

Cement Production

Richard Heede
Climate Mitigation Services
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China, People's Republic

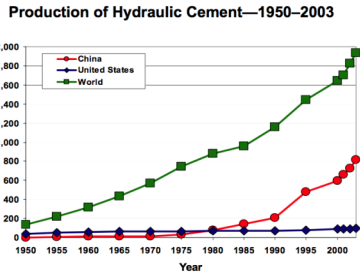
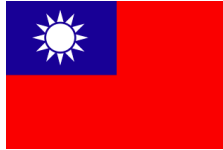
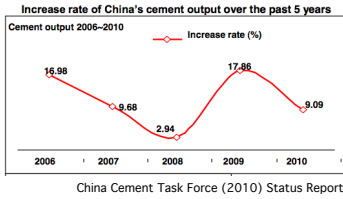
yellow column indicates original reported units

Cement production & emissions data

CDIAC China estimates

Year	Cement Prod		Energy Use		CO2 emissions		CDIAC China cement		
	Clinker ratio	Annual production			Emissions rate	Gross emissions	Cement emissions	Cement emissions	Inferred cement production
	Million tons/yr	Million tonnes/yr			kg CO2/tonne	Million tonnes/yr	MtC	MtCO2	Mt

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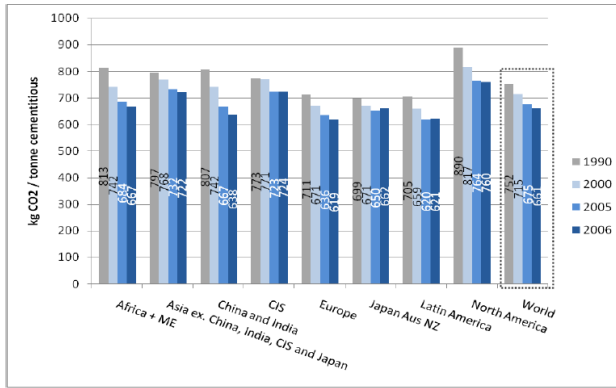
Menzie et al (2004) China's Growing Appetite for Minerals, U.S. Geological Survey OFR-1374.

Year	China USGS MYB1990, 1998, 2002 million tonnes	Menzie et al	Net emissions rate kg CO2/t cementitious product	Net emissions million tonnes CO2
1975	33	Menzie et al	assumed 846	28.2
1976	interpolated 43		assumed 844	36.6
1977	interpolated 53		assumed 842	44.9
1978	interpolated 63		assumed 840	53.2
1979	interpolated 73		assumed 838	61.5
1980	83	Menzie et al	assumed 836	69.7
1981	interpolated 97		assumed 834	80.6
1982	interpolated 110		assumed 832	91.5
1983	interpolated 123		assumed 830	102.4
1984	interpolated 137		assumed 828	113.2
1985	150	Menzie et al	assumed 826	123.9
1986	interpolated 161		assumed 824	132.3
1987	interpolated 171		assumed 822	140.7
1988	interpolated 182		assumed 820	149.1
1989	interpolated 192		assumed 818	157.4
1990	203	USGS Minerals Industry of China	WBSCD CSI 816	165.6
1991	253	USGS Minerals Industry of China	interpolated 801	202.5
1992	308	USGS Minerals Industry of China	interpolated 794	244.6
1993	368	USGS Minerals Industry of China	interpolated 788	289.8
1994	421	USGS Minerals Industry of China	interpolated 781	328.9
1995	476	USGS Minerals Industry of China	interpolated 775	368.6
1996	491	USGS Minerals Industry of China	interpolated 768	377.2
1997	512	USGS Minerals Industry of China	interpolated 762	389.7
1998	536	USGS Minerals Industry of China	interpolated 755	404.7
1999	573	USGS Minerals Industry of China	interpolated 749	428.9
2000	597	USGS Minerals Industry of China	WBSCD CSI 790	471.6
2001	661	USGS Minerals Yearbook 2005, p.35	interpolated 731	483.2
2002	725	USGS Minerals Yearbook 2005, p.35	interpolated 720	522.0
2003	862	Menzie et al	interpolated 709	611.2
2004	970	USGS Minerals Yearbook 2008	interpolated 698	677.1
2005	Alt estimate 1,069	USGS Minerals Yearbook 2009	WBSCD CSI 713	762.1
2006	million tonnes/yr 1,237	USGS Minerals Yearbook 2009	WBSCD CSI 695	859.6
2007	1,350	USGS Minerals Yearbook 2009	674	917.4
2008	1,620	USGS Minerals Yearbook 2009	646	904.4
2009	1,693	USGS Minerals Yearbook 2009, pdf pg 9.16	642	1,045.8
2010	1,777	China Cement Assn: 9.0 percent over 2009	638	1,133.8
Total	16,325			12,974

