Cement Production

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Climate Mitigation Services
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Cement production, general data

yellow column indicates original reported units

Cement production & emissions data

Year	Cement Prod		Energy Use		CO2 emissions	
	Clinker ratio	Annual production				
	Million tons/yr	Million tonnes/yr				
1950						
1951						
1952						
1953						
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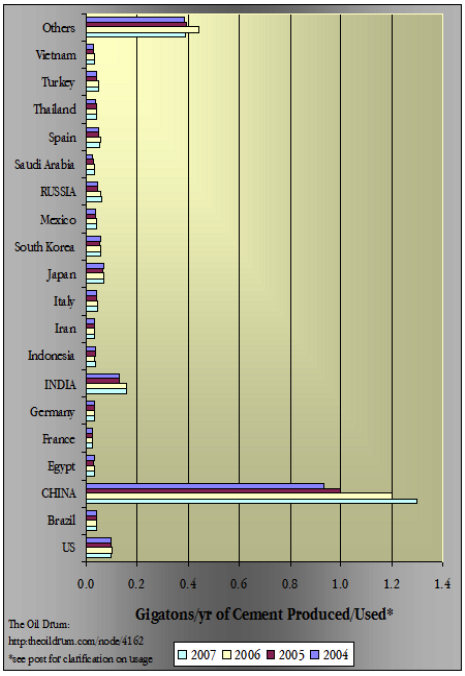
2006						
2007						
2008						
2009						
2010						
Total		-	-	-	-	-

Table 1	WBCSD Cement Industry stats for 2006		
Number of installations	Number	844	17%
Clinker production	Mtonne of clinker	626	44%
Cementitious product productio	Mtonne cementitious proc	801	53%
Gross CO2	Mtonne CO2	544	37%
Net CO2	Mtonne CO2	530	35%
Gross CO2 per tonne of clinker	kg CO2/tonne of clinker	866	-5.30%
Net CO2 per tonne of clinker	kg CO2/tonne of clinker	844	-6.90%
Gross CO2 per tonne cementitic	kg CO2/tonne cementitio	679	-10.60%
Net CO2 per tonne cementitious	kg CO2/tonne cementitio	661	-12.10%
Clinker substitution	Clinker to cement ratio	78	-5.90%
Thermal energy efficiency	MJ/tonne clinker	3,690	-14%
Electric energy efficiency	kWh/tonne cement	111	-3.50%

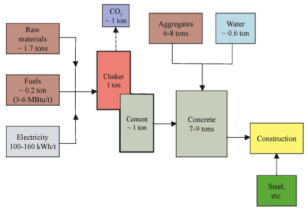
WBCSD, Cement Sustainability Initiative (2009) Cement Industry Energy and CO2 Performance "Getting the Numbers Right", 44 pp., www

Process emissions (calcination):	kg CO2/tonne of clinker	540	Percent process of gross, by year
Gross emissions 1990	kg CO2/tonne of clinker	914	59.1%
Gross emissions 2000	kg CO2/tonne of clinker	880	61.4%
Gross emissions 2005	kg CO2/tonne of clinker	868	62.2%
Gross emissions 2006	kg CO2/tonne of clinker	866	62.4%
Thermal & elec. emissions 2006	kg CO2/tonne of clinker	326	Gross CO2 emissions: All direct (excl on-site elec gen & biomass)
Percent process of gross emissions		62.4%	Net CO2 emissions: Gross minus alt fuel emissions

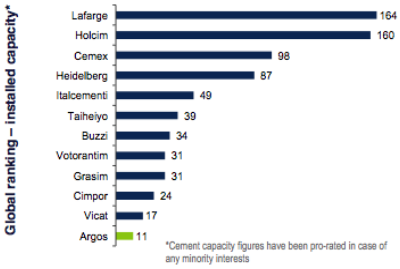


www.theoildrum.com/node/4162

Production Flow for Cement



USGS



www.argos.com.cøwps/wcm/connect/resources/file/eb4e7c00a7d65c9/Argos_general_presentation_15_January_07.pdf?MOD=AJPERES

Cementos Argos (Colombia), Jan07
11.6 million tonne capacity (Colombia, USA, Panama, Venezuela, Haiti, Dominican Rep); nat gas, coal, hydro

Company profiles (Base year 2007)

		Turnover (M€)	Employees (Number)	Production (Mt)	Production capacity (Mt)	Countries (Number)
CSI core Members	Cemex	21,673	67,000		96.7	> 50
	Cimpor	1,966	7,530	24.5	28.4	11
	CRH	20,992	92,000	15.6		32
	Heidelberg	10,862	67,916	88		50
	Holcim	27,052 CHF	89,364	149.6	197.8	> 70
	Italcementi	6,001	23,706	65		22
	Lafarge	17,600	77,721	148.4		72
	Portland Valderrivas	1,886	5,066	18		7
	Titan	1,497	6,034	15.5	16	11
CSI Participants	Siam Cement (cement only)	268 MMTHB	5,918		24.2	9

Lafarge CSR 2008, page 64.

