

CO₂ Emissions Profile of U.S. Cement Industry



Overview

- Purpose of study
- Cement production process
- Energy consumption
- GHG emissions
- State-level analysis



Background and Purpose

- Cement is a key industry from an economic, energy and emissions perspective.
- Have a strong understanding of process-related emissions, combustion-related emissions not as well characterized.
- Useful to have understanding of emission sources at a disaggregated level.



Cement Production Process



- Raw materials, primarily limestone, are extracted from a quarry and crushed.
- Materials finely ground into raw mix and preheated before conveyed to the kiln.

- Clinker is formed in kiln
- Raw mix heated to approximately 1500°C
- Most energy-intensive step in production process



Cement Production Process (2)



- Finish Grinding. Gypsum added; other materials may be added to produce a blended cement.
- Addition of steel balls and a rapidly rotating wheel serve to finely grind and mix the clinker and gypsum.

- Cement stored in silos for shipping
- Shipping typically via road or rail.

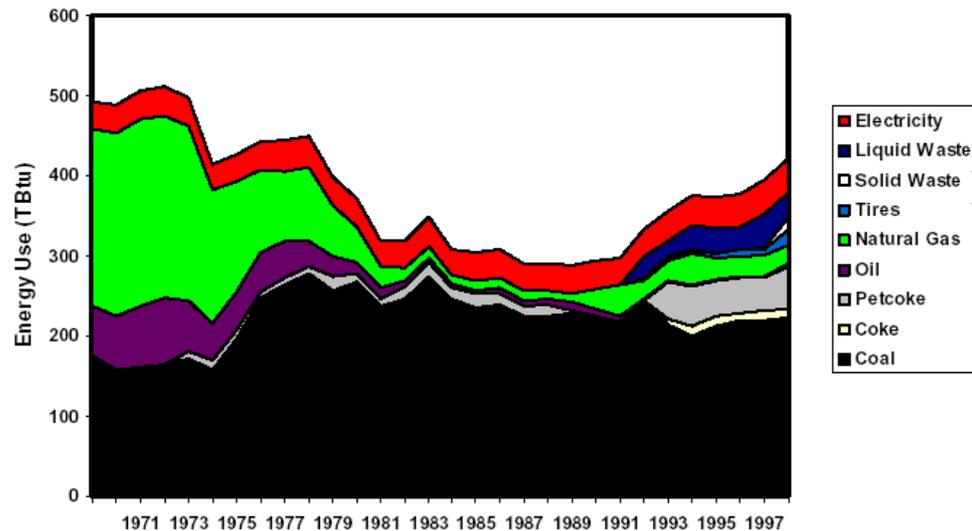


Source: Lafarge



Energy Consumption in Cement Production

- Because of the high temperatures achieved in kilns, a variety of fuels can be consumed.



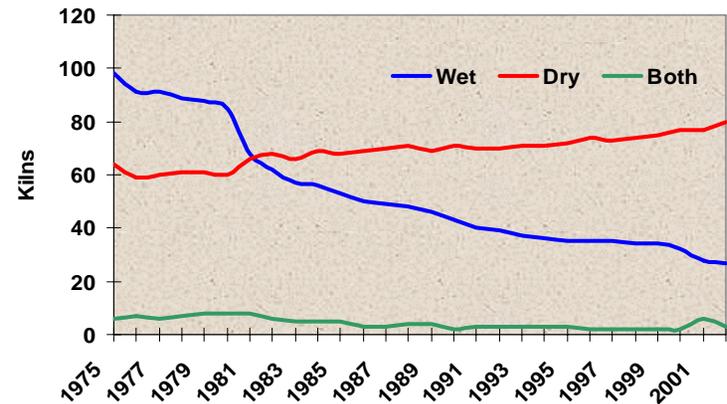
Source: Worrell, E., and C. Galitsky. Energy Efficiency Improvement Opportunities for Cement Making: An ENERGY STAR Guide for Energy and Plant Managers. Environmental Technologies Division. Lawrence Berkeley National Laboratory. January 2004. LBNL-54036



