Review of Air Pollution and the Related Regulations in China

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Abstract

Air pollution is very serious in China. This paper reviews the relevant research and countermeasures in China. The followings are focused in this article: 1) three major types of air pollutions: sulphur dioxide, vehicle emission and indoor air pollution; 2) the health effect of the three types of pollution; 3) major countermeasures adopted by Chinese Government.
Key Words: air pollution, sulphur dioxide, vehicle emission, regulation

INTRODUCTION

One of Chinas most pressing environmental problems today is the air pollution that has resulted from the nations increased energy and automobile use. Among the top ten most polluted cities in the world, three (Beijing, Shenyang and Xian) are in China. Moreover, the air quality in more than 500 major Chinese cities is below World Health Organizations (WHO) guidelines. China has recognized air pollution as a critical problem. With the largest population than any other country in the world, Chinas air pollution problem is one of regional and international concern that affects the quality of life, economic and environmental circumstance of China and the Region. This paper outlines the general characteristics and issues of air pollution in China.

SOURCES OF AIR POLLUTION IN CHINA

Industrial and Domestic Energy Use

Coal burning, the primary source of China's high SO2 emissions, accounts for more than three quarters of the country's commercial energy needs, compared with 17 per cent in Japan and a world average of 27 per cent. China's consumption of raw coal increased 2% per year between 1989 and 1993. Meanwhile, SO_2 emissions increased by more than 20 per cent and TSP increased by approximately 10 per cent. Without even more dramatic measures to control emissions than are currently in place, the deterioration of air quality seems inevitable.

Particulates and SO_2 are the ambient air pollutants of greatest concern; both are byproducts of coal combustion. While industrial emissions of heavy metals and other toxics are also significant contributors to air pollution in China, they are not routinely monitored and will not be addressed in this section.

Trends in Energy Structure (percentages of total energy sources)

Year	Coal	Petroleum	Natural Gas	Hydropower	Total Consumption (Mt coal equivalent)
1962	89.2	6.6	0.9	3.2	165
1985	75.8	17.1	2.2	4.9	602
1996	75.0	17.5	1.6	5.9	1388

Source: Sinton (1996)

The extent and type of air pollution in China vary dramatically by geographic region. SO_2 and particulate emissions are highest in the northern half of China where coal is used to heat homes and other buildings for several months of the year and where industrial centers also depend heavily on coal burning. Yet, air pollution in the north would be much worse if not for the higher quality, cleaner coal that is available there. By contrast, the coal mined in the south of China is high in sulphur and extremely polluting, contributing to serious problems with acidic precipitation, especially in the southwest provinces of Sichuan, Guizhou, Guangxi, and Hunan.

Industry accounts for two thirds of China's coal use industrial boilers alone consume 30 per cent of China's coal. These boilers are usually highly inefficient and emit through low smoke stacks, contributing to much of China's ground-level air pollution, especially small particulates and SO_2. Inefficient and dirty boilers are particularly problematic because many of the industries that use them are located in densely populated metropolitan areas, placing populations in these areas at high risk of exposure. The residential sector accounts for approximately 15 per cent of total coal use, yet is estimated to contribute to more than 30 per cent of urban ground-level air pollution.

Largely because of controls at power plants and within households, particulate emissions have not risen as much as which might have been expected with the doubling of coal consumption. Overall, particulate emissions in China have remained relatively level since the early 1980s. In fact, in some large cities, ambient particulate concentrations have decreased markedly since the 1980s. In contrast, up until the mid 1990s, SO_2 emissions roughly paralleled the increase in coal consumption as a result of inadequate sulphur control measures. However, since about 1996, there have been many efforts that have acted to reduce SO_2 emissions, especially those aimed at reducing the sulphur content of coal used, higher thermal values for the coal, energy efficiency improvements and so forth. Chinas emissions of SO_2 were estimated to be 25.0 million tonnes in 1997 compared with 25.7 million tonnes in 1995 (Streets et al., 2000). Most of the efforts made recently have been the cheap options or options that have other benefits. It remains to be seen whether this de-coupling of SO2 emissions from increases in coal consumption can be maintained.

