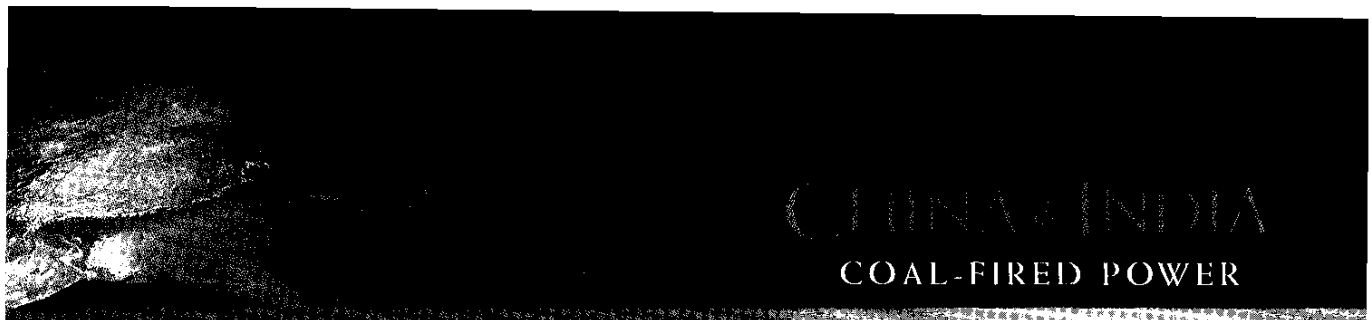

CHINA-INDIA

COAL-FIRED POWER

THE AIR POLLUTION PICTURE IN CHINA

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The fumes and floating dust trailing the country's rapid economic growth have a concerned government legislating air-quality levels and running energy-reduction programs

China's undoubted success in modernizing its economy is shadowed by harmful side effects. One of these is air pollution. Industrial districts of course are the worst affected: the air is laden with fly ash and other particulates and thickened with sulfur dioxide and oxides of nitrogen. Acid rain is a regional phenomenon, and increasing greenhouse gases threaten the globe. The central government strives to combat the problem primarily through laws generated by the Environmental and Resources Protection Committee of the National People's Congress, in particular the Law of Air Pollution Prevention and Control.

First, though, let us indicate the dimensions of the problem. To begin with sulfur dioxide and particulates, the raw figures for 1998 are total sulfur dioxide emissions of nearly 21 million metric tons (Mt), fly ash emissions of over 13 Mt, and industrial dust of nearly 13.5 Mt. In a global context, that makes China the top ranking producer of sulfur dioxide in the world.

Three hundred and twenty-two cities were monitored in 1998 for compliance with World Health Organization (WHO) and China's Ambient Air Quality standards. In the case of sulfur dioxide concentrations, nearly a third of the cities exceeded the WHO standard of 0.05mg/m^3, and about three in 10 did not meet China's Class II Standard of 0.06 mg/m^3. What's more, about 50 of the cities even failed to comply with the Class III Standard of 0.12 mg/m^3. The cities most afflicted by sulfur dioxide are situated in the provinces of Guizhou, Sichuan, Guangxi, Shandong, Hebei, Shanxi, and Gansu.

As for total suspended particulates, only one in 20 of the 322 cities met the WHO standard of 0.09 mg/m^3; only a third met China's Class II Standard of 0.20 mg/m^3 for residential districts. Further, in more than two-thirds

of the cities total suspended particulates exceeded China's Class III Standard of 0.30 mg/m³ for industrial districts. The 20 cities in which suspended particulate concentrations are highest are located principally in northwest China, in the provinces of Nixia, Xinjiang, and (again) Shanxi and Gansu.

In cities of more than a million people, nitrogen oxides are a growing concern. The chief reason is the rapidly rising number of motor vehicles, notably in Beijing, Shanghai, Guangzhou, and Wuhan. Sixty of the 322 cities monitored in 1998 fell short of China's Class II (and WHO's) Standard of 0.05 mg/m³. Beijing and Guangzhou even exceeded the Class III Standard of 0.10 mg/m³.

Combine sulfur dioxide and nitrogen oxides, and the result is acid rain. It has an adverse impact over wide areas on biological and ecological systems and physical structures. In 1995, economic losses arising from damage done by acid rain to crops and human health amounted to more than US $13.25 billion—approximately 2 percent of China's gross national product. Acid rain is concentrated in central, southwest, south, and east China, accounting for about 30 percent of the country. Rain is acid in virtually all southern cities, including Hong Kong—a subject of increasing public complaints.

