Global Cement and Concrete Association (GCCA)
The Cement CO_2 and Energy Protocol, Version 3
CO_2 and Energy Accounting and Reporting Standard for the Cement Industry

Internet Manual for Printout

Version 3.1; created: 19/02/2020

This document will help you to understand the Cement CO_2 and Energy Protocol and the practical aspects of reporting. It is particularly aimed at engineers and managers of cement producers.

For the latest version of this manual please refer to https://www.cement-co2-protocol.org.

Global Cement and Concrete Association

Internet Manual - Editorial Information

This document has been developed by the Global Cement and Concrete Association (GCCA) and European Cement Research Academy (ECRA) building on WBCSD/CSI work. It is intended to help users to work with the Cement CO_2 and Energy Protocol Spreadsheet according to the Protocol Guidance Document. It is intended as an online reference for cement companies worldwide and for the preparation and evaluation of their reports.

This Protocol and related activities shall be compliant with all applicable legal requirements, including competition laws and regulations, whether related to information exchange or to other competition law requirements, guidelines, or practices.

Global Cement and Concrete Association

Global Cement and Concrete Association (GCCA)

Launched in 2018, the GCCA is the trusted, authoritative platform and voice for the cement and concrete sector across the world. Our vision sees a world where concrete supports global sustainable economic, social and environmental development priorities; and where it is valued as an essential material to deliver a sustainable future for the built environment. Our mission is to position concrete to meet the world's needs for a material that can build and support growing, modern, sustainable and resilient communities.

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https://gccassociation.org

ecra
european cement research academy

European Cement Research Academy (ECRA)

ECRA's mission is to advance innovation in the cement industry within the context of sustainable development and to communicate the latest knowledge and research findings in cement and concrete technology. With a membership of over 40 leading cement producers worldwide, ECRA

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supports and conducts research activities on the production of cement and its application in concrete.

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Remarks from the authors:

Due to technical reasons, both the abbreviation forms CO2 and CO_2 are used. The same applies to other chemical formulas.

Copyright

Table of Contents

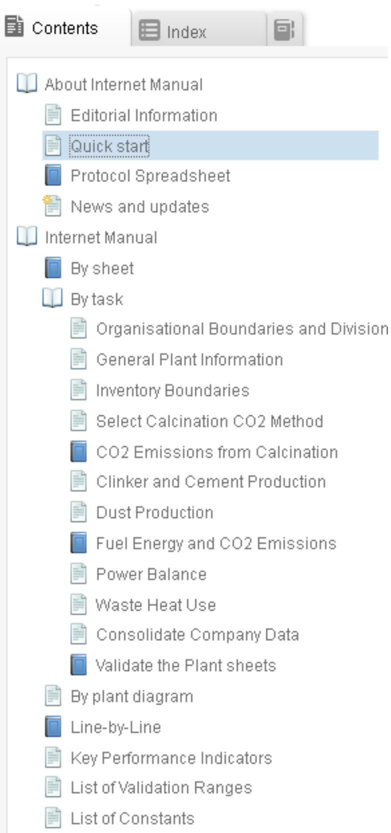
1. Internet Manual - Quick Start

We think about the questions YOU might ask. This manual was designed to make it easy for you to find answers to your questions on the practical aspects of CO_2 and energy reporting. The manual is easy to use and provides you with several mechanisms to find the information you need. Since the manual has been set up as an online help system the contained information is highly linked.

How to use this manual

The manual provides you a structured table of contents, an index, a glossary and a full-text search.

Content

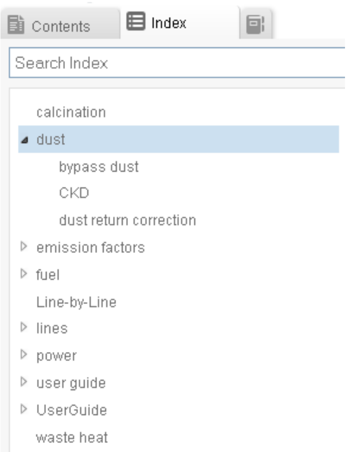


The Internet Manual is structured according to three major aspects:

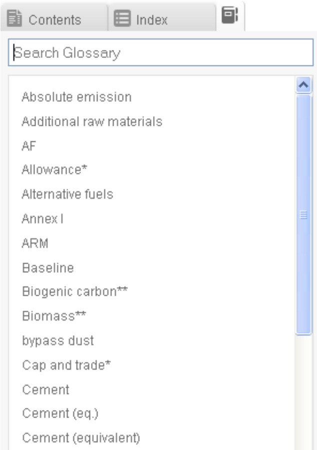
1. Access to the information via the different sheets in the Protocol Spreadsheet, e.g. the Plant sheet (see By Sheet").
2. Access to the information via user tasks, e.g. define inventory boundaries (see "By Task"). A plant diagram provides quick access to essential tasks which need to be performed for many cement plants.
3. Access to the information line by line (see "Line-by-Line").

The **Content** encompasses several additional topics. In the tree structure on the left hand side you can find answers to frequently asked questions (FAQs). Specific terms and abbreviations are explained in a Glossary. Furthermore, you can find information in the Internet Manual by using its Index or Search functions, which you can access by clicking the corresponding icon at the top of the window or at the bottom below the tree structure.

Index

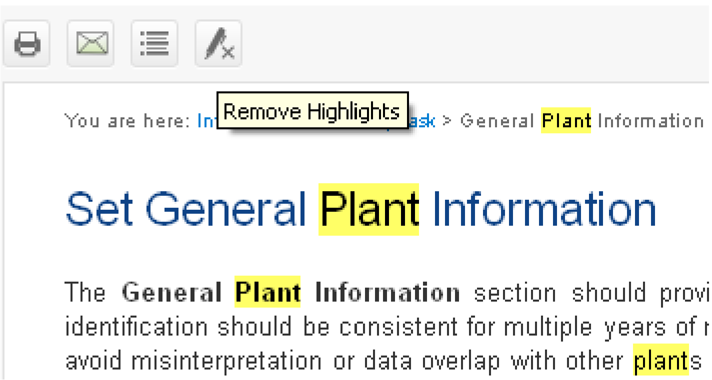


Glossary

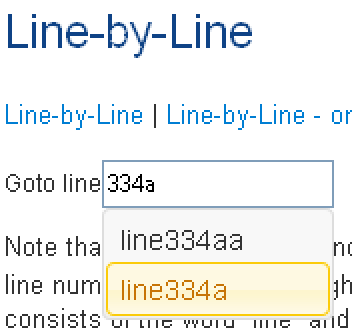


Search

In order to find the relevant section or term on other pages you can look for the highlighted search term. Alternatively you can use the search function of your browser in long lists and tables. In most cases you can access it directly by pressing CTRL+F on your keyboard and entering the search term again. Pressing F3 on your keyboard will direct you to the next search result on the same page.



In the “Line-by-Line” list an additional function is provided at the top of the page. This function allows you to jump directly to the relevant line number.



Navigation

At the top you will find several buttons for navigating through the topics:

1: Click on the logo to return to the homepage

2 - 4: Show content, index or glossary on the left hand side

5: Print current page (topic)

6: Send an URL for the current page (topic) via e-mail

7: Open all dropdown elements in the topic (e.g., FAQs)

8: Remove search highlights

9 + 10: Navigate to the previous or next topic

11: Perform a full-text search

12: Switch to Chinese language version

Figures, Diagrams and Screenshots

In this Internet Manual especially in the section “By Task” you will find a number of figures, diagrams and screenshots from the Protocol Spreadsheet. In some cases, you can enlarge the figure on the screen **by clicking on it**. Click again to shrink the figure to original size.

What do "By Sheet" and "By Task" in the navigation tree mean?

- **By Sheet** means that you can access the information via the individual sheets in the Protocol Spreadsheet (e.g. Plant sheet, Company sheet).

  Each of the sup-topics provides further links e.g. to associated tasks. See "Sheets in the Protocol Spreadsheet" (on page 23) for an overview of the sheets in the Excel® file.

- **By Task** means that you can access the information via user tasks, such as defining the "inventory boundaries".

  Each of the tasks is associated with one or more sheets and hence provides additional links. For example, if a task has to be performed in the Plant sheet of the Excel® file, you will find a link to the Plant sheet on the tasks page. See "Tasks to be performed by the User" (on page 35) for a list of tasks.

Each of the topics should provide links to additional information such as FAQs or a link to the relevant lines in the Line-by-Line reference.

What are the strategies for finding what I am looking for?

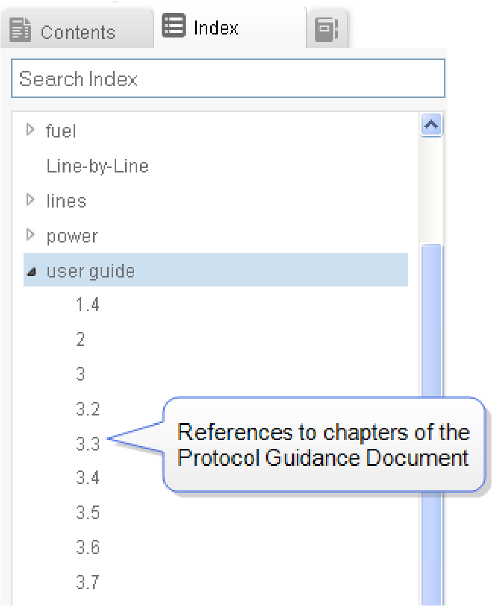
There are many ways to easily find what you need. You can browse the Content, which is organised in a tree structure. In this way you can find more important items which you may need to know about.

- A plant diagram provides quick access to essential tasks, which need to be performed for many cement plants.
- Instead of browsing, you can use the **Index** or **Search a specific keyword** in order to find all topics (pages) with related information in this Internet Manual.
- In order to find a keyword within a certain page or list you need to use the search function of your browser. In most cases you can access it directly by pressing **CTRL+F** on your keyboard and entering the search term again. Pressing F3 on your keyboard will direct you to the next search result on the same page.
- Specific terms and abbreviations are explained in a Glossary .
- The Protocol Spreadsheet and the Protocol Guidance Document can be found in the Download section.

Can I find out how the sections of the Protocol Guidance Document relate to the Internet Manual?

The Protocol Guidance Document is a separate document published by WBCSD CSI now managed by GCCA. However, the Internet Manual provides some links between both documents.

- Within the text of Internet Manual you will find several links to the related sections in the Protocol Guidance Document.
- In the Index of the Internet Manual (see icons at the top of the window) and in the list of Index terms at the very bottom below the heading "user guide" you can find and access these references to chapters of the Protocol Guidance Document in the Internet Manual.

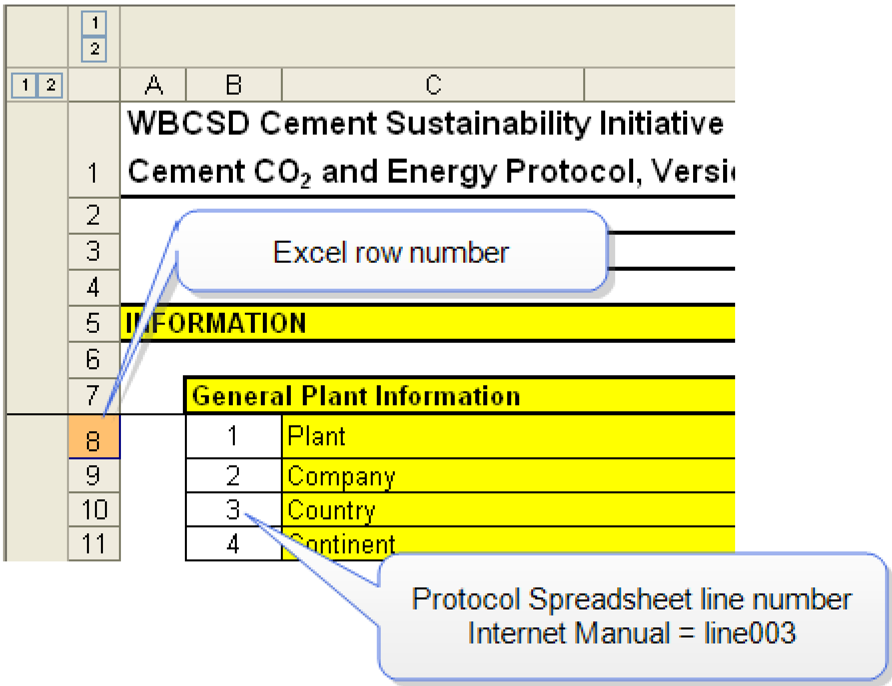


How to get information on a specific line in the Protocol Spreadsheet (Excel® file)

There are two ways to find information on a specific line in the Protocol Spreadsheet:

1. Use the Index or
2. Use the Line-by-Line reference.

Note that the Cement CO_2 and Energy Protocol and the Protocol Spreadsheet have a specific line number index (see Column B in the Excel® file). These line numbers are used throughout all documents of the Protocol. They differ from the Excel® row numbers. In the Internet Manual, the index of line numbers consists of the word “line” and the line number with three digits. For some lines a small letter is added to the number, e.g. “line059c”.



How to use the Protocol Spreadsheet

It is very important that you understand how to fill in and submit the Protocol Spreadsheet properly. This Internet Manual was designed to make this easy for you.

Click on "Cement CO2 and Energy Protocol Spreadsheet" (on page 20) to learn more about the structure of the Protocol Spreadsheet.

How to find answers to Frequently Asked Questions (FAQ's)

It is important to consider the answers to Frequently Asked Questions (FAQs). Other users may have the same questions as you. In the FAQ section you will find many questions which are divided into sections according to topics. The questions and answers have been formulated to address and solve common problems and questions. They may help to understand issues about which you may have queries when you use the Protocol.

See "Frequently Asked Questions (FAQs)" (on page 108)

What has changed since Protocol Version 2?

The revision of the Cement CO_2 and Energy Protocol was performed based on extensive experience with the application of the Protocol Version 2 and its evaluation for several years by many cement companies worldwide. The revised Protocol Version 3 was published by the WBCSD in 2011. It is intended to be applied for the reporting for the year 2011 and onwards.

2. What is new in Version 3 ?

There are many changes which have been implemented in Version 3 since 2011 with respect to the former Version 2 published in 2005. These changes are summarised in the following two items as major and minor changes.

Major changes in the Protocol Version 3 were made regarding the following issues:

- Additional key performance indicators (KPIs), including KPI based on cement (equivalent) production.
- Change to the definition of kiln fuels.
- The accounting for climate-neutral CO_2 emissions from the biomass content of mixed fuels.
- The reporting of CO_2 emissions from raw material calcination with the choice between simple and detailed methods and either based on kiln input or output.
- More extensive (optional) reporting of CO_2 from power generation on-site (“power balance”).
- The addition of harmonised rules to avoid the double counting of internal clinker, cement and MIC transfers and to aid the consolidation of plant level data at company level.
- Change to the definition of net and gross emissions (as in Version 1).

Some minor and/or formal changes have also been made:

- Inclusion of additional general information on the plant in the Plant sheet.
- Inclusion of a validation tool for first- hand checking of the data entered into the Plant sheet.
- Deletion of the section on emission rights.
- Increase of flexibility of reporting for different types of fuels, e.g. the use of alternative fuels for onsite power generation or bio-diesel for trucks in the quarry.
- Update of the default emission factor for bought clinker.
- Updated guidance for emission factors for power from the national grid.
- Option for the reporting of “waste heat used internally” e.g. for on-site power generation.

Further information on changes in the Protocol Spreadsheet can be found in the Release Notes.

3. Cement CO_2 and Energy Protocol Spreadsheet

The Protocol Spreadsheet contains the following sheets:

1. Read Me:

This sheet explains the meaning of the different colours used in the Protocol Spreadsheet and provides essential instructions for the user. You will find more recent updates and additional questions and answers in the section "Frequently Asked Questions (FAQs)" (on page 108) in this online manual. Detailed information on more recent releases of the Protocol Spreadsheet are provided in the News and Updates section of this manual.

2. Comments:

This sheet gives a short explanation for every line of the Plant sheet. The same comments are included in the Line-by-Line section in this Internet Manual.

3. Plant:

This is the primary sheet of the Protocol Spreadsheet. In the end, each plant of the reporting company should have its own Plant sheet. Additional Plant sheets can be created with the button “New Plant Sheet V3.1” in line001. For transferring plant data from version 3.04 to version 3.1 of the Protocol Spreadsheet use the button "New Plant Sheet Transfer V3.04 > V3.1".

It is recommended to name all Plant sheets "Plant_xyz", with xyz could be for example the name of the plant.

- See "Plant Sheet" (on page 28)

4. CalcA1 (Calcination Sheet):

Simple Input Method (A1) auxiliary sheet for determining CO_2 emissions from raw material calcination (can be created for plants with kiln operation, line007c = yes).

The sheet is hidden by default and one auxiliary sheet must be created for each plant which uses this calculation method (see Plant sheet line007n **and** "z Select a Method for Determining CO2 Emissions from Calcination" (on page 44)**).**

- See "Sheet CalcA1 (Simple Input Method)" (on page 30)

5. CalcA2 (Calcination Sheet):

Detailed Input Method (A2) auxiliary sheet for determining CO_2 emissions from raw material calcination (can be created for plants with kiln operation, line007c = yes).

The sheet is hidden by default. One auxiliary sheet must be created for each plant which uses this calculation method (see Plant sheet line007n **and** "z Select a Method for Determining CO2 Emissions from Calcination" (on page 44)**).**

- See "Sheet CalcA2 (Detailed Input Method)" (on page 31)

6. CalcB2 (Calcination Sheet):

Detailed Output Method (B2) auxiliary sheet for determining the corrected CO_2 emission factor of clinker (can be created for plants with kiln operation, line007c = yes).

The sheet is hidden by default and one auxiliary sheet must be created for each plant which uses this calculation method (see Plant sheet line007n **and** "z Select a Method for Determining CO2 Emissions from Calcination" (on page 44)**).**

- See "Sheet CalcB2 (Detailed Output Method)" (on page 31)

7. Company:

This sheet serves to consolidate data and information of all plants of one company. Please note that the data of each Plant sheet must be added manually to the cells as appropriate, e.g. by editing the formulas in all white or light green cells, which contain the word "SUM"!

- See "Company Sheet" (on page 28)

8. Validation:

Validation tool for first general check of input data quality.

- See "Validation Sheet" (on page 32)

9. Control Plant:

Detailed validation tool report at plant level.

- See "Control Plant Sheet" (on page 33)

10. Fuel CO_2 Factors:

Default CO_2 emission factors for fuels used in cement plants.

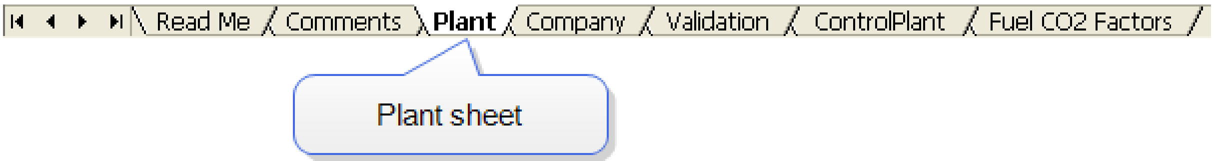
- See "Fuel CO2 Factors Sheet" (on page 34)

3.1. FAQs

See "Frequently Asked Questions (FAQs)" (on page 108) in the FAQ section for questions related to the functioning of the Protocol Spreadsheet and Excel®.

4. Sheets in the Protocol Spreadsheet

The Protocol Spreadsheet consists of several sheets which are created according to the required reporting tasks. E.g. the data reporting for plants is collected in a Plant sheet. You have the possibility to create more sheets if it is necessary to report the data from multiple plants of one company. Excel® acts as the software platform, which makes it easy to deal with your Protocol Spreadsheet and also provides you with additional features. One feature is the ability to archive your records and sheets over many years of reporting. Thus, the Protocol Spreadsheet can be used as a database for the CO_2 and energy data of your company.



The main sheets which are included by default are as follows:

- "Read Me Sheet" (on the next page)
- *Comments sheet (Comments included in* Line-by-Line *)*
- "Plant Sheet" (on page 28)
- "Company Sheet" (on page 28)
- "Validation Sheet" (on page 32)
- "Control Plant Sheet" (on page 33)
- "Fuel CO2 Factors Sheet" (on page 34)

Not all of the sheets need to be filled in - some of them are only for providing help, information or standard values.

Three different calcination sheets are optional and therefore hidden by default. One calcination sheet should be created per plant according to the selection of the calcination CO_2 method for calculating the CO_2 emissions from the calcination of raw materials (CalcA1, CalcA2 and CalcB2 sheets). No auxiliary calcination sheet exists for the simple output method (B1), because its data input and calculations are completely included in the Plant sheet.

Note that all cells which are not coloured (those with a white background) must be filled with the respective values from your plant and company data.

4.1. Read Me Sheet

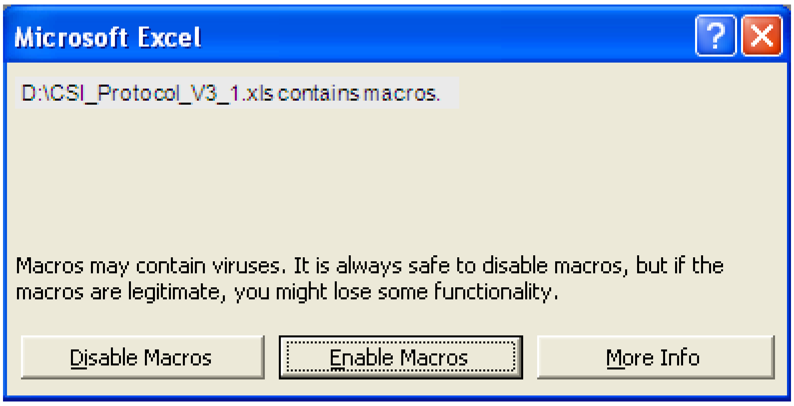
The Read Me sheet contains an overview of the colour codes used in the Protocol Spreadsheet, some important notes to the users and a link to the Frequently Asked Questions (FAQ) section of this online manual.

This Protocol and related activities shall be compliant with all applicable legal requirements, including competition laws and regulations, whether related to information exchange or to other competition law requirements, guidelines, or practices.

Enable macros

The Protocol Spreadsheet is a Microsoft® Excel® file with Visual Basic macros. It is therefore very important to enable macros in your Excel® application via (Options>Macro>Security) or by pressing "enable" if asked to do so on start-up of the Protocol Spreadsheet.

For example in Excel® 2003 an alert will appear:



Plant sheet functionality

The Plant sheet will expand or contract certain sections of lines according to the selection for the **Inventory Boundaries** in Column E (line007a to line007j). Thus, some input lines only become accessible, when needed for the reporting for this plant.

Additional Plant sheets are required, when you report data for several plants of one company in the same Protocol Spreadsheet. In the line001 you will find a button with which you can create a "**New Plant Sheet**". For transferring plant data from version 3.04 to version 3.1 of the Protocol Spreadsheet use the button "New Plant Sheet Transfer V3.04 > V3.1". In the section "Data transfer from V3.04 to V3.1" you will find a step-by-step description on how to use the Plant Sheet Transfer. It is recommended to name all Plant sheets "Plant_xyz", with xyz being replaced e.g. by the name of the plant. This will help you to keep an overview of complex company structures.

Colour codes

The Read Me sheet contains an overview over the colours used in the Protocol Spreadsheet.

Subject	Numbers / Values
Basic information on plant and company	Input cell; value to be entered by Cement Company as appropriate
Calculation of CO_2 emissions	Calculated value
Calculation of Performance indicators, Total absolute and specific emissions	Self-calculating value copied from another part of the sheet
Voluntary data or indicators	Default value, to be corrected by Cement Company if more precise data are available

In the Protocol Spreadsheet it is most important for correct functioning and calculations to enter values in each of the white cells.

Clinker and Cement Production			2012
	Clinker:		
8	Clinker production	[t/yr]	
9	Clinker bought from other (	[t/yr]	
10	Clinker sold to other comp	[t/yr]	
10a	Change in clinker stocks (	[t/yr]	
10b	Internal clinker transfer (+	[t/yr]	
10c	Clinker from internal ceme	[t/yr]	
11	Total clinker consumed	[t/yr]	

Cells which are not coloured must be filled

Some white cells are filled with a default value of “0” (zero) in order to assure correct functioning of some calculation cells. Please change the value of “0” (zero) to your plant (or company) specific data, as appropriate.