World Production and Capacity:
Cement production

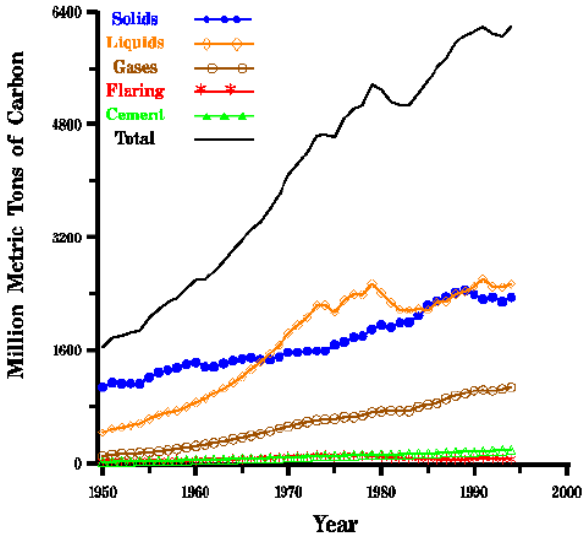
	2006	2007
United States (includes Puerto Rico)	99,700	96,400
Brazil	39,500	40,000
China	1,200,000	1,300,000
Egypt	29,000	29,000
France	21,000	21,000
Germany	33,400	34,000
India	155,000	160,000
Indonesia	34,000	35,000 42,000 42,000
Iran	33,000	34,000
Italy	43,200	44,000
Japan	69,900	70,000
Korea, Republic of	55,000	55,000
Mexico	40,600	41,000
Russia	54,700	59,000
Saudi Arabia	27,100	28,000
Spain e54,000	50,000	
Thailand	39,400	40,000
Turkey	47,500	48,000
Vietnam	32,000	32,000
Other countries (rounded)	442,000	390,000
World total (rounded)	2,550,000	2,600,000

(Data in thousand metric tons unless otherwise noted)
Hendrik G. van Oss, 703-648-7712, hvanoss@usgs.gov
U.S. Geological Survey, Mineral Commodity Summaries

World
million tonnes/yr
1,750
1,850
2,020
2,190
2,350
2,610
2,810
2,860
3,060
3,300

Table 2 if 2010 world production times 0.520 t CO2 per tonne (WBCSD), then:

World cement production & emissions				
Cement	CO2 & carbon emissions			
World Prodn	CMS method	CMS method	CDIAC	CMS/CDIAC
million tonnes	Mt CO2/yr	Mt C/yr	Mt C/yr	%
		0.5071	tCO2 per tonne cementitious	
133.0	67.45	18.39	18.00	102%
149.0	75.56	20.61	20.00	103%
161.0	81.64	22.26	22.00	101%
178.0	90.27	24.62	24.00	103%
194.9	98.84	26.95	27.00	100%
217.3	110.20	30.05	30.00	100%
235.4	119.37	32.55	32.00	102%
246.9	125.21	34.14	34.00	100%
262.5	133.12	36.30	36.00	101%
294.3	149.24	40.70	40.00	102%
316.5	160.50	43.77	43.00	102%
333.2	168.97	46.08	45.00	102%
358.5	181.80	49.58	49.00	101%
378.0	191.69	52.27	51.00	102%
415.6	210.75	57.47	57.00	101%
433.4	219.78	59.93	59.00	102%
464.2	235.40	64.19	63.00	102%
479.8	243.31	66.35	65.00	102%
515.2	261.26	71.25	70.00	102%
543.1	275.41	75.11	74.00	101%
571.8	289.97	79.07	78.00	101%
590.0	299.19	81.59	84.00	97%
661.0	335.20	91.41	89.00	103%
702.0	355.99	97.08	95.00	102%
703.2	356.60	97.25	96.00	101%
702.2	356.09	97.11	95.00	102%
735.4	372.93	101.70	103.00	99%
797.1	404.22	110.23	108.00	102%
853.0	432.56	117.96	116.00	102%
872.4	442.40	120.64	119.00	101%
883.1	447.83	122.12	120.00	102%
886.7	449.65	122.62	121.00	101%
887.4	450.01	122.72	121.00	101%
916.6	464.82	126.76	125.00	101%
941.1	477.24	130.14	128.00	102%
959.4	486.52	132.68	131.00	101%
1,008.0	511.17	139.40	137.00	102%
1,053.0	533.99	145.62	143.00	102%
1,118.0	566.95	154.61	152.00	102%
1,042.0	528.41	144.10	156.00	92%
1,043.0	528.92	144.24	157.00	92%
1,185.0	600.93	163.87	161.00	102%
1,123.0	569.48	155.30	167.00	93%
1,291.0	654.68	178.53	176.00	101%
1,370.0	694.74	189.46	186.00	102%
1,445.0	732.77	199.83	197.00	101%
1,493.0	757.12	206.47	203.00	102%
1,547.0	784.50	213.93	209.00	102%
1,540.0	780.95	212.97	209.00	102%
1,600.0	811.38	221.26	217.00	102%
1,660.0	841.80	229.56	226.00	102%
1,750.0	887.44	242.01	237.00	102%
1,850.0	938.15	255.84	252.00	102%
2,020.0	1,024.36	279.35	276.00	101%
2,190.0	1,110.57	302.86	298.00	102%
2,350.0	1,191.71	324.98	320.00	102%
2,610.0	1,323.56	360.94	355.00	102%
2,810.0	1,424.98	388.60	382.00	102%
2,860.0	1,450.33	395.51	386.00	102%
3,060.0	1,551.76	423.17	411.73	103%
3,300.0	1,673.46	456.36	446.95	102%
63,290	**32,095**	**8,752**	**8,649**	**101.20%**



