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Stationary source emissions — Determination of greenhouse gas (GHG) emissions in energy- intensive industries

Part 3: Cement industry

National foreword

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greenhouse gas (GHG) emissions in energy-intensive
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émissions de gaz à effet de serre (GES) dans les
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ciment

Emissionen aus stationären Quellen - Bestimmung von
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European foreword

This document (EN 19694-3:2016) has been prepared by Technical Committee CEN/TC 264 “Air quality”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate M/478 given to CEN by the European Commission and the European Free Trade Association.

EN 19694, *Stationary source emissions — Determination of greenhouse gas (GHG) emissions in energy-intensive industries* is a series of standards that consists of the following parts:

- *Part 1: General aspects*
- *Part 2: Iron and steel industry*
- *Part 3: Cement industry*
- *Part 4: Aluminium industry*
- *Part 5: Lime industry*
- *Part 6: Ferroalloy industry*

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Introduction

This European Standard for the cement industry has been based on the WBCSD/CSI and WRI: “CO₂ and Energy Accounting and Reporting Standard for the Cement Industry” [1].

Overview of cement manufacturing process

Cement manufacture includes three main process steps (see Figure 1):

- preparing of raw materials and fuels;
- producing clinker, an intermediate, through pyro-processing of raw materials;
- grinding and blending clinker with other products (“mineral components”) to make cement.

There are two main sources of direct CO₂ emissions in the production process: calcination of raw materials in the pyro-processing stage, and combustion of kiln fuels. These two sources are described in more detail below. Other CO₂ sources include direct GHG emissions from non-kiln fuels (e.g. dryers for cement constituents products, room heating, on-site transports and on-site power generation), and indirect GHG emissions from, e.g. external power production and transports. Non-CO₂ greenhouse gases covered by the Kyoto Protocol¹, apart from carbon monoxide (CO) methane (CH₄) and nitrous oxide (N₂O), are not relevant in the cement context, in the sense that direct GHG emissions of these gases are negligible.

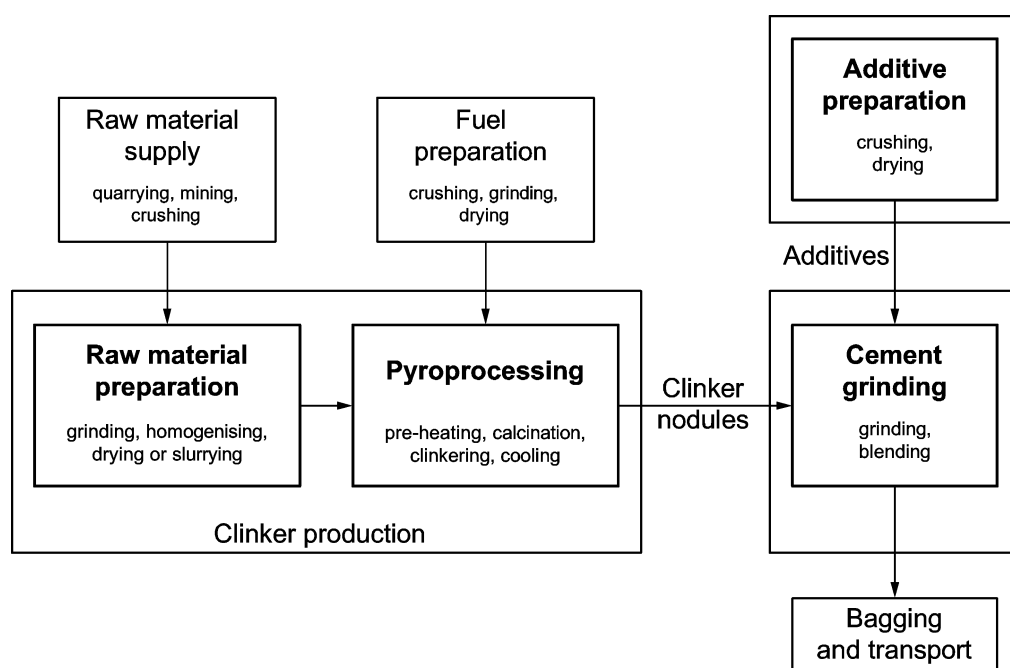


Figure 1 — Process steps in cement manufacture (source: Ellis 2000, based on Ruth et al. 2000)

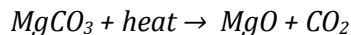
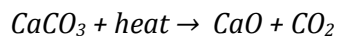
¹ Methane (CH₄), nitrous oxide (N₂O), sulfur hexafluoride (SF₆), partly halogenated fluorohydrocarbons (HFC) and perfluorated hydrocarbons (PFC)