Power Balance			2012
33a	Total power production from separate on-site power generation	[MWh/yr]	0
33aa	Power delivered to cement plant	[MWh/yr]	0

Notes to the user

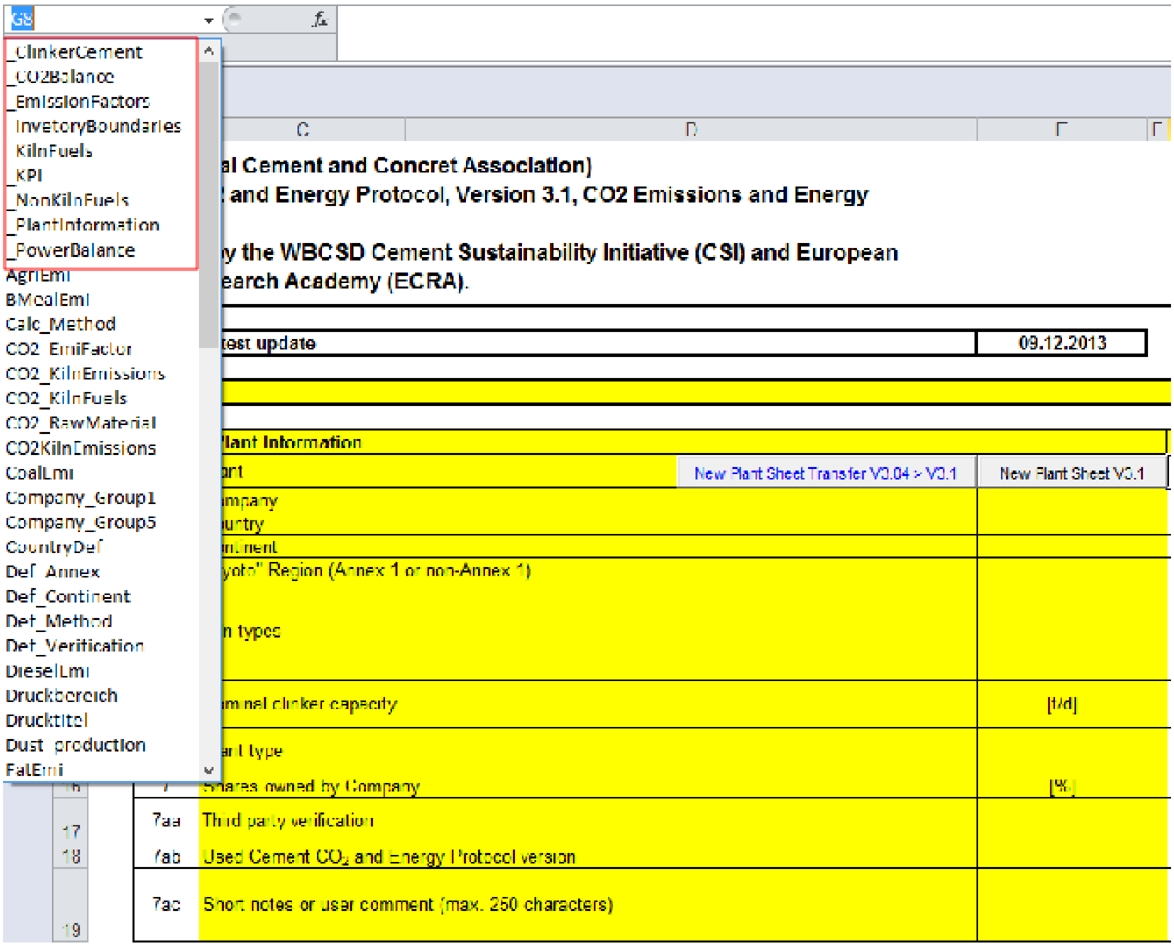
- Pant sheet: **All empty white cells must be completed.** If an input value is zero (0), do not leave the cell blank but enter zero.

- Company sheet: If you are reporting for several plants of one company, the data is consolidated in the Company sheet. **Consolidated totals must be entered manually in all white "SUM" cells.** If a value is zero (0), do not leave the cell blank but enter zero.
- Non-input cells are write-protected to prevent inadvertent changes.
- Please note that the undo-function only works before you have pressed the ENTER-button.

Jump marks in plant sheet

Jump marks are programmed in each Plant Sheet for easy navigation to the following sections:

- General Plant Information (_PlantInformation)
- Inventory Boundaries (_InventoryBoundaries)
- Clinker and Cement Production (_ClinkerCement)
- Power Balance (_PowerBalance)
- CO_2 Emissions (_CO2Balance)
- Performance Indicators (_KPI)
- Kiln Fuels (_KilnFuels)
- CO_2 Emission Factors (_EmissionFactors)
- Non-Kiln Fuels (_NonKilnFuels)



When clicking on one of the mentioned jump marks (cell name) the cursor jumps from any position in the plant sheet to the very first cell (column A) in the first line of the corresponding section in the sheet.

Frequently Asked Questions (FAQs)

The Read Me sheet contains a set of FAQs. Answers to further questions are provided in the section "Frequently Asked Questions (FAQs)" (on page 108) of the Internet Manual (https://www.cement-co2-protocol.org).

4.2. Plant Sheet

The Plant sheet is the most important part of the Protocol Spreadsheet. It is structured in various tasks for the user, e.g. entering the basic data for a plant, define how the plant is accounted for and what process steps are covered by the plant by defining the inventory boundaries.

Please note: A company must add a separate Plant sheet for each of its plants! Additional Plant sheets can be created with the button "New Plant Sheet" in line001. **For transferring plant data from version 3.04 to version 3.1 of the Protocol Spreadsheet use the button "New Plant Sheet Transfer V3.04 > V3.1". In the section "Plant Sheet Transfer" you will find a step-by-step description on how to use the Plant Sheet Transfer. It is recommended to name all Plant sheets as "Plant_xyz", with xyz replaced for example by the name of the plant.**

4.2.1 Tasks

- "Set General Plant Information" (on page 38)
- "Define Inventory Boundaries: Coverage of Main Process Steps " (on page 41)
- "Data on Clinker and Cement Production" (on page 75)
- "Calculate Dust Production Leaving the Kiln System" (on page 80)
- "Enter Kiln Fuel Consumption" (on page 82)
- "Enter Non-Kiln Fuel Consumption" (on page 84)
- "Enter Power Balance" (on page 96)
- "Provide Information on Waste Heat Use" (on page 99)

4.2.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108) plus subsequent FAQ's

4.2.3 Line-by-Line

- See Plant Sheet for a line by line reference

4.3. Company Sheet

The Company sheet is mostly the same as the **Plant sheet**, but all of its cells should contain the data consolidated at company level. This means that the numbers which should be entered on the

Company sheet should be the sum of all the plants which you have within your company.

Most of the lines of the Plant sheet can be found in the Company sheet. All of them have the same title and line number, but you must take care that the values entered in the Company sheet are values at company level. E.g. if you have 3 plants within your company and each one produces 1000 tonnes clinker per year, you have to insert 3000 tonnes as the annual production amount of clinker at the company level in the Company sheet.

Entering internal transfers among plants within the same company does not make sense in this sheet, simply because they will not affect the gross sum at company level. Positive and negative values for internal transfers in the Plant sheets should cancel each other out and add up to 0 (zero).

A possible solution for consolidating Plant sheet data for the Company sheet in the Protocol Spreadsheet: In Excel® you can use the "SUM" function and manually link the lines in the Plant sheets to the relevant lines in the Company sheet - the sums of all relevant Plant sheet values are then updated automatically when you change a value in the Plant sheet. See a more detailed description in the following task.

4.3.1 Tasks

- See "Consolidate Company Data (Aggregate Data from Plants)" (on page 99)

4.3.2 Line-by-Line

In the Company sheet the same line numbers are used as for the corresponding lines in the Plant sheet. Thus, you can use the same Line-by-Line reference for finding more detailed information about the cells in the Pant sheet and in the Company sheet.

4.3.3 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

4.4. Calcination Sheets (A1, A2, B2)

The Protocol provides 4 different methods and 3 different sheets for calculating the CO_2 from calcination.

See "Calculate CO2 emissions from calcination" (on page 47) for further instructions on which method to use and how to calculate the data.

Please note :

- The simple output method (B1) does not require any auxiliary calculation sheet.
- The Calcination sheet(s) will not be checked by the automatic validation tool.

4.4.1 Tasks

- "Calculate CO2 emissions from calcination" (on page 47)
- "Simple Input Method (A1) - LOI of Raw Meal" (on page 48)
- "Detailed Input Method (A2) - Input CO2 Balance" (on page 53)
- "Detailed Output Method (B2) - Corrected Calcination EF" (on page 67)

4.4.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

4.4.3 Line-by-Line

- See Calcination Sheet A1
- See Calcination Sheet A2
- See Calcination Sheet B2

4.4.4 Sheet CalcA1 (Simple Input Method)

This input method (A1) is the simple version of the A2 method. It accounts for most of the items of the A2 method but with less detailed calculations. However, it does not cover additional raw materials which are not part of the kiln feed, e.g. raw materials fed directly to the kiln inlet.

The CalcA1 sheet will be created automatically if you have selected A1 as your calculation method in the Plant sheet in line007n and clicked on the button named "**Create Calcination Sheet**".

4.4.4.1 Tasks

- See "Simple Input Method (A1) - LOI of Raw Meal" (on page 48)
- See "Input Method Dust Return Correction" (on page 59)

4.4.4.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

4.4.4.3 Line-by-Line

- See Calcination Sheet A1

4.4.5 Sheet CalcA2 (Detailed Input Method)

The CalcA2 sheet is an auxiliary for determining the CO_2 emissions from the calcination of raw materials according to the detailed input method (A2). The CalcA2 sheet will be automatically added to the Protocol Spreadsheet if you have selected the detailed input method (A2) as your calculation method in line007n and have clicked on the button named "**Create Calcination Sheet**".

One auxiliary sheet CalcA2 is required for every plant that applies the detailed input method (A2).

The detailed input method (A2) accounts for:

- CO_2 emissions from raw material calcination for clinker production .
- CO_2 emissions from raw material calcination for clinker production.
- CO_2 emissions from the calcination of bypass dust and cement kiln dust (**CKD**[1]) leaving the kiln system.
- CO_2 emissions from the organic carbon content (**TOC**[2]) of raw materials.
- Additional input lines allow for accounting of CO_2 emissions of additional raw materials (**ARM**[3]), which are not part of the kiln feed, but e.g. fed directly to the kiln inlet.

4.4.5.1 Tasks

- See section "z Select a Method for Determining CO2 Emissions from Calcination" (on page 44)
- See "Detailed Input Method (A2) - Input CO2 Balance" (on page 53)

4.4.5.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

4.4.5.3 Line-by-Line

- See Calcination Sheet A2

4.4.6 Sheet CalcB2 (Detailed Output Method)

This sheet is auxiliary and will be automatically added to your Protocol Spreadsheet if you have selected method B2 as your calculation method and have clicked on the button named "**Create calcination sheet**".

---

[1]Cement kiln dust
[2]Total organic carbon
[3]Additional raw materials

In the detailed output method (B2) the CalcB2 auxiliary sheet is used to correct the calcination emission factor for clinker. The auxiliary sheet thus accounts for CO_2 emissions from raw material calcination for clinker production.

The other relevant components of the total CO_2 emissions from raw materials are accounted for in the Plant sheet. These are:

- CO_2 emissions from the calcination of bypass dust and cement kiln dust (**CKD**[1]) leaving the kiln system. See Plant sheet line022, line023, line024 for the input and line037 and line038a for the result.
- CO_2 emissions from the organic carbon content (**TOC**[2]) of raw materials. See Plant sheet line008, line034s for the input and line038b for the result.

See section "When to select which calcination CO2 method/sheet" (on page 45) for information on when to select which method.

4.4.6.1 Tasks

- See "When to select which calcination CO2 method/sheet" (on page 45)
- See "Detailed Output Method (B2) - Corrected Calcination EF" (on page 67)

4.4.6.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

4.4.6.3 Line-by-Line

- See Calcination Sheet B2

4.5. Validation Sheet

The Validation sheet acts as a tool for doing a **first-general check on your sheets for faults and completeness**. It should be used before submitting data. This validation tool/sheet works on the specific year which you need to validate and which is normally selected through the selection list in the sheet itself. The Validation sheet and the "Control Plant Sheet" (on the facing page) are linked to each other. This means that if there are some faults or incomplete data which could make your validation process fail, you will find more details on the results in the Control Plant sheet. Subsequently

[1] Cement kiln dust
[2] Total organic carbon

you have to go back to the other sheets in your Protocol Spreadsheet to correct the errors there. After your correction is finished you should use the validation tool again.

The validation tool applies a simple method to check the input data in the Plant sheet. It is based on a general "List of Validation Ranges" (on page 107). In addition, some calculated data is checked based on validation functions. There may for instance be special cases where values lie outside the validation ranges, but where these values are still assessed as correct, after carefully checking the data. In these cases, the checked values should be accepted, even though the Protocol Spreadsheet validation tool indicates a value outside of the min-max-range in its list of results in the Control Plant sheet.

For the validation of the Protocol Spreadsheet it is most important that the plant sheets are named "Plant_xyz", with xyz being replaced e.g. by the name of the plant. Otherwise the Excel® macros of the validation tool might not be able to identify the Plant sheet correctly.

4.5.1 Tasks

- See "Validate the Plant sheets before submitting Data" (on page 103)
- See "Check for errors" (on page 104)

4.5.2 References

- See the "List of Validation Ranges" (on page 107) for a detailed list of lines and values that are checked by the macros of the Validation sheet
- In the Line by line you can also find line specific information on validation ranges

4.5.3 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

4.6. Control Plant Sheet

The Control Plant sheet contains detailed information on the results of the validation tool of the Protocol Spreadsheet (see "Check for errors" (on page 104)). You have to examine this sheet if your validation has resulted in the red comment “FAILED”. The errors which have been made in the Plant sheets will be marked in the Control Plant sheet.

For example, if the name of your plant has not been entered on the Plant sheet, the Control Plant sheet will show that the name of the plant has not been entered. If the validation tool has found errors in the Plant sheets, you should check your data carefully and correct it, if necessary. Then try to validate your Plant sheets again.

The validation tool applies a simple method for checking the input data in the Plant sheet. It is based on a general "List of Validation Ranges" (on page 107). In addition, some calculated data is checked based on validation functions. There may for instance be special cases where values lie outside the validation ranges, but where these values are still assessed as correct, after carefully checking the data. In these cases, the checked values should be accepted, even though the Protocol Spreadsheet validation tool indicates a value outside the min-max-range in its list of results in the Control Plant sheet. In such a case you can also ignore the red comment “FAILED” in the Validation sheet.

4.6.1 Tasks

- See "Check for errors" (on page 104)

4.6.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

4.7. Fuel CO_2 Factors Sheet

This sheet contains no tasks for you to do, but it contains the standard emission factors for many fuels for reporting under this Protocol. For each fuel you will find **IPCC**[1] or Cement CO_2 and Energy Protocol default factors in unit of kilogramme of CO_2 per gigajoule of the relevant fuel.

On the sheet you can find the reference to the source of information corresponding to each fuel. For tyres used as fuel, the sheet mentions the value of biomass content as a percentage.

Please see the Protocol Guidance Document for additional information (Appendix A4).

4.7.1 References

- See " List of Constants and Default CO2 emission factors " (on page 108)

4.7.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

[1] Intergovernmental Panel on Climate Change

5. Tasks to be performed by the User

What is a "task"?

A task is an activity of the user, such as ""Set General Plant Information" (on page 38)" or ""Define Inventory Boundaries: Coverage of Main Process Steps " (on page 41)".

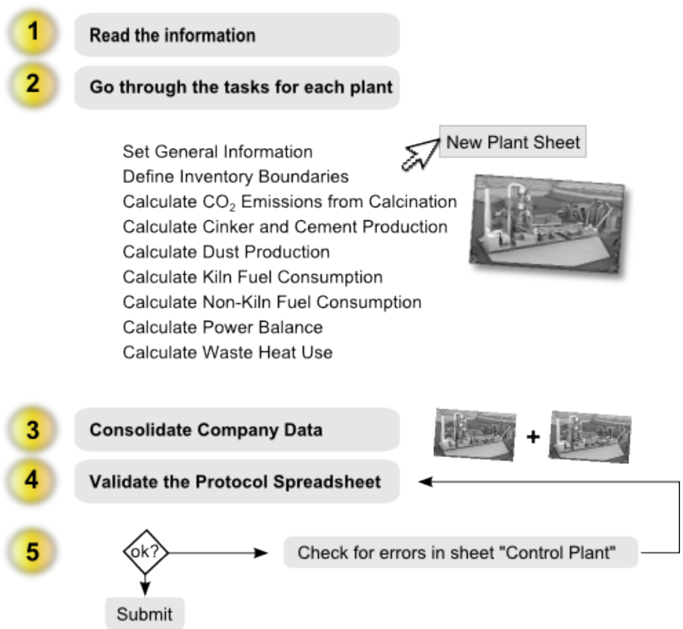
Each of the tasks is associated with one or more sheets. For example, if a task has to be performed in the Plant sheet, you will find a link to the Plant sheet on the page of the task.

Which tasks should be performed in which order?

The main task is to report and submit the correct data and enter it into the proper places on the sheets which are included in the Protocol Spreadsheet. Each task may consist of sub-tasks which are clearly explained in this Internet Manual in order to provide you with a guide through the reporting process with the Cement CO_2 and Energy Protocol.

The following diagram shows the tasks you need to do in order to fill in and submit your Protocol Spreadsheet (you may click on some of the entries in order to jump to the corresponding topic):

Figure 1: List of tasks



5.1. Organisational Boundaries and Division into Plants

Before you start reporting data in the Protocol Spreadsheet, a key task is defining the boundaries of your report with regards to your company (**Organisational Boundaries**), its installations and activities (**Operational Boundaries**).

The Protocol Guidance Document (Chapter 1.4) provides general guidance for drawing appropriate Organisational and Operational Boundaries for the emission inventory.

The Protocol Guidance Document (Chapter 2) specifies the relevant principles for reporting according to the Cement CO_2 and Energy Protocol.

The reporting of companies with several plants will often require separate reporting of data for each plant. Separate inventories may be established for individual facilities as appropriate. For instance, the reporting should allow for the separate evaluation of facilities which are geographically separated or run by distinct operators. In the Protocol Spreadsheet this separation can be performed in one Excel® file by creating and using different Plant sheets for each facility (see "Set General Plant Information" (on page 38)). The impacts of such a division will cancel each other out when the emissions are consolidated at company or group level (See "Consolidate Company Data (Aggregate Data from Plants)" (on page 99)).

Which Installations and Activities should be covered?

Reporting under the Cement CO_2 and Energy Protocol should cover the main direct emissions and indirect CO_2 emissions associated with cement production. The corresponding inputs are foreseen in the Plant sheets of the Protocol Spreadsheet. These emissions include also those related to the consumption of fuel and electricity in upstream and downstream operations. In particular, cement companies should include the following types of activities in their voluntary reporting under this Protocol:

- Clinker production, including raw material quarrying and preparation.
- Grinding of clinker, additives and cement substitutes such as slag, both in integrated cement plants and stand-alone grinding stations.
- Additional fuel use for own power generation.
- Preparation or processing of fuels or fly ash in own installations.

The Protocol Guidance Document (Chapter 3 and 4) provides detailed information on direct and indirect CO_2 emissions that should be included in the reporting.

The Protocol Guidance Document (Chapter 7.1) provides detailed information on Which Installations Should Be Covered.

How to Consolidate Corporate Reporting

The reporting for organisations should furthermore be performed with regard to the extent of which a company controls or owns the respective installations.

In summary, the consolidation of the emissions and energy use of a company's operations should depend on:

- Operational control
- Financial control and
- Equity share.

WBCSD/CSI had decided that cement companies should consolidate their reporting primarily according to the operational control criterion, and secondly according to the ownership criterion if operational control is not clearly assigned to a single legal entity. This approach is summarised in the following table:

Criterion for Consolidation	% GHG to consolidate by reporting entity
First criterion: Operational control	
The reporting entity has operational control	100%
Another legal entity has operational control	0 %
Operational control is not clearly assigned to a single shareholder (“Joint operational control”)	Relative to share ownership (see below)
Second criterion: Equity share ownership	
0% - 100% ownership	pro rata ownership

Table 1: Key for consolidating corporate GHG emissions of cement companies.

The Protocol Guidance Document (Chapter 7.2) provides detailed information on the definition of Operational Control and Ownership Criteria and how to handle complex company structures in the reporting.

See also the revised WBCSD / WRI GHG Protocol (2004) for more detailed guidance and illustrative examples for these consolidation rules.

GCCA has defined consolidation rules in its **GCCA Sustainability Charter and Guidelines** as follows [1]:

“4.4 Organisational boundaries Organisational boundaries define the parts of an organisation - for example, wholly owned operations, joint ventures and subsidiaries - that are to be reported on, and how the data are consolidated. Members can choose one of the following options to set the organisational boundaries for reporting:

- Equity share
- Control Approach - Financial control or operational control
- A combination of equity share and one of the control approaches. In defining control, members are advised to follow their existing rules and practices for financial reporting.

Members shall clearly state in their GCCA and public reporting which method is applied and the exact scope of what is reported. A new or acquired entity/facility/installation needs to comply with this protocol within at the latest two calendar (or financial) years following the start of operation, or the year it was acquired. A closed or sold entity/facility/installation may be excluded from reporting for the whole year of its closure or divestiture. Baseline data must always be corrected following acquisitions or divestments.”

5.2. Set General Plant Information

The **General Plant Information** section should provide a clear identification for each plant and its data which is collected in the Plant sheet. This identification should be consistent for multiple years of reporting, as far as appropriate. You therefore have to fill in the General Plant Information carefully to avoid misinterpretation or data overlap with other plants on company level. Please ensure that the text and description you enter in this section allows for a unique identification and that it relates exactly to the information and data which you are entering in the Plant sheet.

[1] https://gccassociation.org/sustainability-innovation/sustainability-charter-and-guidelines/

General Plant Information				1990
1	Plant	New Plant Sheet Transfer V3.04 > V3.1	New Plant Sheet V3.1	
2	Company			
3	Country			
4	Continent			
5	"Kyoto" Region (Annex 1 or non-Annex 1)			
6	Kiln types			
6a	Nominal clinker capacity		[t/d]	
6b	Plant type			
7	Shares owned by Company		[%]	
7aa	Third party verification			
7ab	Used Cement CO_2 and Energy Protocol version			V3.1
7ac	Short notes or user comment (max. 250 characters)			Recalculation with protocol V3 (GNR data

- Line001: In the first line you are asked to enter the name of your plant using the Latin alphabet. The name of your plant should be clearly distinguishable from the names of other plants on your company level and should allow for the unique identification of the plant for all users of the report. It does not matter whether you use capital or small letters.

  Additional Plant sheets are required, when you report data for several plants of one company in the same Protocol Spreadsheet. In the line001 **you will find a button with which you can create a "New Plant Sheet". For transferring plant data from version 3.04 to version 3.1 of the Protocol Spreadsheet use the button "New Plant Sheet Transfer V3.04 > V3.1". In the section "**Data transfer from V3.04 to V3.1**" you will find a step-by-step description on how to use the Plant Sheet Transfer. It is recommended to name all Plant sheets "Plant_xyz", with xyz being replaced e.g. by the name of the plant. This will help you to keep an overview of complex company structures.**
  If you are reporting for several plants of one company, the data is consolidated in the Company sheet (See "Consolidate Company Data (Aggregate Data from Plants)" (on page 99)**). In the Company sheet you can leave the** line001 **for the plant name and** line006 to line006b **blank.**

For transferring plant data from version 3.04 to version 3.1 of the Protocol Spreadsheet use the button "New Plant Sheet Transfer V3.04 > V3.1" in line001. **In the section** Data transfer from V3.04 to V3.1 **you will find a step-by-step description on how to use the Plant Sheet Transfer.**

- Line002: The second line asks you to enter the name of your company using the Latin alphabet in capital or small letters. The same name of the company should be repeated in all Plant sheets and in the Company sheet.

- Line003 and line004: These lines contain selection lists where you can easily select the country in which your plant is located. Do not forget that this sheet should be filled in on a plant level - **the country name selected should be selected as the country of the plant and not the country of the company**. The continent should be the continent to which the country you have selected above belongs, e.g. if your plant is in China and your company is in Italy, you have to select China in line003 and Asia in line004.
  Countries which are not included in the selection list provided in line003 can be referenced to the categories for “other” countries in certain continent at the end of the selection list.
- Line005: In this line you have to select the Kyoto region to which your plant country belongs. According to the Kyoto protocol, Annex I to the UNFCCC lists the developed country Parties which have special responsibilities in meeting the objective of the convention. They include the OECD countries (excl. Mexico and Korea), the countries of Eastern Europe, Russia, and the European Union. Under the Kyoto Protocol, Annex I Parties have accepted quantified emissions limitation or reduction commitments for the period 2008-2012.
- Line006, line006a and line006b: In these lines you have to select from the categories of kiln types, ranges of nominal clinker capacities, and plant types.
- Line007: This line provides the option to specify the plant share owned by the company. This information is required if the Organisational Boundaries were consolidated and set according to the equity share criterion.
- Line007aa: Select the type of third party data verification in this line. A third party type of review involves an external verifier. For details on independent verification see the revised WBCSD / WRI GHG Protocol (2004) and the Protocol Guidance Document (Appendix 8).
- line007ab: This line contains a fixed value which indicates the Protocol Spreadsheet Version which is used to generate the results in the spreadsheet.
- Line007ac and line007ad in the Company sheet: These lines can be used for short additional user notes, comments and remarks with reference to the data and information of a specific year in the Plant sheet(s) and the Company sheet. Note that only the first 30 letters are directly visible in the cell. You can however enter up to 250 letters in this field, if necessary.

5.2.1 Sheets

- See "Plant Sheet" (on page 28)

5.2.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.2.3 Line-by-Line

- See General Plant Information

5.3. Define Inventory Boundaries: Coverage of Main Process Steps

How to define the Inventory Boundaries for data in the Plant sheet

The task of defining the Organisational Boundaries and the Division into Plants is described in the first task topic. One Plant sheet is required for every facility for which you are reporting separate data. For each Plant sheet you need to specify the General Plant Information and the Inventory Boundaries, which are relevant for all data reported in this Plant sheet.