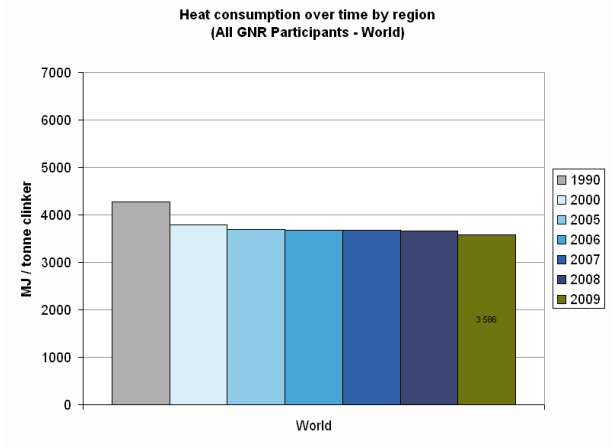
Global CO2 emissions from fossil-fuel burning, cement production, and gas flaring for 1950-92. CDIAC (1999), charts.

WBCSD Cement Sustainability Initiative (2009) Cement Industry Energy and CO2 Performance "Getting the Numbers Right", World Business Council for Sustainable Development, 44 pp., wbcsdcement.org; www.wbcsdcement.org/GNR-2009/index.html
Page 30:
(1) about 60% of gross CO2 emissions originate fom limestone decomposition
(2) 40% are fuel emissions where, apart from energy efficiency, the fuel composition plays a role.
In Figure 6.4: Gross CO2 emissions per tonne of clinker, 2006: GNR global average 866 kg CO2 per tonne of clinker

Table 3 **WBCSD GNR participants data**

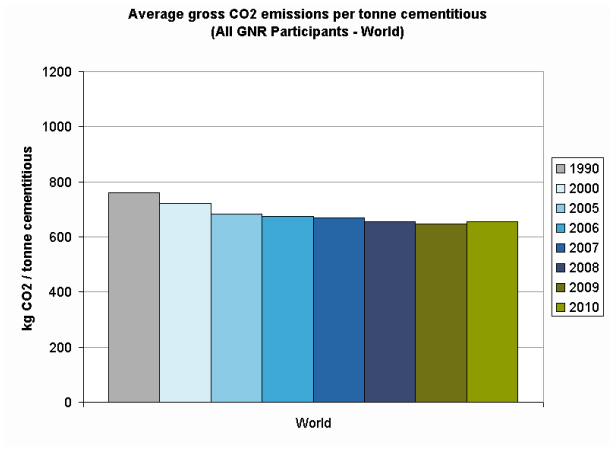
Year	Thermal efficiency MJ/tonne clinker	Net emission rate kg CO2/tonne	Gross emission rate kg CO2/tonne	Production Mt cementitious	Net emissions Mt CO2	Estimated calcining emissions percent of net 420 kg CO2/t
	kg CO2e per tonne cementitious product (column "X")					(420/column "X") (net emission rate)
1990	4,260	754	759	529	400	55.7%
1991		749	754	interpolated		56.0%
1992		745	750	interpolated		56.4%
1993		740	745	interpolated		56.7%
1994		736	741	interpolated		57.1%
1995		731	736	interpolated		57.5%
1996		726	731	interpolated		57.8%
1997		722	727	interpolated		58.2%
1998		717	722	interpolated		58.6%
1999		713	718	interpolated		58.9%
2000	3,760	708	713	627	448	59.3%
2001		703	708	interpolated		59.7%
2002		699	704	interpolated		60.1%
2003		694	699	interpolated		60.5%
2004		690	695	interpolated		60.9%
2005	3,680	685	690	766	518	61.3%
2006	3,670	659	675	835	555	63.7%
2007	3,670	651	668	890	584	64.5%
2008	3,650	638	657	877	568	65.8%
2009	3,580	627	646	803	510	67.0%
2010	3,580	633	655			66.4%

