EESTI STANDARD

EVS-EN 19694-3:2016



# Stationary source emissions - Determination of greenhouse gas (GHG) emissions in energy-intensive industries - Part 3: Cement industry

EESTI STANDARDIKESKUS
ESTONIAN CENTRE FOR STANDARDISATION

## EESTI STANDARDI EESSÕNA | NATIONAL FOREWORD

| | |
|---|---|
| See Eesti standard EVS-EN 19694-3:2016 sisaldab Euroopa standardi EN 19694-3:2016 ingliskeelset teksti. | This Estonian standard EVS-EN 19694-3:2016 consists of the English text of the European standard EN 19694-3:2016. |
| Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas | This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation. |
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| Standard on kättesaadav Eesti Standardikeskusest. | The standard is available from the Estonian Centre for Standardisation. |

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

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# Stationary source emissions - Determination of greenhouse gas (GHG) emissions in energy-intensive industries - Part 3: Cement industry

Émissions de sources fixes - Détermination des émissions de gaz à effet de serre (GES) dans les industries énergo-intensives - Partie 3: Industrie du ciment

Emissionen aus stationären Quellen - Bestimmung von Treibhausgasen (THG) aus energieintensiven Industrien - Teil 3: Zementindustrie

This European Standard was approved by CEN on 5 May 2016.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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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of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.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*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# Introduction

This European Standard for the cement industry has been based on the WBCSD/CSI and WRI: "$CO_2$ 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):

a) preparing of raw materials and fuels;

b) producing clinker, an intermediate, through pyro-processing of raw materials;

c) grinding and blending clinker with other products ("mineral components") to make cement.

There are two main sources of direct $CO_2$ 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 $CO_2$ 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-$CO_2$ greenhouse gases covered by the Kyoto Protocol[1] , apart from carbon monoxide (CO) methane ($CH_4$) and nitrous oxide ($N_2O$), are not relevant in the cement context, in the sense that direct GHG emissions of these gases are negligible.

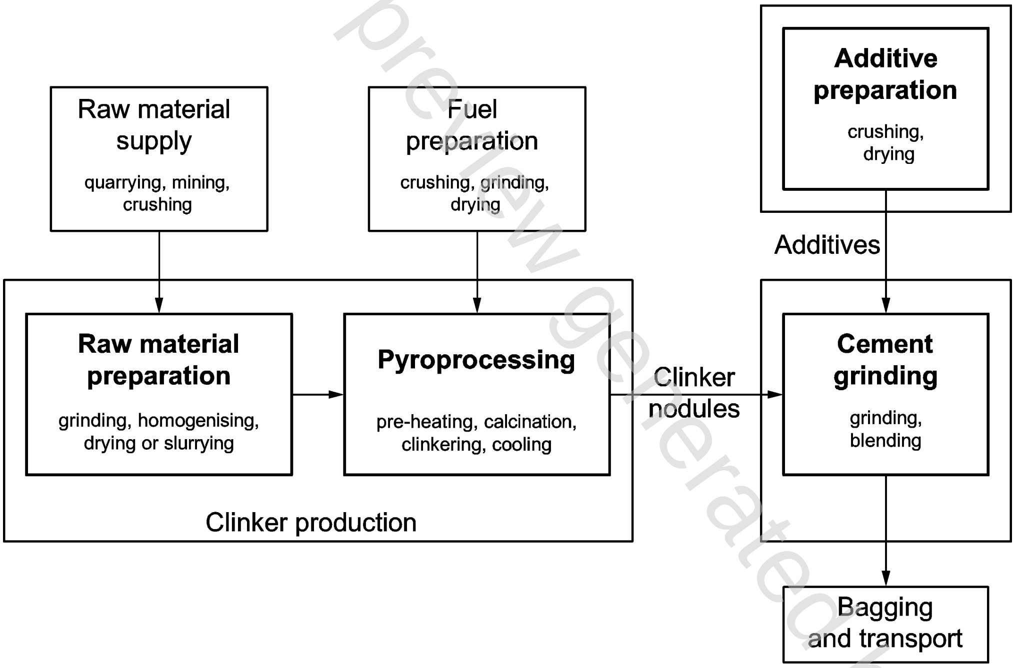


**Figure 1 — Process steps in cement manufacture (source: Ellis 2000, based on Ruth et al. 2000)**

1 Methane ($CH_4$), nitrous oxide ($N_2O$), sulfur hexafluoride ($SF_6$), partly halogenated fluorohydrogencarbons (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 |

**$CO_2$ from calcination of raw materials**

In the clinker production process, $CO_2$ is released due to the chemical decomposition of calcium, magnesium and other carbonates (e.g. from limestone) into lime:

$$CaCO_3 + heat \rightarrow CaO + CO_2$$

$$MgCO_3 + heat \rightarrow MgO + CO_2$$

This process is called "calcining" or "calcination". It results in direct $CO_2$ emissions through the kiln stack. When considering $CO_2$ emissions due to calcination, two components may be distinguished:

— $CO_2$ from raw materials actually used for clinker production, these raw materials are fully calcined in the clinker production process;

— $CO_2$ from raw materials leaving the kiln system as partly calcined cement kiln dust (CKD), or as normally fully calcined bypass dust.

$CO_2$ 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 $CO_2$ emission factor per tonne of clinker is fairly stable with a default value in this standard of 525 kg $CO_2$/t clinker (IPCC default: 510 kg $CO_2$/t clinker, CSI default: 525 kg $CO_2$/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.

$CO_2$ 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.

**$CO_2$ 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 $CO_2$ during pyro-processing. The contribution of this component to the overall $CO_2$ 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.

**$CO_2$ 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 $CO_2$ 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 $CO_2$ 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 $CO_2$ 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 $CO_2$ 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 $CO_2$ 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