U.S. Historical Cement Production

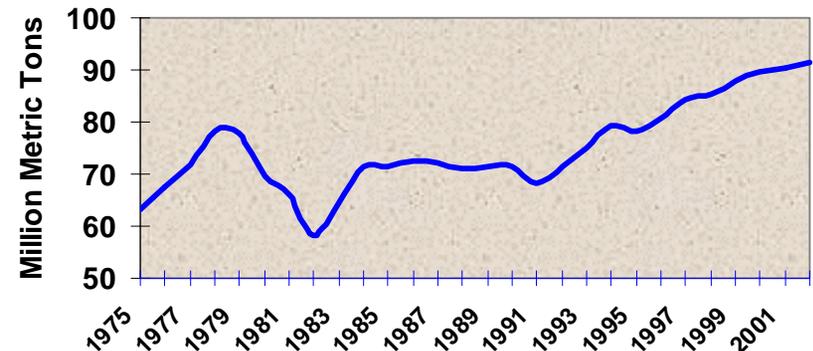
- Energy consumption is related to whether the wet process or the dry process is used.
- While dry process consumes more electricity, the wet process consumes significantly more fuel and is overall more energy-intensive.
- This transition from the wet to the dry process coincided with increased production in the U.S.

Figure 1. Number of Kilns by Process



Source: USGS Mineral Surveys (data from Surveys in 1975-2002)

Total U.S. Cement Production: 1975-2002



Source: USGS Mineral Surveys, various years.



GHG Emissions from Cement Production

- Primarily CO₂, but CH₄ and N₂O may be released through combustion.
- Total emissions a function of whether Portland Cement or Masonry Cement is produced.
 - Portland Cement is made with addition of gypsum: no additional emissions
 - Masonry Cement requires addition of lime.
 - In U.S. Inventory, emissions associated with lime manufacture are not accounted for in cement production, rather in the lime manufacture section.



CO₂ Emissions from Cement Production

- Process-related
 - Created during chemical reaction converting limestone to calcium oxide and CO₂
 - Methodology based on Intergovernmental Panel on Climate Change
 - Cement Kiln Dust
- Combustion-related
 - Result from the consumption of fuels and electricity.
 - Dry process: 224.2 kgC/st (*Source: Worrell and Galitsky, 2004*)
 - Wet process: 249 kgC/st
 - U.S. does not calculate combustion-related emissions separately as part of the Inventory of U.S. Greenhouse Gas Emissions and Sinks