Table 1 — Overview of input places of materials

Raw meal	Input place
Raw materials from natural resources	Raw mill
Alternative raw materials	Raw mill
Raw material flows for clinker production	Input place
Raw meal	Kiln feed
Fuel ashes	Burner or precalciner or fuel dryer
Additional raw materials not part of the kiln feed	Kiln inlet
Fuels flows for clinker and cement production	Input place
Fossil fuels	Burner or precalciner or fuel dryer or raw material dryer
Alternative fuels	Burner or precalciner or fuel dryer or raw material dryer
Alternative fossil fuels	Burner or precalciner or fuel dryer or raw material dryer
Mixed fuels	Burner or precalciner or fuel dryer or raw material dryer
Biomass fuels	Burner or precalciner or fuel dryer or raw material dryer
Cement kiln dust	Output place
Dust return	Preheater
Filter dust	Precipitator / filter
By pass dust	Bypass filter
Cement constituents based products	Output place
Clinker	Kiln (cooler)
Cement	Cement mill
Blast furnace slag	Cement mill or grinding station
Fly ash	Cement mill or grinding station
Gypsum	Cement mill or grinding station
Cooler dust	Cooler, is normally added to the clinker flow to the clinker silo
Cement kiln dust	Preheater or precipitator or filter or bypass filter
Limestone	Cement mill or grinding station
Burnt shale	Cement mill or grinding station
Pozzolana	Cement mill or grinding station
Silica fume	Cement mill or grinding station

CO₂ from calcination of raw materials

In the clinker production process, CO₂ is released due to the chemical decomposition of calcium, magnesium and other carbonates (e.g. from limestone) into lime:



This process is called "calcining" or "calcination". It results in direct CO₂ emissions through the kiln stack. When considering CO₂ emissions due to calcination, two components may be distinguished:

- CO₂ from raw materials actually used for clinker production, these raw materials are fully calcined in the clinker production process;
- CO₂ from raw materials leaving the kiln system as partly calcined cement kiln dust (CKD), or as normally fully calcined bypass dust.

CO₂ from actual clinker production is proportional to the lime content of the clinker,² which in turn varies little in time or between different cement plants. As a result, the CO₂ emission factor per tonne of clinker is fairly stable with a default value in this standard of 525 kg CO₂/t clinker (IPCC default: 510 kg CO₂/t clinker, CSI default: 525 kg CO₂/t clinker [19]).

The amount of kiln dust leaving the kiln system varies greatly with kiln types and cement quality standards, ranging from practically zero to over one hundred kilograms per tonne of clinker. The associated emissions are likely to be relevant in some countries or installations.

CO₂ emissions from calcination of raw materials may be calculated by two methods which are in principle equivalent: Either based on the amount and chemical composition of the products (clinker plus dust leaving the kiln system, output methods B1 and B2), or based on the amount and composition of the raw materials entering the kiln (input methods A1 and A2). See 7.2.1, 7.2.2 for details.

CO₂ from organic carbon in raw materials

The raw materials used for clinker production usually contain a small fraction of organic carbon, which may be expressed as total organic carbon (TOC) content. Organic carbon in the raw meal is converted to CO₂ during pyro-processing. The contribution of this component to the overall CO₂ emissions of a cement plant is typically very small (about 1 % or less). The organic carbon contents of raw materials may, however, vary substantially between locations and between the types of materials used. For example, the resulting emissions may be relevant if a cement company organization (used in this standard) consumes large quantities of certain types of fly ash or shale as raw materials entering the kiln.

CO₂ from fuels for kiln operation

The cement industry traditionally uses various fossil fuels to operate cement kilns, including coal, petroleum coke, fuel oil, and natural gas. Fuels derived from waste materials have become important substitutes for traditional fossil fuels. These alternative fuels (AF) include fossil fuel-derived fractions such as, e.g. waste oil and plastics, as well as biomass-derived fractions such as waste wood and dewatered sludge from wastewater treatment. Furthermore fuels are increasingly used which contain both fossil and biogenic carbon (mixed fuels), like e.g. (pre-treated) municipal and (pre-treated) industrial wastes (containing plastics, textiles, paper etc.) or waste tyres (containing natural and synthetic rubber).

² A second, but much smaller factor is the CaO and MgO content of the raw materials and additives used.

Both traditional fossil and alternative fuels result in direct CO₂ emissions through the kiln stack. However, biomass and bioliquids are considered “climate change-neutral” in accordance with IPCC definitions. Use of alternative (biomass- or fossil-derived) fuels may, in addition, lead to important emission reductions elsewhere, for instance from waste incineration plants or landfills.

Mineral components (MIC) are natural and artificial materials with latent hydraulic properties. Examples of MIC include natural pozzolana, blast furnace slag, and fly ash. In addition, gypsum is within this standard labelled as MIC. MICs are added to clinker to produce blended cement. In some instances, pure MICs are directly added to the concrete by the ready-mix or construction company. Use of MICs leads to an equivalent reduction of direct CO₂ emissions associated with clinker production, both from calcination and fuel combustion. Artificial MICs are waste materials from other production processes such as, e.g. steel and coal-fired power production. Related GHG emissions are monitored and reported by the corresponding industry sector. Utilization of these MICs for clinker or cement substitution does not entail additional GHG emissions at the production site. Consequently, these indirect GHG emissions shall not be included in the cement production inventory.

