetroChina, which reduced the 6 million tons coal, and reduced the 100,000 tons SO_2, as a result the blue sky project was pushed forward, and provide the strong protection for green Olympic 2008.

The Shaan-Jing gas pipeline was finished, the most of Beijing urban use the natural gas which is purified energy, which reduce the dust, CO_2 and NO from coal in the center region, and which improve the air quality in the winter during the heating

season. With the gas flow rate increasing gradually one by one, the environment will be close to the standard of WHO, air quality will be improved, the living standard will be upgraded, and the structure of energy will be changed.

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Dr. Hong Zhang, male, born on Feb. 1963, has been involved in teaching of engineering mechanics and research on the applications of engineering mechanics in petroleum engineering. He obtained a master's degree in mechanical engineering and a doctoral degree in machinery design and theory from China University of Petroleum-Beijing. After working as a teacher since 1985, he participated in the research of strength analysis and optimized design of buried pipeline, diagnosis of sucker rod piping system of orientation well, casing failure mechanism and improvement method, and multi porous rock mechanics. During 1996 and 1997, Dr. Zhang worked in Rock Mechanics Institute, The University of Oklahoma as a visiting scholar for 6 months. Currently, Dr. Hong Zhang is Professor of Faculty of Mechanical & Electronic Engineering, China University of Petroleum, Beijing.