Global Cement and Concrete Association

GCCA Sustainability Guidelines for the monitoring and reporting of CO_2 emissions from cement manufacturing

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Global Cement and Concrete Association (GCCA) is registered in England & Wales, Company No. 11191992

Registered office:
Paddington Central, 6th Floor,
2 Kingdom Street, London, W2 6JP,
United Kingdom
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Executive Summary

Climate Change is one of the major societal challenges of society in 21st century and the cement and concrete sector has a crucial role to play in meeting this challenge. Concrete is the second most used material in the world (after water), with significant volumes demanded globally to build homes, schools, hospitals, workplaces and infrastructure for transport, energy and clean water. Concrete is integral to any climate change strategy not only for building the infrastructure needed to mitigate and adapt to climate change but also because its key component cement has a high carbon intensity.

The Global Cement and Concrete Association (GCCA) is committed to support all of its members and the sector in reducing the emissions of Greenhouse Gases and to improve their carbon footprint. Considering that the carbon footprint of concrete is dominated by the production of cement, and the major GHG associated with cement is CO_2, the GCCA has released this guideline for monitoring and reporting CO_2 emissions of the cement production which also covers energy consumption as one of the key drivers for CO_2 emissions in the sector. These guidelines give an introduction to the monitoring and reporting process, specifies applicable protocols, and delivers the Key Performance Indicators (KPIs) that are considered most relevant for the cement industry. The KPIs can also be used by companies for benchmarking their performance.

GCCA full members are committed to annually report these KPIs to the GCCA through an independent third party and to report these KPIs at company level to their stakeholders. The GCCA publishes aggregated results, taking into account legal constraints and confidentiality limitations.

1. Introduction

1.1 The Global Cement and Concrete Association

The Global Cement and Concrete Association (GCCA) is the global voice of the cement and concrete sector. One of the objectives is to develop and strengthen the sector's contribution to sustainable construction across the value chain. The GCCA aims to foster innovation throughout the construction value chain in collaboration with industry associations as well as architects, engineers, developers, contractors and innovators. In this way, the association demonstrates how concrete solutions can meet global construction challenges and sustainable development goals while showcasing responsible industrial leadership in the manufacture and use of cement and concrete. The GCCA was established in January 2018 and is headquartered in London.

1.2 GCCA Sustainability Charter

These *Guidelines for the monitoring and reporting of CO_2 emissions from cement manufacturing* are part of a package of guidelines developed to support compliance with the *GCCA Sustainability Charter*[1]. The GCCA Sustainability Charter has identified five key pillars, which encompass the sustainability spectrum of the cement and concrete sector, and has set out requirements for full members against each of these:

- Health & Safety
- Climate Change and Energy
- Social Responsibility
- Environment and Nature
- Circular Economy

In applying these guidelines GCCA members must implement the general requirements of the *GCCA Sustainability Framework Guidelines*[2].

1.3 Background

Climate change is a major challenge to society, and business plays a key role in living up to that challenge. Cement is the glue to keep the ingredients of concrete together. With a growing global population, modern society will need concrete for housing, infrastructure and utilities all of which are important for quality of life and society.

The contribution of cement and concrete to climate change is twofold. Firstly, concrete is a sustainable construction material with a unique combination of properties including availability, affordability, longevity and flexibility that make it an inevitable building block of the world's transition towards a carbon-constrained future. Concrete can help to construct the infrastructure needed to mitigate and adapt to the consequences of climate change and offers benefits its capacity to store heat can greatly enhance the energy efficiency of buildings compared to other construction materials. Secondly, the production of concrete and its ingredients is a major source of CO_2 emissions, in particular, the production of cement (which contributes an estimated 85 – 90% to concrete's carbon footprint) accounts for over 5%[3] of man-made GHG emissions. Considering the growth perspectives and the nature of emissions in the sector (that make significant reductions rather hard to achieve) this percentage may rise significantly in the future.

1 GCCA Sustainability Charter, June 2019

2 GCCA Sustainability Framework Guidelines, June 2019

3 Toward a Sustainable Cement Industry, Battelle, 2002

1.4 Relation to other documents

This document, in conjunction with the *GCCA Sustainability Framework Guidelines*, provides guidance to GCCA full members to fulfil the requirements of the GCCA Sustainability Charter relating to Climate Change and Energy. It is based on the CEN Standard EN 19694–3[4].