Transportation

Although the energy and industrial sectors are now the biggest contributors to urban air pollution in China, the transportation sector is becoming increasingly important. The total number of motorized vehicles in China is growing rapidly and has already risen to about 1 million in Beijing and almost 700,000 in Guangzhou. For the country as a whole, the number of vehicles in 1995 climbed to about 28 million. By 2020, the urban vehicle population is expected to be 13 to 22 times greater than it is today. This trend will likely have a major influence on the future of China's air quality. The shift toward vehicle use is most apparent in China's big cities. For example, from 1986 to 1996, the number of vehicles in Beijing increased fourfold, from 260,000 to 1.1 million. Although this is only one tenth of the number of vehicles in Tokyo or Los Angeles, the pollution generated by Beijing motor vehicles equals that in each of the two other cities.

The problem stems not just from the growing size of the vehicle fleet but also from low emissions standards, poor road infrastructure, and outdated technology, which combine to make Chinese vehicles among the most polluting in the world. Vehicle emissions standards in China are equivalent to the standards of the developed world during the 1970s, and some domestic companies are manufacturing vehicles modelled after vehicles from 20 years ago.

Actual emissions often exceed these standards: Chinese vehicles emit 2.5 to 7.5 times more hydrocarbons, 2 to 7 times more nitrogen oxides (NOx), and 6 to 12 times more carbon monoxide (CO) than foreign vehicles. In Beijing, Shanghai, Hangzhou, and Guangzhou, up to 70 per cent of CO emissions have been attributed to motor vehicles. Cars also contribute a large share of hydrocarbons and NOx in the cities for which data are available. As a result, although China's vehicle fleet is small compared with the developed countries, its large cities are already blanketed with smog.

A recent study in Beijing revealed that at all monitoring points within the Third Ring Road a rough boundary separating downtown Beijing and its outskirts the CO levels exceeded the national standard (4 micrograms per cubic metre per day). During the summer, ozone concentrations repeatedly exceeded the national standard which is set on an hourly basis often several times per day. In addition, concentrations of NOx have almost doubled over the past decade.

Compounding these pollution problems is the fact that the burgeoning Chinese motor vehicle fleet is largely fuelled by leaded gasoline. Although lead exposure is known to be a significant health hazard in China, no routine monitoring of environmental concentrations or blood-lead levels is performed. A few studies have been conducted and are described below. These scanty data suggest that ambient lead levels in the urban area of major cities such as Beijing are usually 1 to 1.5 micrograms per cubic metre the national standard is 1 microgram per cubic metre. In some areas, ambient lead levels can reach as high as 14 to 25 micrograms per cubic metre. The health effects described below are significant, although recent and dramatic government actions to phase out leaded gasoline will likely have a major impact on this problem. Beijing and Shanghai as well as other cities have already begun to act and the countrywide phase out was expected to be complete by the year 2000.

Percentage of Emissions in Selected Chinese Cities Attributable to Motor Vehicles (1996)

	CO	Hydrocarbons	NOx	Category
Beijing	48-64	60-74	10-22	District
Shanghai	69	37		District
Shenyang	27-38		45-53	District
Jinan	28		4-6	District
Hangzhou	24-70			Road
Urumqi	12-50			Road
Guangzhou	70		43	

Source: Walsh (1996)

Indoor Air Pollution in China

In China, the effects of outdoor air pollution are mixed with those of indoor air pollution. Households using coal for domestic cooking and heating are especially at risk because coal emits very high levels of indoor particulate matter less than 2.5 microns in size the size believed to be most hazardous to health. (These concentrations can be 100 times more than the proposed US ambient air 24-hour standard.) Exposure to these small-sized particles is especially harmful because they persist in the environment and reach deep into the lungs.

Indoor air pollution affects both urban and rural populations. Nor is it simply a problem indoors: numerous studies have shown that intense indoor coal burning can affect ambient air quality as well. For instance, rural neighborhoods are generally unaffected by urban sources of air pollutants but can be extremely polluted from the burning of coal indoors.

Indoor air pollution causes as many health problems as smoking, with the effects concentrated among women and children.