As for greenhouse gases, a recent inventory indicted the energy sector as their prime source. In 1990, the total from that source in China came to about 550 Mt of carbon, accounting for 95 percent of the total emissions of carbon dioxide. Methane emissions from energy activities totaled 11.5 Mt. Globally, China ranks second to the United States as an emitter of CO_2.

Industrial sources of emissions

So much for the extent of the problem. What are its origins? In 1997, total waste gas emissions from some 55 000 industrial enterprises came to 12 370 billion cubic meters [Table 1], with fuel consumption accounting for three-fifths of emissions on average across all sectors. After fuel consumption, the processes of cement and iron and steel production contribute most to industrial pollution.

China is the largest cement producer in the world with an output of 536 million tons in 1998. Most of its cement production uses wet or semi-dry processing on a small or medium scale, which consumes between 40 and 80 percent more energy than is true of advanced technologies used in developed countries such as Japan. The average recovery of gas from blast furnaces is less than 20 percent in China because of the shortage of recovery facilities and technologies able to use gas with such a low heat value.

Cement plants as well as iron and steel plants and chemical plants exude dust. People working for or living near the plants are especially vulnerable to it, as well as to other pollutants. For example, the *Beijing Youth Daily* reported on 17 August 1999 that on 13 August more than 100 residents living near an iron and steel plant had suffered moderate poisoning from carbon monoxide emitted from a blast furnace.

The power sector's total installed capacity, as of the end of 1997, was 194 GW—a huge system, yet with only a few sulfur dioxide control systems, and those installed for technology demonstration. Unfortunately, the costs of operating and maintaining such systems are much higher than fines for discharging the gas, which stand at US $24.10 per ton of sulfur dioxide.

In 1998, China consumed 28.5 EJ coal, which accounted for 72 percent of total energy consumption. One third of the coal consumed nationally is burned by power plants, accounting for more than half the country's sulfur dioxide emissions and about a quarter of its dust and soot and carbon dioxide [Table 2]. Naturally, those areas where plants rely on high-sulfur coal have the most serious acid rain problems. This is true of Linan in Zhejiang province, Changsha in Hunan, and Guilin in Guizhou.

A lot of coal also is used in homes for cooking and heating, though liquefied petroleum gas, coke gas, and natural gas are coming into wider use, especially in urban areas. There are no uniform data to measure emissions in the residential sector, but many studies have found a relation between coal usage and the incidence of respiratory diseases and cancer. In 1998, respiratory illness accounted for 23 percent of deaths in rural areas and 14 percent in urban areas, ranking respectively as the most frequent and the fourth most frequent cause of death.

Greenhouse gases grow

Regrettably, as one blight fades, another takes its place. Even as domestic use of coal yields to gas in the big cities, auto exhaust is a growing curse. In Beijing, for example, nitrogen oxide concentrations in the atmosphere increased 9 percent per year from 1986 to 1996. A recent study showed that vehicle emissions in the capital contribute two-thirds of the airborne nitrogen oxides, and three-quarters of the carbon monoxide. NO_x levels are such in Beijing that heart and

1. Emission of waste gas by industry in 1997

Industry	Volume of waste gas emitted, Gm³	Percentage of national total	Percentage of waste gases due to combustion[a]
Power[b]	4 148	34%	99%
Iron and steel	2 736	22%	27%
Cement	1 536	12%	15%
Chemical	938	8%	58%
Other	3 012	24%	65%
National total	**12 370**	**100%**	**61%**

Source: China Statistical Yearbook 1998

[a] The remander is due to industrial processes.

[b] Production and supply of electric power, gas and water.

2. Sulfur dioxide and particle emission by industry in 1997

Emissions	SO_2		Dust and soot	
Industry	Volume, kilotons	Percent of total	Volume, kilotons	Percent of total
Power	7 895	56.2	4 025	19.3
Iron and steel	1 664	11.8	1 876	9.0
Cement	796	5.7	6 267	30.0
Chemical	453	3.2	4 749	22.8
Others	3 235	23.1	3 929	18.8
Total	**14 043**	**100.0**	**20 846**	**100.0**

Source: China Statistical Yearbook 1998

lung disease sufferers are at added risk from prolonged exposure.

Lead from vehicle exhaust also is harming human health in the cities. In 1995, 40 percent of the 29 million metric tons of gasoline burned by vehicles still contained lead. The government plans to start phasing out lead from gasoline in the whole country next year.

Rural areas are not without new problems. Traditionally, Chinese farmers burned straw and coal for cooking and heating. In a steady-state system, crops emit the same amount of carbon dioxide when burned as they absorb growing. But now instead of agricultural waste, more and more people are burning liquefied petroleum gas and coal briquettes, which can add to net emissions. China produces 600 million metric tons of straw annually, of which half is used as fodder and fertilizer and a third in the paper-making industry. The remainder is burned on the land, causing serious pollution at harvest time and giving rise to great greenhouse concern.

