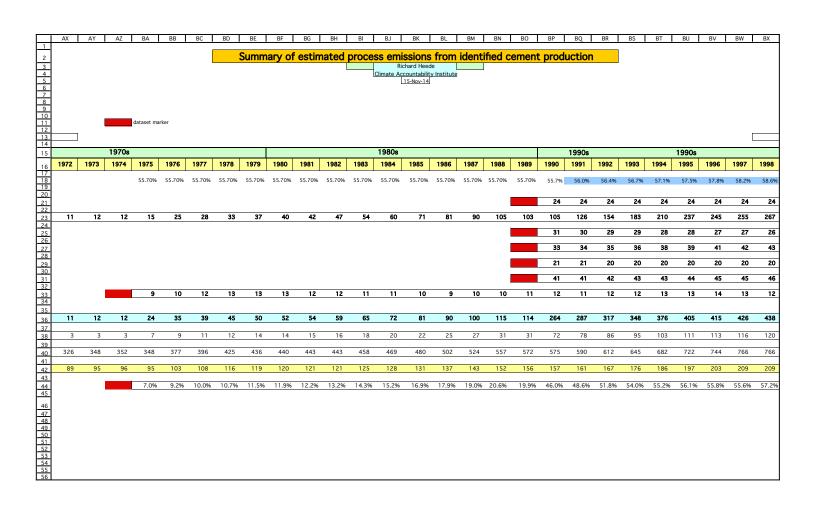
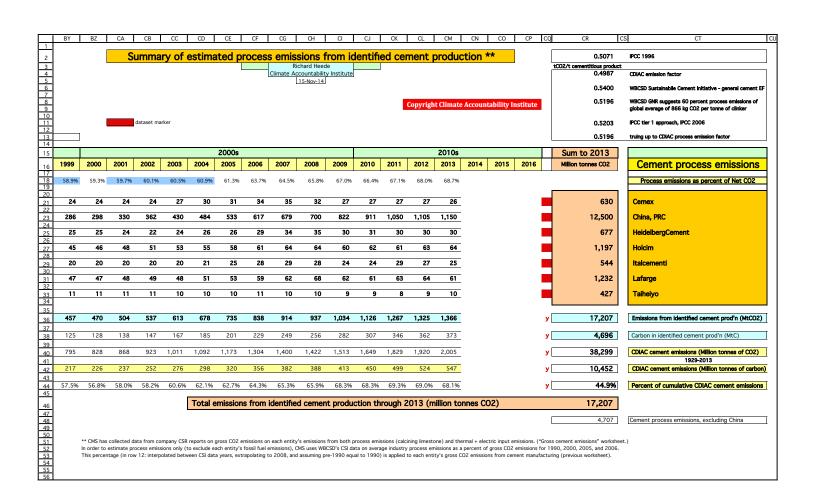


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Cell: CT2

Comment: Rick Heede

CMS lists the IPCC 1996 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: CT4

Comment: Rick Heede

To quote from Boden et al (1995): "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 Ca) //mole Ca(CO3)** 0.635 g CaO / g cement * 0.136 g C / g cement.*

"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 (Griffn 1987).*

(CMS: The formula: (12.01/56.08)*0.635*3.667 = 0.4987, rounded up to 0.500.

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.oml.gov/epubs/ndp/ndp030/ndp0301.htm#co2man

Cell: CT6

Comment: Rick Heede (Mar10):

WBCSD's Cement Sustainability Initiative reports average global gross emissions per tonne of clinker produced at 866 kg CO2 per tonne (declining from 914 kg CO2/tonne in 1990. See rpt for geographic, process (wet vs dry), or temporal variables, and entity reporting by region. Process emissions from calcining limestone into clinker is typically 540 kg CO2 per tonne of clinker.

WBCSD, Cement Sustainability Initiative (2009) Cement Industry Energy and CO2 Performance "Getting the Numbers Right", World Business Council for Sustainable Development, 44 pp., www.wbcsdcement.org

Cell: CT8

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., wbcsdcement.org.

Page 30:

10) 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.

CMS: Thus 60 percent of 866 kgCO2/t = 519.6 kg CO2/tonne.

Cell: CT11

Comment: Rick Heede

PIECC (2006) Guidelines, Vol. 3, Chapter 2, Section 2.2.1.2 Choice of Emission Factors, Tier 1 Method, page 2.11.

"For the default CaO composition, 1 tonne of clinker contains 0.65 tonnes CaO from CaCO3. This carbonate is 56.03 percent CaO and 43.97 percent CO2 by weight (Table 2.1). The amount (X) of CaCO3 needed to yield 0.65 tonnes CaO is: X = 0.65/0.5603 = 1.1601 tonnes CaCO3 (unrounded). The amount of CO2 released by calcining this CaCO3 = 1.1601 • 0.4397 = 0.5101 tonnes CO2 (unrounded). Assuming a correction addition of 2 percent to account for CKD, the rounded default emission factor (EFclc) for clinker is 0.52 tCO2/tonne of clinker.'

Intergovernmental Panel on Climate Change (2006) 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 3: Industrial Processes and Product Use, Chapter 2: Mineral Industry Emissions, www.ipcc-nggip.iges.or.jp/public/2006glvol3.html

Cell: CT13

Comment: Rick Heede

Note: CMS compared carbon emissions from world cement production using USGS production data 1926-2010 results in estimates ~3.8 percent higher than cement emission estimates by CDIAC (based on both totals 1950-2010).

Correcting the Carbon Majors calculations to that of CDIAC suggests a process emission factor of 519.6 - (519.6 0.00377) = 499.86 kg CO2/tonne.

CDIAC (1995) Estimates of Global, Regional, and Naitonal 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

Cell: CT18

Comment: Rick Heede

* CMS has collected data from company CSR reports on net CO2 emissions on each entity's emissions from both process emissions (calcining limestone) and thermal + electric input emissions. ("Net cement emissions" worksheet.)

In order to estimate process emissions only (to exclude each entity's fossi fuel emissions), CMS uses WBCSD: CSI data on average industry process emissions as a percent of net CO2 emissions for 1990, 2000, and 2005-2013. This percentage (in row 12) is applied to each entity's net CO2 emissions from cement manufacturing (previous worksheet).

This percentage data series is derived in the Cement.xls workbook / "Cement industry data", Table 3, row "AB".

Cell: CT23

Comment: Rick Heede

CMS uses CDIAC emissions from cement production in China 1929-2010.

Cell: CT40

Comment: Rick Heede

CDIAC data in million tonnes of carbon converted to CO2, which is 3.664191 times Carbon and oxygen isotopes are accounted for, per Kevin Baumert May05, then at World Resources Institute: CO2 conversion is, precisely: C=12.0107 + 0=15.9994 x 2 = 44.0095/12.0107 = 3.664191.

Cell: CT42

Comment: Rick Heede

From the associated "Methods" paper: CDIAC's emissions methodology is not described.

Boden, T.A., G. Marland, and R.J. Andres. 2009. Global, Regional, and National Fossil-Fuel CO2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001.

Dec11: CMS added CDIAC extrapolations for gas emissions from their dataset "Preliminary 2009-2010 Global & National Estimates by Extrapolation" (undated) to the main file cited above

November 2014: Global Carbon Budget, Fossil fuel and Cement emissions data for 2011-2013.

Cell: CT52 Comment: Rick Heede

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