Although the proportion of China's households that burn polluting biomass fuels indoors for cooking and heating remains significant, it has been declining with the proliferation of alternative energy sources. Largely as a result of government investments, about one third of urban Chinese now have access to gas for cooking, and coal-burning households are increasingly turning to the use of cleaner, more efficient briquettes.

Indoor Air Particulate Air Pollution from Coal Burning in China

LOCATION	URBAN/RURAL	PARTICULATES ($\mu g/m^3$)
Shanghai	Urban	500-1,000
Beijing	Urban	17-1,100
Shenyang	Urban	125-270
Taiyuan	Urban	300-1,000
Harbin	Urban	390-610
Guangzhou	Urban	460
Chengde	Urban	270-700
Yunnan	Rural	270-5,100
Beijing	Rural	400-1,300
Jilin	Rural	1,000-1,200
Hebei	Rural	1,900-2,500
Inner Mongolia	Rural	400-1,600

Note: a. Particles less than 10 micrometres in size.
Source: WRI (1998)

Perhaps the most compelling example of the health impact from indoor air pollution is the extremely high lung cancer rates among non-smoking women in rural Xuan Wei County. Studies conducted by the United States Environmental Protection Agency (USEPA) report that in the three communes with the highest mortality rates, the age-adjusted lung cancer mortality rate between 1973 and 1979 was 125.6 per 100,000 women, compared with average rates of 3.2 and 6.3 for Chinese and US women, respectively, for the same time. Because surveys showed that virtually no women (in the county) smoked tobacco products, other sources of potent exposure must have contributed to these troubling rates. Analyses of indoor air and blood samples from the women indicate that fuel burning inside the home was largely responsible for the lung cancers. The USEPA studies found a strong association between the existence of lung cancer in females and the duration of time spent cooking food indoors. The levels of carcinogenic compounds present in smoky coal (a local type of coal that smokes copiously) were found to be much higher in the women who used smoky coal for cooking.

EFFECTS OF AIR POLLUTION ON HEALTH IN CHINA

Air pollution is thought to be one of the leading risk factors for respiratory diseases, such as chronic obstructive pulmonary disease (COPD), lung cancer, pulmonary heart disease, and bronchitis, diseases that are the leading causes of death in China. The fact that men and woman have similar rates of these diseases, despite women's much lower smoking rates, provides evidence that this high disease burden is related to pollution.

Since the 1980s, a number of studies examining the relationship between ambient air pollution and health effects in China have been conducted; however, it is important to remember that although the studies measured only ambient air pollution levels, in reality people are exposed to a combination of indoor and outdoor air. One of most definitive of these studies examined the relationship between air pollution and mortality in two residential areas of Beijing. According to this study, the risk of mortality was estimated to increase by 11 per cent with each doubling of sulphur dioxide (SO_2) concentration, and by 4 per cent with each doubling of total suspended particulates (TSP). When the specific causes of mortality were examined, mortality from COPD increased 38 per cent with a doubling of particulate levels and 29 per cent with doubling of SO_2. Pulmonary heart disease mortality also increased significantly with higher pollution levels. Levels of air pollution measured often exceeded WHO guidelines, particularly in winter when ambient air pollution was exacerbated by indoor fuel burning and certain climatic conditions. Yet, it is striking that excess mortality was associated with pollutant levels below WHO guidelines, suggesting that the guidelines cannot be perceived as a safe limit.

Respiratory diseases, hospitalization, or doctor visits are often a more sensitive measure of the impact of air pollution on human health than mortality. One recent study confirmed that as concentrations of SO_2 and TSP rose in Beijing, so did visits to the emergency room. This increase in unscheduled hospital visits occurred both when air pollution levels were extremely high (primarily in the winter) and when the levels were below WHO's recommended guidelines, bolstering studies in developed countries that have shown excess respiratory disease and mortality at these lower levels. Although Beijing has been the focus of many studies, it has no monopoly on bad air. Chongqing, the largest and most recently declared autonomous zone, has a higher concentration of SO_2 than any of China's five other largest cities. A recent study found that several symptoms of compromised health, including reduced pulmonary function and increased mortality, hospital admissions, and emergency room visits, were correlated with higher levels of air pollution in Chongqing. A study conducted in another of China's largest cities, Shenyang, estimated total mortality increased by 2 per cent with each 100 micrograms per cubic metre increase in SO_2 concentration, and by 1 per cent for each 100 micrograms per cubic metre in TSP.

