Cement

Sector At-a-Glance

Number of Facilities:	116
Value of Shipments:	$8.3 Billion
Number of Employees:	18,000

Source: U.S. Geological Survey, 2004[1]

Profile The cement sector[2] comprises 116 plants in 36 states that produce portland cement, which is used as a binding agent in virtually all concrete. Concrete, in turn, is used in a wide variety of construction projects and applications, ranging from patios and driveways, to stucco and mortar, to bridges and high-rise buildings.

Strong construction markets helped boost cement consumption in the 1990s. Between 1993 and 2001, the value of shipments more than doubled.[3] At the same time, the cement industry achieved increased efficiency by automating production and closing small facilities. As a result, the average cement kiln produces over 60% more cement today than 20 years ago.[4]

Production Process Cement is composed of four elements – calcium, silica, aluminum, and iron – which are commonly found in limestone, clay and sand. These raw materials undergo the following stages of processing in making portland cement:

- Crushing at the quarry and then proportioning, blending, and grinding at the facility;
- Preheating before entering the facility's rotary cement kiln – a long, firebrick-lined, steel furnace;
- Heating, or pyroprocessing, in the kiln, through which the raw materials become partially molten and form an intermediate product called "clinker"; and
- Cooling the clinker and grinding it with a small quantity of gypsum to create portland cement.

Partnership The Portland Cement Association (PCA) has formed a partnership with EPA's Sector Strategies Program to improve the environmental performance of the cement industry. PCA members operate more than 100 facilities and account for more than 95% of U.S. cement production.[5]

Key Environmental Opportunities The cement sector is working with EPA to improve the industry's performance by:

- Increasing energy efficiency;
- Reducing air emissions;
- Managing and minimizing waste; and
- Promoting environmental management systems.

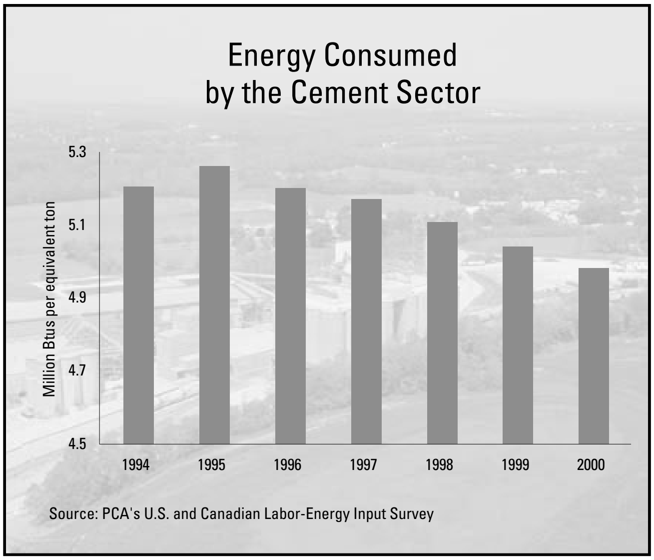
Increasing Energy Efficiency

Cement manufacturing requires thermochemical processing of substantial quantities of limestone and other raw materials in huge kilns at very high and sustained temperatures. Fueled by coal and petroleum coke, electricity, wastes, and natural gas, the sector uses a significant amount of energy in its production processes – an average of 5 million Btus per ton of clinker.[6]

The industry has made progress in reducing the amount of energy required to produce each ton of cement. Sector-wide energy usage fell 4% from 1994 to 2000, following a consistent trend of decreased energy usage that began in the early 1970s.[7] This continued decline is the result of industry's efforts to modernize plants by replacing older, more energy-intensive "wet" kilns with newer "dry" kilns. Wet kilns blend ground raw materials with an aqueous slurry that is then fed into a kiln, whereas dry kilns are fed their raw materials as a blended dry powder. On average, wet process operations use 34% more energy per ton of production than dry process operations.[8] Approximately 80% of U.S. cement capacity now relies on dry process technology.[9]

Case Study: Energy Star Partners

The cement sector is working with EPA's Energy Star program to develop tools to measure energy performance and to assign ratings to plants within the industry. Currently, 18 of the largest cement manufacturing companies are Energy Star partners. As partners, they have committed to measuring and benchmarking their energy performance, and developing and implementing plans to improve their performance.[10]



Reducing Air Emissions

Cement manufacturers are working to reduce emissions of nitrogen oxides (NO_X), sulfur dioxide (SO_2), particulate matter (PM), and greenhouse gases (GHG) from their operations.