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0.1	0.5	1.0
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0.1	0.3	0.7
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0.2	0.8	1.5
0.2	0.6	1.2
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0.6	2.2	4.5
0.9	3.2	6.4
1.3	3.4	6.8
1.7	4.6	9.3
1.7	6.1	12.2
1.8	6.7	13.5
1.1	4.0	8.0
1.1	4.0	8.0
1.4	5.0	10.0
1.4	5.2	10.5
1.5	5.5	11.0
1.5	5.5	11.0
1.1	4.0	8.0
1.2	4.5	9.0
1.4	5.0	10.0
1.4	5.0	10.0
3.1	11.4	22.9
3.1	11.5	22.9
3.4	12.5	24.9
3.4	12.5	24.9
4.1	15.0	29.9
6.7	24.6	49.2
7.6	27.7	55.5
8.9	32.5	65.1
10.1	36.9	73.7
10.9	39.8	79.6
11.4	41.9	83.8
12.8	46.9	93.8
14.7	54.0	108.0
16.5	60.4	120.8
19.4	71.1	142.1
22.0	80.5	161.0
24.4	89.6	179.1
28.5	104.5	209.0
28.1	103.1	206.3
28.6	104.7	209.4
34.4	126.0	251.9
41.9	153.7	307.4
50.0	183.5	366.9
57.3	210.0	420.1
64.7	237.3	474.6
66.8	244.9	489.9
69.6	255.2	510.4
72.9	267.3	534.6
77.9	285.7	571.5
81.2	297.7	595.4
89.9	329.6	659.3
98.6	361.5	723.1
117.2	429.9	859.8
131.9	483.7	967.4
145.4	533.0	1,066.0
168.2	616.7	1,233.5
185.1	678.8	1,357.6
188.8	692.3	1,384.7
219.7	805.6	1,611.2
242.8	890.2	1,780.3
2,496	9,150	18,301

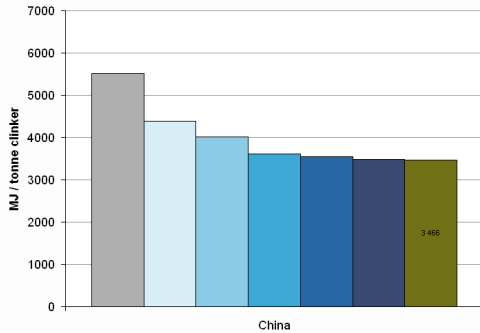
China's Cement Industry Forecast For 2008 - 2010 By Face Zhang; "China's cement output is forecast to grow 10% per annum between 2008 and 2010."
Minerals Industry of China (1994, 1998, and 2002), by Pui-Kwan Tse. minerals.usgs.gov/minerals/pubs/country/2002/chmyb02.pdf

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WBCSD, Cement Sustainability Initiative (2009), page 23.

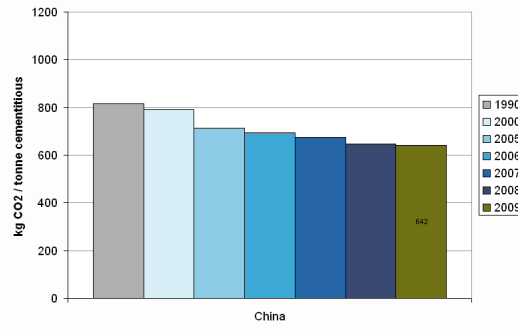
Heat consumption over time by region (All GNR Participants - China)



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)
China	5 520	4 390	4 010	3 610	3 550	3 480	3 470

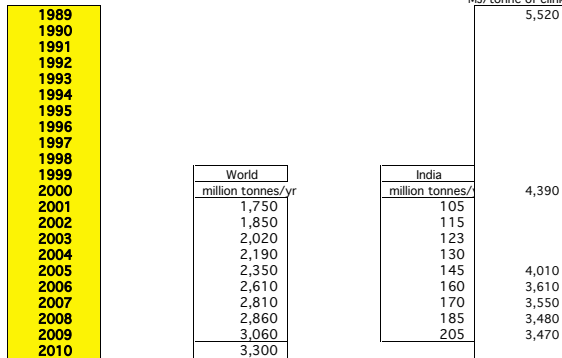
www.wbcsdcement.org/GNR-2009/index.html

Average net CO2 emissions per tonne cementitious (All GNR Participants - China)



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)
China	816	790	713	695	674	648	642

China WBCSD participants Thermal efficiency MJ/tonne of clinker



China, percent of world, 2010: 53.9%

Largest 19 Chinese cement manufacturers

en.wikipedia.org/wiki/Cement_industry_in_China

Anhui Conch Cement Co., Ltd

Tangshan Jidong Cement Co., Ltd

Datong Cement Co., Ltd

Xinjiang Tianshan Cement Co., Ltd

Sichuan Shuangma Cement Co., Ltd

Henan Tongli Cement Co., Ltd

Inner Mongolia Xishui Chuangye Co., Ltd

Anhui Chaodong Cement Co., Ltd

Jiangxi Wannianqing Cement Co., Ltd

Ningxia Saima Industry Co., Ltd

Taiyuan Lionhead Cement Co., Ltd

Shaanxi Qinling Cement Co., Ltd

Sichuan Golden Summit (Group) CO., Ltd

Huaxin Cement Co., Ltd

Fujian Cement Co., Ltd

Hebei Taihang Cement Co., Ltd

Jilin Yatai Group Co., Ltd

Guangdong Tapai Group Co., Ltd

Gansu Qilianshan Cement Co., Ltd

Cell: H9**Comment:** Rick Heede:

According to CDIAC estimates (based on U.S. Bureau of Mines data), China has emitted 28.4 percent of global cement process emissions 1928-2010 (US, the second largest producer, emitted 8.5 percent 1900-2010).