Respiratory diseases are not the only health impacts of concern associated with air pollution. Lead exposure, for instance, leads to neurological damage, particularly in children. China has no comprehensive national database on blood-lead levels, a reliable biomarker of exposure, but some studies show that blood-lead levels are far above the threshold associated with impaired intelligence, neurobehavioral development, and physical growth. (The U.S. standard is 10 micrograms per deciliter.) Between 65 and 100 per cent of children in Shanghai have blood-lead levels greater than 10 micrograms per deciliter. Those in industrialized or congested areas had levels averaging between 21 and 67 deciliters. In Shanghai, prenatal exposures to lead from urban air were associated with adverse development in the children during their first year of life.

Based on dose-response functions from studies conducted within China and in other countries, the World Bank has estimated the number of deaths and diseases associated with air pollution among urban populations. Using the Chinese standards as a benchmark, they estimate the number of deaths that could be prevented if air pollution were reduced to those levels. According to their calculations, approximately 178,000 deaths, or 7 per cent of all deaths in urban areas, could be prevented each year. Another measure of air pollution's impact on health is the number of hospital admissions from respiratory diseases. This study found 346,000 hospitalizations associated with the excess levels of air pollution in urban areas.

Health Effects from Air Pollution in China

From Urban air pollution / from Indoor air pollution	No. of cases
Premature deaths	178,000/111,000
Respiratory hospital admissions	346,000/220,000
Emergency room visits	6,779,000/4,310,000
Lower respiratory infections or child asthma	661,000/420,000
Asthma attacks	75,107,000/47,755
Chronic bronchitis	1,762,000/1,121,000
Respiratory symptoms	5,270,175,000/3,322,631,000
Restricted activity days (years)	4,537,000/2,885,000

Source: SEPA (2001)

AMBIENT AIR QUALITY MONITIORING AND STANDARDS IN CHINA

In a nation-wide effort to improve the air quality, the Chinese government and media have broadcast the daily state of atmosphere of 42 main cities everyday after the evening news since June 5th, 2000. These cities include 32 capital cities of province, municipalities directly under the Central Government and municipal capitals, ten beach cities and main tour cities, which include: Beijing, Tianjin, Shijiazhuang, Taiyuan, Huhehaote, Shenyang, Dalian, Changchun, Haerbin, Shanghai, Nanjing, Suzhou, Nantong, Hangzhou, Wenzhou, Hefei, Fuzhou, Xiamen, Nanchang, Jinan, Qindao, Yantai, Zhengzhou, Wuhan, Changsha, Guangzhou, Shenzhen, Zhuhai, Shantou, Zhenjiang, Nanning, Haikou, Chengdu, Chongqin, Guiyang, Kunming, Lasha, Xi'an, Lanzhou, Xining, Yinchuan, Wulumuqi. These cities are being monitored and controlled by the relevant departments. Before this, only Beijing, Tianjin had reported the state of atmosphere everyday.

According to official Chinese estimates (SEPA 2001), total emissions of sulphur dioxide during 2000 amounted to 19.95 million tons; 16.21 million tons from industrial sources and 3.83 million tons from municipal sources. The total amount of emission of flue gas and dust was 11.65 million tons, 9.53 million tons from industrial sources and 2.12 million tons from municipal sources. The total amount of emission of industrial ashes and powders was 10.92 million tons.