Nitrogen Oxide Emissions

In cement manufacturing, the combustion of fuels at high temperatures in the kiln results in the release of NO_X emissions. Between 1996 and 2001, the normalized quantity of NO_X emissions from the cement sector fell by 3%.[11] Current NO_X emissions from the sector account for approximately 1% of total U.S. non-agricultural NOx emissions.[12]

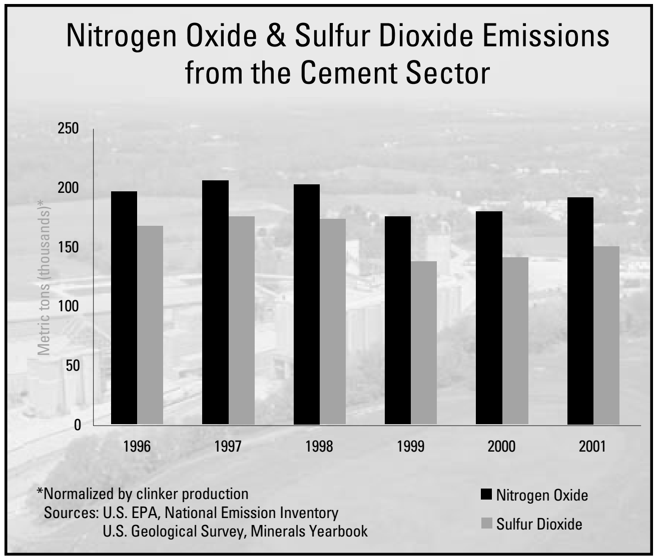
Sulfur Dioxide Emissions

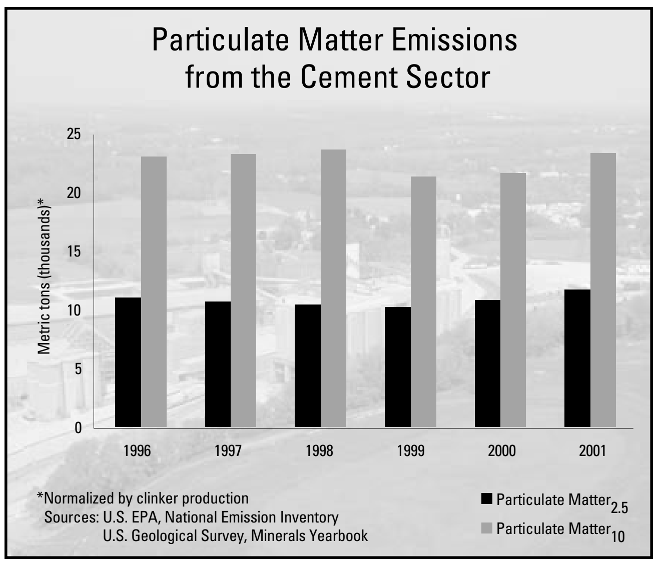
The combustion of sulfur-bearing compounds in coal, oil, and petroleum coke, and the processing of pyrite and sulfate in the raw materials, results in the release of SO_2 emissions from cement operations.

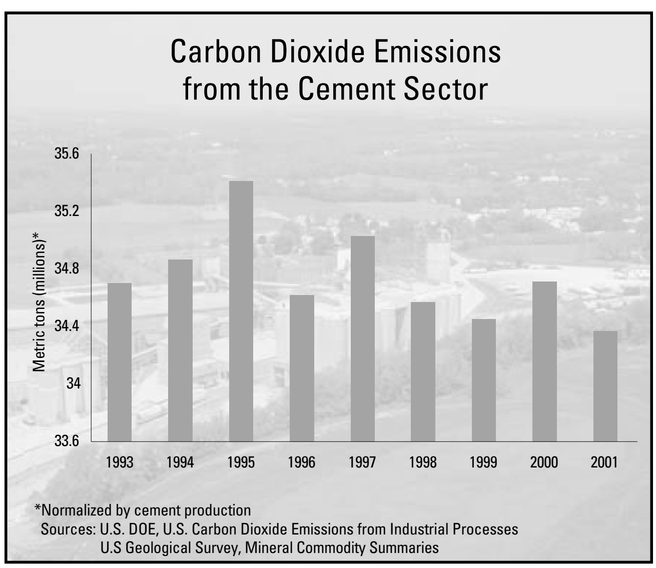
To mitigate these emissions, cement plants typically install air pollution control technologies called "scrubbers" to trap such pollutants in their exhaust gases. In addition, limestone used in the production process has inherent "self-scrubbing" properties, allowing the industry to handle high-sulfur fuels. Between 1996 and 2001, the normalized quantity of SO_2 emissions from the cement sector decreased by 10%.[13]

Particulate Matter Emissions

In cement manufacturing, quarrying operations, the crushing and grinding of raw materials and clinker, the kiln line, and cement kiln dust result in PM emissions. Between 1996 and 2001, the normalized quantity of PM_{10} emissions from the cement sector remained fairly constant, following marked improvements begun in the early years of Clean Air Act implementation..[14]







Greenhouse Gas Emissions

Approximately 98% of man-made carbon dioxide (CO_2) emissions come from the combustion of fuel, for a total of 5.8 million tons in 2002.[15] Of this percentage, about one-third is due to fuel combustion by motor vehicles, and another third comes from power plants. The cement sector contributes to 1.3% of the final third, with CO_2 emissions resulting from the burning of fossil fuels (predominantly coal) during pyroprocessing, and from the chemical reactions (calcination) that convert limestone into clinker.[16] In 2002, cement production resulted in more than 43 million metric tons of CO_2 emissions.[17]

In 2003, PCA formalized its commitment to CO_2 emissions reductions by joining Climate VISION, a voluntary program administered by the U.S. Department of Energy (DOE) to reduce GHG intensity (the ratio of emissions to economic output).[18] PCA has committed to a 10% reduction in CO_2 emissions per ton of product by 2020 (from 1990 levels).