Linked to Cement Process Emissions



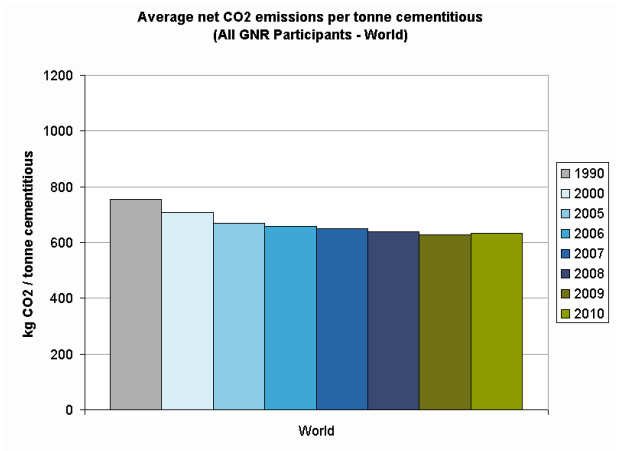
Region	1990 (MJ/t clinker)	2000 (MJ/t clinker)	2005 (MJ/t clinker)	2006 (MJ/t clinker)	2007 (MJ/t clinker)	2008 (MJ/t clinker)	2009 (MJ/t clinker)
World	4 270	3 800	3 700	3 680	3 680	3 660	3 590

WBCSD Sustainable Cement Initiative, GNR Indicator 329
www.wbcsdcement.org/GNR-2009/index.html



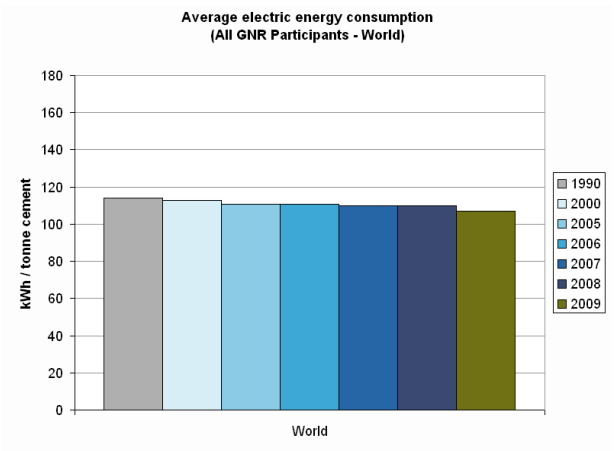
Region	1990 (kg CO2 / t cementitious)	2000 (kg CO2 / t cementitious)	2005 (kg CO2 / t cementitious)	2006 (kg CO2 / t cementitious)	2007 (kg CO2 / t cementitious)	2008 (kg CO2 / t cementitious)	2009 (kg CO2 / t cementitious)	2010 (kg CO2 / t cementitious)
World	759	721	684	675	668	657	646	655

WBCSD Sustainable Cement Initiative, GNR Indicator 323



Region	1990 (kg CO2 / t cementitious)	2000 (kg CO2 / t cementitious)	2005 (kg CO2 / t cementitious)	2006 (kg CO2 / t cementitious)	2007 (kg CO2 / t cementitious)	2008 (kg CO2 / t cementitious)	2009 (kg CO2 / t cementitious)	2010 (kg CO2 / t cementitious)
World	754	708	669	659	651	638	627	633

WBCSD Sustainable Cement Initiative, GNR Indicator 326
Note: 2010 revised data shown (2009 data, used in our analysis, shown underneath)



Region	1990 (kWh / t cement)	2000 (kWh / t cement)	2005 (kWh / t cement)	2006 (kWh / t cement)	2007 (kWh / t cement)	2008 (kWh / t cement)	2009 (kWh / t cement)
World	114	113	111	111	110	110	107

WBCSD Sustainable Cement Initiative, GNR Indicator 3212

CDIAC (1995) Estimates of Global, Regional, and National Annual CO2 Emissions from Fossil-Fuel Burning, Hydraulic Cement Production, and Gas Flaring: 1950-1992,
by T. A.. Boden, G. Marland, & R. J. Andres. cdiac.ornl.gov/epubs/ndp/ndp030/ndp0301.htm#co2man