Pollutant Emission Between 1997 and 2000 (1000s tonnes per annum)

Year	2000	1999	1998	1997
SO_2 from industry	1621	1460	1594	1852
SO_2 from non-industrial sources	383	397	497	494
Soot from Industry	953	953	1175	1565
Soot from non-industrial sources	212	206	277	308
Dust from Industry	1092	1175	1322	1505

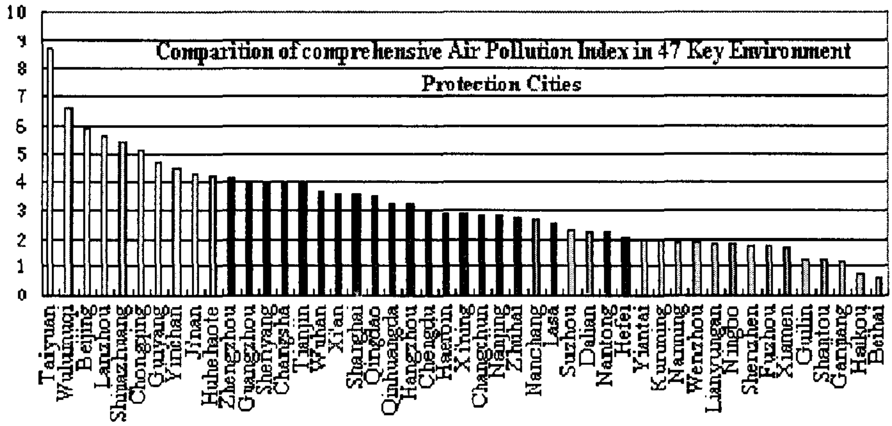
Source: Streets, et al (2000)

Comparison of Emission of Main Air Pollutants in 1995 and 2000

Year	SO_2(10 kt)	Particulate matter(10 kt)	Industrial dust emissions (10 kt)
2000	1995	1165	1092
1995	2370	1735	1731
Percent change	-15.8	-33.2	-36.9

Source: China Environment Yearbook (2001)

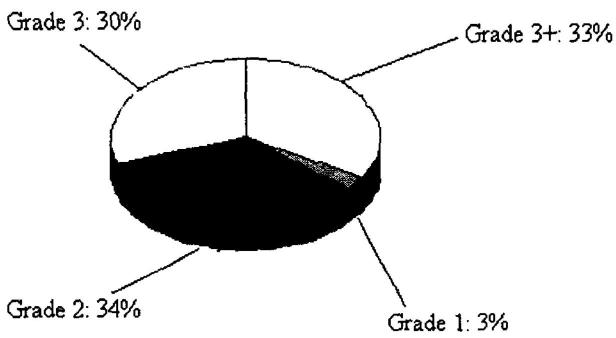
In 2000, 36.5 per cent of the 338 monitored cities met the national air quality standard of Grade II whereas 63.5 per cent were worse than Grade II.. In general, the urban air quality was better than in 1999 which is indicated by the rising percentage of the cities having complied with the air quality standard and the reduced number of the cities with the air quality worse than Grade III.



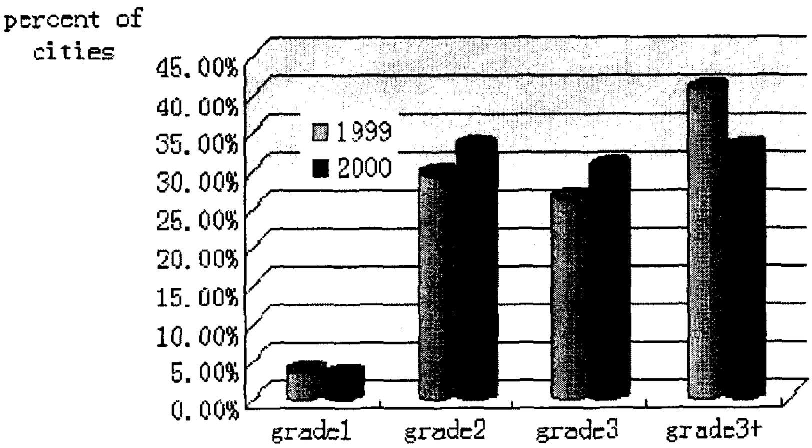
Comparison of Air Pollution Index in 47 Key Cities (1999); SEPA, 2001

The cities for which the average annual value of TSP and PM10 exceeded the limit value of the national standard of Grade II accounted for 61.6 per cent of the total cities included in the statistics. 20.7 per cent of the cities had higher average annual concentration of sulphur dioxide than the limit value of the national standard of Grade II, 8 per cent less compared with 1999. NOx pollution was relatively serious in the super big cities where there was a high population density and a large number of vehicles.