Line no.	Process Step	CO_2 Reporting Mandatory?	Comments
line007a	Raw material supply (quarrying, mining, crushing)	yes - unless n.a.	May require consolidating emissions of two legal entities if raw material supply is contracted to another company and out of the control of the cement company.
line007b	Preparation of raw materials, fuels and additives	yes - unless n.a.	
line007c	Kiln operation (pyro-processing)	yes - unless n.a.	
line007d	Cement grinding, blending	yes - unless n.a.	
line007e	On-site (internal) transports	yes - unless n.a.	CO_2 from owned vehicles (incl. leased vehicles, excl. private owner-drivers) must be reported. Third-party transports can be excluded. See Protocol Guidance Document Chapter 3.8.
line007f	Off-site transports	no	Reporting not mandatory. If reported, distinguish direct CO_2 (own vehicles, incl. leased vehicles) from indirect CO_2 (third-party vehicles). See Protocol Guidance Document Chapter 3.8.
line007g	On-site power generation	yes - unless n.a.	Also report CO_2 if operated only occasionally
line007h	Room heating / cooling	yes - unless n.a.	
line007i	(Add other process as appropriate)	n.a. - unless appropriate for completeness	Indicate the inclusion of reporting for additional plant specific processes, if appropriate, by selecting yes.

Line no.	Process Step	CO_2 Reporting Mandatory?	Comments
line007j	Use of internal cement transfers for blending	yes - unless n.a.	Indicate the reporting of data on the internal cement transfers for blending in line010c and line017a. See Protocol Guidance Document Chapter 7.4.

Table 2: Recommended inventory boundaries for voluntary reporting according to the Cement CO_2 and Energy Protocol

Please also see the Protocol Guidance Document (Chapter 2, Chapter 3.7, Chapter 3.8, Chapter 7.1, Chapter 7.4, Chapter 9.4 and Appendix A2) for further information on the inventory boundaries required by the Cement CO_2 and Energy Protocol.

Make your plant specific selection as follows:

- **"yes"** means that energy consumption and emissions data for the process step are reported.
- **"n.a."** (not applicable) means that the source does not exist at this plant, or that emissions are never generated from this source.
- **"no"** means that emissions are generated as a result of the process step, but the data are not reported -- The selection of “No” needs explanation why "No" was used, except for off-site transport. This explanation can be included (or referenced) in a short note or user comment in line007ac.

The Plant sheet will expand or contract certain sections of lines according to the selection for the Inventory Boundaries in Column E (line007a **to** line007j**). Thus, some input lines only become accessible, when needed for the reporting for this plant.**

For example, by default the input lines in the Plant sheet for kiln fuels (line101 to line156a) and for the reporting of CO_2 emissions from raw material calcination (line034d to line034s) and the selection of one of the input or output calculation methods (line007n) are closed. They only become accessible, when you select “Kiln operation = yes” in line007c.

How to set up the Plant sheet in the Inventory Boundary section

In order to set up the Plant sheet for reporting after setting the „General Plant Information“ please go through each of the lines in the section Inventory Boundaries.

There is a special method for applying the selected Inventory Boundaries to the data record of a specific year with the help of a macro by using the following procedure:

1. In order to set up the Plant sheet for reporting after setting the „General Plant Information“ please

go through each of the lines in the section Inventory Boundaries.

Change the pre-selection in line007a to line007j, column E, as required for a specific plant and year of reporting to “yes”, not applicable “n.a.” or “no”. The pre-selection is “no”.

⚠ **If you keep the selection “no”, remember to explain your selection in** line007ac.

	Inventory Boundaries: Coverage of Main Process Steps	[yes, no or n.a.]
7a	Raw material supply (quarrying, mining, crushing)	yes
7b	Preparation of raw materials, fuels and additives	yes
7c	Kiln operation (pyro-processing)	yes
7d	Cement grinding, blending	
7e	On-site (internal) transport	
7f	Off-site transport with company-owned fleets	no
7g	On-site power generation	no
7h	Room heating and cooling	no
7i	(add other processes as appropriate)	no
7j	use of internal cement transfer for blending	no
7k	Select year to copy and apply inventory boundaries (7a - 7j)	

yes
no
n.a.

2. The accessibility of specific sections of the plant sheet is controlled by defining the Inventory Boundaries in line007a to line007j, column E. The Plant sheet will expand and contract relevant sections of lines according to the selected Inventory Boundaries.

3. Apply the inventory boundary definition by selecting the relevant reporting year in line007k, column E:

	Inventory Boundaries: Coverage of Main Process Steps	[yes, no or n.a.]
7a	Raw material supply (quarrying, mining, crushing)	no
7b	Preparation of raw materials, fuels and additives	no
7c	Kiln operation (pyro-processing)	no
7d	Cement grinding, blending	no
7e	On-site (internal) transport	no
7f	Off-site transport with company-owned fleets	no
7g	On-site power generation	no
7h	Room heating and cooling	no
7i	(add other processes as appropriate)	no
7j	use of internal cement transfer for blending	no
7k	Select year to copy and apply inventory boundaries (7a - 7j)	

2006
2007
2008
2009
2010
2011
2012
2013

The macro automatically copies the inventory boundaries definition to the column of the selected year of reporting.

Inventory Boundaries: Coverage of Main Process Steps		[yes, no or n.a.]	2011
7a	Raw material supply (quarrying, mining, crushing)	yes	yes
7b	Preparation of raw materials, fuels and additives	yes	yes
7c	Kiln operation (pyro-processing)	yes	yes
7d	Cement grinding, blending	yes	yes
7e	On-site (internal) transport	yes	yes
7f	Off-site transport with company-owned fleets	yes	yes
7g	On-site power generation	yes	yes
7h	Room heating / cooling	yes	yes
7i	(add other processes as appropriate)	yes	yes
7j	use of internal cement transfer for blending	yes	yes
7k	Select year to copy and apply inventory boundaries (7a - 7j)	2011	

After defining the Inventory Boundaries for each year which is relevant for your reporting, you can enter additional data step by step into the columns of the Plant sheet. Note however, that all empty white cells must be completed. If an input value is zero (0), do not leave the cell blank but enter zero.

See further information on the "Read Me Sheet" (on page 24) regarding the Plant sheet functionality, the colour code used in the cells of the Protocol Spreadsheet and some important notes to the user.

5.3.1 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.3.2 Line-by-Line

- See Inventory Boundaries: Coverage of Main Process Steps for a line by line reference

5.4. z Select a Method for Determining CO_2 Emissions from Calcination

Kiln operation and calcination

If you select "yes" in line007c **for the kiln operation,** line007n **will become accessible. In** line007n **you must select the method for the calculation of CO_2 emission from raw material calcination.**

7n	1.) Select calcination CO_2 method (A1; A2; B1; B2) B1=Standard (no seperate calcination sheet needed). 2.) For A1; A2; B2 check if appropriate calcination sheet (CalcA1; CalcA2 or CalcB2) is already availabe next to plant sheet. 3.) If not, press the 'create' button one time in order to create one new calcination sheet. Create Calcination Sheet

CO_2 is released from carbonates during the pyro-processing of the raw meal. This calcination process is directly linked to clinker production. Hence, the calcination sheets only need to be filled in if the plant operates a kiln producing clinker. This means that line007c must be set to "yes", otherwise line007n is protected and not accessible.

When to select which calcination CO_2 method/sheet

The Cement CO_2 and Energy Protocol provides four methods for determining the CO_2 emissions from raw material calcination:

1. Input methods: **Amount of the raw meal consumed**
   - A1: Simple input method based on analysis of the loss on ignition (LOI) of raw meal
   - A2: Detailed input method based on analysis of the CO_2 released from total carbon (**TC**[1]) of raw meal (Input CO_2 balance)
2. Output methods: **Amount of clinker produced**
   - B1: Simple output method based on a standard calcination CO_2 emission factor (Cement CO_2 and Energy Protocol default: 525 kg CO_2/t clinker)
   - B2: Detailed output method based on CaO and MgO analysis of clinker and input materials (corrected calcination CO_2 emission factor)

The choice between the simple and the detailed method depends on both the intended use of reporting and the availability of data. Also, consider the completeness of your accounting and look at the example for a Mass Balance of a Kiln System in the task section on CO_2 Emissions from Calcination.The detailed reporting methods are preferred, if the data required for the more detailed methods can be made available with sufficient accuracy and within the limits of practicability. The simple methods are also intended for companies which have just started CO_2 reporting.

	Simple Input Method A1	Detailed Input Method A2	Simple Output Method B1	Detailed Output Method B2
Principle parameter and analysis method	raw meal consumed LOI[2] (weight loss on ignition)	raw meal consumed CO_2 released from total carbon (e.g. by IR-analysis of gases)[3]	clinker produced, default value	clinker produced, CaO & MgO analysis (e.g. by XRF)

[1]Total carbon
[2]Loss on Ignition
[3]CO_2 from total carbon is used as clarification for the analytical parameters of the Detailed Input Method A2. The term "CO_2 content", which is used in the Protocol Guidance Document and in the Protocol Spreadsheet, leads to misunderstandings.

	Simple Input Method A1	Detailed Input Method A2	Simple Output Method B1	Detailed Output Method B2
CO_2 from organic carbon (TOC[1])	partially included separate analysis for raw materials with high TOC content	included as part of CO_2 released from total carbon no separate accounting required	default value	TOC analysis (if relevant) or default value
CO_2 from bypass dust	included, complete calcination assumed, no analysis	residual CO_2 from total carbon	default value of clinker, complete calcination assumed	CaO & MgO analysis or default value of clinker
CO_2 from CKD[2]	LOI	CO_2 released from total carbon	default value or analysis	analysis or default value
Additional raw materials fed to calciner or kiln inlet	not covered	CO_2 released from total carbon accounted separately	included, no separate accounting required	included, no separate accounting required

Table 3: Overview of methods for the determination of CO_2 emissions from raw material calcination

Depending on the selected method (A1, A2, B2) you are now asked to "Calculate CO2 emissions from calcination" (on the facing page) in an auxiliary sheet (the so-called **Calcination sheet)**. The auxiliary sheets are hidden by default. Please note that one auxiliary sheet must be created for each plant which uses one of the three calculation methods A1, A2, B2 (see Plant sheet line007n). The simple output method B1, which is completely implemented and pre-selected in the Plant sheet, does not require an auxiliary Calcination sheet.


The Protocol Guidance Document (Chapter 3.2) describes the methods in more details.

How to create a calcination sheet

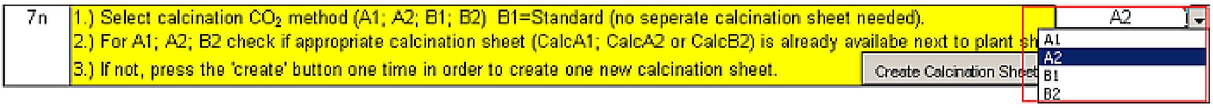
If you select a method other than B1 for the first time in a certain Plant sheet, you will need to create a new calcination sheet. You can do this in few steps as shown below.

1. Select "Yes" in line007c (as shown above).

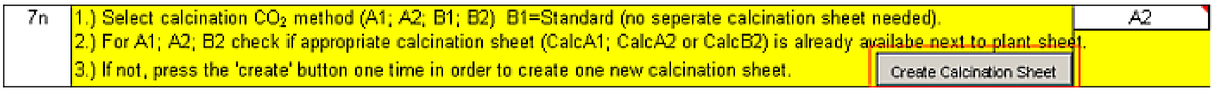
2. Select the method you want to use for the data in the Plant sheet from the drop down list of line007n.

---

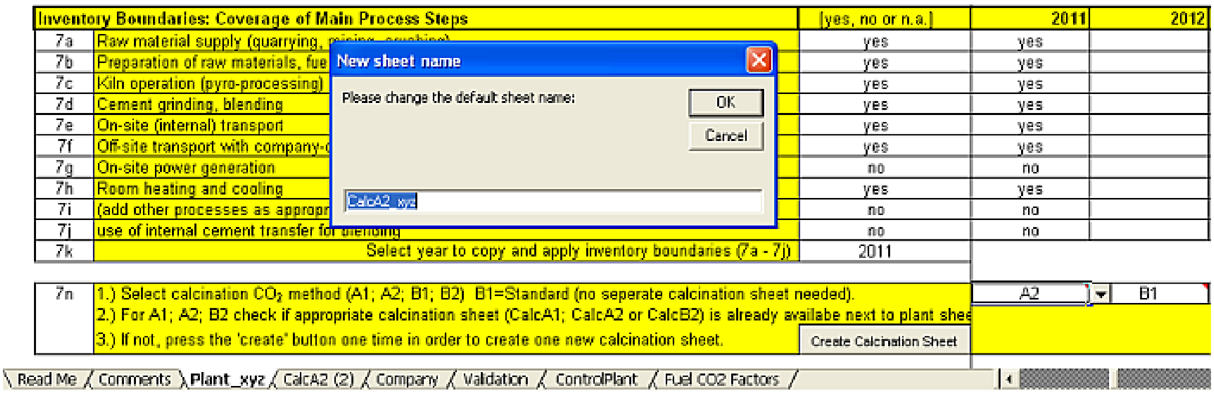
[1]Total organic carbon
[2]Cement kiln dust



3. When using this method for first time, click "Create Calcination Sheet" in order to add a new calcination sheet to your Protocol Spreadsheet.



4. A message will appear which asks you to enter the name of the new calcination sheet. Please note the following suggestion for the naming of auxiliary calcination sheets, e.g. for the detailed input method A2: "CalcA2_xyz" (instead of xyz after the underscore you can enter your plant name).



5. A new calcination sheet will be created as shown in the figure above.

Afterwards you should enter all required data in the auxiliary calcination sheet. See task CO_2 Emissions from Calcination

See task "Integrate the results of the Calcination sheet into the Plant sheet" (on page 70) for further information on how to transfer the result of your calculation from a calcination sheet into the Plant sheet.

5.5. Calculate CO_2 emissions from calcination

Depending on the selected method in the plant sheet, you are asked to calculate the values in a separate calcination sheet.

See the section "When to select which calcination CO2 method/sheet" (on page 45) for information on when to select which method.

- Method A1: see "Simple Input Method (A1) - LOI of Raw Meal" (below)
- Method A2: see "Detailed Input Method (A2) - Input CO2 Balance" (on page 53)
- Method B1: see "Simple Output Method (B1) - Standard Calcination EF" (on page 65)
- Method B2: see "Detailed Output Method (B2) - Corrected Calcination EF" (on page 67)

Where to put the results from the calcination sheet

Please see task "Integrate the results of the Calcination sheet into the Plant sheet" (on page 70) for further information on how to transfer the results from the output line(s) of your calculation from a calcination sheet into the corresponding Plant sheet.

Please note that the calcination sheet(s) will not be checked by the automatic validation tool.

5.5.1 Sheets

- See "Sheet CalcA1 (Simple Input Method)" (on page 30)
- See "Sheet CalcA2 (Detailed Input Method)" (on page 31)
- See "Sheet CalcB2 (Detailed Output Method)" (on page 31)

5.5.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.5.3 Line-by-Line

- See Calcination Sheet A1
- See Calcination Sheet A2
- See Calcination Sheet B2

5.5.4 Simple Input Method (A1) - LOI of Raw Meal

The simple input method (A1) is in principle based on the determination of the loss on ignition of raw meal (**LOI**[1]$_{RM}$, uncalcined). The loss on ignition of the kiln feed ($LOI_{kiln\ feed}$) can be used instead of LOI_{RM}, as long as the dust return is not significantly calcined (degree of calcination: d<5%) and contributes with less than 20% to the amount of kiln feed.

[1]Loss on Ignition

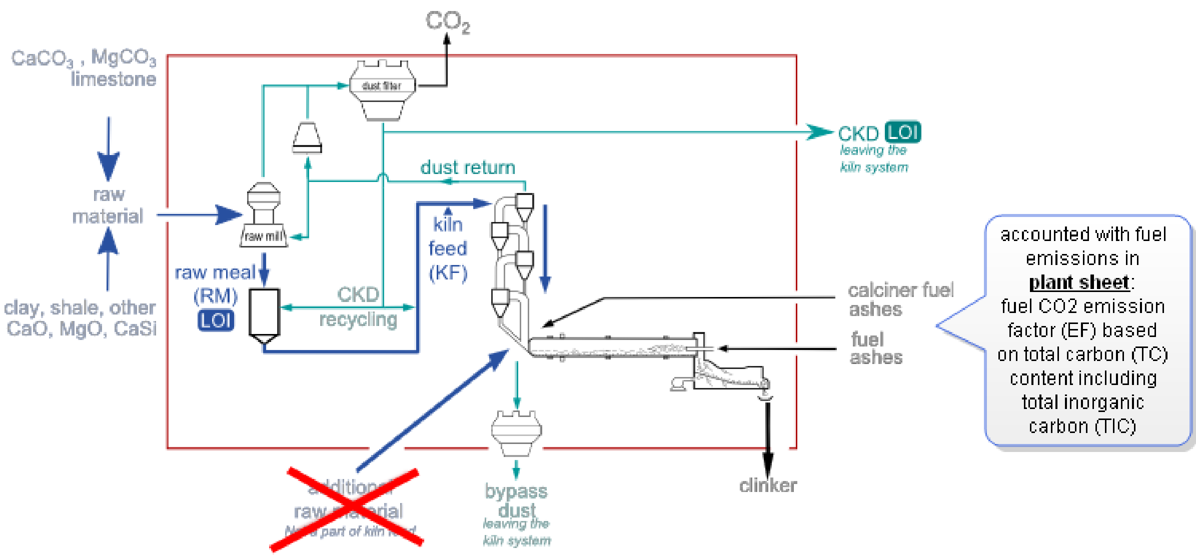
Furthermore, the simple input method (A1) accounts for CO_2 emissions from the calcination of CKD and bypass dust leaving the kiln system. For bypass dust complete calcination is assumed and no LOI analysis is required.

CO_2 emissions from the organic carbon content (TOC) of raw materials are partially included by using the LOI of raw meal as the principle parameter. However, a separate analysis and determination of CO_2 emissions from the TOC will be required for raw materials with high TOC content. This could be necessary, for example, if a plant consumes substantial volumes of shale or fly ash high in TOC content as raw materials entering the kiln.

The simple input method (A1) does not account for additional raw materials, which are not included in the kiln feed. If these are relevant for the completeness of the emission inventory, the detailed input method (A2) should be used.

Please also see the Protocol Guidance Document (Chapters, 3.2 and 3.3; Appendix A3).

Figure 2: Diagram of the simple input method (A1)



CO2 emissions from raw material calcination for clinker production

Raw meal		
500	Kiln feed (dry weight)	[t/yr]
501	Dust return correction of kiln feed	[%, dry weight]
502	Raw meal (RM) loss on ignition (LOI_{RM})	[%, dry weight]
503	Raw meal consumed = Kiln feed *(1-Dust return correction)	[t/yr]
504	CO_2 amount (LOI raw meal consumed)	[t/yr]
505	Emission factor of raw meal consumed	[tCO_2 /tRM]

CO2 emissions from calcination of bypass dust and cement kiln dust (CKD) leaving the kiln system

CKD leaving the kiln system		
510	CKD leaving the kiln system (dry weight)	[t/yr]
511	CKD loss on ignition (LOI_{CKD})	[%, dry weight]
512	CKD calcination rate *d*	[%]
513	Emission factor CKD	[tCO_2/tCKD]
514	CO_2 amount of CKD leaving the kiln system	[t/yr]

CO2 emissions from the organic carbon content (TOC) of raw materials.

Absolute CO2 emissions from calcination		
520	CO_2 amount (LOI raw meal consumed, fully calcined clinker and bypass dust)	[t CO_2/yr]
521	CO_2 amount of CKD leaving the kiln system	[t CO_2/yr]
522	Total CO_2 from raw materials (including CKD leaving the kiln system and organic carbon content)	[t CO_2/yr]

Data Simple Output Method (A1)		
525	**Output CalcA1:** Raw meal consumption (=Plant sheet lines 34e)	[t/yr]
526	**Output CalcA1:** Total CO_2 from raw materials (=Plant sheet line 34f)	[t CO_2/yr]

Use the results from those lines as input data in the plant sheet section
Data for Simple Output Method (A1)

To calculate CO_2 emissions from the calcination of raw materials by using this method:

- line500 to line504 calculate the CO_2 emissions from the calcination of raw meal (**RM**[1]) consumed based on the loss on ignition of the raw meal (LOI_{RM}). The determination is based on the amount of raw meal consumed, i.e. the measured amount of kiln feed corrected for dust return, in order to prevent double counting of the recycled part of the kiln feed. For line501 please also see the additional information on Determination of dust return correction regarding Input Methods (A1) and (A2).

- Lines 510 to 514: The simple input method (A1) accounts for CO_2 emissions from bypass dust leaving the kiln system by assuming its complete calcination.
- Lines 520 to 522 determine the total CO_2 emissions from the calcination of raw materials.

[1]Raw meal

Use the results in lines525 and line526 as input data in the plant sheet section Data for Simple Output Method (A1).

Please note:

- Please note that the total inorganic carbon (TIC) in fuel ash, like carbonates, is already accounted for as fuel CO_2 emissions based on fuel CO_2 emission factors (EF) determined from the total carbon (TC) content.
- Residual humidity and the organic carbon content (TOC) of the raw meal consumed are part of the LOI of the raw meal and accounted for as CO_2 emissions.
- If $LOI_{kiln\ feed}$ is used as the principle parameter, the relative difference between LOI_{RM} and $LOI_{kiln\ feed}$ should be < 1% and the degree of calcination in the dust return from the pre-heater should not exceed 5%. This is normally the case for the dry process with cyclone pre-heaters.

Calculation Details

The calculations of CO_2 emissions from raw meal are based on the following equation:

Equation 1: Total CO_2 from raw materials (method A1)

$$\begin{aligned} CO_2\ raw\ materials = Kiln\ Feed \\ & \times (1 - Dust\ Return\ Correction) \\ & \times LOI_{RM} \\ & + CKD\ leaving\ kiln\,system \times EF_{CKD} \end{aligned}$$

with:

- *CO_2 from raw materials [t CO_2/yr] = plant sheet* line039*: Total CO_2 from raw materials*
- *Kiln Feed = Kiln feed in t/yr*
- *Dust Return Correction = Dust return correction in (%) of the kiln feed*
- *LOI_{RM} = Loss on ignition of raw meal in %*
- *CKD leaving kiln system = CKD leaving the kiln system in t/yr*
- *EF_{CKD} = Emission factor of CKD leaving the kiln system in t CO_2/t_{CKD}*

Please note that the parameter CKD here refers only to the amount of CKD leaving the kiln system (IPCC: "discarded kiln dust"). The corresponding CO_2 emission factor is determined as described in the Protocol Guidance Document, Section 3.3, in reference to Equation 1 and 2, whereby the fractions of carbonate CO_2 of raw meal ($fCO2_{RM}$) and of CKD leaving the kiln system ($fCO2_{CKD}$) are estimated from analyses of the loss on ignition (LOI_{RM} and LOI_{CKD} respectively).

Equation 2: CO_2 emission factor for CKD (Protocol Guidance Document, Section 3.3, Equation 1 expressed for method A1)

$$EF_{CKD} = \frac{LOI_{RM} \times d}{1 - LOI_{RM} \times d}$$

with:

- *EF_{CKD} = Emission factor of CKD leaving the kiln system in t CO_2/t_{CKD}*
- *LOI_{RM} = Loss on ignition of raw meal in %*
- *d = Degree of calcination*

Equation 3: Degree of calcination of CKD leaving the kiln system (Protocol Guidance Document, Section 3.3, Equation 2 expressed for method A1)

$$d = 1 - \frac{LOI_{CKD} \times (1 - LOI_{RM})}{(1 - LOI_{CKD}) \times LOI_{RM}}$$

with:

- *LOI_{CKD} = Loss on ignition for CKD in %*
- *LOI_{RM} = Loss on ignition of raw meal in %*

Note: The total inorganic carbon (**TIC**[1]) in fuel ash originating from carbonates is already accounted for as fuel CO_2 emissions based on fuel CO_2 emission factors (EF) determined from the total carbon (TC) content.

[1]Total inorganic carbon

Where to put the results from the calcination sheet

Please see task "Integrate the results of the Calcination sheet into the Plant sheet" (on page 70) for further information on how to transfer the results from the output line(s) of your calculation from a calcination sheet into the corresponding Plant sheet.

Please note that the calcination sheet(s) will not be checked by the automatic validation tool.