The basic mass balance methods used in this standard are compatible with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories issued by the Intergovernmental Panel on Climate Change (IPCC) [4], and with the revised WRI / WBCSD Greenhouse Gas Protocol [9]. Default emission factors suggested in these documents are used, except where more recent, industry-specific data has become available.

The 2006 IPCC Guidelines [4] introduced a Tier 3 method for reporting CO₂ emissions from the cement production based on the raw material inputs (Vol. III, Chapter 2.2.1.1, Formula 2.3). However, a large number of raw material inputs and the need to continuously monitor their chemical composition make this approach impractical in many cement plants. The different raw materials are normally homogenized before and during the grinding process in the raw mill. The WRI / WBCSD therefore recommended alternative methods for input-based reporting of CO₂ emissions from raw material calcination in cement plants. They rely on determining the amount of raw meal consumed in the kiln system. In many cement plants the homogenized mass flow of raw meal is routinely monitored including its chemical analysis for the purpose of process and product quality control. The input methods based on the raw meal consumed are already successfully applied in cement plants in different countries and seem to be more practical than Tier 3 of the 2006 IPCC Guidelines [4]. They were included in the Cement CO₂ and Energy Protocol Version 3 (Simple Input Method A1 and Detailed Input Method A2, 7.2.1).

1 Scope

This European Standard specifies a harmonized methodology for calculating GHG emissions from the cement industry, with a view to reporting these emissions for various purposes and by different basis, such as, plant basis, company basis (by country or by region) or even international group basis. It addresses all the following direct and indirect sources of GHG included [1]:

- Direct GHG emissions (scope 1) from sources that are owned or controlled by the organization, such as emissions result from the following sources:
 - process: calcinations of carbonates and combustion of organic carbon contained in raw materials;
 - combustion of kiln fuels (fossil kiln fuels, alternative fossil fuels, mixed fuels with biogenic carbon content, biomass and bioliquids) related to clinker production and/or drying of raw materials and fuels;
 - combustion of non-kiln fuels (fossil fuels, alternative fossil fuels, mixed fuels with biogenic carbon content, biomass and bioliquids) related to equipment and on-site vehicles, room heating/cooling, drying of MIC (e.g. slag or pozzolana);
 - combustion of fuels for on-site power generation;
 - combustion of carbon contained in wastewater.
- Energy indirect GHG emissions (scope 2) from the generation of purchased electricity consumed in the organization's owned or controlled equipment;
- Other indirect GHG emissions (scope 3) from bought clinker. Excluded from this standard are all other scope 3 emissions from the cement industry.

2 Normative references

Not applicable.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

additional raw material

Adrm

additional raw materials are not part of the kiln feed and are fed directly to the calciner or the kiln inlet

3.2

alternative fossil fuel

fossil fuel derived from waste materials without biogenic content and not listed by IPCC

3.3

alternative raw material

Arm

alternative raw materials are raw materials for clinker production derived from artificial resources

3.4

bioliquids

liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass

3.5

bypass dust

discarded dust from the bypass system dedusting unit of suspension preheater, precalcliner and grate preheater kilns, normally consisting of kiln feed material which is fully calcined or at least calcined to a high degree

3.6

cement

building material made by grinding clinker together with various mineral components such as gypsum, limestone, blast furnace slag, coal fly ash and natural volcanic material; includes special cements such as the ones based on calcium aluminates

3.7

cement (eq.)

calculated cement production value which is determined from clinker produced on-site in an integrated cement plant applying the plant specific clinker/cement-factor

3.8

cement constituent

main and minor additional constituents of cement plus calcium sulphates and additives in cement

3.9

cement kiln dust

CKD

any discarded dust from dry and wet kiln system dedusting units, consisting of partly calcined kiln feed material which includes bypass dust or any other dust flows coming from the clinker production

3.10

cement constituents based products

all clinker produced for cement making or direct clinker sale, plus mineral components consumed or processed for sale excluding pre-processed mineral components imported from another cement plant

3.11

clinker

intermediate product in cement manufacturing and the main substance in cement; clinker is the result of calcination of limestone in the kiln and subsequent reactions caused through burning (see EN 197-1)

3.12

clinker plant

plant where clinker is produced without having onsite grinding to cement

3.13

concrete addition

finely divided inorganic material with pozzolanic or latent hydraulic properties or nearly inert, used in concrete in order to improve certain properties or to achieve special properties

3.14

fossil direct emissions

total direct emissions of GHGs within the boundaries excluding GHG emissions from biomass fuels or biogenic carbon content of mixed fuels

3.15

dust return

dust arising during clinker manufacture that is ultimately returned to the raw mill or kiln system; this does not include bypass dust

Note 1 to entry: See Figure 6 for an example of mass flows in the clinker production process.