Total CO₂ Emissions from U.S. Cement Production

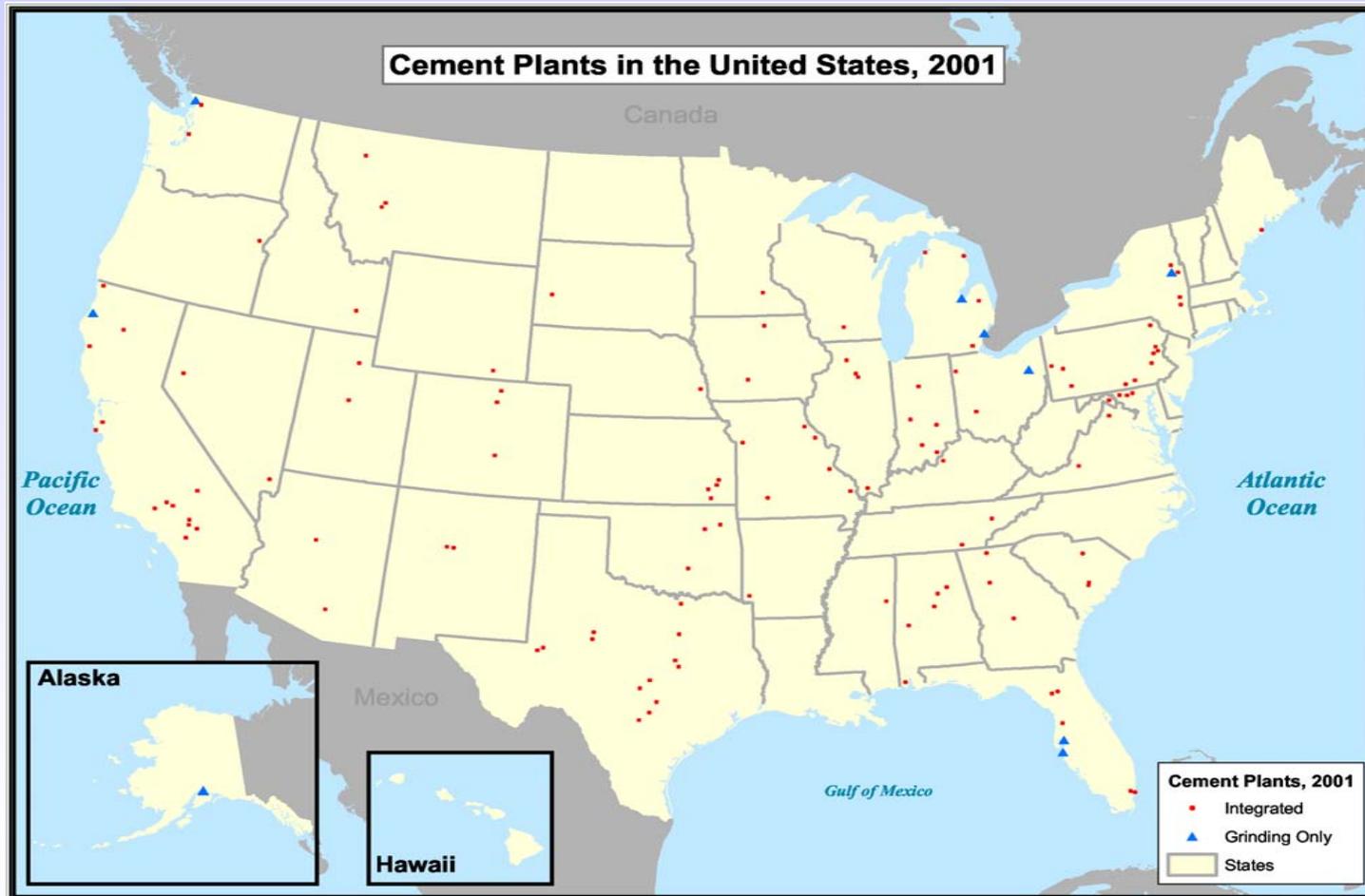
Table 1. Historical Trends in Combustion- and Process-related CO₂ Emissions from U.S. Cement Manufacturing (MMTCO₂)

	<i>1994</i>	<i>1995</i>	<i>1996</i>	<i>1997</i>	<i>1998</i>	<i>1999</i>	<i>2000</i>	<i>2001</i>
<i>Combustion-related CO₂</i>	30.6	31.3	31.6	32.1	32.9	36.1	36.5	35.5
<i>Process-related CO₂ (incl. CKD)</i>	36.1	36.8	37.1	38.3	39.2	40.0	41.2	41.4
<i>Total CO₂</i>	66.7	68.1	68.7	70.4	72.1	76.1	77.7	76.9

Source: Minerals Yearbook, Vol. 1, Metals and Minerals, 2002. U.S. Geological Survey. U.S. Department of the Interior. July 2003. Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2002. U.S. Environmental Protection Agency. February 2004. ICF communications with Hendrick van Oss, USGS, 15 April 2004.