5.5.4.1 Sheets

- See "Sheet CalcA1 (Simple Input Method)" (on page 30)

5.5.4.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.5.4.3 Line-by-Line

- See Calcination Sheet A1

5.5.5 Detailed Input Method (A2) - Input CO_2 Balance

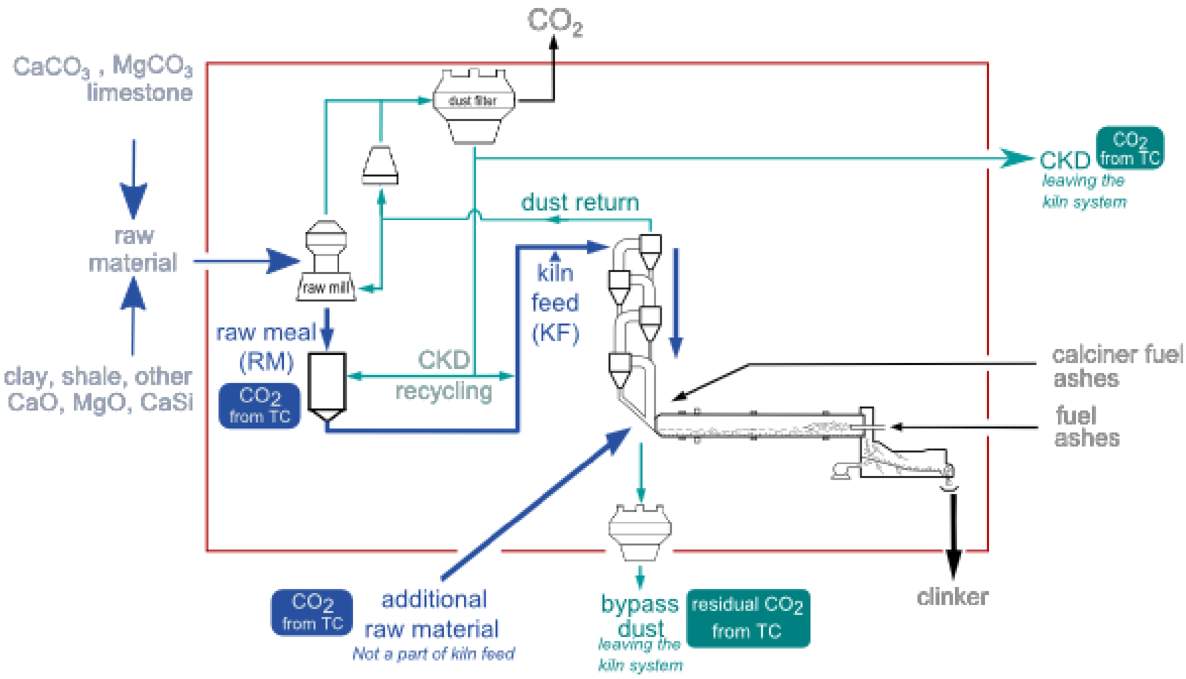
This method is in principle based on determining the amount of raw meal consumed and analysing the CO_2 released from total carbon (**TC**[1]) of raw meal (uncalcined). The CO_2 released from TC[2] of the kiln feed can be used instead if it is demonstrated, that no systematic difference exists between both parameters, and that the complete CO_2 emissions are reported, with regard to the limits of accuracy and practicality.
The detailed input method (A2) accounts for CO_2 emissions from the organic carbon content (TOC) of raw materials and the calcination of bypass dust, **CKD**[3] leaving the kiln system.


Please also see the Protocol Guidance Document (Chapter 3.3).

The following diagram illustrates the flow of mass and dust in a cement plant.

[1] Total carbon
[2] CO_2 from total carbon is used as clarification for the analytical parameters of the Detailed Input Method A2. The term "CO_2 content", which is used in the Protocol Guidance Document and in the Protocol Spreadsheet, leads to misunderstandings.
[3] Cement kiln dust

Figure 3: Diagram of the detailed input method (A2)



The names of mass flows in the diagram directly relate to the reporting with the calcination sheet CalcA2:

Raw meal			1990
600	Kiln feed	[t/yr, dry weight]	
601	Dust return correction of kiln feed	[%, dry weight]	
602	Raw meal CO_2 content ($fCO2_{RM}$)	[%, dry weight]	
603	Raw meal consumed = Kiln feed *(1-Dust return correction)	[t/yr]	0
604	CO_2 amount (CO_2 of raw meal consumed)	[t CO_2/yr]	0
605	Emission factor of raw meal consumed	[tCO_2/tRM]	

Additional raw material # 1 (not part of kiln feed)			1990
610	Additional raw material (ARM)	[t/yr, dry weight]	
611	ARM CO_2 content	[%, dry weight]	
612	ARM CO_2 amount	[t CO_2/yr]	0

- The section Raw meal in the calcination sheet contains the information on the amount of kiln feed, its correction for dust return and the analysis of the total CO_2 released from TC of the raw meal. See the additional information on the determination of dust return correction regarding input methods (A1) and (A2).

  Line600 to line603 calculate the calcination of raw meal consumed, in order to prevent double counting of the recycled part of the kiln feed. The corresponding amount of CO_2 is determined based on the **CO_2 released from TC[1] of the raw meal** (RM). The complete CO_2 emissions of the raw meal must be determined. This can be done e.g. by total carbon (TC) analysis (or CO_2 IR-analysis of the gases released from the heated and fully oxidised sample).

- The section Additional raw material # 1 (not part of kiln feed) (#1 - #10; # = number) contains the amount of additional raw materials and the analysis of their CO_2 released from TC.

- The section Bypass dust correction for uncalcined fraction refers to the amount of bypass dust and its residual CO_2 from total carbon in the diagram.

- The section CKD leaving the kiln system in the calcination sheet refers only to the amount of cement kiln dust (CKD) and its CO_2 released from TC that is not recycled to the kiln feed in the diagram.
- Lines 671 to 676 determine the total CO_2 emissions from the **calcination of raw materials** (TIC) and from their **organic carbon content** (TOC).

Calculation Details

Equation for the detailed input method (A2) as implemented in the auxiliary sheet CalcA2:

[1] CO_2 from total carbon is used as clarification for the analytical parameters of the Detailed Input Method A2. The term "CO_2 content", which is used in the Protocol Guidance Document and in the Protocol Spreadsheet, leads to misunderstandings.

Equation 4: Detailed Input Method (A2)

$$
\begin{aligned}
CO_2\ Raw\ Materials\ = \\
& Kiln\ Feed \times (1 - DustReturnCorrection) \times fCO2_{RM} \\
& + CKDleavingkilnsystem \times EF_{CKD} \\
& BypassDleavingkilnsystem \times fCO2_{BypassD} \\
& + \sum_i (ARM_i \times fCO2_{ARM,i})
\end{aligned}
$$

where:

- *CO_2 Raw Materials = total CO_2 from raw materials (t CO_2/yr), Plant sheet* line039
- *Kiln Feed = amount of kiln feed measured at plant level (t/yr)*
- *Dust Return Correction = fraction of returned dust with reference to the Kiln Feed*
- *$fCO2_{RM}$ = weight fraction of CO_2 released from TC[1] in the raw meal*
- *CKD leaving kiln system = amount of cement kiln dust leaving the kiln system (t/yr)*
- *EF_{CKD} = CO_2 emission factor of partially calcined cement kiln dust (t CO_2/t CKD) based on TC*
- *BypassD leaving kiln system = amount of bypass dust leaving the kiln system (t/yr)*
- *$fCO2_{BypassD}$ = weight fraction of CO_2 released from TC in the bypass dust*
- *ARM_i = amount of additional raw material i (t/yr), which is not part of the Kiln Feed*
- *$fCO2_{ARM,i}$ = weight fraction of CO_2 released from TC in the additional raw material i*

In the case of using the values from a $CaCO_3$ and $MgCO_3$ analysis, the CO_2 emissions from the total organic carbon content (TOC) of the raw materials consumed must be added manually in order to determine the correct input values for the CO_2 released from TC and the "Total CO_2 from raw materials" (line676) according to the detailed input method (A2).

[1] CO_2 from total carbon is used as clarification for the analytical parameters of the Detailed Input Method A2. The term "CO_2 content", which is used in the Protocol Guidance Document and in the Protocol Spreadsheet, leads to misunderstandings.

Equation 5: Total CO_2 from raw material

$$fCO_2 = \left(\frac{CaCO_3}{M_{CaCO3}} + \frac{MgCO_3}{M_{MgCO3}} \right) \times M_{CO2} + \frac{Total\ Organic\ Carbon\ (TOC)}{M_C} \times M_{CO2}$$

where:

- *fCO_2 = weight fraction of carbonate CO_2 (%)*
- *$CaCO_3$, $MgCO_3$ = relative amount of elements (%)*
- *Total Organic Carbon (TOC) = relative amount of organic carbon (%)*
- *M_{CaCO3} = 100.087 g/mol (*)*
- *M_{MgCO3} = 84.314 g/mol (*)*
- *M_C = 12,010 g/mol (*)*
- *M_{CO2} = 44,010 g/mol (*)*

* *Please also see* " List of Constants and Default CO2 emission factors " (on page 108)

The CO_2 released from inorganic carbon of the input materials and **CKD**[1] and bypass dust leaving the kiln system can alternatively be determined from $CaCO_3$ and $MgCO_3$ analysis (CO_2 from total inorganic carbon, TIC). In this case the CO_2 emissions from the organic carbon content (TOC) of the raw materials consumed must be added manually to determining the input values for lines 602, 611, 614, 617, etc. in order to account for the complete CO_2 emissions (CO_2 from total carbon content TC = **TIC**[2]+**TOC**[3]).

[1]Cement kiln dust
[2]Total inorganic carbon
[3]Total organic carbon

Please note:

- The resulting "Total CO_2 from raw materials" in line 671 and 676 should in any case account for CO_2 emissions from the total carbon (TC, including CO_2 from organic carbon) content of raw materials according to the detailed input method (A2).
- CO_2 emissions from TIC and TOC of additional raw materials (**ARM**[1]), which are not part of the kiln feed, should be accounted for by filling in lines 610 to 639 as appropriate.
- The CO_2 emissions from the organic carbon content (TOC) of additional raw materials are correctly accounted for in lines 610 to 639 by specifying the complete CO_2 emissions.
- As for raw meal, this can be done e.g. by total carbon (TC) analysis (or CO_2 IR-analysis of the gases released from the heated and fully oxidised sample).

Adjustments to the concept of the input method: In special cases an adjustment of the concept of the input methods might be necessary in order to reflect certain material flows in a plant and to ensure that they are correctly accounted for. In this case, the corresponding adjustments should be made in a customised auxiliary sheet, not in the plant sheet. The adjustments should be explained, and accompanied by an overview of all relevant material flows. Furthermore it should be demonstrated that CO_2 emissions from the complete and partial calcination of raw materials and from the organic carbon content of raw materials are completely and more accurately accounted for by the adjusted method.

Please also see the Protocol Guidance Document (Chapter 3.3).
An **alternative method of accounting for CO_2 emissions** from additional raw materials with very high organic carbon content (TOC) is described in the Protocol Guidance Document.

Where to put the results from the calcination sheet

Please see task "Integrate the results of the Calcination sheet into the Plant sheet" (on page 70) for further information on how to transfer the results from the output line(s) of your calculation from a calcination sheet into the corresponding Plant sheet.

Please note that the calcination sheet(s) will not be checked by the automatic validation tool.

5.5.5.1 Sheets

- See "Sheet CalcA2 (Detailed Input Method)" (on page 31)

[1] Additional raw materials

5.5.5.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

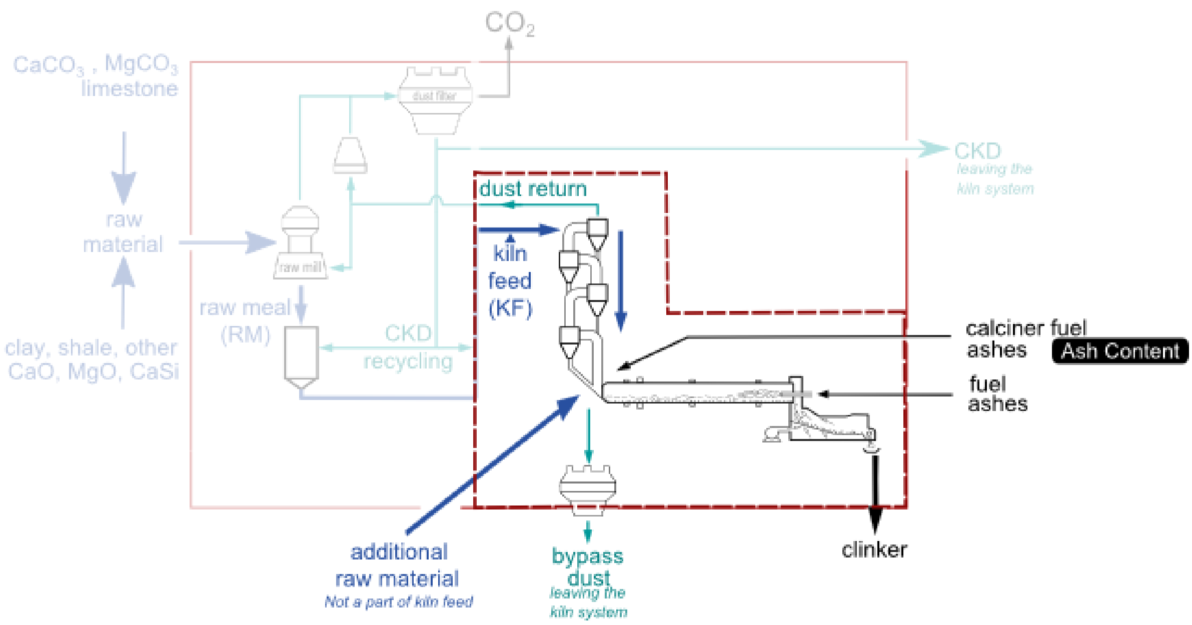
5.5.5.3 Line-by-Line

- See Calcination Sheet A2

5.5.6 Input Method Dust Return Correction

In the diagram of the mass balance of a kiln system the green lines represent the dust path through the system. Some values and parameters within this path are required for reporting in case you are using the simple input method A1 or the detailed input method A2. The **principle parameter** for reporting the CO_2 emissions of raw material calcination according to the input methods is the amount of **raw meal consumed for clinker production**. This parameter depends on the kiln feed and the dust return from the preheater system. Thus, the amount of raw meal consumed must be quantified from a **kiln mass balance**, which is indicated by the **red dashed line** in the following diagram:

Figure 4: Diagram of a kiln mass balance



Which values and parameters are required regarding dust?

If you take a look at the "Sheet CalcA1 (Simple Input Method)" (on page 30) or "Sheet CalcA2 (Detailed Input Method)" (on page 31) you will find the following lines for reporting the values of the dust mass flows:

- Dust return correction of kiln feed: line601 and line501
  The correction of the kiln feed by the rate of dust return prevents double counting of recycled dust.
- CKD leaving the kiln system (dry weight): line655 and line510
- CKD CO_2 released from total carbon (TC)[1] on line656 or CKD loss on ignition LOI_{CKD} on line511
- Bypass dust leaving the kiln system: line650 and its residual CO_2 from TC in line651

Which methods can be used to calculate the dust return correction?

The fraction of dust return with reference to the kiln feed shall be determined at plant level. For that purpose different methods can be applied. The necessary evaluations shall be documented in addition to the Protocol Spreadsheet. Two common methods for determining the dust return correction are the following:

1) **Dust return weighing**:

If you have the equipment in your plant which allows you to weigh the dust return directly, then you can use data recorded by your weighing system for the dust return and relate it to the data recorded for the amount of kiln feed in certain periods or through the year in order to determine the dust return correction.

2) **Determining the fraction of dust return from a kiln mass balance:**

The fraction of the dust return can also be determined from a kiln mass balance. For this method the weighing of clinker and the analysis of the input materials and fuel ash content is required. For the calculations you can use the following mass balance formula:

summation of mass entered to kiln = summation of mass leaving the kiln

Then:

[1] CO_2 from total carbon is used as clarification for the analytical parameters of the Detailed Input Method A2. The term "CO_2 content", which is used in the Protocol Guidance Document and in the Protocol Spreadsheet, leads to misunderstandings.

Equation 6: Kiln mass balance

$$KF \times (1 - DR) = \frac{P - F \times FA - ARM \times (1 - LOI_{ARM}) + BypassD \times (1 - LOI_{BypassD})}{1 - LOI_{RM}}$$

where:

- *KF = Kiln feed in tonne per day (t/d)*
- *DR = Dust return correction in percentage (%)*
- *P = Clinker production in tonne per day (t/d)*
- *F = Fuel consumption in tonne per day (t/d)*
- *FA = Fuel ash content in percentage (%)*
- *ARM = Additional raw materials in tonne per day (t/d)*
- *LOI_{ARM} = Loss on ignition of additional raw materials in percentage (%)*
- *$BypassD$ = Bypass dust in tonne per day (t/d)*
- *LOI_{BD} = Loss on ignition of bypass dust in percentage (%)*
- *LOI_{RM} = Loss on ignition of raw meal dust in percentage (%)*

In any case, the methods applied for determining the fraction of dust return and the kiln mass balance should provide sufficient accuracy. If the determination is based on certain periods of kiln operation, these periods have to be representative for the operation of the kiln during the reporting year.

Please see "Example for calculating the dust return correction" (below) for an example on how to calculate the dust return correction.

5.5.7 Example for calculating the dust return correction

In order to calculate the dust return correction of the kiln feed you have to evaluate a mass balance based on your own calculations beside the Protocol Spreadsheet. In this topic a practical example of this calculation is presented.

The example refers to a plant with a production of 1 million tonnes of clinker per year. The dust return correction of the kiln feed must be determined in order to determine the CO_2-emissions from raw material calcination by one of the two input methods (A1, A2) in the Protocol Spreadsheet. Raw meal consumed means the amount of raw meal consumed for the production of clinker in the kiln including calcined bypass dust leaving the kiln system: For the determination of the dust return correction, two methods have been suggested in the topic ""Input Method Dust Return Correction" (on page 59)".

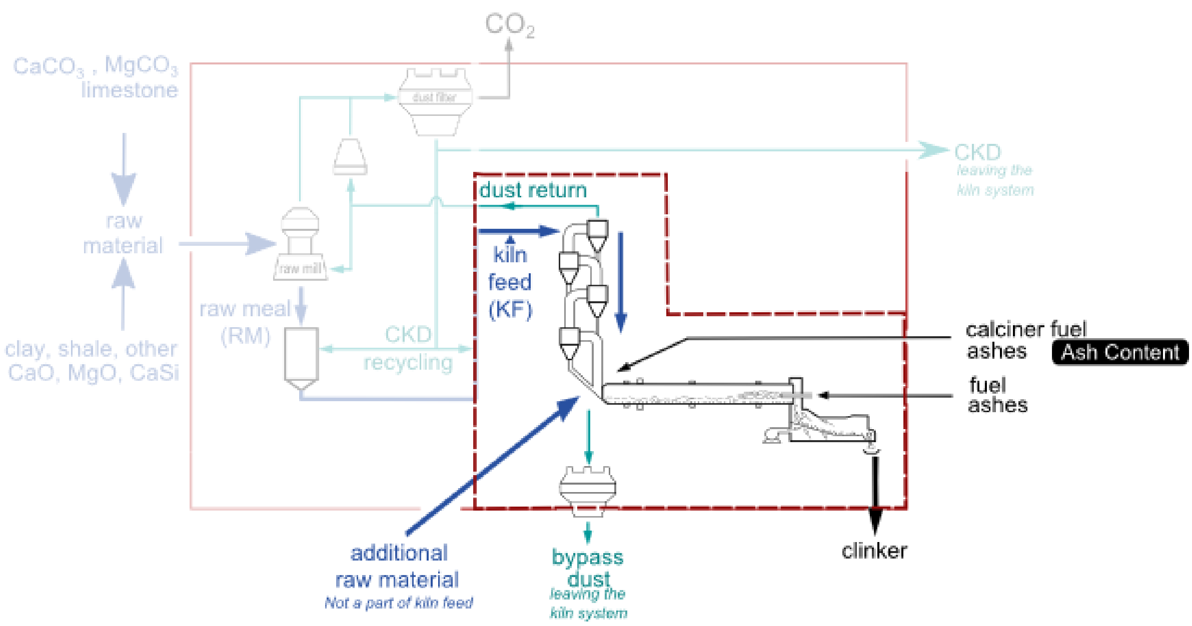
1) **Dust return weighing**:
If you have the possibility in your plant to weigh the dust return directly, you can use the measured mass values for determining the fraction of dust return in relation to the total amount of kiln feed either in certain periods or throughout the year. This method can be applied by measuring the amount of kiln feed and the amount of dust return during a certain period of one day or several hours. Therefore the complete dust return should be measured on a calibrated process scale or by exporting it to trucks and measuring the amount of dust return on a truck scale.

Equation 7: Dust return

$$KF \times (1-DR) = KF \times (1-\text{Weight of dust return} / KF)$$
$$DR = \text{Weight of dust return} / KF$$

with:

- *KF = Kiln Feed in tonnes per day (t/d)*
- *DR = Dust Return correction in percentage (%)*
- *Weight of dust return in tonnes per day (t/d)*



2) **Determining the fraction of dust return from a kiln mass balance:**
If weighing of the dust return is not an option for you, the fraction of dust return can be determined from a kiln mass balance. On the input side of the kiln system there are the kiln feed (KF in the equation below) minus the dust return fraction (DR), additional raw materials (ARM, not part of the kiln feed) and fuel ashes (FA). On the output side stand clinker production (P) and bypass dust leaving the kiln system. Since the LOI (Loss on Ignition) of the raw meal and the additional raw materials is also a mass output of the system, a correction of these material masses for their LOI has to be conducted as well as for potentially incomplete calcination of bypass dust.

This kiln mass balance is described by the following equation:

Equation 8: Kiln mass balance

$$KF \times (1-DR) \times (1-LOI_{RM}) + ARM \times (1-LOI_{ARM}) + F \times FA = P + BypassD \times (1-LOI_{BypassD}) \quad (1)$$

$$KF \times (1-DR) = \frac{P - F \times FA - ARM \times (1-LOI_{ARM}) + BypassD \times (1-LOI_{BypassD})}{1-LOI_{RM}} \quad (2)$$

$$DR = 1 - \frac{P - F \times FA - ARM \times (1-LOI_{ARM}) + BypassD \times (1-LOI_{BypassD})}{KF \times (1-LOI_{RM})} \quad (3)$$

where:

- *KF = Kiln Feed in tonnes per day (t/d)*
- *DR = Dust Return correction in percentage (%)*
- *P = Clinker Production in tonnes per day (t/d)*
- *F = Fuel consumption in tonnes per day (t/d)*
- *FA = Fuel Ash content in percentage (%)*
- *ARM = Additional Raw Materials in tonnes per day (t/d)*
- *LOI_{ARM}= Loss On Ignition of additional raw materials in percentage (%)*
- *BypassD = Bypass Dust in tonnes per day (t/d)*
- *$LOI_{BypassD}$ = Loss On Ignition of bypass dust in percentage (%)*
- *LOI_{RM} = Loss On Ignition of raw meal in percentage (%)*

Note that: The value of (F×FA) is equal to the summation of all fuel types used for clinker production, for example (F×FA) = $(F \times FA)_{kiln\ fuel\ type\ 1}$ + $(F \times FA)_{kiln\ fuel\ type\ 2}$ + $(F \times FA)_{calciner\ fuel}$

Thus, the amount of kiln feed should be weighed during a kiln test period (e.g. 24 h), in which the operation conditions are representative for the kiln operation during the whole reporting year. Such kiln tests should be repeated regularly in order to assure correct reporting of the total raw meal consumed for clinker production, i.e. the kiln feed corrected for the fraction of dust return. Using the data of such a kiln test, the correction for dust return "DR" remains as the only unknown in the equation above. It is assumed, that the rate of dust return remains more or less stable and represents the efficiency of separation of the upper cyclone(s) of the kiln system.