Although no officially published data directly inventories and totals greenhouse gas emissions in China, they can be calculated from energy consumption, industrial processes, and other relevant activities. The results indicate that energy activities are the major emission sources [Table 3]. According to generally accepted estimates, burning coal emits 68 percent more carbon dioxide than gaseous fuels do, at equivalent heat value.

Environmental protection laws...

As noted earlier, the Environmental and Resources Protection Committee of the National People's Congress has prime responsibility for generating laws on the environment and resources. The committee plays a key role in drafting, revising, and passing the legislation.

The State Environmental Protection Administration (SEPA) is the administrative department in charge of environmental protection directly under the State Council, as are other ministries. Its main job is to unify the supervision and management of nationwide environmental protection.

The state agency includes under its umbrella a multilevel, nationwide management system having units at the national government, province, municipality, and county levels.

Also responsible for enforcing the relevant laws and drafting regulations and measures for their own sectors are the environmental protection offices of sectors or commissions (including the State Development and Planning Commission and the State Economic and Trade Commission), which like SEPA are under the State Council.

China's system of environmental law embraces four levels:

- At the highest level, Article 6 in the Constitution provides the foundation and guiding principles for making environmental laws. It stipulates that the state protect and improve the living and ecological environments, and that it prevent and control pollution and other public hazards.
- Next highest, the Law of Environmental Protection of People's Republic of China, issued in 1979, is the fundamental law for environmental protection and also the basis for making special laws.
- More narrowly, special laws and regulations include nine laws and a series of regulations for protecting ecological systems and natural resources, as well as six laws and more than 20 regulations for preventing and controlling pollution and other public hazards.
- Finally, there are national and local standards for environmental quality, pollutant emissionsfundamental standards, method and sample standards, and more.

The first version of the Law of Air Pollution Prevention and Control was issued in 1987, the second in 1995. The second emphasized control of sulfur emissions from coal-fired plants and acid deposition abatement. Since early 1999, the third version of the law has been discussed with a view to enhancing the system of total emission control, reducing vehicle emissions, and so on. Probably, the third version will be issued by the end of this year.

...and their enforcement

The following three provisions are very important when it comes to implementing environmental laws:

Environmental impact assessment. Article 13 of the environmental protection law stipulates that for all construction projects having impacts on the environment, an environmental impact assessment report must be compiled, examined, and approved.

Three simultaneities rule. This is the unique system for environmental management created in China, which requires that, for all construction projects, technical retrofit projects, and regional development projects, the equipment for controlling pollution and ecological damage must be designed, constructed, and put into production simultaneously with the main engineering and construction effort. Approval from SEPA is required, and plans for waste treatment and measurement of emissions or effluents must be in place.

Emission charge system. Article 28 of the Law on Environmental Protection stipulates that units discharging pollutants with higher concentrations than specified in national or local standards must pay emis-

3. The main sources of greenhouse gases

Source type	CO_2, megatons of carbon	Methane, megatons
Energy	+546.6–559.6	11.75
Industrial processes	+21.5	N.A.
Agriculture	N.A.	18.23
Changed land use and forestry	-86	N.A.
Landfill and wastewater	N.A.	2.45
Net emission	**+482.1–495.1**	**32.43**

Source: China Climate Change Country Study, Tsinghua University Press, 1999

N.A. = not applicable

4. Likely effect on greenhouse gases of greater energy efficiency

Equipment	Estimated reduction in carbon emissions by 2010
Industrial boilers	62 megatons
Industrial motors	106 megatons
Lighting	68 megatons
Household electric appliances	11 megatons

Source: China Climate Change Country Study, Tsinghua University Press, 1999

sion charges. Special laws for air and water pollution also set emission charges, which are higher if emissions or effluents exceed national or local standards.

Air pollution abatement

There is more to protecting the environment than laying down the law and even enforcing it. The Chinese government has taken action by conducting a set of special programs aimed at reducing pollutant emissions. A plan for sulfur-dioxide–controlled regions and acid-rain–controlled regions (called two controlled zones) is one of them. In this plan there are 109 projects in all.

