A CHINA ENVIRONMENTAL HEALTH PROJECT RESEARCH BRIEF

Environmental and Health Threats from Cement Production in China

August 31, 2007

This research brief was produced as part of the China Environment Forum's partnership with Western Kentucky University on the U.S. AID-supported China Environmental Health Project

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Overview of Cement Production in China

China is the world's largest producer of cement, manufacturing 1.24 billion tons in 2006 alone.[1] China's cement production has grown about 10 percent per year over the past two decades, and is now growing even faster to keep up with massive urbanization. According to a press release from the Chinese National Bureau of Statistics, China produced 620 million tons of cement in the first half of 2007, which is an increase of 16 percent over the same period in the previous year.[2] Today China produces roughly half of total global output, whereas the next three largest producers—India, Japan, and the United States—combined produce less than 20 percent of the world's cement. China's cement demand will continue to be high in the near future to meet development goals, with cement production expected to peak at 1.25 trillion tons (Mt) around the year 2010.[3]

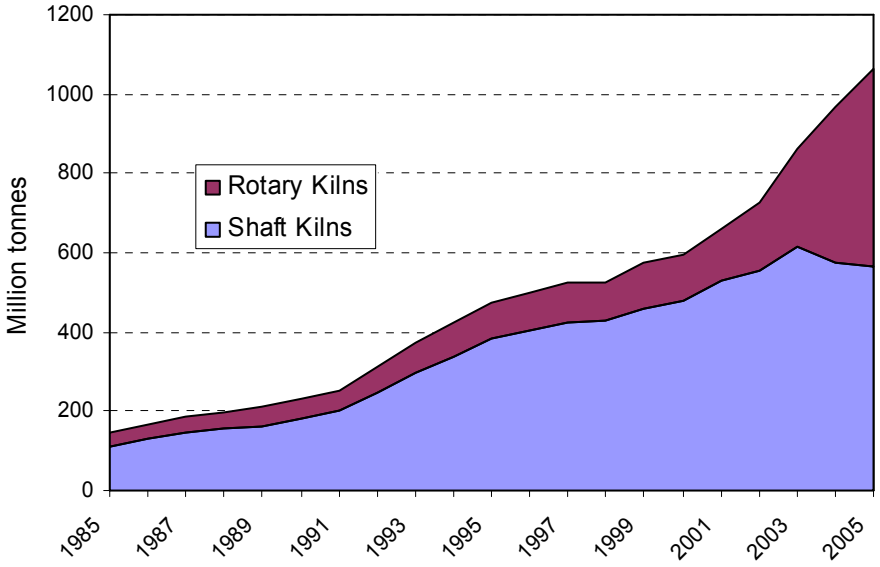
Challenges of Cement Production in China: Huge Energy Consumer and Air Polluter

By nature, cement production is a highly energy-intensive process. It is estimated that China's cement industry—much of which is produced in energy inefficient, highly polluting kilns—consumes roughly six percent of the nation's energy, with 80 percent of that coming directly from coal and other fossil fuels and the remaining 20 percent from electricity.[4] Cement is made by combining clinker—a mixture of limestone and other raw materials that have been pyroprocessed in the cement kiln—with gypsum and other cement additives. Clinker production typically occurs in kilns heated to about 1,450°C, making clinker production the most energy-intensive process in cement manufacturing.

China's cement sector is inefficient due to the large number of small or outdated kilns. The kiln, which predominantly burns coal, is the major energy-consuming component of the cement-making process. There are basically two types of cement kilns used for the production of clinker: vertical shaft and rotary kilns. Most of the cement produced in China is made in relatively inefficient and polluting vertical shaft kilns with poor combustion efficiency, although some of these kilns are being closed as larger rotary kilns are being constructed, especially in the more developed regions in eastern China.

While shaft kilns are common in China, they have not been used in the West since the turn of the 20th century. China still uses shaft kilns because they are smaller and cheaper and thus can be brought online faster than rotary kilns. For example, it takes one year or less to build a shaft kiln, while a rotary kiln can take two to three years.[5]

The cement sector is growing rapidly, for example, in 2002 the World Business Council for Sustainable Development projected that China's cement production would reach 750 million tons by 2010, exceeded the projection in 2006 when production reached 1.24 billion tons.[6] Energy consumption varies significantly among Chinese cement producers due to the wide range of technologies in use. Modern cement precalciner plants in China are as efficient as any in the world, while some of the waste-heat power generation kiln plants use more than twice as much energy per unit of clinker produced, although some of the wasted energy will be re-captured. All of these plants depend on coal, which makes the wasteful plants major contributors to air pollution.[7] Although the use of coal has tended to decrease over the last ten years, coal consumption for shaft kilns has had almost no change indicating that the use of these kilns has peaked.