3.16

filter dust leaving the kiln system

cement kiln dust (CKD) leaving the kiln system excluding by pass dust

3.17

fossil fuel

all fossil fuels listed by IPCC

3.18

grinding plant

plant for cement production where cement constituents are ground without having onsite clinker production

3.19

gross emission

fossil direct GHG emissions excluding GHG emissions from on-site power production

3.20

integrated cement plant

plant where clinker is produced and partly or fully ground to cement

3.21

kiln system

tubular heating apparatus used in the production of clinker, including preheater and/or pre-calciner

3.22

kiln feed

raw materials, often processed as raw meal (including recirculated dust), which are fed to a pre-heater or directly into the kiln system

3.23

kiln inlet

kiln hood, or entrance to the tubular heating apparatus for materials

3.24

kiln fuel

fuel fed to the kiln system plus fuels that are used for drying or processing of raw materials for the production of clinker and the preparation of kiln fuels

3.25

mineral components

cement constituents other than clinker plus concrete additions processed in view of changing their properties

3.26

net emission

gross emissions excluding GHG emissions from alternative fossil fuels and comparable benchmark emissions from external heat or energy transfer

3.27

non-kiln fuel

fuels which are not included in the definition of kiln fuels

3.28

petcoke

petroleum coke, a carbon-based solid fuel derived from oil refineries

3.29

raw material

materials used for raw meal preparation for clinker production

3.30

raw material preparation

processes applied for converting raw materials to raw meal

3.31

raw meal

raw meal consists of the ground raw materials for clinker production

3.32

raw meal consumed

part of the raw meal, which is consumed for clinker production and the formation of calcined bypass dust

3.33

recirculated dust

all dust flows that are reused as kiln feed

Note 1 to entry: See Figure 6 for an example of mass flows in the clinker production process.

3.34

total direct GHG emission

all direct emissions of GHGs within the boundaries including GHG emissions from raw materials processing, fossil fuels, biomass and biogenic carbon content of mixed fuels, and CO₂ from waste water combustion

4 Symbols and abbreviated terms

For the purposes of this document, the following symbols and abbreviated terms apply.

Adrm Additional raw material

AF Alternative fuel

AFR	Alternative fuel and alternative raw material
Arm	Alternative raw material
BPD	Bypass dust
cem eq.	cement (eq.)
cem prod.	cement constituents based product
CKD	Cement kiln dust
cli	clinker
CSI	Cement sustainability initiative of the WBCSD
EF	Emission factor
EU ETS	The CO ₂ Emissions Trading Scheme of the European Union
FD	Filter dust
GCV	Gross calorific value (synonym for higher heat value, HHV)
GHG	Greenhouse gas
GWP	Global warming potential
HHV	Higher heat value (synonym for gross calorific value, GCV)
IPCC	Intergovernmental panel on climate change
KF	Kiln feed
KPI	Key performance indicator
LHV	Lower heat value (synonym for net calorific value, NCV)
LOI	Loss on ignition
MIC	Mineral component
m_N^3	normal cubic meters (at 1013 hPa and 0 °C)
NCV	Net calorific value (synonym for lower heat value, LHV)
OPC	Ordinary Portland Cement
RM	raw meal
TC	Total carbon (the sum of TOC and TIC)
TIC	Total inorganic carbon
TOC	Total organic carbon
UNFCCC	United Nations Framework Convention on Climate Change
WBCSD	World Business Council for Sustainable Development
WRI	World Resources Institute

5 Determination of GHGs based on the mass balance method

5.1 General

The volume of GHG emissions may be determined by the mass balance method (see 5.3) or by (continuous) stack emission measurements (see 5.4).

5.2 Major GHG in cement

For the mass balance the emissions have been related to carbon assuming that all carbon is converted into CO₂, with exclusion of all other GHG components assuming that these are negligible.

The measurements should include measurements of CH₄ and N₂O as these are assumed to be the only important non-CO₂ GHG emissions.

5.3 Determination based on mass balance

The GHG emissions of an installation may be determined based on mass balance. Emissions from source streams are calculated from input or production data, obtained by means of measurement systems, and additional parameters from laboratory analyses including calorific factor, carbon content and biomass content. Standard factors may also be used; see Annex B for hints regarding emission factors.

5.4 Determination by stack emission measurements

The GHG emissions of an installation may also be determined by measurement. Emissions from an emission source are determined based on continuous measurement of the concentration of the relevant greenhouse gas in the flue gas and of the flue gas flow.

5.5 Gross and net emissions

5.5.1 General

For the purpose of comparison of GHG emissions of plants/installations from different sectors within the energy-intensive industries it is essential that the boundaries for monitoring and reporting of these emissions are identical on plant level, even when being different in detail for each sector. Within this view the GHG emissions from pure biomass and from the biogenic carbon content of mixed fuels are being recognized as climate change neutral and therefore treated as zero direct GHG emissions.