Compared with 1999, the percentage of the cities whose air quality met the national standard of Grade II rose from 33.1 to 36.5 per cent. The percentage of cities with air quality worse than Grade III declined from 40.6 to 33.1 percent. Out of 47 key cities for environmental protection, 27 met the national air quality standard of Grade II; 7 met the standard of Grade III and 13 had the air quality worse than Grade III.



Percentage by Grade of Urban Air Quality in China (2000) Source: SEPA (2001)



Statistics of Grades of Urban Air Quality in 2000 Source: SEPA (2001)

POLLUTION REDUCTION MEASURES

The major problems that China has faced in effective pollution reduction policies and regulations include inadequate economic and social analysis for total load control, poor cost-benefit analysis for least cost option, absence of effective instruments to implement least cost options (i.e. investment, technology, human resources), poor monitoring and law enforcement, and poor inter-province and inter-agency co-ordination.

In the midst of these obstacles, China has recently made an enormous effort to abate urban air pollution. The revised Law of Air Pollution Prevention and Control of the People's Republic of China was ratified by the Standing Committee of the National People's Congress on 29 April 2000 and enacted from September 2000. The revised Law of Air Pollution Prevention and Control has more precise and stricter provisions for air pollution prevention and control. Emended law air pollution and prevention and control was put into practice 1 September 2001. This is the second entire emendation after law of air pollution prevention and control passed by the Committee of People's congress Council in September of 1987 and the first emendation by Committee of People's congress Council in 1995. The new law is an important law to prevent and control air pollution; it embodies governmental determination to enforce air pollution prevention and control and to improve environmental quality.

In the emended law of air pollution prevention and control, important policies and tactics by the Central Committee of Communist Party and State Department are embodied for controlling air pollution, such as the control of the total amount of pollutants, a license system, a system of charging for cleaning up contamination instead of a system of charging for exceeding standards, reporting on city air pollution, enhancing prevention and cure of vehicles' emissions and city dust, popularization of the production and use of clean energy, and so forth.

The emended law of air pollution prevention and control made more progress compared to the former in the following areas:

1) Reinforcing prevention. To enhance the control of emissions from vehicles, the emended law contains particular regulations on vehicle manufacture, use and maintenance, quality of fuel, monitoring and inspection.
2) Strengthening control of city dust. City governments are encouraged to adopt measures such as afforestation, increasing the area of greenbelt per person, decreasing the area of bare land, so as to prevent dust pollution. Building construction or other dust-producing operations must adopt measures to prevent dust pollution according to local environmental protection regulations.
3) Prohibiting the exceedence of pollution standards. The original law only contained

financial penalties for exceeding pollution standards and didn't regulated that it is an irregularity. The emended law stipulates that exceeding pollution standards is an irregularity.

4) Carrying out total control and licensing of air pollutant releases. The emended law of air pollution prevention and control states that the areas of poor air quality can be classified as acid rain control area and sulphur dioxide control areas by State Department's approval.
5) Establishing a system of emissions charging. The emended law made great progress on charging for emissions instead of just charging for excessive emissions. It is based on the polluter pays principle.
6) Carrying out clean production. The emended law encourages the exploitation and use of clean energy such as solar energy, wind, waterpower, etc. It states that corporations should preferentially adopt clean production techniques to make full use of the energy and so decrease air pollutant.
7) Strengthening legal responsibility. The emended law includes stronger penalties and allows for greater flexibility in the implementation of the law.

In addition to this revised law, China is also implementing more specific projects in the areas of urban smoke, factory emission controls and inspection, acid rain control, SO_2 Emission Control, Vehicle Emission Control Pilots on lead-free gasoline, Emissions Trading and SO_2 tax economic instruments and various other projects. The policies and regulations in the areas of stationary and mobile sources are detailed below.

