EPA United States Environmental Protection Agency

U.S. Cement Industry Carbon Intensities (2019)

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Cement plants operate high temperature kilns to produce clinker, which is ground and blended with other materials to make cement, the bonding agent in concrete. Cement manufacturing is energy intensive and a major source of greenhouse gas (GHG) emissions from the industrial sector. In 2019, ninety-two cement plants reported emissions of 67 million metric tons of carbon dioxide equivalents (CO_2e) to the U.S. Environmental Protection Agency (EPA). These emissions comprise roughly 10% of the industrial sector's direct reported emissions.[i]

Reducing cement plant GHG emissions and product carbon intensity are important goals for both the cement industry and its customers. To assist the U.S. cement industry in evaluating its efforts to decarbonize, EPA calculated the 2019 carbon intensities for the intermediate and final products of cement plants: clinker and cement. These intensities serve as reference points for the industry's carbon performance, represented as tons of carbon emitted per ton of clinker and tons of carbon emitted per ton of cement. The intensities are derived from cement plant data reported to the U.S. EPA Greenhouse Gas Reporting Program (GHGRP) and reflect direct emissions (Scope 1) from on-site fuel use and process emissions, comprising the majority of GHG emissions from cement plants.[ii] The table below presents quartile carbon emissions intensities for clinker and cement for the reporting cement plants. For this study, the 75th percentile reflects plants with lower carbon intensities and the 25th percentile reflects plants with higher carbon intensities. The 50th percentile is the median.

2019 Direct Carbon Intensities

Quartile	Metric Ton CO_2 / Metric Ton of Clinker	Metric Ton CO_2 / Metric Ton of Cement	Carbon Intensity
75th percentile	0.787	0.722	Low
50th percentile (median)	0.838	0.776	Midpoint
25th percentile	0.934	0.886	High

Methodology

Cement plants operating in the United States and its territories report total annual greenhouse gas emissions, clinker production, and cement production under the U.S. EPA GHGRP. To calculate carbon emission intensities, only data from cement plants reporting emissions using continuous emission monitoring systems (CEMS) was used.[iii] These emissions reflect the total cement kiln CO_2 emissions from fuel combustion and from the calcination of limestone (process emissions) at the plants. Emissions from biogenic fuels, methane (CH_4), and nitrogen oxide (NO_2) were excluded.[iv] CO_2 emissions from other on-site sources, such as stationary combustion unrelated to the kiln, were not included.[v] Data for calendar year 2019 (January – December) were analyzed. Carbon intensities for clinker and cement were calculated for each plant by dividing total annual CO_2 emissions from the kiln by the plant's total annual production of clinker or cement. A distribution of plant carbon intensities was created, and the intensity levels for the 25th, 50th, and 75th percentiles were calculated.

For the purposes of this evaluation, a plant with a carbon intensity at the 75th percentile emits less carbon dioxide per metric ton of clinker or cement than a plant with carbon intensity around the median intensity level (i.e., 50th percentile). Cement plants operating at the 50th percentile perform at the midpoint for the industry, while plants operating above the 50th percentile (i.e., those plants with intensities lower than 0.838 CO_2 per ton of clinker or 0.776 CO_2 per ton of cement) are operating at above average carbon performance and emit lower levels of CO_2 per ton of clinker or cement than plants below the median. Plants operating at or below the 25th percentile emit higher levels of CO_2 per ton of clinker or cement.

Those seeking to compare their cement plant's carbon intensity to the benchmarked quartiles should use the plant's annual data submission to U.S. EPA according to the reporting rules of the U.S. EPA GHGRP for calendar year 2019 and the following calculation using metric tons (MT):

MT CO_2/ MT clinker or cement = Total kiln MT CO_2 emissions / total MT clinker or total cement production

Observations

The quartile distributions of carbon intensities for clinker and cement are relatively narrow. For example, clinker from plants at the 75th percentile is 6% less carbon intensive than clinker from plants at the 50th percentile. The difference in carbon intensity between clinker from plants at the 50th versus 25th quartiles is 10%. The table below shows the differences in carbon intensity between the quartiles for clinker and cement.

Inter-quartile differences in carbon intensity	Clinker	Cement
75th vs 50th	6%	7%
50th vs 25th	10%	12%
75th vs 25th	16%	19%

Both large and small plants were observed in all carbon intensity quartiles. Additionally, no correlations were observed between carbon intensity and plant location, with plants in all quartiles being distributed across the country.

Periodically reviewing manufacturers' clinker and cement emissions intensities provides an opportunity to see the progress made by cement manufacturers in reducing carbon dioxide emissions from on-site fuel use in the kiln and from process-related emissions. These emissions may be reduced through a variety of means, including:

- production of blended forms of cement that include lower amounts of clinker in the final product;
- institution of energy efficiency measures that reduce fuel consumption; and,
- selection of lower carbon fuels.

These and other strategies can result in lower carbon intensity in final cement products.

For more information about the EPA's Greenhouse Gas Reporting program

Cement Plant Reporting Requirements: https://www.epa.gov/ghgreporting/subpart-h-cement-production
Cement Technical Documentation: https://www.epa.gov/ghgreporting/subpart-h-technical-support-document
Code of Federal Regulations – Subpart H - Cement Production: https://www.ecfr.gov/cgi-bin/text-idx?SID=2a1b1531ba5026f83908a18f85bc1c94&mc=true&node=sp40.23.98.h&rgn=div6
Relationship of the GHGRP to the national *Inventory of U.S. Greenhouse Gas Emissions and Sinks*: https://www.epa.gov/ghgreporting/greenhouse-gas-reporting-program-and-us-inventory-greenhouse-gas-emissions-and-sinks.

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[i] Derived from direct emissions reported to the US EPA's Greenhouse Gas Reporting Program for year 2019 (www.ghgdata.epa.gov). This data set only includes direct emissions (Scope 1) from on-site fuel use and manufacturing processes (i.e., emissions from calcination) from plants generally with annual GHG emissions over 25,000 metric tons. Within the cement sector, all plants are required to report. Total reported direct emissions from industrial plants for 2019 were 683 million metric tons of CO_2e. Industrial sector emissions excludes emissions from Power Plants, Petroleum & Natural Gas Systems, Waste, Underground Coal Mines, Universities, Military, and Use of Electric Equipment. CO_2e emissions include Methane (CH_4), Nitrous Oxide (N_20), process emissions and other gases. The *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019* provides estimates of total national emissions from the cement sector in Chapter 3 (Energy) and Chapter 4 (Industrial Processes and Product Use). See https://www.epa.gov/ghgreporting/greenhouse-gas-reporting-program-and-us-inventory-greenhouse-gas-emissions-and-sinks.

[ii] Indirect (Scope 2) GHG emissions associated with electricity use represent less than 10% of total emissions from cement plants.

[iii] About 90% of cement plants reported GHG emissions based on data from Continuous Emissions Monitoring Systems (CEM) that measure carbon emissions released to atmosphere. Data from plants not using CEMs was excluded to ensure a consistent data set.

[iv] Emissions from biogenic fuels (e.g., wood waste) and other gases (CH_4 and NO_2), on average, were less than 1% of total emissions for most plants using CEMS.

[v] Emissions from other stationary sources (e.g., boilers, generators) unrelated to cement kilns were, on average, less than 1% of total emissions reported in 2019.