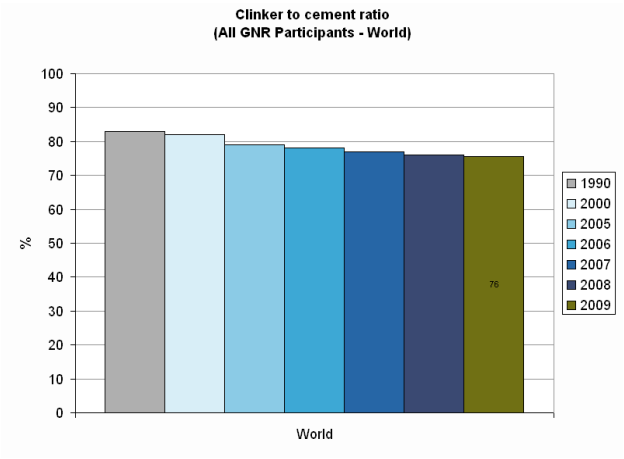
3.1 CO2 Emissions from Cement Manufacturing

Because cement manufacturing uses essentially 100% of the calcium oxide obtained from burning the calcium carbonate during calcination, the amount of calcium oxide content in the finished cement is a good measure of the amount of CO2 released during production (Griffin 1987). To determine the amount of CO2 released from cement manufacturing, one needs to know how much cement was manufactured, the average calcium oxide content per unit of cement, and a factor to convert the calcium oxide content into carbon dioxide equivalents. Cement production data published by the U.S. Bureau of Mines are currently reported in thousand short tons, but before 1970 the data were reported in barrels. To ensure consistent units throughout the 1950-92 record, two equations were used to convert cement production estimates to units of metric tons. Cement production before 1970 was calculated by usi cement production (in metric tons) = 0.17055 * quantity of cement produced (in barrels), (3) where 0.17055 is the metric-ton equivalent for a barrel.

After 1969, net cement production was calculated by using cement production (in metric tons) = 0.90718474 * quantity of cement produced (in short tons), (4) where 0.90718474 is the metric-ton equivalent for a short ton. The amount of CO2 produced from cement production was calculated by using CO2 production (in metric tons of C) = 0.136 metric tons of C per metric ton cement ? quantity of cement produced (metric tons) (5)

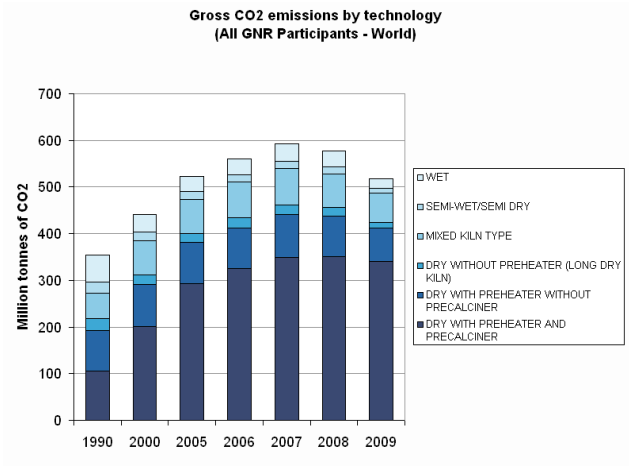
This conversion factor was obtained by dividing the molar mass of carbon by the molar mass of calcium oxide and multiplying this quotient by the average fraction of calcium oxide contained in cement: (12.01 g C/mole CaCO3 ÷ 56.08 g CaO /mole CaCO3) * 0.635 g CaO /g cement = 0.136 g C /g cement (6)

The consensus that 63.5% of the typical cement in the world is composed of calcium oxide is based on the opinions of experts consulted in the field, as well as inspection of composition data by type and country (Griffin 1987).



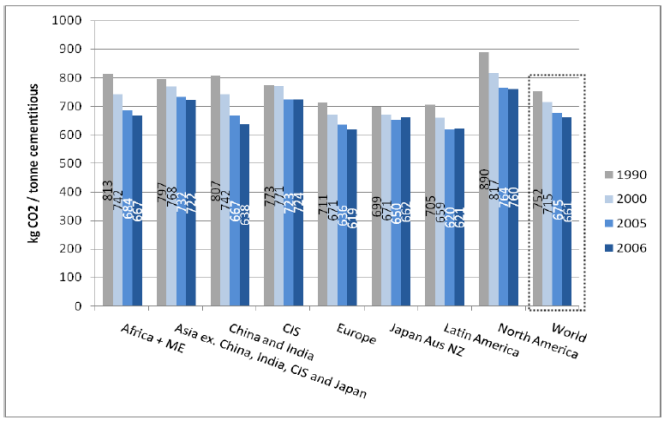
Region	1990 (%)	2000 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)
World	83	82,1	79	78,1	77	76,1	75,6