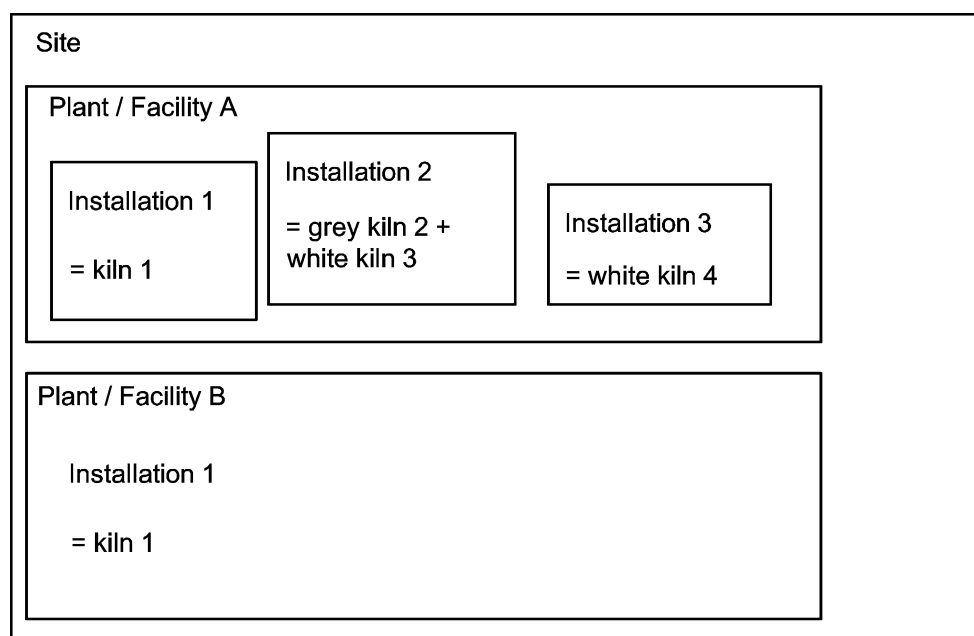


Figure 2 — Site / Facility / Plant / Installation

For a plant this leads to the so called “fossil direct GHG emissions”, to the value of which may be compared with comparable volumes from sites within different sectors. It is an absolute volume of reported GHGs by a plant, site or organization, see Figure 2 and definitions.

But this volume of “fossil direct GHG emissions” cannot be used for comparison of the performances of installations within the cement industry sector. A site that is producing its own electricity (power) will have higher fossil direct GHG emissions than a nearly identical site which gets the electricity from the external grid as emissions of external electricity production are reported as indirect GHG emissions. For comparison reasons the emissions from on-site power productions have to be excluded from the fossil direct GHG emissions leading to the so called “gross emissions”.

This concept of gross emissions enables a comparison of GHG emissions on plant, site or organization level.

Table 2 — Definitions of direct emissions

Direct emissions			Minus			Emissions group
Total	direct	GHG				
emissions						
Total	direct	GHG	-	Emissions from pure biomass and from the biogenic carbon content of mixed fuels	=	Fossil direct GHG emissions
emissions						
Fossil	direct	GHG	-	Emissions from on-site power production	=	Gross emissions
emissions						

The concept of gross emissions enables comparison of direct GHG emissions on plant level within the cement industry. This concept does not enable fair comparison of performance of plants and installations for their effect on global climate change – see Tables 2 and 3.

This standard offers the incentive of taking advantage of indirect GHG savings from the use of alternative fuels and raw materials (AFR) by reporting gross (including alternative fossil fuels) and net (excluding alternative fossil fuels) emissions.

Some waste materials may substitute traditional fossil fuels and minerals in cement production. The recovered wastes are called alternative fuels and raw materials (AFR). As a result, direct CO₂ emissions from traditional fuels are reduced but direct CO₂ emissions from wastes (“waste-to-energy conversion”) occur. The direct CO₂ emissions from waste combustion can be higher or lower than the displaced emission, depending on the emission factors of the fuels involved. Moreover, wastes can be of fossil or biomass origin.

In addition to those direct effects, utilization of AFR results in indirect GHG 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 CO₂ emissions from waste combustion at the cement plant, depending on local conditions (type of waste, reference disposal path), see Figure 3.

Gross emissions are the total direct GHG emissions (excl. on-site power generation) from a cement plant or organization, including GHG from fossil wastes (but excluding CO₂ from biomass wastes, which is treated as a memo item). Advantages from indirect GHG savings reflect the GHG emission reductions achieved at waste disposal sites as a result of AFR utilization. The actual reductions will usually be difficult to determine with precision; hence the countable savings will to some degree have to be agreed upon by convention, rather than based on “precise” GHG impact assessments.

Table 3 — Gross and net emissions

Direct GHG emissions		Minus		Emissions group
Gross emissions	-	Emissions from alternative fossil fuels and non-biogenic content of mixed fuels	—	—
			—	—
			—	—
	-	Comparable benchmark emissions for external heat transfer	—	— Net emissions

Net emissions are the gross emissions minus the advantages for indirect GHG savings. As far as practicable, reported AFR advantages should take into account local circumstances (e.g. national agreements, life cycle analyses of local AFR use, etc.). When reporting to third parties, supporting evidence for the savings should be provided and verified as appropriate. As a default, this standard assumes indirect savings to be equal to the direct GHG emission from fossil AFR use.