Case Study: Voluntary Reporting of GHG Emissions

DOE's 1605(b) Voluntary Reporting of Greenhouse Gases Program:

- *Provides a tool for measuring GHG emission reductions;*
- *Collects voluntarily reported data on GHG emissions and activities aimed at reducing GHG emissions; and*
- *Gathers information on commitments to reduce GHG emissions and increase carbon sequestration.*[19]

Two participating Lehigh Cement facilities submitted reports in 2002 showing a combined emission reduction of more than 450,000 metric tons of CO_2 equivalent.[20]

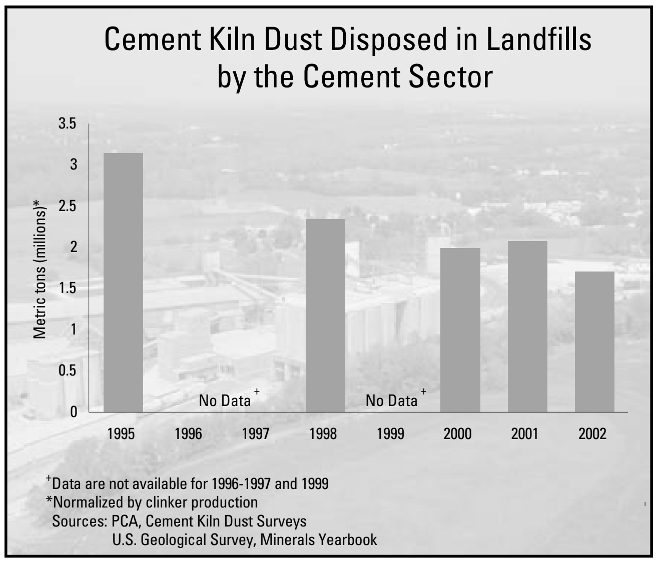
Managing and Minimizing Waste

Cement kiln dust (CKD) is the broad term that refers to particles released from the pyroprocessing line. CKD includes partially burned raw materials, clinker, and eroded fragments from the refractory brick lining of the kilns. Modern plants typically try to recover CKD, because it can be reused in the manufacturing process. Recycling CKD serves the environment by:

- Reducing the amount of raw materials needed;
- Reducing energy consumption, since the material is already partially processed; and
- Reducing health concerns associated with landfilling (e.g., the possible release of heavy metals and dust into the air and water).

Currently about two-thirds of the CKD generated is returned to the kiln for reuse in the manufacturing process.[21] The amount of CKD recycled continues to increase as old process lines are replaced or updated. There are limits to the recycling of CKD in the manufacturing process, however, because contaminants (such as alkalis) can build up in the CKD and compromise the quality of the clinker.

The CKD that is not recycled is either disposed at a landfill or sold to other sectors for “beneficial reuse” applications such as road fill, liming agent for soil, or stabilizer for sludges and other wastes. Between 1995 and 2002, the normalized quantity of CKD disposed dropped from 3.1 million metric tons to 2 million metric tons. During the same time period, beneficial reuse of CKD varied between 570,000 and 920,000 metric tons.[22]



Promoting Environmental Management Systems

Interest in environmental management systems (EMS) is increasing in the cement sector. PCA has begun discussing the development of an EMS program with its membership. Details of the program are expected to be announced in mid-2004.

Case Study: EMS at St. Lawrence Cement Group

In 2000, St. Lawrence Cement Group created a 5-year Sustainable Environmental Performance business plan, which identified key issues, opportunities, and actions to be integrated into its management framework. As part of the plan, St. Lawrence committed to:

- *Implementing an ISO 14001-certified EMS at all of its cement manufacturing and grinding facilities by the end of 2004;*
- *Reducing CO_2 emissions per ton of product by 15% by 2010 (from 2000 levels); and*
- *Reducing consumption of virgin raw materials per ton of product by 15% by 2007 (from 2000 levels).*

St. Lawrence has also implemented a corporate emission and reporting standard, which allows it to track energy consumption, air emissions, and CKD recycling across all of its facilities. The table below highlights the company's progress to date in these areas.[23]

Environmental Improvements at St. Lawrence Cement Group[24]

Performance Measure	2000	2002
Total cement production (million tons)	3.5	4.1
Electrical consumption (kwh/ton)	152	144
Heat consumption (gigajoules/ton)	3.94	3.48
CO_2 emissions (kg/ton)	792	704
NO_x emissions (kg/ton)	2.9	2.1
SO_2 emissions (kg/ton)	2.3	2.0
CKD previously disposed, then recycled (thousand tons)	50	24