Calculation Example

For the example, the following values are assumed for the parameters, which have to be measured in each kiln system:

P	=	3,000 tonnes per day	
KF	=	5,100 tonnes per day	
F	=	500 tonnes per day	
FA	=	7%	(physical property of all fuels determined as mass weighted average from laboratory analysis of the individual fuel types)
ARM	=	153 tonnes per day	(in this example 3% of kiln feed)
LOI_{ARM}	=	40 %	
BypassD	=	102 tonnes per day	(in this example 3.4% of clinker production and calcination rate d= 95%)
$LOI_{BypassD}$	=	2.6%	
LOI_{RM}	=	35%	

Inserting these numbers into the equation above, the following amount of kiln feed minus dust return mass is determined, which is the amount of raw meal consumed:

KF × (1 - DR) = (3,000 (t/d) - 500 (t/d) × 7% - 153 (t/d) × (1 - 40%) + 102 (t/d) × (1 - 2.6%)) / (1 - 35%)

KF × (1 - DR) = **4,573 (t/d)**

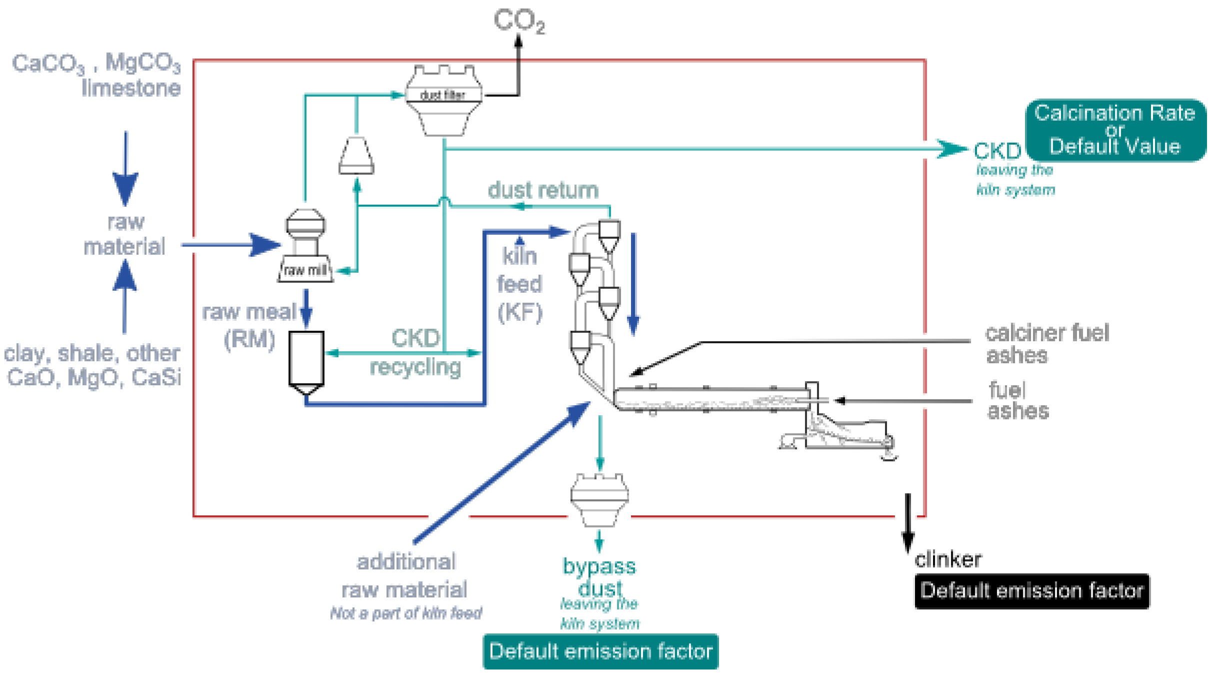
Solving the equation for DR yields the fraction of dust return correction according to equation

DR = 1 - 4,573 tonnes per day/5,100 tonnes per day = 10.33%

5.5.8 Simple Output Method (B1) - Standard Calcination EF

B1 is the simple output method for determining the CO_2 emission from the calcination of raw materials. The method is based on clinker production, CKD and bypass dust leaving the kiln system and one standard CO_2 emission factor for the calcination CO_2 referenced to clinker (Cement CO_2 and Energy Protocol default = 525 kg CO_2/t clinker). It has no separate calcination sheet as the other calculation methods have, but its data fields have been integrated into the plant sheet. For this reason, the simple output method is the pre-selection in line007n. Applying the detailed calcination CO_2 methods B2 (output) or A2 (input) is preferable, if more detailed and sufficiently accurate data can be made available.

Figure 5: Diagram of the simple output method (B1)



Please also see the Please also see the Protocol Guidance Document (Chapter 3.4).

The relevant input lines in the Plant sheet are:

- line008: Clinker Production
- line022, line023 and line024: Bypass dust and cement kiln dust (CKD) leaving the kiln system

The calcination rate d of the CKD should preferably be based on plant-specific data. In the absence of such data, a default value of 0 should be used for dry process kilns because CKD is usually not or only to a negligible degree calcined in a dry process. In other processes (half dry, half-wet or wet) calcination rates can be significant. In the absence of data, a default value of 1 should be used for these kiln types. This value is conservative, i.e. it will in most cases lead to an overstatement of CKD-related emissions.

Equation 9: Calcination rate d of CKD

The calcination rate d of CKD can be determined according to the analysis of the loss on ignition (LOI) of CKD and raw meal (RM) according to the following equation:

$$d = 1 - \frac{LOI_{CKD} \times (1 - LOI_{RM})}{(1 - LOI_{CKD}) \times LOI_{RM}}$$

where:

- *LOI_{CKD} = weight loss on ignition of the CKD*
- *LOI_{RM} = weight loss on ignition of the raw meal*

The Protocol Guidance Document (Appendix 3) provides more detailed information on how to determine the calcination CO_2 emissions and the degree of calcination d based on analysis of the CO_2 content of CKD and raw meal.

line034m, line034n, line034o:

The grey colour of the input cells in the Plant sheet indicates that default values were pre-selected. These values shall be corrected by the cement company if more precise data are available

The standard calcination emission factor (EF) shall preferably be based on plant-specific data. National or regional standard values are also acceptable in the simple output method B1. In the absence of better data, a default value of 525 kg CO_2/t clinker shall be used. This value is comparable to the IPCC default (510 kg CO_2/t) corrected for typical MgO contents in clinker.

5.5.8.1 Sheets

- See "Sheet CalcB2 (Detailed Output Method)" (on page 31)

5.5.8.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

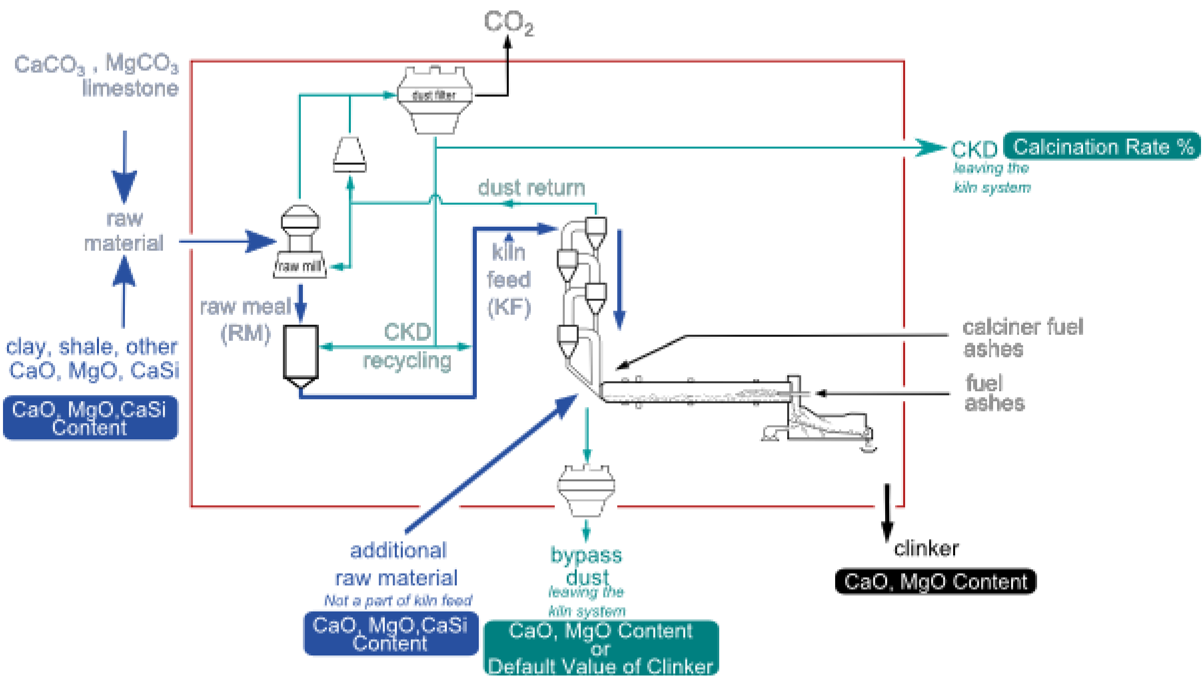
5.5.8.3 Line-by-Line

- See Calcination Sheet B2

5.5.9 Detailed Output Method (B2) - Corrected Calcination EF

The detailed output method (B2) accounts for CO_2 emissions from the calcination process per tonne of clinker produced.

Figure 6: Diagram of the detailed output method (B2)



To apply the detailed clinker-based output method, companies should use their plant-specific data related to clinker and dust leaving the kiln system:

1. The analysis of the CaO and MgO content of clinker and the input of raw materials is required for determining a corrected calcination emissions factor (EF) in the auxiliary sheet CalcB2.
2. The CO_2 emissions resulting from the calcination of bypass dust and cement kiln dust (CKD) leaving the kiln system are accounted for in the Plant sheet, as described for the simple output method (B1).

Clinker # 1		
700	Clinker produced	[t/yr]
701	CaO content (incl. free lime)	[%]
702	MgO content	[%]
703	CaO amount	[t/yr]
704	MgO amount	[t/yr]

Clinker # 2		
705	Clinker produced	[t/yr]
706	CaO content (incl. free lime)	[%]
707	MgO content	[%]
708	CaO amount	[t/yr]
709	MgO amount	[t/yr]

(If more than 2 types of clinker are produced, add lines for clinkers #3 - n, and adjust formulae in lines 730, 733 and 734)

Total clinker		
730	Total clinker produced	[t/yr]
731	Average CaO content (incl. free lime)	[%]
732	Average MgO content	[%]
733	Total CaO amount	[t/yr]
734	Total MgO amount	[t/yr]

ection for non-carbonate sources of CaO, MgO found in clinker (input of CaO and MgO into kiln, e.g. raw materials whi

Raw material # 1		
740	non-carbonate source in raw material consumed	[t/yr, dry weight]
741	CaO content	[%, dry weight]
742	MgO content	[%, dry weight]
743	CaO amount	[t/yr]
744	MgO amount	[t/yr]

Raw material # 1		
780	Ca/Mg-silicate source Raw material consumed	[t/yr, dry weight]
781	Ca content of Ca-Silicate raw materials	[%, dry weight]
782	Mg content of Mg-Silicate raw materials	[%, dry weight]
783	CaSi amount	[t/yr]
784	MgSi amount	[t/yr]

Please also see the Protocol Guidance Document (Chapter 3.4).

Correct calculation of the CO_2 emission factor for the calcination of raw materials:

- Lines 700-734 calculate the amount of CaO and MgO that is contained in the clinker. Data entered in must represent all clinker produced to ensure completeness of reporting.
- Lines 740-774 calculate the amount of CaO and MgO in the clinker which stems from non-carbonate sources. Only pre-calcined raw materials entering the kiln (e.g. fly ash, slag) and

natural raw materials with relevant content of non-carbonate CaO and MgO must be reported here. Recycled dust should not be counted.

- Lines 780-804 calculate the amount of Ca and Mg in the clinker which stems from silicate sources. Only raw materials entering the kiln and raw materials with relevant content of Ca-silicate and Mg-silicate must be reported here. Recycled dust should not be counted.
- Lines 810-813 automatically calculate the CO_2 emissions based on the amounts of CaO and MgO found in clinker and correct them for non-carbonate and silicate sources of CaO and MgO.

Please note:

If that raw material inputs contain significant amounts of carbonates other than $CaCO_3$, $MgCO_3$ and $CaMg(CO_3)_2$, such as e.g. $FeCO_3$, $MnCO_3$, Na_2CO_3, K_2CO_3, then a CO_2 equivalent should be added to the MgO content of clinker for the CO_2 emissions from calcination of these carbonates in order to assure complete reporting of CO_2 emissions.

Calculation Details

Data Detailed Input Method (B2)		
820	**Output CalcB2:** Calcination emission factor corrected for non-carbonate and silicate sources of CaO,MgO in clinker (=Plant	[kg CO_2/t cli]

Use the corrected calcination emission factor from line820 as input data in the Plant sheet section Data for Detailed Input Method (B2).

Where to put the results from the calcination sheet

Please see task "Integrate the results of the Calcination sheet into the Plant sheet" (on the next page) for further information on how to transfer the results from the output line(s) of your calculation from a calcination sheet into the corresponding Plant sheet.

Please note that the calcination sheet(s) will not be checked by the automatic validation tool.

5.5.9.1 Sheets

- See "Sheet CalcB2 (Detailed Output Method)" (on page 31)

5.5.9.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.5.9.3 Line-by-Line

- See Calcination Sheet B2

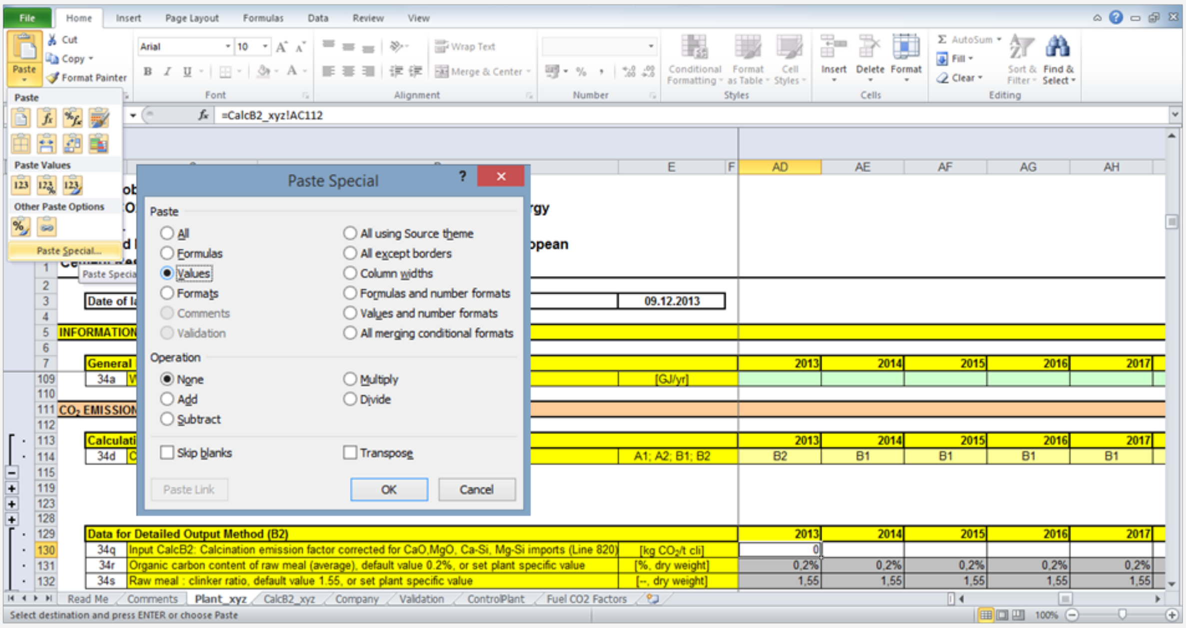
5.5.10 Integrate the results of the Calcination sheet into the Plant sheet

Important note:

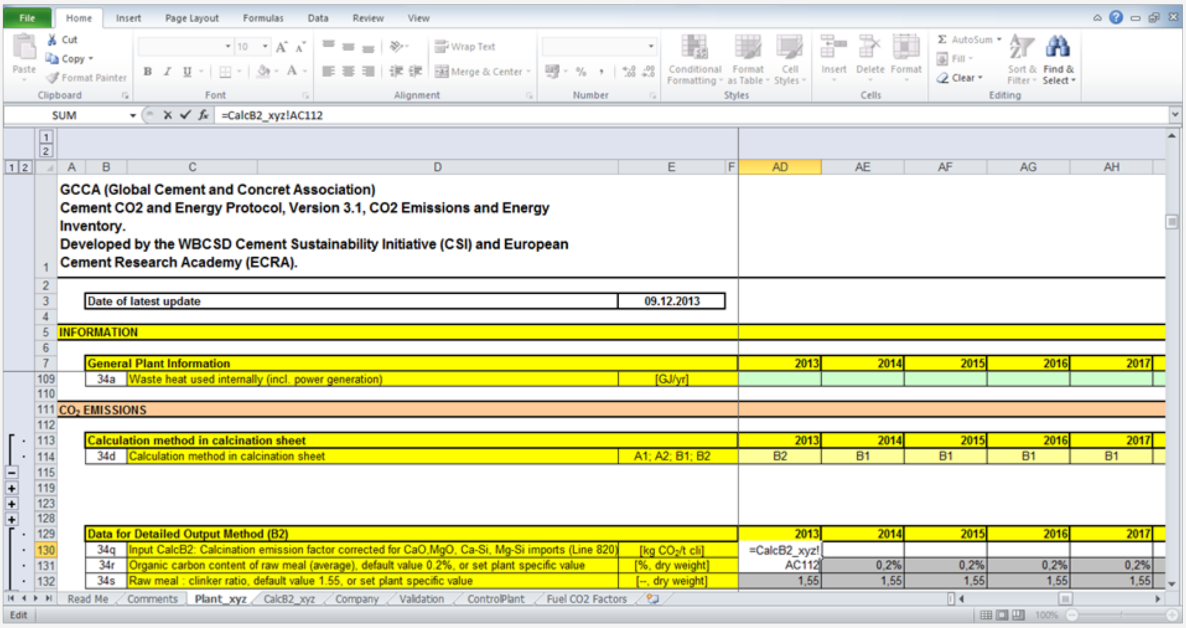
The results from the Calcination sheets are not (!) automatically transferred into the Plant sheet. In order to use the results from your calculations in the Calcination sheets, the results for each plant must be entered by hand in the corresponding Plant sheet.

For copying results from the output cell to the input cell in the Plant sheet, the simple ‘copy & paste’ function in Excel is not (!) suitable.
Instead, please use either:

Option a) Use the Excel® functions ‘copy & paste special... > paste value’.



Option b) Insert an Excel® formula in the input cell in the Plant sheet for copying the value from the corresponding Calcination sheet, e.g. for the following cell in the Plant sheet: Plant_ xyz!AB130 ‘=CalcB2_xyz!AA112’.



Please check carefully that you are copying the data of the correct year. Note that for example data for the year 2011 are recorded in column AB in the Plant sheet and in column AA in the Calcination sheets.

The steps for integrating the results from the Calcination sheets into the corresponding Plant sheet are summarised below:

1. First "Calculate CO2 emissions from calcination" (on page 47)
2. Manually copy the results of 1 or 2 output data from the Calcination sheet to the corresponding input cells in the Plant sheet (line034d to line034s, depending on the calculation method in the Calcination sheet).

Calculation method in calcination sheet			**1990**
34d	Calculation method in calcination sheet		
Data for Simple Input Method (A1)			**1990**
34e	Input CalcA1: Raw meal consumption (Line 525)		
34f	Input CalcA1: Total CO_2 from raw materials (Line 526)		
Data for Detailed Input Method (A2)			**1990**
34i	Input CalcA2: Raw meal consumption (Line 681)		
34j	Input CalcA2: Total CO_2 from raw materials (Line 682)		
Data for Simple Output Method (B1)			**1990**
34m	Standard calcination emission factor [default 525 kg CO_2/t clinker]	[kg CO_2/ t cli]	525
34n	Organic carbon content of raw meal (average), default value 0.2%, or set plant specific value	[%, dry weight]	0,2%
34o	Raw meal : clinker ratio, default value 1.55, or set plant		1,55
Data for Detailed Output Method (B2)			**1990**
34q	Input CalcB2: Calcination emission factor corrected for CaO,MgO, Ca-Si, Mg-Si imports (Line 820)	[kg CO_2/ t cli]	
34r	Organic carbon content of raw meal (average), default value 0.2%, or set plant specific value	[%, dry weight]	0,2%
34s	Raw meal : clinker ratio, default value 1.55, or set plant specific value	[--, dry weight]	1,55

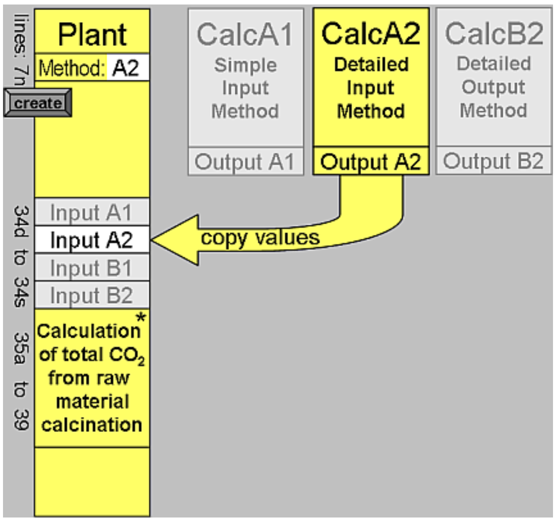
34e: Waste heat exported to third parties

34f: parameters for simple input method (A1)

34i: parameters for detailed input method (A2)

34j: parameters for detailed input method (A2)

parameter for detailed output method (B2)



Please note:

- In the case of the simple input method (A1), the data from line525 and line526 must be copied to the Plant sheet line034e and line034f.
- In the case of the detailed input method (A2), the data from line681 and line682 must be copied to the Plant sheet line034i and line034j.
- The simple output method (B1) does not use an auxiliary Calcination sheet.
- In the case of the detailed output method (B2), the data from line820 must be copied to the Plant sheet line034q.

In the case of the simple or detailed output methods (B1 or B2) the corresponding input values in grey cells (line034m to line034o or line034r and line034s) should be adjusted to plant-specific values, if possible. Please see the further explanation for the simple output method (B1).

5.5.10.1 Sheets

- See "Plant Sheet" (on page 28)

5.5.10.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

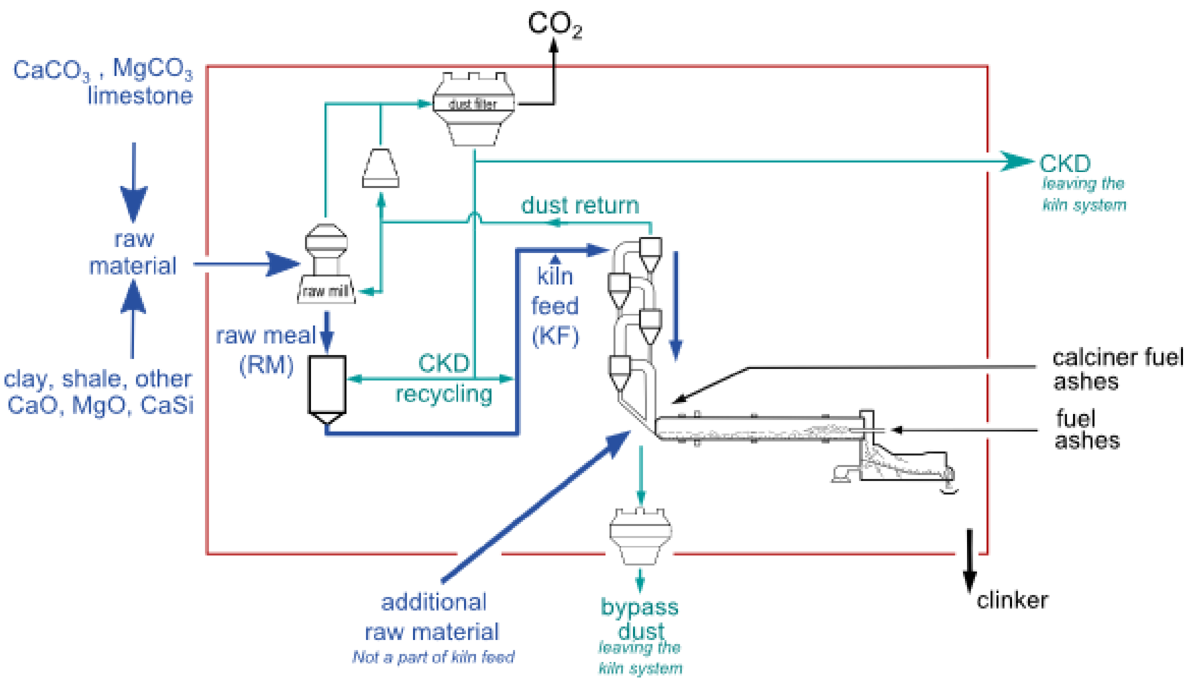
5.5.10.3 Line-by-Line

- See Data for Simple Input Method (A1)
- See Data for Detailed Input Method (A2)
- See Data for Simple Output Method (B1)
- See Data for Detailed Output Method (B2)

5.5.11 Mass Balance of a Kiln System

The following diagram illustrates an example of the mass flows in a cement plant and the mass balance of a kiln system from raw meal (RM) to clinker.

Figure 7: Schematic diagram of material and dust flows in a cement plant



The reporting of CO_2 emissions from the calcination of raw materials depends on the principle choice of the method for determining the mass balance: 1. from the input side (raw meal consumption) or 2. from the output side (clinker production).

Accordingly, you need to consider the reporting of the mass flows **Bypass dust**[1], cement kiln dust (**CKD**[2]) leaving the kiln system (and crossing the red boundary in the diagram) and additional raw materials (**ARM**[3]), which are not part of the normal kiln feed, as follows:

1. **Simple input method (A1) and detailed input method (A2):** The actual amount of raw meal consumed for clinker production can be determined by weighing the kiln feed and subtracting the **Dust return**[4].

- **Bypass dust** leaving the kiln system is accounted for in the amount of raw meal consumed. Additional calculations may be required if the bypass dust is only partially calcined. This is implemented only in the detailed input method (A2): line650
- **CKD recycling** remains within the mass balance and therefore does not need additional reporting.
- **CKD leaving the kiln system** (and crossing the red boundary in the diagram) needs to be quantified and requires additional reporting in the input methods (A1 and A2): line510 or line655
- **Additional raw materials (ARM)** which are not part of the kiln feed are not accounted for by the amount of raw meal consumed. Thus, they require additional reporting in the input methods. However, the necessary calculations are only implemented in the detailed input method (A2): line610 to line630. The simple input method (A1) should therefore not be used if **ARM**[5] are relevant for the complete reporting of the CO_2 emissions.

2. **Simple output method (B1) and detailed output method (B2):** The amount of clinker production can be determined from calculating the clinker mass balance (see Clinker and Cement Production) or by direct weighing.

- **Bypass dust** leaving the kiln system requires separate reporting: line022
- CKD recycling remains within the mass balance. Thus, it does not need additional reporting.