Energy Sources

By the end of September 2000, 3735 out of 4895 key industrial enterprises for which SO_2 emissions exceeded 100 tonnes/year have complied with the emission standard, a 76 per cent compliance rate. From January to September 2000, 4732 mines producing high sulphur coal have been closed, which resulted in a reduction in high-sulphur coal production by 19 million tons. 106 units using coal for power generation have been shut down. 862 small-scale cement and glass production factories and 393 small-scale iron and steel production plants have also been shut down.

The development of natural gas as an environmentally sustainable alternative to coal and leaded gasoline use has begun in some Chinese cities; however, it is far from becoming widespread as of yet. In the Ninth Five Year Plan, China has stipulated its aim to produce 30,000 natural gas powered automobiles by the year 2000 and 200,000 by the year 2005. The Plan expects to reduce sulphur dioxide emissions to 21 million tonnes and save 1.5 million tonnes of gasoline. More studies to formulate effective and appropriate regulations to ensure compliance are still needed.

China is also currently developing its Law of Energy Efficiency and has outlined the following energy efficiency goals for the Ninth Five Year Plan period:

a) Convert less coal to electricity and improve efficiency

China plans to build high efficiency power plants near coal mines so that the energy used for coal transportation coal dust pollution during coal transport can be reduced. Coal consumption for electricity will be reduced from the current level of 427 g/kWh to 365 g/kWh. Efficient transmission lines will be built to reduce energy loss during transmission and transformation. Outdated urban electric transmission networks will be renovated. Various pumps and pneumatic machines, which currently consume over one third of the nation's electricity, will be improved.

b) Publicise and disseminate cleaner coal technology

China will promote coal gasification, coal and water mixture (CWM) technology, and mold coal. It will also recover and utilize coal bed methane to reduce global warming gas emissions and to save energy resources.

c) Reform urban energy use

The Government will increase combinations of heating and power supplies in urban areas. It will establish demonstration residential blocks with energy efficient air conditioning and central heating systems.

d) Promote the development of renewable energy sources

The Government will increase the use of other energy supplies, besides coal. It will produce 300,000 to 600,000 kW of nuclear power generators; import large-scale nuclear power plants for coastal areas where power shortages are severe; increase the hydropower supply to 80 million kilowatts; increase China's wind power generating capacity to 200,000 kilowatts; increase geo-thermal power to 3 million standard coal equivalent (SCE); and continue to explore solar energy potential. It will also encourage biogas energy in rural areas to reduce dependence on traditional biomass fuels.

e) Deepen the energy price reform

In an attempt to limit energy use, the Government will encourage efficient usage and gradually phase out energy subsidies to raise funds for the energy development program.

Vehicle Emissions Reduction Policies

The Chinese government began to implement automotive emission standards in 1984. At present, the automotive emission standard formulated with reference to ECER15 is being carried out. Particulate emission standards for vehicular diesel engines were formulated in 2000. In June 2000, Chinese policies phased out leaded gasoline for vehicles, with the unleaded content in the gasoline above 99 per cent. With the use of unleaded gasoline across the country, lead emissions can be reduced by more than 1500 tonnes annually. The concentration of lead in the urban air will be substantially reduced. Those cities that use unleaded gasoline ahead of other cities have also begun to take the leadership in controlling other pollutants in the gasoline, such as sulphur, olefin and aromatic hydrocarbon.

The State Quality and Technical Supervision Administration (SQTSA) has recently taken steps to improve air quality in China's cities. Four new standards tightening controls over vehicle exhaust emissions have been promulgated. These standards have been applied to a range of vehicles manufactured after the beginning of 2000, according to Yin Minghan, director of the administration's Industry and Transportation Standardization Department.

Liquefied petroleum gas (LPG) vehicles, compressed natural gas (CNG) vehicles and those powered by diesel engines, which are not covered by the existing State standards, will also be regulated by the new standards. The standards were established with reference to vehicle exhaust regulations of the UN Economic Commission for Europe. Current vehicle exhaust emission standards were issued 10 years ago, when private cars were not so common and environmental problems not so serious.