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 emissions of CO₂.

** World Business Council for Sustainable Development Cement Sustainability Initiative (2009) Cement Industry Energy and CO₂ Performance: 'Getting the Numbers Right', wbcscement.org, 44 pp. See GNR Indicator 326, reproduced at the "Cement industry data" worksheet in this portfolio.

Cell: M13**Comment:** Rick Heede:

CDIAC data on cement emissions (cdiac.ornl.gov/ftp/trends/emissions/prc.dat) 1928-2008 (plus preliminary global emissions for 2009 and 2010, converted to MtC).

Cell: O13**Comment:** Rick Heede:

Following CDIAC we multiply C by 3.667. CMS elsewhere uses the isotopic value of 3.664191 CO₂/C.

Cell: Q13**Comment:** Rick Heede:

CDIAC emission estimation protocol asserts that "CO₂ production (in metric tons of C) = 0.136 metric tons of C per metric ton cement * quantity of cement produced (metric tons)." 0.136 tC * 3.667 CO₂/C = 0.499 tCO₂ per tonne of cement produced; round to 0.5, or 2 tonnes cement production per tonne of CO₂.

The mole calculation is as follows: (12.01 g C/mole CaCO₃ ÷ 56.08 g CaO /mole CaCO₃) * 0.635 g CaO /g cement = 0.136 g C/g cement. Boden, Marland, & Andres (1995). CDIAC basis its cement emission estimates on US Bureau of Mines cement production data.

Cell: F63**Comment:** Rick Heede:

CMS estimates China's cement production from the chart above* for 1975, 1980, and 1985. CMS interpolates between these dates to USGS data for 1990.

* U.S. Geological Survey China's Growing Appetite for Minerals by David Menzie, Pui-Kwan Tse, Mike Fenton, John Jorgenson, and Hendrik van Oss Open-File Report 2004-1374.

Cell: E92**Comment:** Rick Heede:

USGS Minerals Yearbook 2008, xls data. China: estimated production of mineral commodities, 2004-2008, in million metric tonnes.

Cell: J94**Comment:** Rick Heede:

WBCSD, Cement Sustainability Initiative (2009) Cement Industry Energy and CO₂ Performance "Getting the Numbers Right", World Business Council for Sustainable Development, 44 pp., www.wbcscement.org
CMS assumes that China's hydraulic cement plants improve, on average, by 4 kg CO₂ per tonne of cementitious product per year from 2006 to 2010. This may prove too aggressive.

Cell: D96**Comment:** Rick Heede:

China Cement Industry Report, 2008-2009, www.researchinchina.com/htmls/Report/2008/5615.html, "In 2007, cement output reached 1.35 billion tons in China, and during the first ten months of 2008, cement output has reached as many as 1.135 billion tons in China."

Cell: D97**Comment:** Rick Heede:

Bharat Book Bureau (2010) Research Report on Chinese Cement Industry, 2010-2011, March 2010, 40 pp, \$3,000.

Abstract: In 2009, Chinese cement production amounted to 1.63 billion tons, rising by 17.91% YOY; the growth rate was raised by 12.71% YOY. In 2009, Chinese cement industry maintained a good momentum with the expanding scale. The growth rate of total assets was also higher than 2008, but the growth rate of the product sales revenue saw a slight decrease. In 2009, Chinese cement industry realized the sales revenue of CNY 500.72 billion with the YOY growth rate of 17.21%; the growth rate was reduced by 6.77% YOY.

Thanks to Chinese domestic high demand for cement and robust profitability of cement enterprises, Chinese cement industry continued the high-speed expansion in 2009. In 2009, the investment in Chinese cement industry came up to CNY 170.07 billion, rising by 61.75% YOY. By the end of 2009, there were about 420 cement production lines under construction and over 140 production lines remaining to be started in China. After the completion of all these production lines, Chinese cement production capacity will be increased by 800 million tons and the annual cement production capacity will be 2.7 billion tons. However, the annual demand for cement in China is only 1.6-1.7 billion tons, leaving the severe surplus of about 1 billion tons.

Cell: E97**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: W97**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: E98**Comment:** Rick Heede:

China's cement production is expected to expand 9.09 percent over 2009.

China Cement Task Force (2010) Status Report of China Cement Industry, 8th CTF Meeting, Vancouver, March 2010, www.asiapacificpartnership.org/pdf/Cement/8th_meeting/Project_01_China_PPT.pdf
China production estimated by USGS for 2010 totals 1,800 thousand tonnes. <http://minerals.usgs.gov/minerals/pubs/commodity/cement/mcs-2011-cemen.pdf>

Cell: W98**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: AG103

Comment: Rick Heede:

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