---

[1]Discarded dust from the bypass system dedusting unit of suspension preheater, precalciner and grate preheater kilns, normally consisting of kiln feed material which is fully calcined or at least calcined to a high degree.
[2]Cement kiln dust
[3]Additional raw materials
[4]This part of the kiln feed is not consumed for clinker production or to form bypass dust but is transported back by the gas flow (opposite direction to the mass flow) and (firstly) out of the preheater system. It is returned to the dust cycle, which often involves the raw mill and a dust filter system. Relatively small amounts of cement kiln dust (CKD) leaving the kiln system originate from this dust cycle and dust return.
[5]Additional raw materials

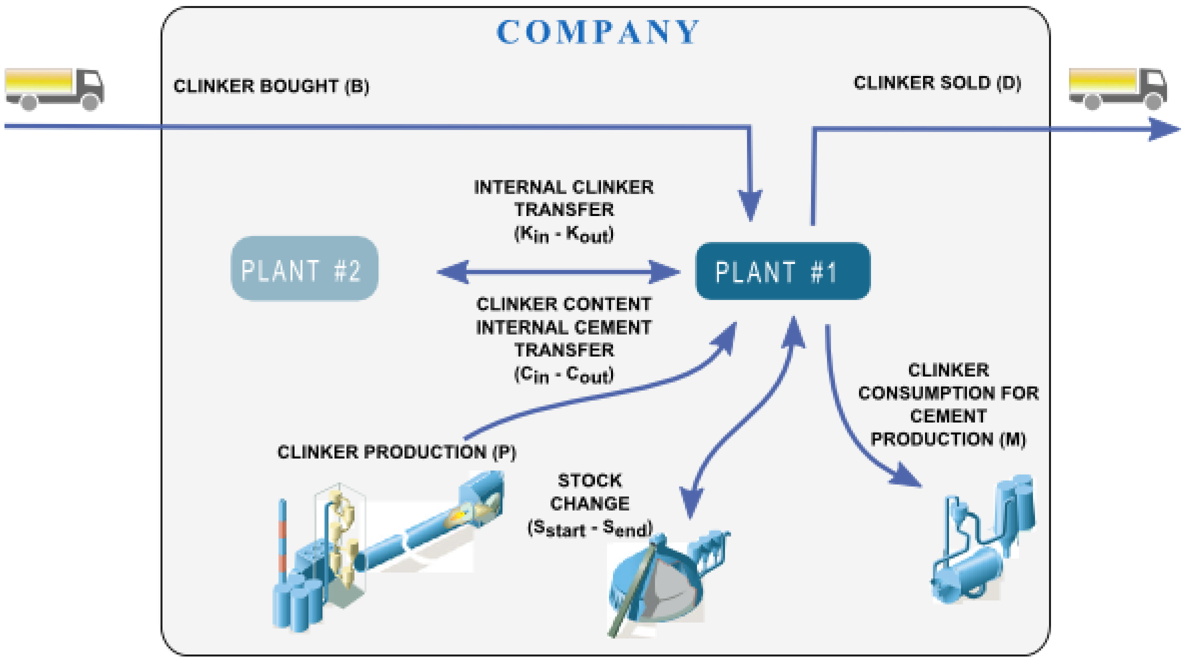
- The mass flow of **CKD**[1] **leaving the kiln system** (and crossing the red boundary in the diagram) needs to be accounted for additionally: line023.
- **Additional raw materials (ARM)** do not need to be accounted for additionally in the output methods, which are based on the clinker production.

5.6. Data on Clinker and Cement Production

The task of entering the data on clinker and cement production is related to a **mass balance** which should be determined on at plant level. The following plant mass balance diagram will help you to obtain the requested values as required for correct calculations.

Please also see the Protocol Guidance Document (Chapters 7.4 and 6.4).

Figure 8: Schematic diagram on how to determine the clinker mass balance in a plant (e.g. Plant #1)



A second way to a better understanding of the mass balance is the explanation of the mass balance equation. As shown above on the diagram; the inputs and outputs of clinker and also the clinker content in the cement have been taken into account.

[1] Cement kiln dust

Clinker mass balance

Clinker mass balance means:

sum of clinker input = sum of clinker output

Equation 10: Clinker mass balance

For the clinker mass balance at plant level this means:

$$B + S_{start} + C_{in} + K_{in} + P = D + S_{end} + C_{out} + K_{out} + M$$

where:

- B = *the clinker which is bought from other companies.*
- S_{end} = *the amount of clinker in stock at the end of the reporting year*
- C_{in} = *the amount of clinker in cement which is received from other plants of the same company (internal transfer).*
- K_{in} = *the clinker amount, which is received from other plants of the same company (internal transfer).*
- P = *amount of clinker produced*
- D = *the clinker amount which is sold to other companies.*
- S_{start} = *the amount of clinker in stock at the start of the reporting year.*
- C_{out} = *the amount of clinker in cement which is sent to other plants of the same company (internal transfer).*
- K_{out} = *the clinker amount which is sent to other plants of the same company (internal transfer).*
- M = *the amount of clinker consumed for cement production.*

The **amount of clinker consumed** which is calculated in line011 in the Plant sheet can therefore be expressed by the following equation:

Equation 11: Clinker consumption

$$M = P + B - D - (S_{end} - S_{start}) + (C_{in} - C_{out}) + (K_{in} - K_{out})$$

where:

- *M = the amount of clinker consumed for cement production.*
- *P = amount of clinker produced*
- *B = the clinker which is bought from other companies.*
- *D = the clinker amount which is sold to other companies.*
- *S_{end} = the amount of clinker in stock at the end of the reporting year*
- *S_{start} = the amount of clinker in stock at the start of the reporting year.*
- *C_{in} = the amount of clinker in cement which is received from other plants of the same company (internal transfer).*
- *C_{out} = the amount of clinker in cement which is sent to other plants of the same company (internal transfer).*
- *K_{in} = the clinker amount, which is received from other plants of the same company (internal transfer).*
- *K_{out} = the clinker amount which is sent to other plants of the same company (internal transfer).*

In Plant sheet line numbers, this means:
line011 = line008 + line009 - line010 - line010a + line010b + line010c

The following sections refer to the consumption and processing of mineral components.

In addition to the consumption of clinker for cement production, the sum of mineral components consumed for cement production is represented in line018 named ‘Total MIC consumed for Portland and blended cements’.

In addition to the sales of cements, the sales of processed mineral components are summarized in line019 named ‘Total processed MIC's used as clinker or cement substitute sold externally’.

The different types of materials produced are summarised in lines020, line021, line021a and line021b.

Please also see the Protocol Guidance Document (Chapter 6.2) and the glossary for more details on the following definition of the products clinker, cement (equivalent) and cementitious products.

Please refer to the Protocol Guidance Document (Chapter 7.4) for information on the correct accounting of internal transfers of clinker, cement and mineral components (MIC) in the Plant sheets and the Company sheet in relation to line010b, line010c, line017a and line019c.

Clinker, line008:
In the context of this Protocol, clinker refers to grey and white clinker used for the production of grey and white cement. The production of clinker is the main source of CO_2 in cement production.

Cement (equivalent), line021b:
Cement (equivalent)[1] is a cement production value, which is determined from clinker produced on-site applying the plant specific clinker/cement-factor. Hence, it is a virtual cement production under the assumption that all clinker produced in a plant is consumed for cement production in the same plant and applying the real plant specific clinker/cement factor.

Cementitious products, line021a:
Cementitious products[2] consist of all clinker produced by the reporting company for cement making or direct clinker sale, plus gypsum, limestone, CKD and all clinker substitutes consumed for blending, plus all cement substitutes. The terms “cementitious products” or “binders” are used, as it is a sum of clinker and mineral components. Clinker bought from third parties for the production of cement is excluded here, since this clinker is already included in the inventory of the third party. Note that the denominator excludes the following:

- Bought clinker, used for cement production; line650
- Granulated slag and fly ash from coal fired power plants, which are stored or sold to another company without any processing for changing their properties (e.g. grinding or thermal treat-

[1]Cement (equivalent) is a cement production value which is determined from clinker produced on-site applying the plant specific clinker/cement-factor. Hence it is a virtual cement production under the assumption that all clinker produced in a plant is consumed for cement production in the same plant and applying the real plant specific clinker-/cement factor.

[2]All clinker produced by the reporting company for cement making or direct clinker sale, plus gypsum, limestone, CKD and all clinker substitutes consumed for blending, plus all cement substitutes. For this denominator, the terms “cementitious products” or “binders” are used, as it is a sum of clinker and mineral components. The denominator excludes clinker bought from third parties for the production of cement, since this clinker is already included in the inventory of the third party.

ment);

- Cement volumes which are traded without any processing.

Cementitious products can therefore be described as the total of all cements and clinker produced by a cement company, excluding the clinker purchased from another company and used to make cement.

Cement, line020:

Cement[1] in the Protocol refers to building materials made by grinding clinker together with various mineral components such as gypsum, limestone, blast furnace slag, coal fly ash and natural volcanic material. It acts as the binding agent when mixed with sand, gravel or crushed stone and water to make concrete. While cement qualities are defined by national standards, there is no worldwide, harmonized definition or standard for cement. In the Cement CO_2 and Energy Protocol and the “**Getting the Numbers Right**[2]” database, “cement” includes all hydraulic binders that are delivered to the final customer, i.e., including all types of Portland cements, composite cements and blended cements, but excluding direct sales of pure clinker”.

Please also see the Protocol Guidance Document (Chapter 6.3) and the Glossary.

5.6.1 Sheets

- See "Plant Sheet" (on page 28)

5.6.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.6.3 Line-by-Line

- See Clinker and Cement Production

[1] A 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. It acts as the binding agent when mixed with sand, gravel or crushed stone and water to make concrete. While cement qualities are defined by national standards, there is no worldwide, harmonised definition or standard for cement. In the "WBCSD - CSI Cement CO2 and Energy Protocol" and the "Getting the Numbers Right" database, both now managed by GCCA, "cement" includes all hydraulic binders that are delivered to the final customer, i.e., including all types of Portland, composite and blended cements, plus ground granulated slag and fly ash delivered to the concrete mixers, but excluding pure clinker.

[2] The GNR (“Getting the Numbers Right” or “GCCA in NumbeRs”) is a key tool in how key sustainability progress is monitored and reported. The GNR database is now managed by the GCCA, having transferred at the end of 2018 from the Cement Sustainability Initiative (an initiative run through the World Business Council for Sustainable Development).

5.7. Calculate Dust Production Leaving the Kiln System

For bypass dust and cement kiln dust (**CKD**[1]) mass flows leaving the kiln system you should fill in the following section in the Plant sheet. This section will be opened if you select "Yes" for kiln operation in line007c.

Dust Production (dry weight)			1990
22	Bypass dust leaving kiln system	[t/yr, dry weight]	0
23	CKD leaving the kiln system	[t/yr, dry weight]	0
24	CKD calcination rate *d* (Plant specific value or default 0%= dry kilns, 100%= for other kiln types)	[%]	0%

The amount of bypass dust and CKD leaving the kiln system should reflect your measurements at the plant level.

If you have selected the simple input method (A1) or the detailed input method (A2) for determining the CO_2 emissions from calcination, then the amount of CKD leaving the kiln system must be specified also in the corresponding auxiliary sheets CalcA1 (line510) or CalcA2 (line655). In the simple input method (A1) bypass dust is assumed to be fully calcined (as clinker). If this is not the case, the detailed input method (A2) can be used to account for partially calcined bypass dust in the auxiliary sheet CalcA2 (line650).

Please see the information on how to calculate the plant specific value for the CKD calcination rate *d* in the description of the different methods available for the determination of CO_2 emissions from calcination.

The Protocol Guidance Document (Appendix A3) provides more detailed information for determining the CKD calcination rate *d*.

What is meant by dust production leaving the kiln system?

The extraction of **Bypass dust**[2] and cement kiln dust (**CKD**[3]) from the kiln system serves to control the input of excessive circulating elements (alkali, sulphur, chlorine), particularly in cases of low-

[1]Cement kiln dust

[2]Discarded dust from the bypass system dedusting unit of suspension preheater, precalciner and grate preheater kilns, normally consisting of kiln feed material which is fully calcined or at least calcined to a high degree.

[3]Cement kiln dust

alkaline clinker production. The term “CKD” is sometimes used to denote all dust from cement kilns, i.e. also from bypass systems. Dust is relevant for complete CO_2 reporting if it is fully or partly calcined and not recycled but leaving the kiln system, i.e. discarded bypass dust and dust from long dry, semi dry, semi wet and wet kiln system dedusting units, consisting of partly calcined kiln feed material (see also "Input Method Dust Return Correction" (on page 59)).

Please see the example of a mass flow diagram and the "Mass Balance of a Kiln System" (on page 73).

5.7.1 Sheets

- See "Plant Sheet" (on page 28)

5.7.2 Line-by-Line

- See Dust Production (dry weight)

5.8. Fuel Energy and CO_2 Emissions

The reporting of fuel consumption in the Protocol Spreadsheet is separate for kiln and non-kiln fuels.

- **Kiln fuels** are all fuels used in and for the clinker production process. This means those fuels fed to the kiln system plus fuels that are used for the drying or processing of raw materials for the production of clinker and the preparation of other kiln fuels.
- **Non-kiln fuels** are all other fuels used in the plant, which are not included in the definition of kiln fuels. For instance fuels used for plant and quarry vehicles, room heating, thermal process equipment (e.g. dryers) for the preparation of mineral components for cement grinding or in an installation separate from the kiln for on-site production of electrical power.

This separation is relevant for assessing the fuel and energy consumption of clinker production and the definition of several **KPI**[1]s of the Cement CO_2 and Energy Protocol.

The Protocol Guidance Document (Chapters 3.7, 3.8 and 5) provides more detailed guidance for reporting kiln and non-kiln fuels.

[1]Key Performance Indicator

The Protocol considers a number of different **fuel categories** and corresponding **fuel parameters**, which should be determined at plant level. Please see the description for these tasks in the corresponding sub-topics.

5.8.1 Enter Kiln Fuel Consumption

Kiln fuels are all fuels used in and for the clinker production process. This means those fuels fed to the kiln system plus fuels that are used for the drying or processing of raw materials for the production of clinker and the preparation of other kiln fuels.

Line101 to line123 are used to report those kiln fuels fed directly to the kiln or calciner of a kiln system (excluding drying of raw materials and fuels).

Kiln Fuel Consumption in tonnes per year		
101	**Conventional fossil fuels (excl. drying of raw materials and fuels)**	
102	coal + anthracite	[t/yr]
103	petrol coke	[t/yr]
104	(ultra) heavy fuel	[t/yr]
105	diesel oil	[t/yr]
106	natural gas	[1'000 Nm^3/yr]
107	shale	[t/yr]
107a	lignite	[t/yr]
108	**Alternative fossil and mixed fuels (excl. drying of raw materials and fuels)**	
109	waste oil	[t/yr]
110	tyres	[t/yr]
111	RDF including plastics	[t/yr]
112	solvents	[t/yr]
113	impregnated saw dust	[t/yr]
113a	mixed industrial waste	[t/yr]
114	other fossil based wastes and mixed fuels	[t/yr]
115	**Biomass fuels (excl. drying of raw materials and fuels)**	
116	dried sewage sludge	[t/yr]
117	wood, non impregnated saw dust	[t/yr]
118	paper, carton	[t/yr]
119	animal meal	[t/yr]
120	animal bone meal	[t/yr]
121	animal fat	[t/yr]
122	agricultural, organic, diaper waste, charcoal	[t/yr]
123	other biomass	[t/yr]

Whereas the fuels used for drying or processing of raw materials for the production of clinker and the preparation of other kiln fuels are reported separately (but also as kiln fuels) in line124 to line126a.

Drying of raw materials and fuels		
124	Conventional fossil fuels	
124a	coal + anthracite + lignite	[t/yr]
124b	petrol coke	[t/yr]
124c	(ultra) heavy fuel	[t/yr]
124d	diesel oil	[t/yr]
124e	natural gas	[1'000 Nm^3/yr]
124f	shale	[t/yr]
125	Alternative fossil and mixed fuels	
125a	other fossil based wastes and mixed fuels	[t/yr]
126	Alternative biomass fuels	
126a	other biomass	[t/yr]

It is usual in cement plants that many types of fuels are used in kiln operations, e.g. coal, different types of fossil fuels, alternative fuels, biomass fuels, etc.

The consumption of each fuel type has to be determined at plant level in tonnes per year [t/yr]. Note that natural gas consumption should be reported in units of 1000 normal cubic meters per year [1000 Nm^3/yr]. For example, if your consumption of natural gas in the kiln system was 27000 Nm^3 in a certain year of reporting, enter the value of 27 in line106.

If you are using other kinds of fuels which are not covered by a certain category in a section, you are asked to report these fuel types in the lines which indicate "other" types of fuel. In addition to the amount of fuel consumption, the corresponding Fuel Parameters of the lower heating value (**LHV**[1]), the emission factor (**EF**[2]) for **Mixed fuels**[3] and also the biogenic carbon content (Cbio/TC) should be determined.

For an overview of the fuel types used in the Plant sheet and their reporting parameters, please see Fuel Categories and "Parameters for Reporting Fuel Energy Use and CO2 Emissions" (on page 90).

For the **fuel "coal"** for instance, input is needed in the following lines:

- t/yr of coal that is used as **kiln-fuel** (not for drying!): line102
- t/yr of coal that is used for the **drying of raw materials and fuels** only: line124a
- Lower Heating Value (**LHV**[4]) of coal in GJ/t: line132
- CO_2 emission factors in GJ/t for coal: line186 (default value given)

[1]Lower heat value
[2]Emission factor
[3]Term used in this Guidance Document for referring to fuels that are a mix of biomass and fossil fuel, i.e. fuel with a certain biogenic carbon content.
[4]Lower heat value

The kiln fuel consumption is summarised as energy use in terajoules per year [TJ/yr] in line025 to line028.

Kiln Fuel Consumption incl. raw material and fuel drying		
25	Total heat consumption of kilns	[TJ/yr]
25a	Total heat consumption of kilns excluding drying of fuels and raw materials	[TJ/yr]
26	Conventional fossil fuels	[TJ/yr]
27	Alternative fuels, fossil content; excluding biomass fraction of mixed fuels	[TJ/yr]
28	Biomass fuels, incl. biomass content of alternative fuels	[TJ/yr]

Further evaluations of energy use and CO_2 emissions from fuels are provided in the KPI section.

Please also see the Protocol Guidance Document for further guidance on the reporting of fuel energy use and CO_2 emissions (Chapters 3.5, 3.6, 3.7 and 5).

5.8.1.1 Sheets

- See "Plant Sheet" (on page 28)
- See "Fuel CO2 Factors Sheet" (on page 34) for standard emission factors

5.8.1.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.8.1.3 Line-by-Line

- See Kiln Fuel Consumption in tonnes per year

5.8.2 Enter Non-Kiln Fuel Consumption

For an overview of the fuels used in the sheet as well as the usage of lower heating values please see "Fuel Energy and CO2 Emissions" (on page 81).

Non-kiln fuels are all other fuels used in the plant, which are not included in the definition of kiln fuels. For instance fuels used for plant and quarry vehicles, room heating, thermal process equipment (e.g. dryers) for the preparation of mineral components for cement grinding or in an installation separate from the kiln for on-site production of electrical power.

The following different sections of non-kiln fuel use will be required and opened in the Plant sheet according to your selection for the definition of the inventory boundaries:

- Equipment and on-site vehicles
- Room heating and cooling

- Drying of mineral components
- On-site power generation

Different types of fuels may be used in these operations in your plant. The consumption of each fuel type has to be determined at plant level in tonnes per year [t/yr]. Note that natural gas consumption should be reported in units of 1000 normal cubic meters per year [1000 Nm^3/yr].

Non-Kiln Fuel Consumption in tonnes per year			1990
301	Equipment and On-Site Vehicles fossil fuels		
301a	diesel oil	[t/yr]	0
301b	gasoline	[t/yr]	0
301ba	other fossil fuels	[t/yr]	0
301c	Equipment and On-Site Vehicles fuels (containing biomass)		
301d	bio and mixed diesel	[t/yr]	0
302	Room Heating and Cooling		
302a	diesel oil	[t/yr]	0
302b	natural gas	[1'000 Nm^3/yr]	0
302c	other fossil fuels	[t/yr]	0
303	Drying of mineral components		
303k	Conventional fossil fuels		
303a	coal + anthracite+ lignite	[t/yr]	0
303b	petrol coke	[t/yr]	0
303c	(ultra) heavy fuel	[t/yr]	0
303d	diesel oil	[t/yr]	0
303e	natural gas	[1'000 Nm^3/yr]	0
303f	shale	[t/yr]	0
303g	Alternative fossil and mixed fuels		
303h	other fossil based wastes and mixed fuels	[t/yr]	0
303i	Alternative biomass fuels		
303j	other biomass	[t/yr]	0
304	On-site power generation		
304aa	Conventional fossil fuels		
304a	coal + anthracite + lignite	[t/yr]	0
304b	(ultra) heavy fuel	[t/yr]	0
304c	diesel oil	[t/yr]	0
304d	natural gas	[1'000 Nm^3/yr]	0
304i	petrol coke	[t/yr]	0
304j	other fossil fuels	[t/yr]	0
304f	Alternative fossil and mixed fuels		
304g	other fossil based wastes and mixed fuels	[t/yr]	0
304h	Alternative biomass fuels		
304e	other biomass	[t/yr]	0

Here you have the ability to add more fuels which are not included in the sheet in case it is used in your plant and not covered by the protocol.

If you are using **other kinds of fuels** which are not covered by a certain category in a section, you are asked to report these fuel types in the lines which indicate "other" types of fuel.

In addition to the amount of fuel consumption, the corresponding Fuel Parameters of the lower heating value (**LHV**[1]), the emission factor (**EF**[2]) for mixed fuels and also the biogenic carbon content (Cbio/TC) should be determined.

For an overview of the fuel types used in the Plant sheet and their reporting parameters, please see Fuel Categories and "Parameters for Reporting Fuel Energy Use and CO2 Emissions" (on page 90).

For the **IPCC**[3] and Cement CO_2 and Energy Protocol default CO_2 emission factors of the fuels please see the "Fuel CO2 Factors Sheet" (on page 34).

The non-kiln fuel consumption is summarized as energy use in terajoules per year [TJ/yr] in line030 to line032.

Non-Kiln Fuel Consumption			1990
30	Equipment and on-site vehicles	[TJ/yr]	0
31a	Room heating and cooling	[TJ/yr]	0
31b	Drying of mineral components	[TJ/yr]	0
31c	On-site power generation	[TJ/yr]	0
32	Total non-kiln fuel consumption	[TJ/yr]	0

Further evaluations of energy use and CO_2 emissions from fuels are provided in the "List of Key Performance Indicators (KPI)" (on page 107).

Please also see the Protocol Guidance Document for further guidance on the reporting of fuel energy use and CO_2 emissions (Chapters 3.5, 3.6, 3.8).

5.8.2.1 Sheets

- See "Plant Sheet" (on page 28)

5.8.2.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.8.2.3 Line-by-Line

- See Non-Kiln Fuel Consumption

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1 Lower heat value
2 Emission factor
3 Intergovernmental Panel on Climate Change

5.8.3 Fuel Categories

In the following sections you will find general information on the fuel categories used for reporting in the Protocol Spreadsheet.

Note that the CO_2 emissions from all fuels reported in one category are evaluated with one common CO_2 emission factor (EF) and for mixed fuels also with one biogenic carbon content. The values corresponding to each fuel category are defined in line186 **to** line209**.**

Conventional fossil fuels

coal + anthracite

This class of fuel encompasses several kinds of coal. Waste coal may also be included which is a by-product of coal processing, containing coal, along with trace minerals, dirt, and other materials.

petrol coke

Petrol coke (or petcoke) is a carbon-based solid derived from oil refineries.

(ultra) heavy fuel

Heavy fuel is a flammable liquid consisting of a complex mixture of hydrocarbons of various molecular weights and other liquid organic compounds.

diesel oil

Standard diesel oil is assumed to consist of 100% fossil carbon. One CO_2 emission factor is defined for standard diesel oil in line189. Alternatively, a fuel category “bio and mixed diesel” is available for the equipment and on-site vehicles fuels (see Alternative fossil and mixed fuels).

natural gas

Note that the amounts of natural gas are reported in the unit [1000 Nm3/yr]. Nm^3 refers to normal cubic meters at 1013 hPa and 0 °C.

shale

Shale is a sedimentary rock that can serve as a fuel when it has a high carbon content.

lignite

Lignite is a soft brown type of coal. It is also referred to as “brown coal”. Its lower heating value (LHV) is normally smaller than the LHV of hard coal or anthracite.

gasoline

Refined liquid fuel obtained from petroleum especially used for car engines.

other fossil fuels (Equipment and On-Site Vehicles)

Category for all fossil fuels used for equipment and on-site vehicles other than diesel oil or gasoline

other fossil fuels (Room Heating and Cooling)

Category for all fossil fuels used for room heating and/or cooling other than diesel oil or natural gas

other fossil fuels (On-Site Power Generation)

Category for all fossil fuels used for on-site power generation, which are not reported in another category of the on-site power generation section.

Alternative fossil and mixed fuels

waste oil

Waste oil is any petroleum-based or synthetic oil which, through use or handling has become unsuitable for its original purpose.

tyres

Tyres here mean tyres which are made of rubber and other synthetic materials. Normally, tyres contain a natural rubber component. The CSI Cement CO2 and Energy Protocol therefore foresees a default value of 27% for their biogenic carbon content.