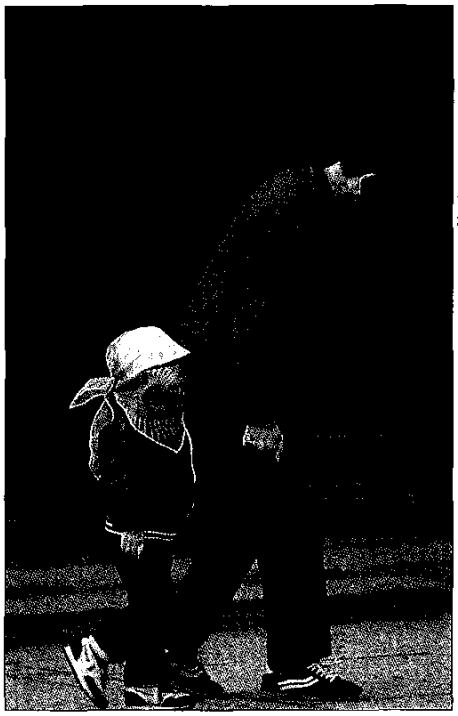
The main measures are flue gas desulfurization for power plants and large-scale boilers, plus the popularization of briquette coal and washing of coal. Others are the installation of coal-forming machines before combustion or adoption of circulating fluidized bed combustion for small-scale boilers, plus coal gasification, liquefied petroleum gas, and a centralized (district) heating project.

Upon completion of the plan, annual emissions of sulfur dioxide should be 920 000 tons lower than at the start. The goal is that between 1999 and 2010, sulfur dioxide emissions should be treated and capped at the 1995 level, and that after 2010, there should be further reductions and improvements. In the two controlled zones, no new mines will be dug for high-sulfur coal (sulfur content exceeding 3 percent). Production of such coal in existing mines is also to be restricted.

Another program involves air pollution control for key cities. Each year there are to be declines of 870 000 tons of sulfur dioxide and 1 070 000 tons of fly ash in all 30 cities in the plan. At the same time, 3.32 million tons of coal should be saved every year. The country is to work out stricter standards on the exhaust emissions of automobiles to improve its urban air quality, discipline or close enterprises that rely upon antiquated equipment, and promote the use of advanced techniques.

Although no specific program targets greenhouse gases, China has conducted several programs that could reduce the growth rate in carbon dioxide emissions. The key measures aim to improve energy efficiency, develop new and renewable energy resources, and adopt other low- or noncarbon energy such as nuclear power. These programs will contribute to optimizing the energy mix and burning less coal.

At present, China is shutting down small, inefficient coal-fired plants with high pollutant emissions. It is estimated that power plants should be able to burn 20 percent less coal after being retrofitted. Taking 1995 as the base: if the energy efficiency of a power plant increases 20 percent, it can reduce its carbon dioxide emissions by 40 Mt of carbon. If the shares of hydropower and nuclear power are raised by 1 percent of total electricity generation each, 4 Mt of coal would be conserved and carbon dioxide emissions would be reduced by 2 Mt of carbon.



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[1] People wearing surgical masks or scarves to protect themselves against air pollution are commonly seen in Chinese cities.

China has a vast quantity of low-efficiency, energy-intensive equipment in its industrial and residential sectors. The average efficiency of industrial boilers is about 10 percent lower than in the advanced industrial countries, and the figure for electric motors and fans is more than 10 percent lower. Table 4 shows the potential of greenhouse gas mitigation estimated through energy efficiency improvement.

Some international programs

Renewable energy will soon be helping, too. With support from the United Nations Development Programme and some foreign governments, the Chinese government is carrying out a five-year project to promote the widespread commercialization of renewable energy technologies. The expectation is that the project will benefit 60 million people in China's vast rural areas, where there is no access to electricity generated from fossil fuel.

In the last decades, along with the rapid economic growth, China has made a lot of effort to control air pollution and has achieved obvious air quality improvement. However, air pollution is still very serious in China, causes large economic losses, and is a barrier to further development. As a developing country, China is eager to pay equal attention to economic development and environmental protection. ◆

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To probe further

For an overview, consult the China National Environmental Monitoring Center's 1998 *Environmental Quality Outline of China*, March, 1999, and the State Statistical Bureau's *Statistical Survey of China*, 1999.

Information on vehicular emissions can be found in He Dongquan's doctoral dissertation, *Study on Urban Vehicular Pollution Assessment System and Emission Control Target*, Tsinghua University, 1999; and Liu, D.Q., *Urban Land Use and the Sustainable Development of Urban Transport*, another doctoral dissertation, Tsinghua University, 1999.

For dangers connected with the home environment, see He Xingzhou et al., *Lung cancer and indoor air pollution from coal burning* (Yunnan Science and Technology Press, Kunming, 1994) and Guo Lin et al., "The difference of indoor air pollution using gas as domestic fuel: before and after," appearing in *Journal of Environment and Health* (1994), Vol. 7, no. 1, p. 8.

China's environmental programs are described in *China Trans-Century Green Project*, jointly produced by the National (now State) Environmental Protection Agency, the State Planning Commission, and the State Economic and Trade Commission, China Environmental Science Press, Beijing, 1997.

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