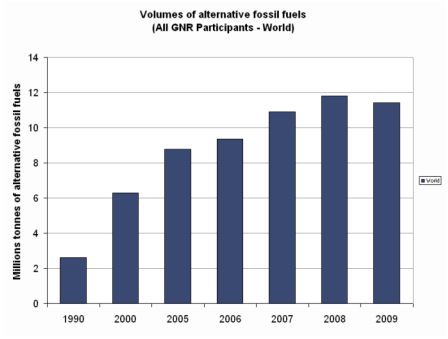
WBCSD Sustainable Cement Initiative, GNR Indicator 3213



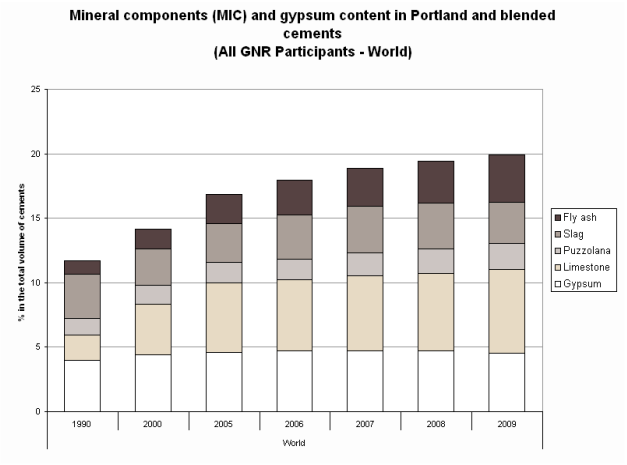
Year	Dry with preheater and precalciner (t CO2/year)	Dry with preheater without precalciner (t CO2/year)	Dry without preheater (long dry kiln) (t CO2/year)	Mixed kiln type (t CO2/year)	Semi-wet/semi dry (t CO2/year)	Wet (t CO2/year)
1990	105 000 000	86 900 000	25 800 000	55 200 000	24 000 000	58 200 000
2000	201 000 000	89 500 000	21 400 000	73 800 000	18 900 000	36 900 000
2005	293 000 000	88 900 000	18 200 000	73 100 000	16 500 000	33 600 000
2006	326 000 000	87 100 000	20 600 000	76 700 000	16 000 000	34 700 000
2007	348 000 000	92 900 000	20 900 000	76 900 000	16 200 000	36 700 000
2008	351 000 000	86 600 000	19 700 000	71 600 000	14 400 000	34 100 000
2009	341 000 000	70 300 000	11 900 000	63 500 000	11 300 000	18 900 000

WBCSD Sustainable Cement Initiative, GNR Indicator 316





Year	World (t)
1990	2 600 000
2000	6 280 000
2005	8 780 000
2006	9 370 000
2007	10 900 000
2008	11 800 000
2009	11 400 000



region	year (%)	Gypsum (%)	Limestone (%)	Puzzolana (%)	Slag (%)	Fly ash (%)	Total (%)
World	1990	3,96	1,97	1,29	3,41	1,08	11,7
-	2000	4,42	3,93	1,46	2,78	1,54	14,1
-	2005	4,58	5,4	1,58	3,05	2,26	16,9
-	2006	4,72	5,5	1,62	3,4	2,74	18
-	2007	4,73	5,79	1,77	3,66	2,92	18,9
-	2008	4,69	6,03	1,87	3,58	3,25	19,4
-	2009	4,55	6,49	2,03	3,18	3,64	19,9
Total	-	31,6	35,1	11,6	23,1	17,4	119

WBCSD Sustainable Cement Initiative, GNR Indicator 3219

IPCC Second Assessment Report, Industry, chapter 20, quotes Griffin (1987): calcination releases ~0.5 t CO2 per tonne of cement (60% of 1.25 tCO2 total).

WBCSD cement industry CO2 protocol recommends a default factor of 525 tCO2 per tonne of clinker
Note: see Table 3 for calculation of net calcining emissions as a percentage of net emissions per tonne cementitious product

2.3.2 Emission Estimation Methodology for CO_2

Estimation of CO_2 emissions from cement production is accomplished by applying an emission factor, in tonnes of CO_2 released per tonne of clinker produced, to the annual clinker output.[2] The emission factor (EF) is the product of the fraction of lime used in the cement clinker and a constant reflecting the mass of CO_2 released per unit lime.

$$EF_{clinker} = \text{Fraction CaO} \times (44.01 \text{ g/mole } CO_2 / 56.08 \text{ g/mole CaO})$$
or
$$EF_{clinker} = \text{Fraction CaO} \times 0.785$$

There are two methods for calculating this emission factor. The first is to assume an average CaO fraction in clinker. Since clinker is mixed with gypsum, which contains no lime per unit, to make cement, clinker has a higher lime percentage than finished cement. The average clinker lime percentage has been estimated to be 64.6 per cent.[3] This number when multiplied by the molecular weight ratio of CO_2/CaO (0.785) gives a clinker emission factor of 0.5071 tonnes of CO_2/tonne of clinker produced.

$$EF_{clinker} = 0.646 \times 0.785 = 0.5071$$

A second method is to assemble country or regional data on clinker production by type and clinker CaO content by type, then calculate a weighted average for cement lime content in the country. In most countries, the difference in the results of these two methods is likely to be small; any error in the lime content assumption is likely to be smaller than the uncertainty in clinker and cement production figures (Griffin, 1987).