RDF including plastics

Refuse-derived fuel (RDF) is an alternative fuel derived from wastes such industrial or municipal solid waste (MSW). RDF consists largely of the combustible components of municipal waste such as plastics and biodegradable waste. It is also referred to as solid recovered fuel (SRF).

solvents

Chemical solvents which consist of different types of combustible liquids.

impregnated saw dust

Composed of fine particles of wood which are a byproduct in the wood manufacturing processes but not pure wood biomass due to the impregnation.

mixed industrial waste

Different types of industrial wastes which are combustible materials.

bio and mixed diesel

Note that the CO_2 emissions from bio and mixed diesel are evaluated with one common CO_2 emission factor (line199a) and biogenic carbon content (line200g)

other fossil based wastes and mixed fuels

Category for all fossil based wastes and mixed fuels which are not reported in another category of alternative fuels and mixed fuels. Note that the CO_2 emissions from all fuels in this category are evaluated with one common CO_2 emission factor (line200) and biogenic carbon content (line200h)

Biomass fuels

dried sewage sludge

Sewage sludge is a result of sewage water treatment or similar processes. The sludge consists of biogenic organic materials and is normally dried for fuel use.

wood, non-impregnated saw dust

paper, carton

animal meal

Residues from the meat industry which consist of animals as source of organic carbon.

animal bone meal

Residues from the meat industry consisting of the bones of animals .

animal fat

Fat which is produced from animals.

agricultural, organic, diaper waste, charcoal

other biomass

Category for all biomass fuels which are not reported in another category of biomass fuels. Note that the biogenic CO_2 emissions from all fuels in this category are evaluated for the memo item with one common CO_2 emission factor (line209). A biogenic carbon content of 100% is assumed.

5.8.4 Parameters for Reporting Fuel Energy Use and CO_2 Emissions

In the Protocol Spreadsheet the energy and CO_2 emissions from fuel use are reported based on the data of the fuel consumption, lower heating values (**LHV**[1]), and the matching CO_2 emission factors (**EF**[2]):

Equation 12: Fuel energy use

$$Fuel\ energy\ use\ [TJ/yr] = Fuel\ [t/yr] \times LHV_{fuel}\ [GJ/t] \times [1\ t/1000kg]$$

where:

- *Fuel = Amount of fuel in tonne per year*
- *LHV_{fuel} = Lower heating value of fuel in gigajoules per tonne*

[1]Lower heat value
[2]Emission factor

Equation 13: CO_2 emissions from fuels

$$CO_2\ emissions\ [t\ CO_2/yr] = Fuel\ [t/yr] \times LHV_{fuel}\ [GJ/t] \times [1\ t/1000kg] \times EF_{fuel}\ [kg\ CO_2/GJ]$$

where:

- *Fuel = Amount of fuel in tonne per year*
- *LHV_{fuel} = Lower heating value of fuel in gigajoules per tonne*
- *EF_{fuel} = Emission factor of fuel in kg CO_2 per gigajoule*

Lower Heating Value (LHV)

Fuel consumption and lower heating values (LHV or net calorific value NCV) of fuels are routinely measured at plant level.

It is important to note that the applied heating value always has to match the status of the fuel, especially with respect to the correct moisture content.

Fuels might have variable moisture content during its weighing (e.g. raw coal or dried coal). Normally the lower heating value (**LHV**[1] or net calorific value **NCV**[2]) is determined from a dried sample. Subsequently a moisture correction has to be applied to the results, e.g. by correcting the mass reference of the **LHV**[3] from the dried sample back to the original moisture content of the fuel as it is consumed or weighed (e.g. for raw coal and dried coal).

Furthermore, the correct reference of the CO_2 emission factors (EF) must be assured. The reference should be to the heat determined by the lower heating value (LHV).

For the conversion of higher heating values (**HHV**[4] or gross calorific value **GCV**[5]) to LHV the equation defined in the 2006 IPCC Guidelines (Vol. II, Section 1.4.1.2, Box 1.1) can be applied (see "Lower and Higher Heating Values (LHV and HHV)" (on page 94)).

[1]Lower heat value
[2]Net calorific value
[3]Lower heat value
[4]Higher heat value
[5]Gross calorific value

CO_2 Emission Factors (EF)

Generally, the CO_2 emission factors of all fuels should represent the complete CO_2 emissions from the use of the fuel based on the total carbon content (TC). Due to very high combustion temperatures in cement kilns and the long residence time in kilns, carbon in all kiln fuels shall be treated as fully oxidized.

Companies are encouraged to use plant- or country-specific emission factors if reliable data are available. Alternatively, IPCC and CSI Cement CO2 and Energy Protocol default emission factors per GJ lower heating value are listed in the "Fuel CO2 Factors Sheet" (on page 34) and the " List of Constants and Default CO2 emission factors " (on page 108). However, the CO_2 emission factors of alternative fuels (**AF**[1]) and mixed fuels depend very much on the type of fuel and, therefore, should be specified at plant level where practical.

CO_2 emission factors (per lower heating value in [kg CO_2/GJ]) for kiln fuels and non-kiln fuels are reported in line186 to line209.

Biogenic carbon content (Cbio/TC) of mixed fuels

CO_2 from biomass fuels and the biogenic carbon content of mixed fuels is considered climate-neutral, because biogenic CO_2 emissions can be compensated by the re-growth of biomass in the short term. According to the 2006 IPCC Guidelines CO_2 from the combustion of biomass (including biomass fuels, biomass wastes and the biomass fraction of mixed fuels) is therefore reported separately as a "memo item", but excluded from the total direct CO_2 emissions.

Consequently, the CO_2 emissions of **Mixed fuels**[2] shall be separated in their fossil and biogenic part. This is done by determining the share of the biogenic carbon in the fuel's overall carbon content, according to international standards (e.g. EN 15440).

Companies are advised to use a conservative approach in determining the biogenic carbon content, meaning that the biogenic carbon content should not be overestimated. A fossil carbon content of 100% should be assumed for fuel types in the case of a lack of reliable information on their biogenic carbon content until more precise data becomes available.

The biogenic carbon contents (Cbio) per total carbon content (TC) of mixed fuels are reported in line200a to line200h. Please use a value of 0% if the fuel does not contain biogenic carbon and is therefore a purely fossil fuel or if the biogenic carbon content is very uncertain or unknown.

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[1] Alternative fuels

[2] Term used in this Guidance Document for referring to fuels that are a mix of biomass and fossil fuel, i.e. fuel with a certain biogenic carbon content.

Equation 14: Biomass CO_2 emissions (Memo Item)

$$Biomass\ CO_2\ emissions\ (MemoItem)\ [t\ CO_2/yr] = Fuel\ [t/yr] \times LHV_{fuel}\ [GJ/t] \times [1\ t/1000kg] \times EF_{fuel}\ [kg\ CO_2/GJ] \times \frac{Cbio}{TC}[\%]$$

where:

- *Fuel = Amount of fuel in tonne per year*
- *LHV_{fuel} = Lower heating value of fuel in gigajoules per tonne*
- *EF_{fuel} = Emission factor of fuel in kg CO_2 per gigajoule*
- *Cbio/TC = Percentage of biogenic carbon content*

Fossil carbon content of mixed fuels

Direct CO_2 from the combustion of fossil fuels, fossil alternative fuel and the **Fossil carbon**[1] fraction of mixed fuels should be calculated and included in the direct CO_2 emissions:

[1]Carbon derived from fossil fuel or other fossil source. Definition taken from: Glossary of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Equation 15: Direct fossil CO_2 emissions

$$Direct\ fossil\ CO_2\ emissions\ [t\ CO2/yr] = Fuel\ [t/yr] \times LHV_{fuel}\ [GJ/t] \times [1\ t/1000kg] \times EF_{fuel}\ [kg\ CO_2/GJ] \times (1\ [100\%] - \frac{Cbio}{TC}\ [\%])$$

where:

- *Fuel = Amount of fuel in tonne per year*
- *LHV_{fuel} = Lower heating value of fuel in gigajoules per tonne*
- *EF_{fuel} = Emission factor of fuel in kg CO_2 per gigajoule*
- *Cbio/TC = Percentage of biogenic carbon content*

The Protocol Guidance Document (Chapters 3.5, 3.6 and 5) provides more detailed guidance for reporting CO_2 from conventional fossil fuels, alternative fuels, mixed fuels and biomass fuels.

5.8.5 Lower and Higher Heating Values (LHV and HHV)

There are two different types of heating value, which are the **lower heating value** (**LHV**[1]) and the **higher heating value** (**HHV**[2]). By definition the higher heating value is equal to the lower heating value with the addition of the heat of vaporization of the water content in the fuel. These values can be measured in the laboratory for each type of fuel used in the kiln system. However, higher heating values must be converted, in order to obtain the correct values that should be used in the Plant sheet.

Mathematically the relation between both values can be expressed by the following formula [2006 IPCC Guidelines, Vol. II, Section 1.4.1.2, Box 1.1]

[1]Lower heat value
[2]Higher heat value

Equation 16: Conversion of higher to lower heating values in GJ/t (= MJ/kg)

$$LHV = HHV - 0.212 \times H - 0.0245 \times M - 0.008 \times Y$$

where

- *HHV = Higher heating value*
- *H = Percent hydrogen*
- *M = Percent moisture*
- *Y = Percent oxygen (from an ultimate analysis which determines the amount of carbon, hydrogen, oxygen, nitrogen and sulphur as received (i.e. includes Total Moisture (TM))*

In the white cells in line132 to line137 the lower heating values (LHV) of conventional fossil kiln fuels can be entered:

Fuel Lower Heating Values			1990
131	Conventional fossil fuels		
132	coal + anthracite	[GJ/t]	0,0
133	petrol coke	[GJ/t]	0,0
134	(ultra) heavy fuel	[GJ/t]	0,0
135	diesel oil	[GJ/t]	0,0
136	natural gas	[GJ/1'000 Nm^3]	0,0
137	shale	[GJ/t]	0,0
137a	lignite	[GJ/t]	0,0

Because in many plants some of the fossil kiln fuels are also used for other purposes, all following sections on LHVs of conventional fossil fuels use the values of the kiln fuels as default values. Those lines are of grey colour an can be overwritten for entering more specific values (as in the previous version of the CSI Protocol):

- Drying of raw materials and fuels (line154a to line154f)

Drying of raw materials and fuels			1990
154	Conventional fossil fuels		
154a	coal + anthracite + lignite	[GJ/t]	0,0
154b	petrol coke	[GJ/t]	0,0
154c	(ultra) heavy fuel	[GJ/t]	0,0
154d	diesel oil	[GJ/t]	0,0
154e	natural gas	[GJ/1'000 Nm^3]	0,0
154f	shale	[GJ/t]	0,0

- Non-Kiln Fuel Lower Heating Values (line311a, line312a and line312b)

Non-Kiln Fuel Lower Heating Values			1990
311	Equipment and On-Site Vehicles fossil fuels		
311a	diesel oil	[GJ/t]	0,0
311b	gasoline	[GJ/t]	0,0
311ba	other fossil fuels	[GJ/t]	0,0
311c	Equipment and On-Site Vehicles fuels (containing biomass)		
311d	bio and mixed diesel	[GJ/t]	0,0
312	Room Heating and Cooling		
312a	diesel oil	[GJ/t]	0,0
312b	natural gas	[GJ/1'000 Nm^3]	0,0

- Drying of mineral components (line313a to line313f)

313	Drying of mineral components		
313k	Conventional fossil fuels		
313a	coal + anthracite + lignite	[GJ/t]	0,0
313b	petrol coke	[GJ/t]	0,0
313c	(ultra) heavy fuel	[GJ/t]	0,0
313d	diesel oil	[GJ/t]	0,0
313e	natural gas	[GJ/1'000 Nm^3]	0,0
313f	shale	[GJ/t]	0,0

- On-site power generation (line314a to line314i)

314	On-site power generation		
314aa	Conventional fossil fuels		
314a	coal + anthracite + lignite	[GJ/t]	0,0
314b	(ultra) heavy fuel	[GJ/t]	0,0
314c	diesel oil	[GJ/t]	0,0
314d	natural gas	[GJ/1'000 Nm^3]	0,0
314i	petrol coke	[GJ/t]	0,0

The lines turn into white colour when overwritten.

5.9. Enter Power Balance

The power balance of the Cement CO_2 and Energy Protocol refers to electrical power consumed and/or produced in a cement plant. Thus, power here means **electrical energy**.

In the Protocol Spreadsheet power consumption and production in a cement plant is distinguished according to the sources of the power:

- External power (grid power, line033c to line033d)
- Power from on-site power generation (line033a to line033ad)
- Power from waste heat recovery (line033b to line033bc)

Consumption of external electrical power

In most cases, cement plants use electrical power from external sources (grid power) which was produced for example in power plants. The total consumption of external power is reported in line033c in the Protocol Spreadsheet and separately for different consumers as follows.

line033ca: external power consumption at the cement plant including the kiln, cement grinding, raw material preparation and the quarry (= purchased power minus power sold back in case of own power production).

Additionally, external power from the grid may be consumed at facilities for on-site power generation or waste heat recovery (see below), e.g. to cover the consumption of auxiliaries in the power generating system. This external power consumption should be reported in the line033cb and line033cc, respectively. Together with the external power consumption at the cement plant (line033ca), the sum of all external power consumption from the grid in line033c is denoted as “Total external power consumption for cement manufacturing”.

The power consumed in the plant up to and including clinker production is specified in line033e.

This value includes the power consumption of the kiln system, for the preparation of raw materials, kiln fuels and power consumption in the quarry. It allows calculating the KPI on the specific power consumption of the clinker production (line098).

Power Balance			1990
33a	Total power production from separate on-site power generation	[MWh/yr]	0
33aa	Power delivered to cement plant	[MWh/yr]	0
33ab	Power delivered externally	[MWh/yr]	0
33ac	Power consumed by on-site power generation equipment	[MWh/yr]	0
33ad	CO_2 per power unit produced by separate on-site power generation	[kg CO_2/MWh]	
33b	Total power production from waste heat recovery	[MWh/yr]	0
33ba	Power delivered to cement plant	[MWh/yr]	0
33bb	Power delivered externally	[MWh/yr]	0
33bc	Power consumed by waste heat recovery equipment	[MWh/yr]	0
33c	Total external power consumption for cement manufacturing	[MWh/yr]	0
33ca	External power delivered to cement plant	[MWh/yr]	
33cb	Cement-related external power delivered to on-site power generation plant	[MWh/yr]	0
33cc	Cement-related external power delivered to waste heat recovery plant	[MWh/yr]	0
33d	CO_2 per power unit produced externally	[kg CO_2/MWh]	
33e	Power consumption up to and including clinker production	[MWh/yr]	
33	Total cement plant power consumption	[MWh/yr]	

Always use measured values from your plant measuring system, if available. Please also use your measuring equipment to check each of the values in the power balance. For example the total external power consumption in line033c should correspond to an external power consumption measurement for grid power. Alternatively, the split of certain parameters, e.g. the actual amount of internal and external power delivery, must be calculated based on auxiliary information available at plant level or estimated, if measuring systems do not exist for each individual parameter of the power balance.

Note that the measuring unit is MWh/yr. Therefore, if you have another measuring unit system, you must convert it to MWh/yr units to avoid calculation errors.

Please see the Protocol Guidance Document (Appendix A5) for further information on units and conversion factors.

On-site power generation and waste heat recovery

The plant may have its own power generation facilities. For the reporting in the Protocol Spreadsheet two types of facilities are differentiated:

1. **Separate on-site power generation** - which in most cases uses additional non-kiln fuels to produce electrical power. A separate section exists for reporting the non-kiln fuels used for on-site power generation (line304).
2. **Waste heat recovery** - which uses waste heat from the kiln system to produce electrical power. In most cases the energy for these facilities is originally derived from the use of kiln fuels. The waste heat recovery is then a way to save power and increase the entire energy system efficiency.

The total power production of these generation facilities has to be specified in line033a and line033b, respectively (if visible, depending on the selected inventory boundaries).

The power produced by on-site generation unit(s) (line033a) is normally consumed by power consumption unit(s), e.g. stationary equipment, at the cement plant itself (line033aa) or externally outside the cement plant (line033ba). In line033ac power produced on-site and used to cover the internal consumption of the power generation unit has to be reported. In line033ad the CO_2 emission factor per kWh is calculated based on the non-kiln fuels used by the on-site power generation facility. For the calculation of the key performance indicators (**KPI**[1]s) of electrical energy consumption you have to fill in these values which explain how this generated power had been used. The remaining difference between the total on-site power production and its delivery to the cement plant or external consumers is the power consumed at the on-site power generation equipment itself (line033c).

The power produced from waste heat recovery (line033b) is subject to the same differentiation. The corresponding power deliveries and consumption of the waste heat recovery system itself are reported in the line033ba, line033bb and line033bc, respectively.

5.9.1 Sheets

- See "Plant Sheet" (on page 28)

[1]Key Performance Indicator

5.9.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.9.3 Line-by-Line

- See Power Balance

5.10. Provide Information on Waste Heat Use

Waste Heat Use		
34	Waste heat supplied to external consumers	[GJ/yr]
34a	Waste heat used internally (incl. power generation)	[GJ/yr]

Waste heat from the cement plant may be supplied to external customers as a substitute for conventional heat or energy sources. If this applies to your plant, the amount of supplied waste heat should be reported in line034.

The amount of waste heat used internally, for example for power generation in a facility for waste heat recovery or for drying purposes can be specified in line034a. The reporting of these data is voluntary and allows - if needed - the comparison of plants using their waste heat for different purposes.

The unit of reported number should be in gigajoules per year [GJ/yr].

5.10.1 Sheets

- See "Plant Sheet" (on page 28)

5.10.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.10.3 Line-by-Line

- See Waste Heat Use

5.11. Consolidate Company Data (Aggregate Data from Plants)

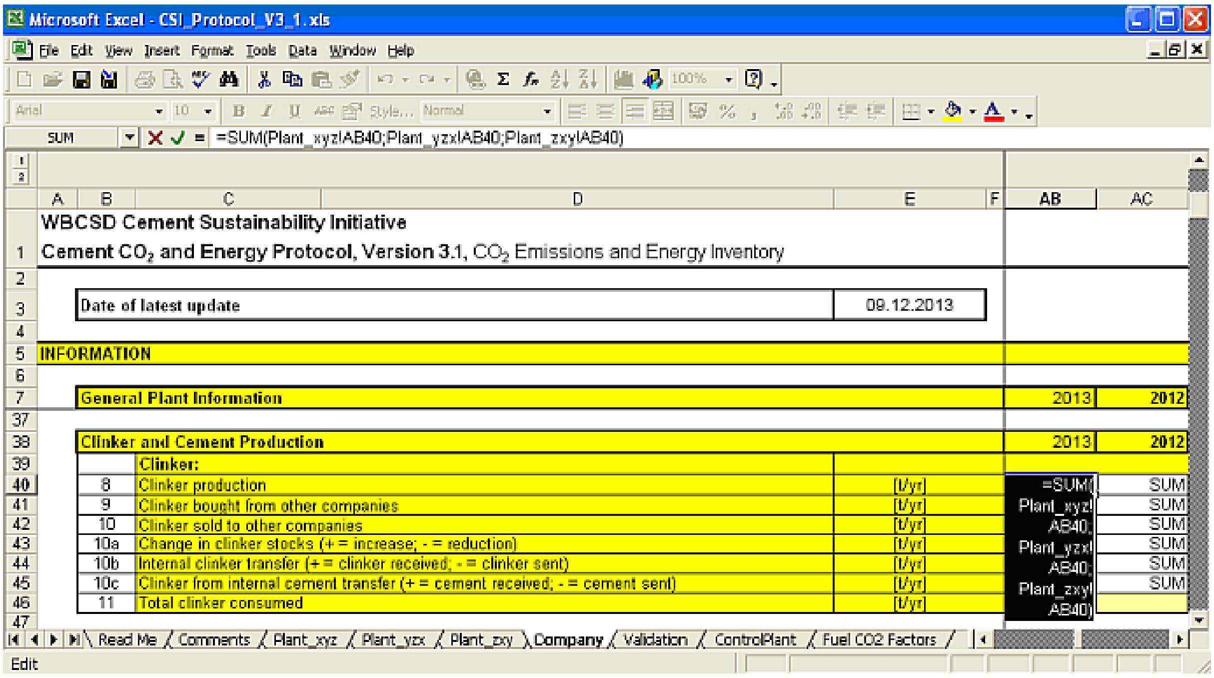
The structure of the Company Sheet corresponds to the structure of the Plant sheet. It serves to provide consolidated values for the whole company or a defined unit of the company (see also

"Organisational Boundaries and Division into Plants" (on page 36)).

It is a task of the user of the Protocol Spreadsheet to aggregate the values from all Plant sheets. This is done by calculating the consolidated "SUM" in the Company Sheet. Please note the following information before starting:

- You can use the Excel® function "SUM" to link the values from the Plant sheets to the corresponding values in the Company Sheet.

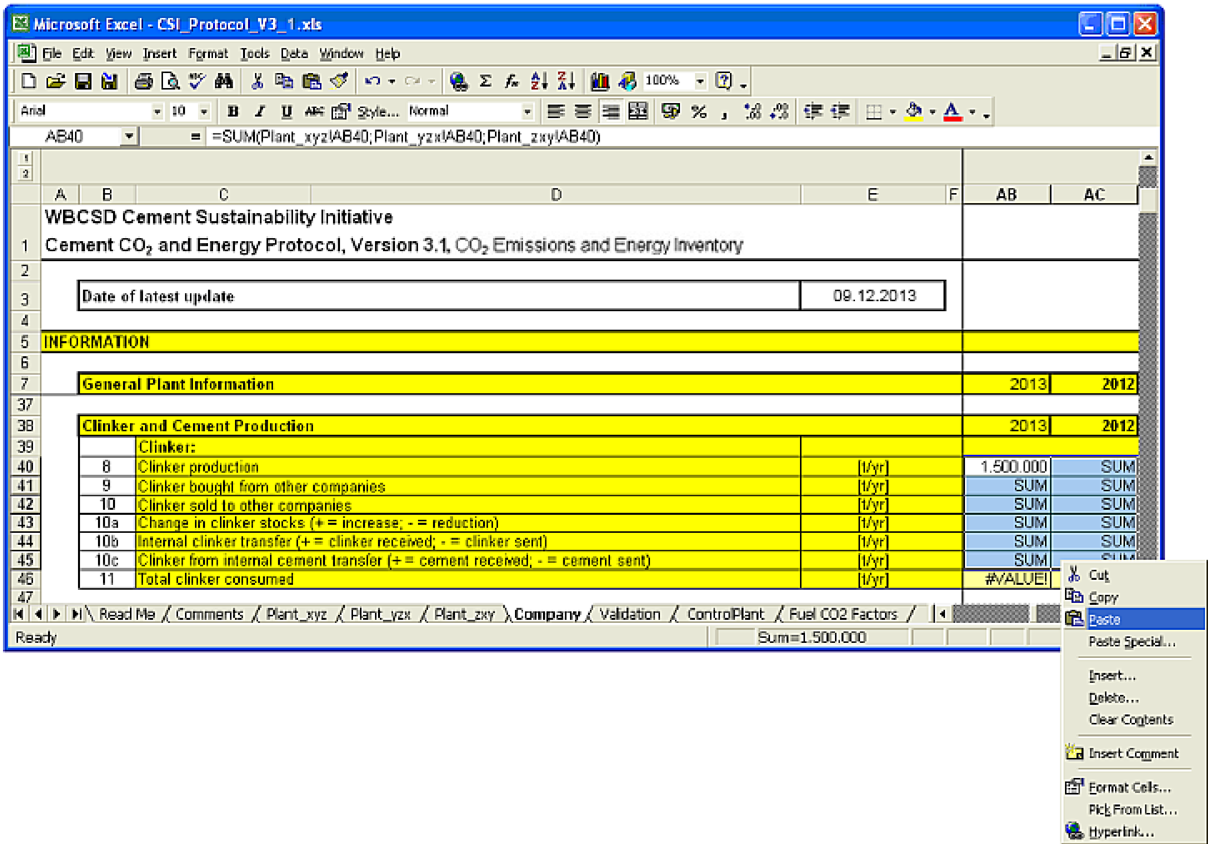
  For example for aggregating the clinker production (line008) of three plants of a company in 2011:
  Company!AB40 "=SUM(Plant_xyz!AB40;Plant_yzx!AB40;Plant_zxy!AB40)"



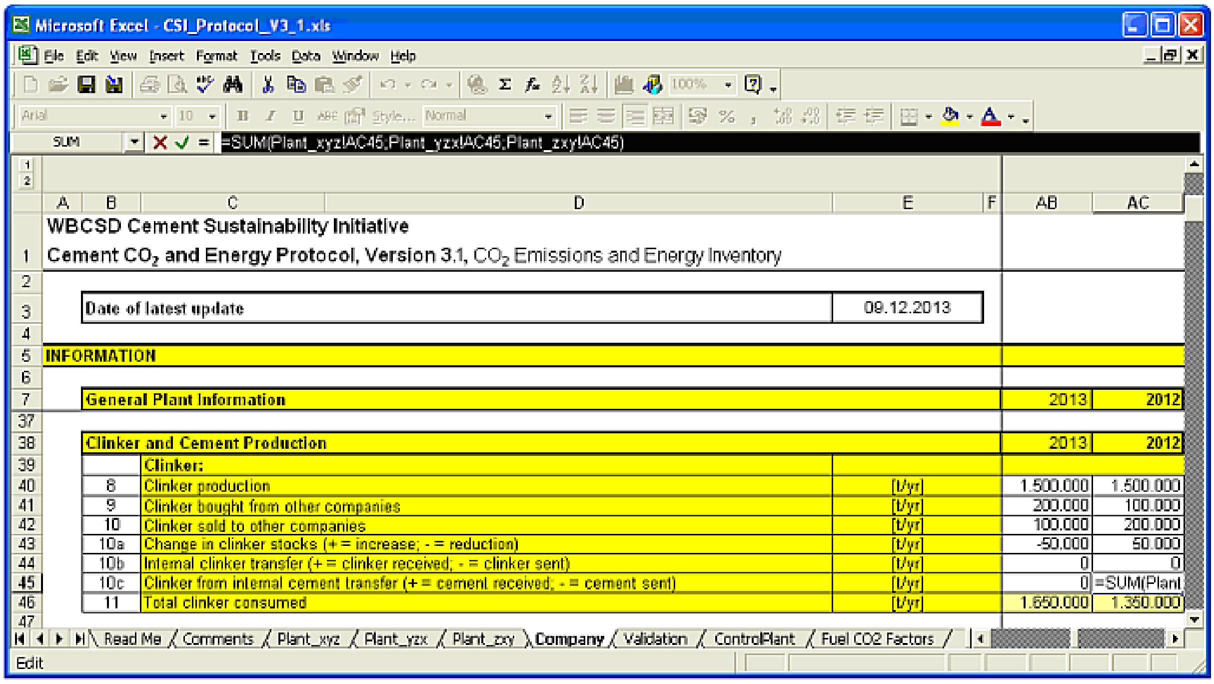
  You can use the help function of Excel® to learn more about how to use the function "SUM" and link the cells with each other.