2. Relevance

The relevance of climate change mitigation and adaptation is now well established in global society. Early action by the cement sector has resulted in a continuous decrease of emissions per tonne of product since 1990 (reference year), but at that the same time the global cement demand has increased to more than 4 billion tonnes in 2016[5] with a total emissions of about 2.2 Gigatonnes CO_2 in 2014[6] which according to the IEA, represents a 27% share of global direct industrial CO_2 emissions.

Achieving the sustainable transition of the 2 degree Celsius Scenario from the UNFCCC Paris Agreement implies a significant reduction of the global direct CO_2 emissions from cement manufacture of 24% compared to current levels by 2050 given the expected increase in global cement production[7]. While this reduction may appear to be relatively modest, it has to be considered that significant further CO_2 reductions from cement manufacturing are challenging for a number of reasons:

1. Limestone, a key raw material, emits CO_2 at the high temperatures needed for production of Portland cement clinker. These so-called process emissions account for about 60% of total CO_2 emissions are very hard to reduce.

2. The other 40% of CO_2 emissions arise from the combustion of fuels which provide the heat for the process and from emissions from electricity generation. While there is greater potential to reduce CO_2 emissions from combustion of fuels this depends on the availability and policy on use of alternative fuels (especially those with a biomass content). Energy efficiency is not expected to contribute significantly to CO_2 reduction as modern clinker kilns already operate close to their thermodynamic optimum.

3. Recognised short- to medium-term levers to reduce CO_2 is the use of clinker substitutes, but these may be constrained by the availability of suitable substitutes as a result of GHG reduction efforts in other sectors (e.g. less fly ash due to phasing out of coal-fired power generation).

4. Cement demand and production will continue to grow at global level as indicated by the IEA. With continued emissions reductions in other industrial sectors, the relative share of cement industry emissions may increase due to the technological and economic challenge of reducing process emissions.

4 EN 19694–3: Stationary source emissions — Determination of Greenhouse Gas (GHG) emissions in energy intensive industries — Part 3: Cement industry

5 CEMBUREAU Activity Report 2017, June 2018

6 Technology Roadmap, Low-Carbon Transition in the Cement Industry, WBCSD/IEA, April 2018

7 Same reference.

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These GCCA guidelines focus on the practicalities of monitoring and reporting CO_2 emissions from cement production. As part of the standardisation processes under CEN, this methodology has been proven during field tests[8]:

1. Mass balance on the output or input of cement plants show the highest level of accuracy of CO_2 emissions. The mass balance methods account for the total carbon content and thus all oxidised carbon (CO_2 and CO). This sum covers more than 99.5% of the direct GHG emissions.

2. The direct GHG emissions of cement plants almost entirely consist of CO_2. The contribution of other non-CO2 GHG emissions has been shown to be negligible.

The mass balance concept used in these guidelines, covers all cement plant CO_2 emissions including those from the main stack and from other emission points.

3. Objectives

This document, in conjunction with the *GCCA Sustainability Framework Guidelines*, provides guidance to GCCA full members to fulfil the requirements of the GCCA Sustainability Charter relating to Climate Change and Energy. However, the importance of monitoring and reporting should not be reduced to a requirement under the GCCA Sustainability Charter, it is the basis of all efforts to manage and reduce CO_2 emissions and supports transparent communication with stakeholders.

GCCA full members have committed to:

1. Develop a climate change mitigation strategy and publish targets and progress.
2. Report annually to the GCCA climate change data in line with the guidelines.

These guidelines are intended as a tool for cement companies worldwide. They provide a harmonised methodology for calculating CO_2 emissions from cement production, with a view to reporting these emissions for various purposes. They address all direct and the main indirect sources of CO_2 emissions related to the cement manufacturing process.

4. Operational Context

CO_2 emissions from cement production arise from different sources within the production process and therefore will be emitted by several point sources. The most accurate way to measure these emissions is based on the mass balance methodology in which the input of materials (fuels, raw materials) and output (clinker, cement, dust) is combined with emissions factors (measured or from default values).