If information on clinker production is not readily available, an emission factor in tonnes of CO_2 released per tonne of cement produced can be applied to annual cement production instead. This approach has been followed by Marland et al. (1989), who took the average CaO content of cement to be 63.5 per cent, yielding an emission factor of 0.4985 CO_2/cement (0.136 tonne CO_2 as C/tonne cement).

$$EF_{cement} = 0.635 \times 0.785 = 0.4985$$

IPCC (Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Reference Manual, Volume 3, Industrial Processes, Section 2.3: Cement Production, www.ipcc-nggip.iges.or.jp/public/gl/invs6a.html

Table 1. Historical Trends in Combustion- and Process-related CO_2 Emissions from U.S. Cement Manufacturing ($MMTCO_2$)

	1994	1995	1996	1997	1998	1999	2000	2001
Combustion-related CO_2	30.6	31.3	31.6	32.1	32.9	36.1	36.5	35.5
Process-related CO_2 (incl. CKD)	36.1	36.8	37.1	38.3	39.2	40.0	41.2	41.4
Total CO_2	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.

Hanle, Lisa, Kamala R. Jayaraman, & Joshua S. Smith (2004) "CO2 Emissions Profile of the U.S. Cement Industry," 13th International Emission Inventory Conference Working for Clean Air, Clearwater, FL, 14 pp.

Table 4-3: CO_2 Emissions from Cement Production (Tg CO_2 Eq. and Gg)

Year	Tg CO_2 Eq.	Gg
1990	33.3	33,278
2005	45.2	45,197
2006	45.8	45,792
2007	44.5	44,538
2008	40.5	40,531
2009	29.0	29,018
2010	30.5	30,509

EPA (2012) Draft Inventory, page 4-4.

Cell: I9
Comment: Rick Heede:
Chiefly World Business Council for Sustainable Development data from WBCSD's Cement Sustainability Initiative (2009) Cement Industry Energy and CO2 Performance: 'Getting the Numbers Right', wbcsdcement.org, 44 pp.
Also CDIAC cement emissions estimation protocol (page 3).

Cell: K11
Comment: Rick Heede:
Emissions from cement fabrication are of two main types: Calcining process of calcium carbonate into clinker liberates carbon dioxide, and emissions from the energy used in the manufacturing process. Typically not included in the emissions estimates are transportation energy, the burning of wastes, or plant construction.

Cell: E12
Comment: Rick Heede:
The industry calcination factor ranges from 525 to 900 kg CO2 per tonne of clinker (net), but of course varies from company to company, and will tend to decrease over time as process efficiencies improve. WBCSD (2002) "Toward a Sustainable Cement Industry: Key Performance Indicators," by Joseph Fiksel, Battelle, for WBCSD. "Each tonne of Ordinary Portland Cement generates ~900 kg of net CO2 emissions ... and consumes roughly 3,000 MJ of total electrical and thermal energy," p. 8.

Cell: H12
Comment: Rick Heede:
Most cement companies will aggregate emissions from energy use with emissions from cement fabrication. This column is provided for companies that provide both data.

Cell: K12
Comment: Rick Heede:
Average CO2 emissions intensity have declined 16.5 percent from 1990 to 2009 -- from 758 net kg CO2 per tonne of cementitious product in 1990 to 633 kg CO2/t in 2009, according to WBCSD data.** This project estimates process emissions from calcining limestone and thus excludes emissions from fuel and electricity inputs inputs to cement manufacturing. The emission rates and net total company emissions both include process and energy-related emission; a subsequent worksheet (SumCement.xls) estimates process emions of CO2.
** World Business Council for Sustainable Development Cement Sustainability Initiative (2009) Cement Industry Energy and CO2 Performance: 'Getting the Numbers Right', wbcsdcement.org, 44 pp. See GNR Indicator 326, reproduced at the "Cement industry data" worksheet in this portfolio.

Cell: P13
Comment: Rick Heede:
USGS Historical Statistics for Mineral and Material Commodities in the United States By Thomas D. Kelly and Grecia R. Matos http://minerals.usgs.gov/ds/2005/140/

Cell: R15
Comment: Rick Heede:
CMS adopts the IPCC Guideline factor of EF clinker = 0.646 * 0.785 = 0.5071 tCO2 per tonne of clinker produced. (Average clinker lime percentage of 64.6 percent; molecular weight ratio of CO2/CaO = 78.5 percent.)