Location of U.S. Cement Plants



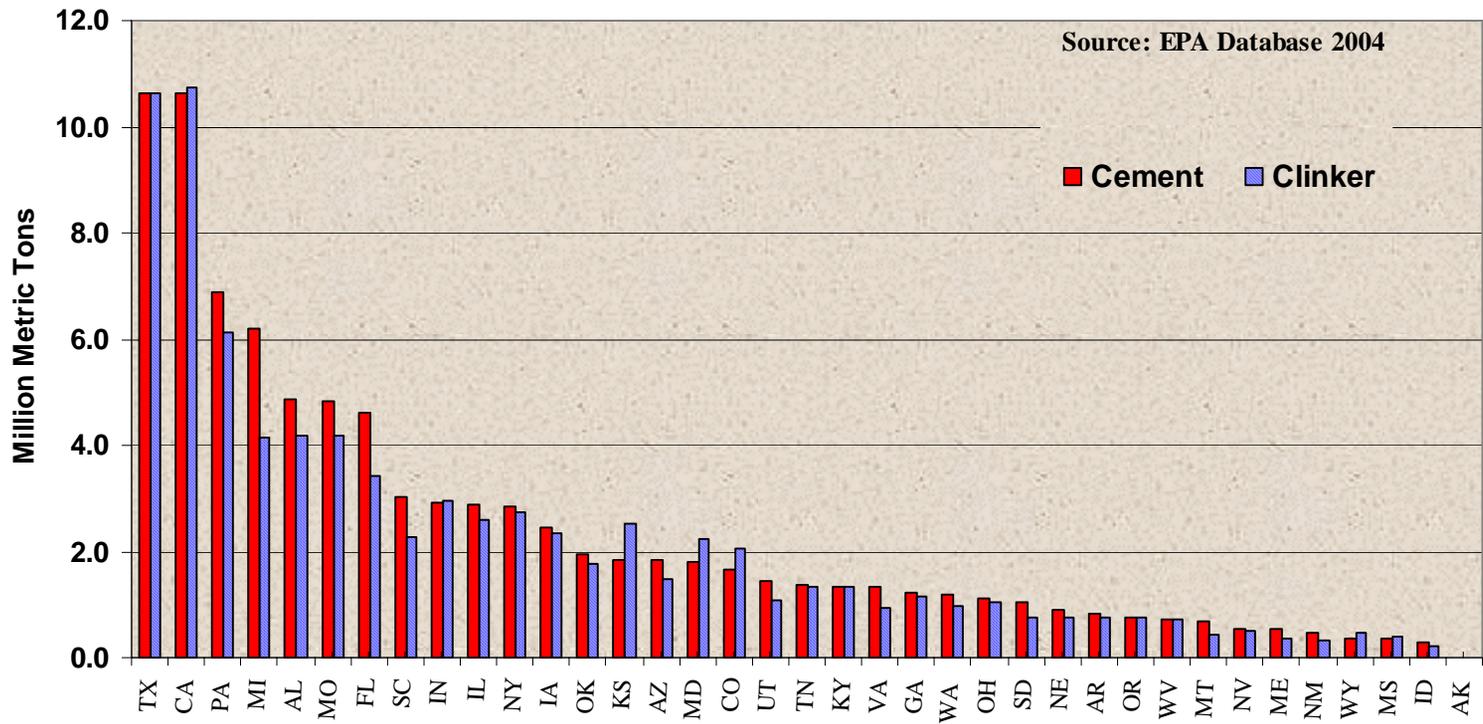
Developing a Profile of the U.S. Cement Industry

- Methodology
 - Finding facility-level data
 - U.S. Geological Survey and EIA's Manufacturing Energy Consumption Survey provide aggregated data.
 - Where facility-level data are available, fuel consumption not always provided.
 - Used capacity information
 - Applied known capacity utilization factors
 - Used published average annual carbon emission factor for wet facilities and dry facilities.