This approach is a simplification of the AFR issue. It is however, in the medium-term, the least onerous and most practicable approach, where transparency is achieved through disclosure of gross and net emissions.

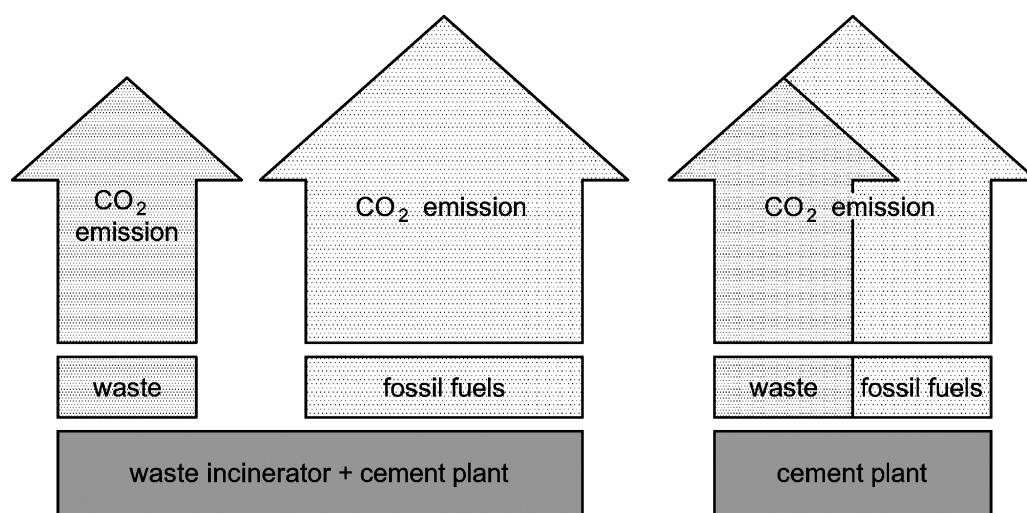


Figure 3 — Indirect saving of GHG emissions by the use of waste as alternative fuel in a cement plant

5.5.2 Gross emissions

5.5.2.1 General

Table 4 — Emission sources included within “Total direct GHG emissions”

GHG from raw materials + GHG from traditional fossil fuels + GHG from alternative fossil fuels (fossil wastes) + GHG from fossil carbon of mixed (alternative) fuels covering GHG from all kiln fuels and all non-kiln fuels including GHG from on-site power generation + GHG emissions from biomass and biogenic carbon of mixed fuels + GHG from combustion of wastewater
= Total Direct GHG emissions

Memo items • Indirect GHG (bought electricity & clinker)

Table 5 — Emission sources to be reported within “fossil direct GHG emissions”

GHG from raw materials + GHG from traditional fossil fuels + GHG from alternative fossil fuels (fossil wastes) + GHG from fossil carbon of mixed fuels covering GHG from all kiln fuels and all non-kiln fuels including GHG from on-site power generation + GHG from combustion of wastewater
= Fossil direct GHG emissions
Memo items • GHG from biomass fuels • GHG from biogenic carbon of mixed fuels • Indirect GHG (bought electricity & clinker)

Table 6 — Emission sources to be reported within “gross emissions”

GHG from raw materials + GHG from traditional fossil kiln fuels + GHG from alternative fossil kiln fuels (fossil wastes) + GHG from waste water combustion + GHG from fossil carbon of mixed kiln fuels and non-kiln fuels (excluding on-site power generation)
= Gross emissions
Memo items • GHG from biomass fuels • GHG from biogenic carbon of mixed (alternative) fuels • GHG from fossil carbon of mixed fuels used for on-site power generation • Indirect GHG (bought electricity & clinker)

5.5.2.2 Accounting of CO₂ emissions from the biomass content of fuels

The CO₂ emissions originating from the biogenic carbon content of mixed fuels are not accounted as part of the gross emissions. Biomass CO₂ from these fuels is added up with the CO₂ from pure biomass to give the total biomass CO₂ and reported as memo item. It is subtracted when calculating absolute direct CO₂ emissions.

5.5.2.3 Net emissions and indirect GHG savings related to utilization of wastes as alternative fuels

The cement industry recovers large quantities of waste materials for use as fuel and/or raw material. These recovered wastes are also referred to as *alternative fuels and raw materials (AFR)*. By utilizing AFR, cement companies reduce their consumption of traditional fossil fuels while at the same time helping to avoid conventional disposal of the waste materials by landfill or incineration.

Increased utilization of AFR can have an influence on the direct GHG emissions of a cement organization because the emission factors of the AFR can differ from those of the displaced fuels. Moreover, the carbon contained in the AFR can be of fossil and/or biomass origin. As mentioned above, utilization of AFR by the cement industry typically results in GHG emission reductions at landfills and incineration plants where these wastes would otherwise be disposed. The combination of direct GHG emissions impacts, indirect GHG emission reductions, and resource efficiency makes the substitution of AF for traditional fossil fuels an effective way to reduce global GHG emissions (see e.g. IEA 1998, CSI / ECRA 2009 and WBCSD / IEA 2009).