Implementation of the new standards beginning next year is expected to result in a remarkable improvement in air quality, the official said. Tail-gas emissions are expected to be cut by 80 per cent. It is expected by the Government that the standards will also spur domestic automobile manufacturers to work towards more advanced technologies, and foster a stronger sense of responsibility for the whole society. Results of any assessment of the standards have yet to be seen. Key domestic auto manufacturers have been invited to participate in drafting the standards to ensure that the 80 per cent decrease in exhaust emissions is within their technological capabilities. The Chinese Government is also engaged in drafting State standards for unleaded petrol and diesel fuels citing fuel quality as another important factor in controlling the quality of tail gas emissions.

Furthermore, in order to decrease the energy consumption and emission pollution of China's automotive products, the Chinese government has given support on the establishment of the joint venture corporation, which will produce the electronic control system (EMS) of engines for vehicle use. According to the program, a production capability of 1 million units was expected in the domestic market by 2000.

The United Nations and international financial organizations have paid close attention and given great support to China's automotive industry, particularly for research and development of energy efficiency, emission control, and safety improvement. The United Nation Development Programme (UNDP) has financed an emission control and passive safety project for the formulation of standards for China's automotive industry. The main organization undertaking this project is the China Automotive Technology and Research Centre. In addition, loans from the World Bank have provided financial support for the establishment of the State's key laboratory for automotive safety and energy economy at Tsinghua University.

According to SEPA, the Chinese Governments long-term objectives for reducing vehicle emissions through the internationally-sponsored project include:

a) Improvement of the technical level of China's automotive products, and realize the targets of 50 per cent emission decrease, 10 per cent average energy efficiency, and increase safety performance by 100 per cent.

b) Formulation and development of regulations that completely control automotive emissions and testing of evaluation methods for automotive emission and energy efficiency products. Reduction by 50 per cent of the emission of pollutants from petrol and diesel engines produced for domestically made vehicles and establish a related testing centre.

c) Reduction of fuel consumption of motor vehicles by ten per cent compared with the present level, and improvement of the automobile emission level and safety performance. Establishment of an EMS System Engineering Centre, which will formulate the technical standards for the matching of EMS with engines, and will carry out the preliminary R&D work for the application of the electronic technologies to motor vehicles.

The project is implemented by the Ministry of Machinery Industry (MMI) and the State Environment Protection Agency (SEPA). It is hoped that the implementation of this project will give China more scientific and strict standards on vehicle emission, fuel consumption, and safety performance. The project will also greatly increase the ability of the State to monitor the automotive industry, to enhance the fairness and authority of the inspection of vehicles produced by both local and foreign manufacturers, and to help remove artificial international trade barriers. Through this project, it is also hoped that energy consumption will be further lowered. For example, a 10 per cent saving in fuel consumption would yield savings of 3 million tonnes of fuel per year thus greatly lower the emission of pollutants.

In the area of alternative fuels, China is also experimenting with several programmes to try to find alternatives to conventional internal combustion engine vehicles. Within the last year, several cities have started pilot projects using compressed natural gas or liquefied natural gas buses, and in June 1998 China inaugurated an electric vehicle demonstration project with seventeen vehicles of various sizes in Shantou city- Nan Ao island, an area in northern Guandong Province.

FUTURE CHALLENGES

According to the Chinese Research Academy of Environmental Sciences, the main challenge for the future of Chinas air pollution reduction lies in its population and socioeconomic growth. Industrialization and globalization, urbanization and an ageing population are all factors which will contribute to air pollution in the country. In addition, China will also need to focus on efficiency of technology and energy measures, clean fuels, emissions reduction technologies, least costs option and regional adaptation. Cleaning up China air quality will be a long and arduous task. For Beijing alone, improving air quality to Chinas grade II standards (average annual concentration of SO_2 no more than 60 $\mu g/m^3$, NO_2 no more than 80 $\mu g/m^3$ and respirable particulates no more than 100 $\mu g/m^3$) would require the sum of RMB 35 000 million (US$4 200 million). To reach the same target for all 47 urban areas currently designated as key cities would cost US$40 000 million, according to Chinese government estimates. It is planned that Beijing will spend RMB 78 000 million to clean up its air between 1999 and 2003. This figure includes municipal expenditures as well as central government inputs. With the Beijing 2008 Olympic Games on the horizon, it is expected that China will make an extra effort to clean up its air and provide the necessary financial resources.

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