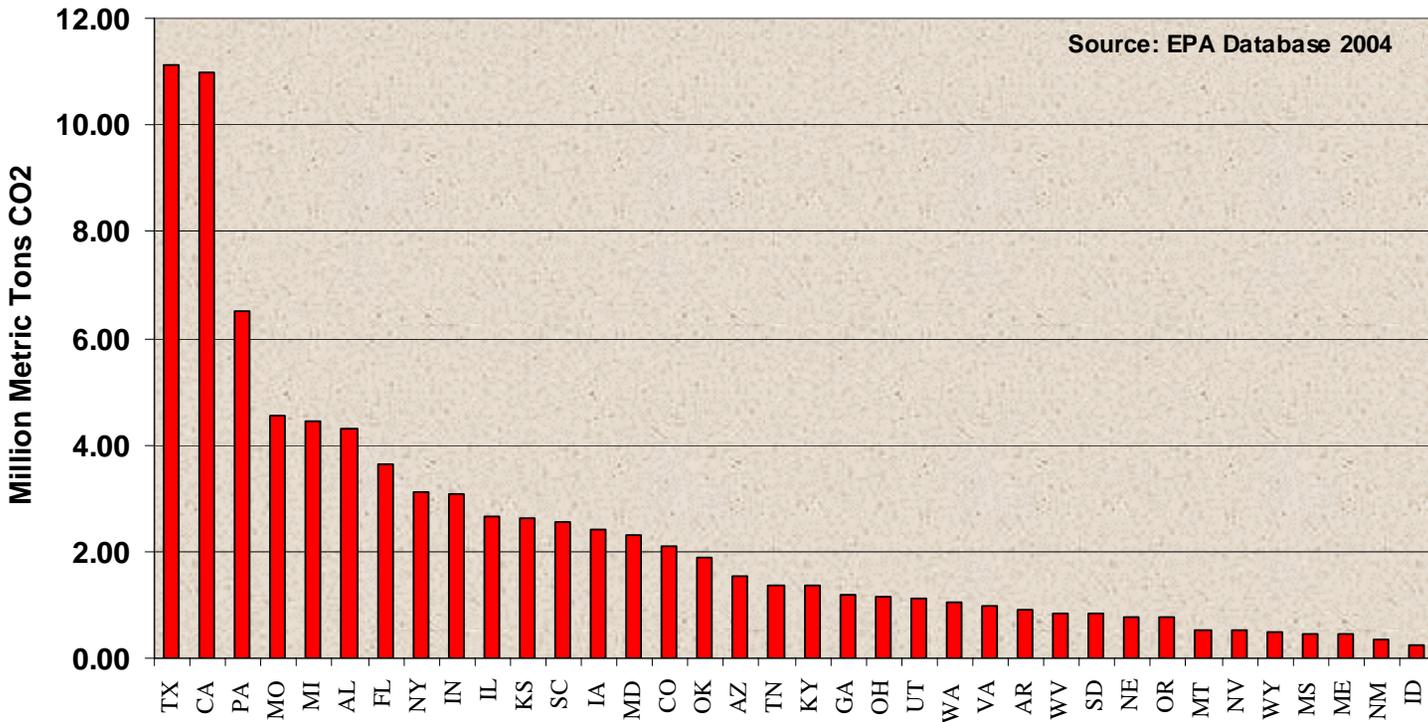
State-level Production

Estimated Annual Production by State, 2001



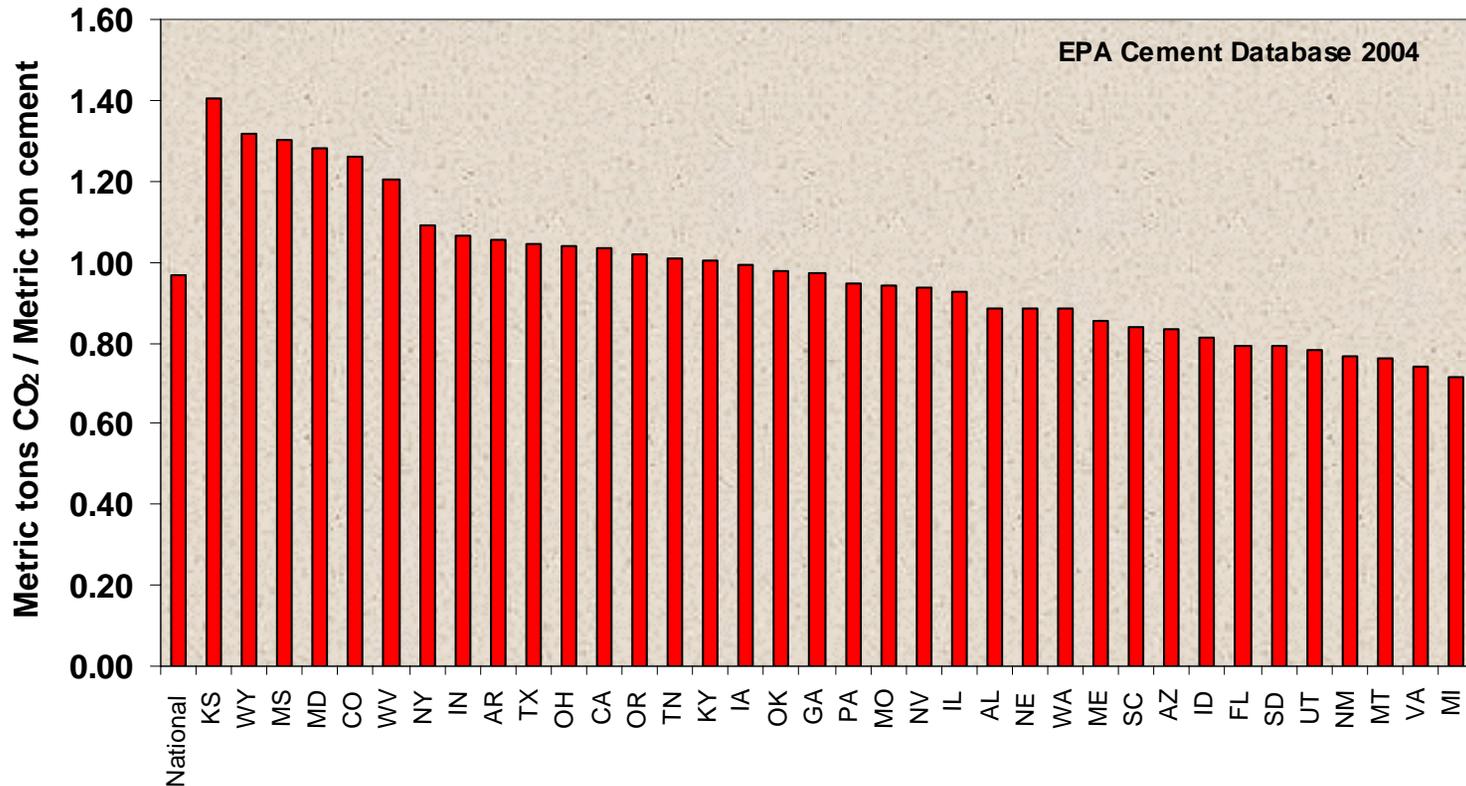
State-level CO₂ Emissions

Cement Industry Carbon Dioxide Emissions, 2001



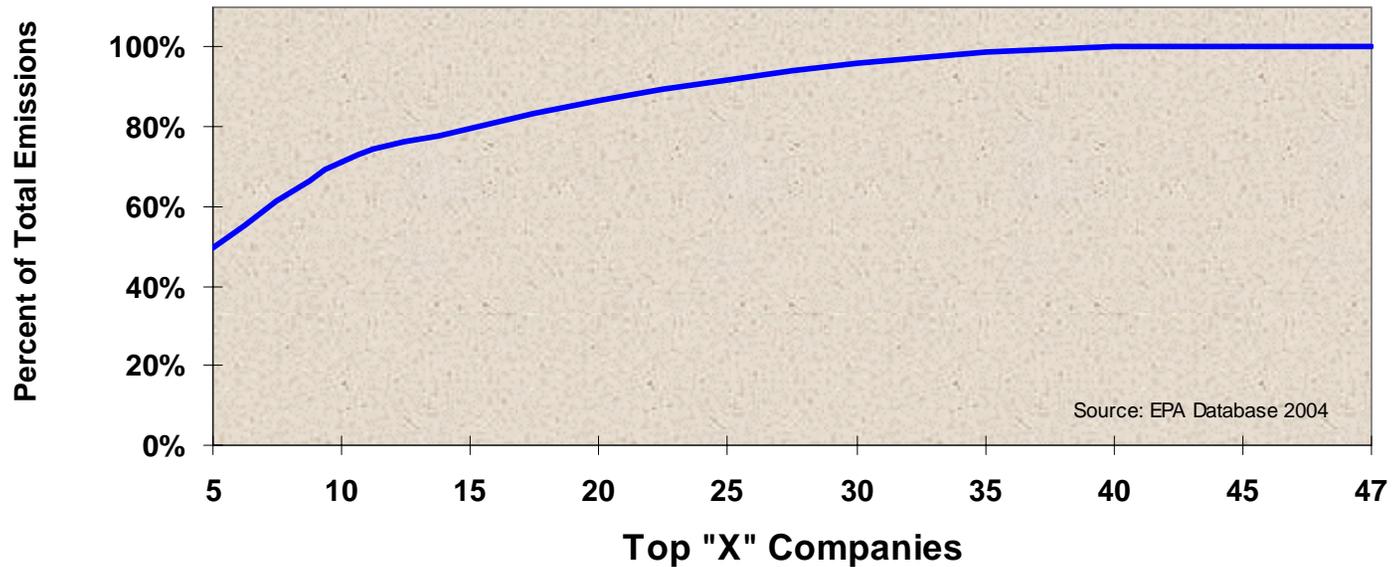
State-level CO₂ Intensity

Cement Industry Carbon Dioxide Intensity, 2001



Company Concentration

Company Concentration of CO₂ Emissions



Next Steps

- First step
- Try to replace the national average emissions factor with a facility-specific emissions factor for cement production.
- Investigate further mix of “other” fuels consumed in kilns.



Thank you for your time and
attention!

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