The balance sheet approach described in 5.5.2 ensures completeness, rigor and transparency of reporting.

- Direct GHG emissions resulting from the combustion of fossil AF shall always be included in the organization's gross emissions, in accordance with 7.6.

With the following concept this standard provides a framework for reporting also indirect GHG emission reductions achieved by using alternative fuels.

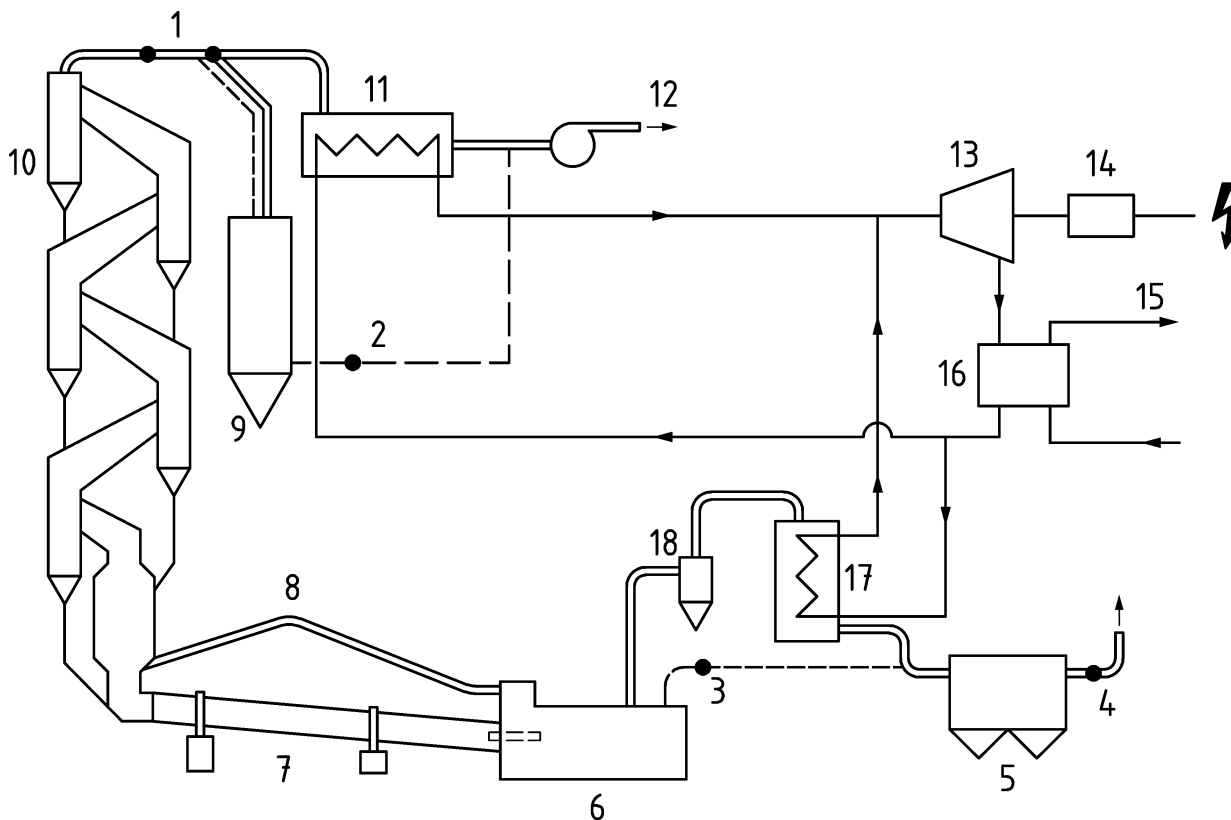
- Indirect GHG emission reductions at landfills and incineration plants are accounted by subtracting from the gross emissions the fossil GHG emissions of alternative fuels.

See 10.2 for the reporting requirements with respect to net emissions.

5.5.3 Other indirect GHG emission reductions

Utilization of waste heat

Some cement plants export waste heat to external consumers as a substitute for conventional energy sources. In analogy to the indirect effects related to the use of alternative fuels, a cement organization may account for the indirect GHG emission reductions resulting from such waste heat exports.