The methodology is fully described the CEN standard on CO_2 emissions from the cement industry[9]. These guidelines are accompanied by an Excel spreadsheet as practical tool to help cement plants and cement companies to prepare CO_2 inventories. An Internet Manual[10] is available on the CO_2 Excel-file with detailed explanations and guidance.

8 Stationary source emissions – Determination of Greenhouse Gas (GHG) emissions in energy-intensive industries — Part 3: Cement industry, EN-19694-3

9 Stationary source emissions — Determination of Greenhouse Gas (GHG) emissions in energy-intensive industries — Part 3: Cement industry, EN-19694-3

10 www.cement-co2-protocol.org

4.1 CO_2 Emissions: Direct/Indirect and Scopes

Direct and indirect CO_2 emissions in cement production result from the sources indicated in table 1. Direct emissions are emitted at the cement plant, while indirect emissions are related to the cement production, but do not occur at the cement plant itself. Apart from this differentiation on direct and indirect, the differentiation on the so-called scope of the emissions is needed. In conformance with the WRI/WBCSD Protocol[11] there are three scopes:

1. **Scope 1** emissions are direct emissions occurring from sources that are owned or controlled by the company.
2. **Scope 2** emissions are indirect emissions from the generation of purchased electricity, heat and steam[12] consumed in the company's owned or controlled equipment.
3. **Scope 3** is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company. For cement production the emissions occurred at the production of clinker volumes purchased are a clear Scope 3 emission.

Table 1: Sources of direct and indirect emissions

Direct/indirect		Source	Scope	Covered
1	**Direct**	Calcination of carbonates, and combustion of organic carbon contained in raw materials.	1	Yes
2	**Direct**	Combustion of kiln fuels related to clinker production a. Combustion of conventional fossil fuels b. Combustion of alternative fossil fuels and mixed fuels with biogenic carbon content c. Combustion of biomass fuels and biofuels (including biomass wastes).	1	Yes
3	**Direct**	Combustion of non-kiln fuels (e.g. hot gas generator, dryers) a. Combustion of conventional fossil fuels b. Combustion of alternative fossil fuels and mixed fuels with biogenic carbon content c. Combustion of biomass fuels and biofuels (including biomass wastes).	1	Yes
4	**Direct**	Combustion of fuels for on-site power generation.	1	Yes
5	**Direct**	Combustion of the carbon contained in wastewater.	1	No
6	**Indirect**	Emissions related to the electrical power consumed from external power production.	2	Yes
7	**Indirect**	Emissions related to clinker purchased.	3	Yes
8	**Indirect**	Emissions related to business travels.	3	No
9	**Indirect**	Emissions related to the production, preparation and transport of (alternative) fuels outside the company.	3	No

11 The Greenhouse Gas Protocol. A Corporate Accounting and Reporting Standard. WBCSD/WRI 2004, World Business Council for Sustainable Development & World Resources Institute, 2004 revised edition

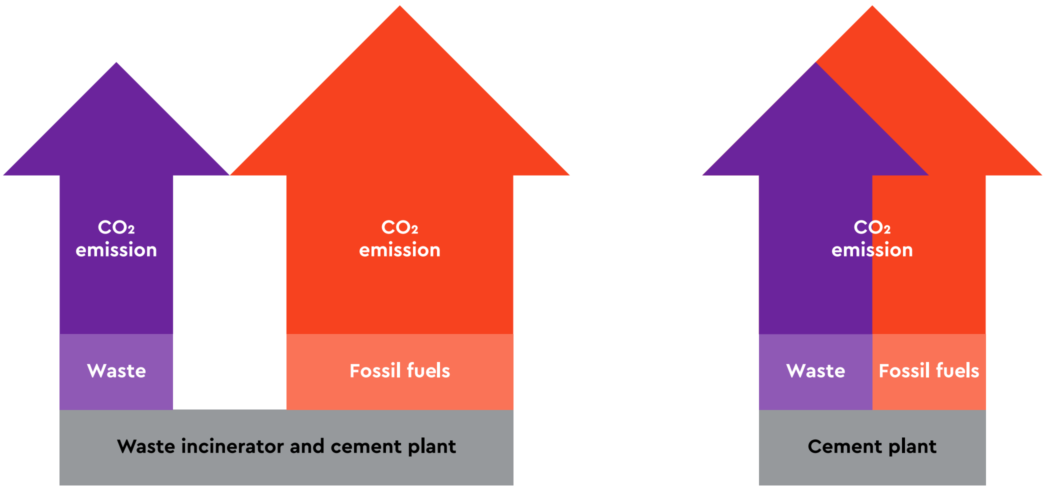
12 In cement production imports of heat and steam are not relevant and therefore not covered in this guideline.