Annual Chinese Cement Production by Rotary and Shaft Kilns, 1985-2005[8]

Toxins from Cement Plants

The cement industry is a major source of multiple air toxics, among them dioxins and dioxin-like chemicals, mercury, carbon monoxide, particulate matter and greenhouse gas emissions. Ambient air levels of total suspended particulates (TSP) and sulfur dioxide (SO_2) in Chinese cities are among the highest in the world. In turn these heavy pollutant loads are closely associated with significant respiratory illness and approximately 200,000 premature deaths each year in urban areas.[9] Cement plants are responsible for over 40 percent of total industrial particulate emissions.[10]

China contributes approximately 14 percent of global carbon dioxide (CO_2) emissions, of which Chinese cement plants are responsible for about 6 to 8 percent. These emissions are produced in roughly equal parts from fuel combustion and the release of carbon dioxide from limestone at high temperature. Carbon dioxide emissions from small Chinese cement plants are two or more times higher than plants in industrialized nations due to poor efficiencies requiring more fuel use.[11]

A 2006 American Chemical Society publication on air emissions in China estimated that total mercury (Hg) emissions from all anthropogenic sources increased at an average annual rate of 2.9 percent from 1995 to 2003.[12] Nonferrous metals smelting and coal combustion together contributed almost 80 percent of total mercury emissions during the past decade in China. Chinese cement production was the third largest contributor to total mercury emissions in 2003.[13]

Moreover, the production of clinker, which is the most necessary procedure in cement manufacturing, is also the source of almost all toxic pollutants such as dioxins and furans in China. Cement kilns destroy dioxins in hazardous waste fuels during the clinker combustion process, but dioxins can be formed after combustion if the offgases are not quickly cooled. These exhaust gases must pass through air pollution control devices, such as electrostatic precipitators or fabric filtration baghouses, in order to reduce fine particulate emissions.[14]

Toxic emissions produced from cement manufacturing are very harmful to humans and wildlife as several are persistent bioaccumulative toxics that can be transported inter-continentally.

International Initiatives and Promising Global Partnerships

In efforts to overcome the challenges of cement manufacturing, the Chinese government has extensively developed government policies and programs to improve the energy efficiency and pollution control in the cement sector. China has been proactively engaged in various international initiatives such as the Asia-Pacific Partnership on Clean Development and Climate, which is helping China in the adoption of advanced cement production technologies and efficient management skills.

The Asia-Pacific Partnership on Clean Development and Climate joins Australia, China, India, Japan, the Republic of Korea, and the United States together in an innovative new effort to accelerate the development and deployment of clean energy technologies in eight sectors.[15] The partnership created task forces to promote activities to expand investment and trade in cleaner energy technologies, goods and services in these key market sectors. The Cement Task Force aims to facilitate the uptake of best available technology and environmental management systems in partnership countries through the introduction and/or replacement of old technology in favor of dry processing technologies, energy-efficient technologies, process improvements, power generation from waste heat recovery, and enhanced co-processing of low grade primary fuels and industry wastes. The partners have also committed to measure and reduce key air emissions, including CO_2, SO_x, NO_2, and particulate matter.[16]

Among the member countries, China has been one of the most active participants in the Cement Task Force. Through cement-related partnership activities, China aims to reduce energy use and pollution, and maximize the industry's economic performance and output. The partnership also catalyzed the Chinese central government to provide national bonds for **cement sector** projects that utilize waste and other by-products, reduce energy consumption, and promote environmental protection.

Future Directions in Cleaning up the Cement Sector

Retrofitting cement kilns in China contributes to improving energy efficiency as well as reducing greenhouse gas emissions and other toxic pollutants.[17] With government implementation of monitoring policies (such as the Industrial Development Policies on Cement) and various development policies, opportunities exist within Chinese cement industry to improve energy efficiency while maintaining or enhancing productivity. The central government plans on "backward capacities elimination," doing away with low productivity kilns, such as wet process kiln, dry process plain kilns, and shaft kilns. This procedure will play a very important role in reducing China's CO_2 emissions.[18] Moreover, China is also working closely with the Asian Development Bank to financially support its ambitious cement sector retrofit projects. Therefore, although the cement industry has played a large role in causing China to be denounced as the world's biggest polluter, the industry abounds with opportunities for improvement.

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[2] National Bureau of Statistics of China, July 23, 2007. *Value-Added of Industry Expanded in the First Half Year.* http://www.stats.gov.cn/english/newsandcomingevents/t20070723_402419512.htm

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[7] Although the use of coal has tended to decrease over the last ten years, coal consumption for shaft kilns has had almost no change indicating that the use of these kilns has peaked.
[8] Cui, 2006a; Cui, 2005; ITIBMIC, 2004; Soule, et al., 2002. (cited in unpublished report, *"Opportunities for Improving Energy and Environmental Performance of China's Cement Kilns"*, by Lynn Price and Christina Galitsky, March 2006).
[9] Mason H. Soule, Jeffrey S. Logan, and Todd A. Stewart. World Business Council for Sustainable Development, March 2002. *Trends, Challenges, and Opportunities in China's Cement Industry.*
[10] Ibid.
[11] Lynn Price; Christina Galitsky. Lawrence Berkeley National Laboratory March 2006. *Opportunities for Improving Energy and Environmental Performance of China's Cement Kilns.*
[12] Ye Wu, Shuxiao Wang, David G. Streets, et al. American Chemical Society, 2006. *Trends in Anthropogenic Mercury Emissions in China from 1995 to 2003.*
[13] Ibid.
[14] Lynn Price; Christina Galitsky. Lawrence Berkeley National Laboratory. March 2006. *Opportunities for Improving Energy and Environmental Performance of China's Cement Kilns.*
[15] The 8 sectors of the APP are aluminum, buildings and appliances, cement, cleaner use of fossil energy, coal mining, power generation and transmission, renewable energy and distributed generation, and steel.
[16] Asia-Pacific Partnership on Clean Development and Climate. http://www.asiapacificpartnership.org/CementTF.htm
[17] Lynn Price; Christina Galitsky. Lawrence Berkeley National Laboratory March 2006. *Opportunities for Improving Energy and Environmental Performance of China's Cement Kilns.*
[18] China Cement Working Team for Asia-Pacific Partnership on Clean Development and Climate, April 18, 2007. *Measures on CO_2 Emission Reduction for China Cement Industry.*