Key

- | | | | |
|----|-------------------------|----|----------------------------|
| 1 | Raw gas from preheater | 2 | Bypass of preheater boiler |
| 3 | Bypass of cooler boiler | 4 | Cooler exhaust air |
| 5 | Cooler vent filter | 6 | Clinker cooler |
| 7 | Rotary kiln | 8 | Tertiary air duct |
| 9 | Conditioning tower | 10 | Preheater tower |
| 11 | Preheater boiler | 12 | To raw grinding |
| 13 | Turbine | 14 | Generator |
| 15 | Cooking tower | 16 | Condenser |
| 17 | Cooler boiler | 18 | De-duster |

Figure 4 — Schematic of application of Waste Heat Recovery (WHR) and electrical power generation in cement manufacture

Similar advantages may be applied for other forms of waste heat utilization [7]. So this standard offers the possibility of reporting voluntarily waste heat utilization within the plant (e.g. for raw material or slag drying or power generation) in order to allow a fair comparison between plants exporting heat and plants using the heat internally. This requires additional calculation taking into account waste energy utilized only for clinker or cement production and the total energy flow in GJ/a may be reported. The reporting is voluntary.

Further, in the case of electrical power generation from waste heat originating from the kiln system (Figure 4) any additional fuel used in the kiln system is accounted as kiln fuel and consequently emissions are accounted as direct GHG emissions of the kiln system. In order to provide more detailed information, this standard distinguishes between waste heat recovery and separate on-site power generation. In any case, when applying in their voluntary reporting, companies should consider whether their actions indeed contribute to a global reduction in GHG emissions, or merely to a shift of emissions between different entities.

6 System boundaries

6.1 General

Drawing appropriate boundaries is one of the key tasks in an emissions inventory process.

6.2 Operational boundaries

Operational boundaries refer to the types of sources covered by an inventory. A key distinction is between direct and indirect GHG emissions:

- a) **Direct GHG emissions** are emissions from sources that are owned or controlled by the reporting organization. For example, emissions from fuel combustion in a cement kiln are direct emissions of the organization owning (or controlling) the kiln. This includes the direct emissions from additional fuel use such as for raw material or fuel drying or for on-site power generation.
- b) **Indirect GHG emissions** are emissions that result as a consequence of the activities of the reporting company but occur at sources owned or controlled by another organization. For example, emissions from the generation of grid electricity consumed by a cement organization will qualify as indirect.

Clause 7 of this standard provides detailed guidance on the different sources of direct emissions occurring in cement plants. Indirect GHG emissions are addressed in Clause 8.

Companies shall use the operational boundaries outlined in Table 3 for the determination of GHG emissions at the cement plant. Any deviation from these boundaries shall be reported and explained.

Table 7 — Operational boundaries

Process Step	Scope	Inclusion in standard	Direct or indirect GHG emissions
Quarrying of raw materials	Scope 1 Scope 3	Scope 1 yes: for quarries owned, controlled or managed by the organization Scope 3 no: for quarries not owned by the organization	Direct Other indirect
Raw materials transport	Scope 1 Scope 3	Scope 1 yes: for lorries owned by the organization Scope 3 no: for lorries not owned by the organization	Direct Other indirect
Raw materials drying	Scope 1	Yes	Direct
Raw materials grinding	Scope 1	Yes	Direct
Fuel preparation in plant	Scope 1	Yes	Direct
Fuel preparation outside plant	Scope 1 Scope 3	Scope 1 yes: for installations owned by the organization Scope 3 no: for installations not owned by the organization	Direct Other indirect
Fuels for kiln	Scope 1	Yes	Direct
Non kiln fuels (raw materials, fuel)	Scope 1	Yes	Direct

Process Step	Scope	Inclusion in standard	Direct or indirect emissions or GHG
Mobile transport of fuels	Scope 1 Scope 3	Scope 1 yes: for lorries owned by the organization Scope 3 no: for lorries not owned by the organization	Direct Other indirect
CKD = Bypass and/ or filter dust	Scope 1	Yes	Direct
Calcination	Scope 1	Yes	Direct
Imported Clinker	Scope 3	Yes, needs inclusion for cement process KPIs	Other indirect
Drying of cement constituents	Scope 1	Yes	Direct
Cement grinding	Scope 2	Yes	Energy indirect
Packaging and Dispatch	Scope 2	Yes	Energy indirect
Mobile transport for dispatch	Scope 1 Scope 3	Scope 1 yes: for lorries owned by the organization Scope 3 no: for lorries not owned by the organization	Direct Other indirect
Electricity consumption for whole production process	Scope 2	Yes	Energy indirect
On-site power production	Scope 1	Yes	Direct
Waste Heat Recovery	Scope 1	Yes	Direct
Room heating / cooling	Scope 1	No	Direct
Mobile transport in plant	Scope 1 Scope 3	Scope 1 yes: for mobile equipment owned by the organization Scope 3 no: for mobile equipment not owned by the organization	Direct Other indirect
Stock changes	Scope 1, 2 and 3	Yes, for calculation / KPIs	Direct

6.3 Organizational boundaries

6.3.1 General

Organizational boundaries define which parts of an organization – for example wholly owned operations, joint ventures and subsidiaries – are covered by an inventory, and how the emissions of these entities are consolidated. This standard provides guidance on organizational boundaries.

6.3.2 Which installations should be covered?

GHG emissions result not only from kiln operations, but also from upstream and downstream processes, particularly from quarry operations and (indirectly) cement grinding. These facilities may be located a