4.2 Gross and Net Emissions

Some waste materials may substitute traditional fossil fuels and minerals in cement production. The recovered wastes are called alternative fuels and raw materials. As a result, direct CO_2 emissions from traditional fuels are reduced but direct CO_2 emissions from wastes ("waste-to-energy conversion") occur. The direct CO_2 emissions from waste combustion can be higher or lower than the displaced fossil fuel source, depending on the emission factors of the fuels involved. Moreover, wastes can be of fossil, biomass or mixed origin.

In addition to those direct effects, utilisation of Alternative Fuels results in indirect GHG (e.g. not only CO_2) savings at landfills and incineration plants where these wastes may otherwise be disposed. These savings can partly, fully or more than fully offset the direct CO_2 emissions from waste combustion at the cement plant, depending on local conditions (type of waste, reference disposal path), see Figure A.

Figure A: Indirect saving of CO_2 emissions by the use of waste as alternative fuel



Gross emissions are the total direct CO_2 emissions (excluding on-site power generation) from a cement plant or organisation, including CO_2 from fossil wastes (but excluding CO_2 from biomass wastes, which is not reported). Advantages from indirect CO_2 savings reflect the CO_2 emission reductions achieved at waste disposal sites as a result of alternative fuels utilisation in cement plants. This is indicated[13] in Table 2.

Table 2: Gross and Net Emissions

Total direct emissions	–	Emissions from pure biomass and from the biogenic carbon content of mixed fuels	=	Fossil direct emissions
Fossil direct emissions	–	Emissions from on-site power production	=	Gross emissions
Gross emissions	–	Emissions from alternative fossil and non-biogenic content of mixed fuels – Comparable benchmark emissions for external heat transfer	=	Net emissions

13 Petcoke is seen as traditional fossil fuel and therefore related emissions are not considered as climate change neutral in conformity with the WRI/WBCSD Greenhouse Gas protocol.

4.3 Emissions Measurements

It is possible to measure the CO_2 emission at the main stack of a cement kiln. The development of measurement technologies is progressing positively and the accuracy is improving.

Nevertheless, these guidelines require that the CO_2 performance of cement manufacturing shall use the mass balance methodology.

The mass balance methodology has the advantage that the factors that influence the performance of a cement plant can be readily identified, e.g. thermal energy consumption, electrical power consumption for cement grinding, biomass fraction, etc.

5. Key Performance Indicators

The GCCA is aware of the need to track the progress of improvements, and to communicate this progress clearly to stakeholders. These guidelines therefore include a number of simple, reliable and representative KPIs.

For a basic performance comparison four KPIs have been defined as indicated in Table 3. For the calculation of these KPIs the Basic Parameters as set out in the *GCCA Sustainability Framework Guidelines* will be needed.

Table 3: Key Performance Indicators for CO_2 and Energy in cement manufacturing

KPIs		Unit	Explanation
1	Total direct CO_2 emissions – gross	metric tonnes /year	Total direct CO_2 emissions (excluding on-site electricity production) originating from fossil carbon, i.e. excluding CO_2 emissions from biomass which are considered climate neutral.
2	Total direct CO_2 emissions – net	metric tonnes /year	Gross CO_2 emissions minus CO_2 emissions from alternative fossil fuels.
3	Specific CO_2 emissions – gross	kg/tonne cementitious material	Gross CO_2 emissions per tonne of cementitious materials produced.
4	Specific CO_2 emissions – net	kg/tonne cementitious material	Net CO_2 emissions per tonne of cementitious materials produced.

6. Glossary and Definitions

CEN:
European Committee for Standardisation

IEA:
International Energy Agency