Cell: AB51
Comment: Rick Heede:
This column calculates a time series of calcining emissions as a percent of gross emissions reported by WBCSD Cement Sustainability Initiative members, which are globally reported for 1990, 2000, and 2005 - 2009. This series is linked to the Cement.xls worksheet summarizing estimated calcining process emissions from data on cement production (fuel emissions + process emissions).

Cell: AB54
Comment: Rick Heede:
Based on WBCSD Cement Sustainability Initiative protocol (2011) default factor of 525 tCO2/tonne clinker (see details below) times an industry average of approximately 80 percent clinker in cementitious product (due to substitute and additional materials such as gypsum, fly ash, etc), CMS estimates 420 tCO2 per tonne of cementitious product is attributable to the calcining process (CaCO3 ---> CaO + CO2) (525 * 0.8 = 420).
Cement Sustainability Initiative (2011) CO2 and Energy Accounting and Reporting Standard for the Cement Industry, 76 pp. www.wbcsdcement.org/pdf/tf1_co2%20protocol%20v3.pdf.
Page 16: "In the absence of better data, a default of 525 kg CO2/t clinker shall be used (Simple output method B1). This value is comparable to the IPCC default (510 kg CO2/t) corrected for typical MgO contents in clinker." Appendix 3: Details on Calcination CO 2 Reporting of CO2 emissions from raw material calcination based on clinker output: Summary of IPCC and CSI Recommendations and Default Emission Factor for Clinker IPCC (2006) recommends calculating calcination CO2 based on the CaO content of the clinker produced (0.785 t CO2/t CaO, multiplied with the CaO content in clinker). A default CaO content in clinker of 65% is recommended, corresponding to 510 kg CO2/t clinker.

Cell: M76
Comment: Rick Heede:
USGS Minerals Yearbook 2009, Table 22: Hydraulic Cement: World Production by Country 2005-2009, at: http://minerals.usgs.gov/minerals/pubs/commodity/cement/index.html#myb

Cell: M77
Comment: Rick Heede:
World cement production in 2010 (estimated): 3,300 thousand tonnes, Hendrik van Oss, USGS. http://minerals.usgs.gov/minerals/pubs/commodity/cement/mcs-2011-cemen.pdf

Cell: AT78
Comment: Rick Heede:
"CO2 is emitted during cement production in two ways. Approximately 0.75 t of CO2 is produced per ton of cement from combustion of fossil fuels to operate the rotary kiln. The second source is calcination, in which calcium carbonate (CaCO3) from limestone, chalk, or other calcium-rich materi- als is heated in kilns to form lime (CaO) by driving off CO2. This process produces about 0.5 t of CO2 per ton of cement. Thus, combining these two sources, for every ton of cement produced, 1.25 t of CO2 is released into the atmosphere—of which 60% comes from energy inputs and 40% from calcination (Griffin, 1987). Worldwide, cement production accounted for approximately 162 Mt of C emissions in 1991, or about 2.6% of total global carbon from oxidation of fossil fuels. The United States annually produces about 9.3 Mt C from cement production, or 6% of global cement-production carbon (CDIAC, 1993)." www.ipcc-wg2.gov/publications/SAR/SAR_Chapter%2020.pdf
Griffin, R.C., 1987: CO2 release from cement production, 1950-1985. In: Estimates of CO2 Emissions from Fossil Fuel Burning and Cement Manufacturing, Based on the United Nations Energy Statistics and the U.S. Bureau of Mines Cement Manufacturing Data [Marland, G., T.A. Boden, R.C. Griffin, S.F. Huang, P. Karciruk, and T.R. Nelson (eds.)]. Report No. ORNŁCDIAC-25, Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, TN, pp. 643-680.
CDIAC elaborates: (12.01 g C/mole CaCO3 ÷ 56.08 g CaØmole CaCO3) * 0.635 g CaØg cement = 0.136 g C/g cement. CMS: 0.136 gC per g cement * 3.667 = 0.50 gCO2 per g.
http://cdiac.esd.ornl.gov/

Cell: AT80
Comment: Rick Heede:
Cement Sustainability Initiative (2011) CO2 and Energy Accounting and Reporting Standard for the Cement Industry, 76 pp. www.wbcsdcement.org. Page 16: "In the absence of better data, a default of 525 kg CO2/t clinker shall be used. This value is comparable to the IPCC default (510 kg CO2/t) corrected for typical MgO contents in clinker." In Appendix 3, Details on Calcination CO2: "Reporting of CO2 emissions from raw material calcination based on clinker output: Summary of IPCC & CSI Recommendations and Default Emission Factor for Clinker IPCC (2006) recommends calculating calcination CO2 based on the CaO content of the clinker produced (0.785 t CO2/t CaO, multiplied with the CaO content in clinker). A default CaO content in clinker of 65% is recommended, corresponding to 510 kg CO2/t clinker."