- If you aggregate and link the Plant sheets cells or values with corresponding cells in the Company Sheet, please do this very carefully and make sure to link rows (line numbers) and columns (reporting years) correctly.

You can use the copy & paste functions from the “Edit” Menu in Excel in order to transfer the formula containing the “SUM” function from one cell to neighbouring rows and columns (lines and years). Thereby you avoid editing each cell individually and potential errors in the links to Plant sheet cells.



- Please carefully **double check the correctness of the consolidated values** in the Company Sheet and the copied formulas. See for example the consolidated company values for the total clinker consumed in line011 and the formula in the cell Company!AC45, which is used for aggregating the Plant sheet data in line010b and the year 2012:



- The **internal transfer of materials among plants** of the same company should not be taken into account in the values consolidated at company level. The values from the Plant sheets should cancel each other out and result in a SUM of 0 (zero) in the Company Sheet, for example in line010b and line010c.
- Some lines of the Plant sheet, which are not relevant or meaningful on company level, have been erased from the Company Sheet.

5.11.1 Sheets

- See "Company Sheet" (on page 28)

5.11.2 FAQs

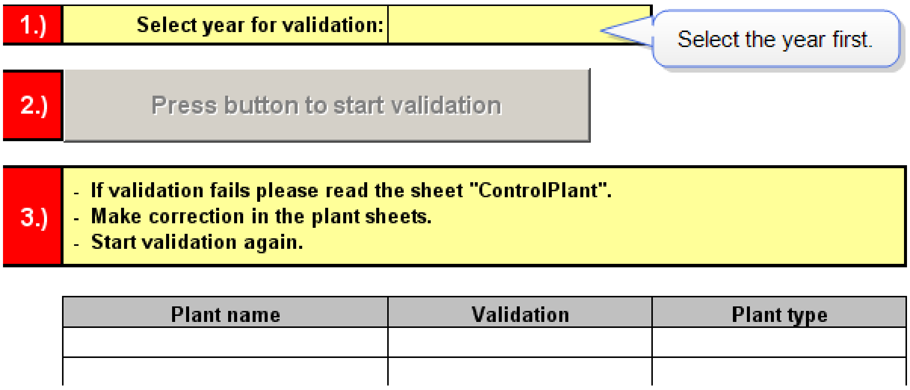
- See "Frequently Asked Questions (FAQs)" (on page 108)

5.11.3 Line-by-Line

The Company Sheet is not contained in the Line-by-Line reference since its lines contain items identical to the lines in the Plant sheet.

5.12. Validate the Plant sheets before submitting Data

After you have completed all the required sheets and ensured that all the desired data are reported properly, you should then take a final step before submitting the data and validate all Plant sheets contained in your Protocol Spreadsheet. By using the validation tool you can perform a first general check. The tool performs several automated tests on the completeness of the Plant sheet data and whether it lies within a general range of values for cement plants. On the Validation sheet and the Control Plant sheet you can find the validation results and remarks about whether specific data in the Plant sheets has passed or not.



To validate your Protocol Spreadsheet, you just need to follow steps 1, 2 and 3. If you find a problem with validation indicated by the red text “FAILED”, go to the Control Plant sheet , where you will find remarks on the errors which are associated with your Plant sheets. Carefully check your data and correct it, if necessary. Then try again to validate the Plant sheet data. In most cases, all errors should be removed in the Plant sheets before submitting your data.

If validation fails due to values outside the validation range

The validation tool will check if all required cells contain values and if these values are within a certain range of common values for cement plants (see "List of Validation Ranges" (on page 107)). This is to help users avoid making mistakes during data input, such as unfilled cells and lost or additional trailing zeros.

If the validation fails due to a value outside the min-max validation range, it does not automatically mean that the entered value is wrong! However, you should double-check the value and then ignore the message of the validation tool if the given numbers are definitely correct.
Please see "Check for errors" (on the next page) for further information.

5.12.1 Sheets

- See "Validation Sheet" (on page 32)
- See "Control Plant Sheet" (on page 33)

5.12.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

5.12.3 Check for errors

If the validation fails, you will find information on which Plant sheet caused the problem in the list below.

1.)	Select year for validation:	1990

2.) Press button to start validation

3.)
- If validation fails please read the sheet "ControlPlant".
- Make correction in the plant sheets.
- Start validation again.

Plant name	Validation	Plant type
Plant	FAILED	GREY CEMENT

More detailed remarks of the validation tool are recorded in the Control Plant sheet.

"NoValue" Error

If you forgot to fill in a cell, the validation tool will give you the hint “NoValue”.

Plant Level							
Year	Tab Name	Line	Comment	Min	Value	Max	Note
1990	Plant	8	Clinker		NoValue		

In this case the user forgot to fill in the clinker production (line008).

Out of Validation Range

Plant Level							
Year	Tab Name	Line	Comment	Min	Value	Max	Note
1990	Plant	8	Clinker production	0	90000000000	10000000	

In this case the user entered a value outside of the validation range and which therefore should be checked carefully and corrected if necessary.

If you are sure that the numbers provided are correct, you can ignore the related error message from the validation tool. This means that you can save the Protocol Spreadsheet and submit your data even if you have errors messages left.

5.12.3.1 Sheets

- See "Validation Sheet" (on page 32)
- See "Control Plant Sheet" (on page 33)

5.12.3.2 FAQs

- See "Frequently Asked Questions (FAQs)" (on page 108)

6. Appendix

6.1. List of Key Performance Indicators (KPI)

Please see the Protocol Guidance Document for additional information (Chapter 5, Chapter 6, Appendix A6 and Appendix A7).

This section of the Internet Manual is not included in the printout version. For further information please refer to the online version of the Internet Manual at https://www.cement-co2-protocol.org.

6.2. List of Validation Ranges

If the validation fails due to a value outside the min-max validation range, it does not automatically mean that the entered value is wrong! However, you should double-check the value and then ignore the message of the validation tool if the given numbers are definitely correct.
Please see "Check for errors" (on page 104) for further information.

Please see also "Validate the Plant sheets before submitting Data" (on page 103).

This section of the Internet Manual is not included in the printout version. For further information please refer to the online version of the Internet Manual at https://www.cement-co2-protocol.org.

6.3. Changes in Version 3

This section of the Internet Manual is not included in the printout version. For further information please refer to the online version of the Internet Manual at https://www.cement-co2-protocol.org.

6.4. Frequently Asked Questions (FAQs)

This section of the Internet Manual is not included in the printout version. For further information please refer to the online version of the Internet Manual at https://www.cement-co2-protocol.org.

6.4.1 Additional Questions

If you have questions, please carefully read the answers to the Frequently Asked Questions (FAQs). Additional questions on the Cement CO_2 and Energy Protocol Spreadsheet can be addressed to gnrpmc@gccassociation.org.

6.5. List of Constants and Default CO_2 emission factors

Table 4: List of Constants and Default CO_2 emission factors

Name	Unit	Value	Comment
Molecular weights			
$CaCO_3$	g/mol	100,087	
$MgCO_3$	g/mol	84,314	
CaO	g/mol	56,078	
MgO	g/mol	40,304	
CO_2	g/mol	44,010	
Ca	g/mol	40,078	
Mg	g/mol	24,305	
Fuel CO_2 factors			
Fossil fuels			
coal + anthracite	kg CO_2/GJ	96	IPCC defaults are: 94.6 for coking coal and other bitu-minous coal, 96.1 for sub-bituminous coal, and 98.3 for anthracite
petrol coke	kg CO_2/GJ	92,8	Based on measurements compiled by former WBCSD/CSI Task Force 1. See Guidance Document, Appendix 4 for details.
(ultra) heavy fuel	kg CO_2/GJ	77,4	IPCC default for residual fuel oil.

Name	Unit	Value	Comment
diesel oil	kg CO_2/GJ	74,1	
natural gas (dry)	kg CO_2/GJ	56,1	
oil shale	kg CO_2/GJ	107	
lignite	kg CO_2/GJ	101	
gasoline	kg CO_2/GJ	69,3	
Alternative fossil fuels			
waste oil	kg CO_2/GJ	74	Based on measurements compiled by former WBCSD/CSI Task Force 1. See Guidance Document, Appendix 4 for details.
tyres	kg CO_2/GJ	85	Best estimate of former WBCSD/CSI Task Force 1
tyres - % biomass	% biomass	27,0%	Best estimate of former WBCSD/CSI Task Force 1
plastics	kg CO_2/GJ	75	Best estimate of former WBCSD/CSI Task Force 1
solvents	kg CO_2/GJ	74	Based on measurements compiled by former WBCSD/CSI Task Force 1. See Guidance Document, Appendix 4 for details.
impregnated saw dust	kg CO_2/GJ	75	Best estimate of former WBCSD/CSI Task Force 1
mixed industrial waste	kg CO_2/GJ	83	Best estimate of former WBCSD/CSI Task Force 1
other fossil based wastes	kg CO_2/GJ	80	Best estimate of former WBCSD/CSI Task Force 1
Biomass fuels			
dried sewage sludge	kg CO_2/GJ	110	= IPCC default for solid biomass fuels
wood, non impregnated saw dust	kg CO_2/GJ	110	= IPCC default for solid biomass fuels
paper, carton	kg CO_2/GJ	110	= IPCC default for solid biomass fuels
animal meal	kg CO_2/GJ	89	Based on measurements compiled by former WBCSD/CSI Task Force 1. See Guidance Document, Appendix 4 for details.
animal bone meal	kg CO_2/GJ	89	Best estimate of former WBCSD/CSI Task Force 1
animal fat	kg CO_2/GJ	89	Best estimate of former WBCSD/CSI Task Force 1
agricultural, organic, diaper waste, charcoal	kg CO_2/GJ	110	= IPCC default for solid biomass fuels
other biomass	kg CO_2/GJ	110	= IPCC default for solid biomass fuels

6.6. Downloads

This section of the Internet Manual is not included in the printout version. For further information please refer to the online version of the Internet Manual at https://www.cement-co2-protocol.org.

6.7. Glossary and Abbreviations

6.7.1 Glossary

Please see the WBCSD / WRI GHG Protocol and the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for an extended glossary.

A

Absolute emission

Absolute GHG emissions are expressed as a mass stream, for example in tonnes of CO2 per year (t CO2/yr).

Additional raw materials

Additional raw materials, e.g. added directly to the calciner or kiln inlet, which are not part of the kiln feed, which is normally a homogenized mass flow fed to a pre-heater system.

AF

Alternative fuels

Allowance

A GHG allowance is a commodity giving its holder the right to emit a certain quantity of GHG. [GHG allowances are typically allocated by a regulator to the emitters covered by a cap and trade system. Definition taken from: revised WBCSD / WRI GHG Protocol (2004)

Alternative fuels

Fuel materials or products used as a source of thermal energy and not classified as traditional fuel. In the cement industry wastes such as plastics, solvents, waste oil, end-of-life tyres, etc. and different types of mixed or pure biomass fuels are used.

Annex I

Annex I to the UNFCCC lists the developed country Parties which have special responsibilities in meeting the objective of the Convention. They include the OECD countries (excl. Mexico and Korea), the countries of Eastern Europe, Russia, and the European Union.

Under the Kyoto Protocol, Annex I Parties have accepted quantified emissions limitation or reduction commitments for the period 2008-12. See http://unfccc.int/parties_and_observers/items/2704.php for further information

ARM

Additional raw materials

B

Baseline

Reference emission level. The term is used with different meanings in different contexts. It can denote:- the historical emission level of an entity in a reference year,- the projected future emission level of an entity if no extra mitigation measures are taken (business-as-usual scenario),- the hypothetical emission level against which the climate benefits of GHG reduction projects are calculated.

Biogenic carbon

Carbon derived from biogenic (plant or animal) sources excluding fossil carbon. Note that peat is treated as a fossil carbon in these guidelines as it takes so long to replace harvested peat. Definition taken from: Glossary of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Biomass

Organic matter consisting of or recently derived from living organisms (especially regarded as fuel) excluding peat. Includes products, by-products and waste derived from such material. Definition taken from: Glossary of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Bypass dust

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

C

Cap and trade

A system that sets an overall emissions limit, allocates emissions allowances to participants, and allows them to trade allowances and emission credits with each other. Definition taken from: Glossary of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Cement

A 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. It acts as the binding agent when mixed with sand, gravel or crushed stone and water to make concrete. While cement qualities are defined by national standards, there is no worldwide, harmonised definition or standard for cement. In the "WBCSD - CSI Cement CO2 and Energy Protocol" and the "Getting the Numbers Right" database, both now managed by GCCA, "cement" includes all hydraulic binders that are delivered to the final customer, i.e., including all types of Portland, composite and blended cements, plus ground granulated slag and fly ash delivered to the concrete mixers, but excluding pure clinker.

Cement (eq.)

Cement (equivalent)

Cement (equivalent)

Cement (equivalent) is a cement production value which is determined from clinker produced on-site applying the plant specific clinker/cement-factor. Hence it is a virtual cement production under the assumption that all clinker produced in a plant is consumed for cement production in the same plant and applying the real plant specific clinker/cement factor.

Cement kiln dust

Cement kiln dust, relevant for complete CO2 reporting is especially the partly calcined CKD leaving the kiln system, i.e. discarded dust from long dry and wet kiln system dedusting units, consisting of partly calcined kiln feed material (see also "dust return"). The extraction and discarding of CKD and bypass dust serve to control the input of excessive circulating elements (alkali, sulphur, chlorine), particularly in cases of low-alkaline clinker production. The term "CKD" is sometimes used to denote all dust from cement kilns, i.e. also from bypass systems.

Cement Sustainability Initiative

Between 1999 and 2019 the WBCSD CSI was a global effort by 24 major cement producers with operations in more than 100 countries. The Global Cement and Concrete Association (GCCA) announced the formation of a strategic partnership with the World Business Council for Sustainable Development (WBCSD) to facilitate sustainable development of the cement and concrete sectors and their value chains. The new partnership also created synergies between their work programs to benefit both the GCCA and WBCSD, and their respective member companies. As part of the new agreement, the work carried out by the Cement Sustainability Initiative (CSI) transferred from WBCSD to the GCCA on 1 January 2019, with activities managed out of the GCCA's London office.

Cementitious products

All clinker produced by the reporting company for cement making or direct clinker sale, plus gypsum, limestone, CKD and all clinker substitutes consumed for blending, plus all cement substitutes. For this denominator, the terms "cementitious products" or "binders" are used, as it is a sum of clinker and mineral components. The denominator excludes clinker bought from third parties for the production of cement, since this clinker is already included in the inventory of the third party.

CKD

Cement kiln dust

cli

Clinker

Climate-neutral

Burning of climate-neutral fuels does not increase the GHG stock in the atmosphere over a relevant time span. CO2 emissions from renewable biomass contained in alternative fuels are climate-neutral because they are compensated by an equivalent absorption by plants.

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.

Credit

GHG offsets can be converted into GHG credits when used to meet an externally imposed target. A GHG credit is a convertible and transferable instrument usually bestowed by a GHG program. Defition taken from: revised WBCSD / WRI GHG Protocol (2004)

CSI

Cement Sustainability Initiative

D

Direct emissions

Direct GHG emissions are emissions from sources that are owned or controlled by the reporting entity. Examples include the emissions from cement kilns, company-owned vehicles, quarrying equipment, etc.

Dust return

This part of the kiln feed is not consumed for clinker production or to form bypass dust but is transported back by the gas flow (opposite direction to the mass flow) and (firstly) out of the preheater system. It is returned to the dust cycle, which often involves the raw mill and a *dust filter system. Relatively small amounts of cement kiln dust (CKD) leaving the kiln system originate from this dust cycle and dust return.*

E

EF

Emission factor

Emission factor

Emission factor, here normally CO2 emission factor per mass for materials or per heat for fuels.

EU ETS

European Emission Trading Scheme

European Emission Trading Scheme

The CO2 emissions trading scheme of the European Union which started in 2005. The EU ETS covers CO2 emissions from most significant industrial sources. From 2013, other GHG will also be included. For further information see http://ec.europa.eu-/clima/policies/ets/index_en.htm

F

Fossil carbon

Carbon derived from fossil fuel or other fossil source. Definition taken from: Glossary of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

G

GCCA

Global Cement and Concrete Association

GCV

Gross calorific value

Getting the Numbers Right

The GNR (“Getting the Numbers Right” or “GCCA in NumbeRs”) is a key tool in how key sustainability progress is monitored and reported. The GNR database is now managed by the GCCA, having transferred at the end of 2018 from the Cement Sustainability Initiative (an initiative run through the World Business Council for Sustainable Development).

GHG

Greenhous gas

Global Warming Potentials

Global Warming Potentials are calculated as the ratio of the radiative forcing of one kilogramme greenhouse gas emitted to the atmosphere to that of one kilogramme CO2 over a period of time (e.g., 100 years).

GNR

Getting the Numbers Right

Greenhouse gas

The greenhouse gases listed in Annex A of the Kyoto Protocol include: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF6).

Gross calorific value

Gross calorific value (= higher heat value, HHV)

Gross CO2 emissions

Total direct CO2 emissions (excluding on-site electricity production) originating from fossil carbon, i.e. excluding CO2 emissions from biomass which are considered climate-neutral. As of Protocol version 3, the CO2 emissions originating from the biogenic carbon content of mixed fuels are not accounted for.

GWP

Global Warming Potentials Definition taken from: Glossary of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

H

HHV

Higher heat value

Higher heat value

Higher heat value (= gross calorific value, GCV), often in GJ per ton of fuel. The higher heat value includes the latent heat contained in water vapour, which is released when condensing water vapour so that all water is in liquid state. Compare 2006 IPCC Guideline4, Vol. II, Section 1.4.1.2.

I

IEA

International Energy Agency

Indirect emissions

Indirect GHG emissions are emissions that are a consequence of the operations of the reporting company, but occur at sources owned or controlled by another company. Examples include emissions related to purchased electricity, employee travel and product transport in vehicles not owned or controlled by the reporting company, and emissions occurring during the use of products produced by the reporting company.

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change is an international body of scientists. Its role is to assess the scientific, technical and socio-economic information relevant to the understanding of the risk of human-induced climate change (www.ipcc.ch).

Inventory

A quantified list of an organisation's GHG emissions and sources.

IPCC

Intergovernmental Panel on Climate Change

K

Key Performance Indicator

An industry-used term for a type of measure of performance. KPIs are commonly used by organisations to evaluate their success or the success of a particular activity in which they are engaged.

KF

Kiln feed

Kiln

A tubular heating apparatus used in the production of clinker (2006 IPCC Guidelines "manufacture of cement"). The calcination reaction may take place in the kiln itself, or, where so-equipped, it may partly or completely take place in a preheater and/or precalciner apparatus ahead of the kiln. Definition taken from: Glossary of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Kiln feed

Raw materials, often processed as raw meal, which are fed to a pre-heater or directly into the kiln system. The kiln feed often contains a certain quantity of recycled dust, which was returned from the pre-heater or kiln system (see also "dust return").

Kiln fuel

Fuels 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 (See Section 3.7)

KPI

Key Performance Indicator

L

LHV

Lower heat value

LOI

Loss on Ignition

LOIRM

Loss on Ignition of raw meal

Loss on Ignition

Loss on Ignition is a test used in inorganic analytical chemistry, particularly in the analysis of minerals. It consists of strongly heating ("igniting") a sample of the material at a specified temperature, allowing volatile substances to escape, until its mass ceases to change.

Lower heat value

Lower heat value (= net calorific value, NCV), often in GJ per ton of fuel. The lower heat value excludes the latent heat contained in water vapour. Compare 2006 IPCC Guideline4, Vol. II, Section 1.4.1.2.

M

MIC

Mineral components

Mineral components

Mineral components are natural or artificial mineral materials with hydraulic properties, used as a clinker or cement substitutes (e.g. blast furnace slag, fly ash, pozzolana).

Mixed fuels

Term used in this Guidance Document for referring to fuels that are a mix of biomass and fossil fuel, i.e. fuel with a certain biogenic carbon content.

N

NCV

Net calorific value

Net calorific value

Net calorific value (= lower heat value, LHV), often in GJ per ton of fuel. The net calorific value excludes the latent heat contained in water vapour.

Net CO2 Emissions

Gross CO2 emissions minus CO2 emissions from alternative fossil fuels. This definition corresponds to the original Protocol version 1. Note that the option for subtracting bought emission rights for reporting net emissions according to the alternative definition in Protocol version 2 was hardly used.

Nm3

Normalcubic meters (at 1013 hPa and 0 °C)

Non-kiln fuel

Fuels used by the company, which are not included in the definition of kiln fuels. For instance fuels used for plant and quarry vehicles, room heating, thermal process equipment (e.g. dryers) for the preparation of mineral components for cement grinding or in an installation separate from the kiln for on-site production of electrical power (See Section 3.8).

O

Offset

GHG offsets are discrete GHG emission reductions used to compensate for (i.e., offset) GHG emissions elsewhere, for example to meet a voluntary or mandatory GHG target or cap. Offsets are calculated relative to a baseline that represents a hypothetical scenario for what emissions would have been in the absence of the mitigation project that generates the offsets. To avoid double-counting, the reduction giving rise to the offset must occur at sources or sinks not included in the target or cap for which it is used. Definition taken from: Glossary of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

OPC

Ordinary Portland Cement

Ordinary Portland Cement

In the CSI Cement CO2 and Energy Protocol OPC refers to a common type of cement with high clinker content, consisting of over 90% ground clinker and about 5% gypsum. Note that differences exist between names and definitions of cement types in national standards. OPC is often referred to as"Portland cement" or "CEM I" according to the European standard EN 197-1:2007, "Portland cement" or "P•I" or "P•II" according to the Chinese standard GB175-2007,"Portland cement Types I to V according to the US standard ASTM C 150 and"Portland" or "PC" as described in the 2006 IPCC Guideline for National Greenhouse Gas Inventories. According to the Chinese standard GB175-2007 the name"Ordinary

Portland cement" with the notation "P•O" and the notation "P•C" for "Composite Portland cements" can refer to cement types with significantly lower content of clinker.

P

Petcoke
Petroleum coke, a carbon-based solid derived from oil refineries.

Pozzolana
A material that, when combined with calcium hydroxide, exhibits cementitious properties

Process emissions
Emissions from industrial processes involving chemical transformations other than combustion. Definition taken from: Glossary of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

Protocol
The methodology for calculating, monitoring and reporting GHG emissions.

R

Raw material
Materials used for raw meal preparation, e.g. limestone, iron ore, sand etc., before they are treated thermally, e.g. for drying.

Raw material preparation
Processes applied for converting raw materials to raw meal (e.g. grinding, homogenization, drying)

Raw meal
The raw meal consists of the ground raw materials. The raw material processing can involve drying or the addition of water. The raw meal composition is controlled and normally very stable, because the clinker burning process requires a defined chemical composition of the kiln feed.

Raw meal consumed
The part of the raw meal, which is consumed for clinker production and the formation of calcined bypass dust. Compared to the kiln feed, the quantity of raw meal consumed excludes the part of recycled dust (see "dust return").

RM
Raw meal

S

Specific emissions

Specific emissions are emissions expressed on a per unit output basis, for instance in kg of CO2per tonne of cement.

T

TC

Total carbon

TIC

Total inorganic carbon

TOC

Total organic carbon

Total carbon

Total carbon, the sum of TOC and TIC

Total inorganic carbon

Carbon, mostly bound in the mineral matter of materials (e.g. carbonates in fuel ashes)

Traditional fuels

Fossil fuels defined by the International Panel on Climate Change (IPCC) guidelines, including mainly: coal, petcoke, lignite, shale, petroleum products and natural gas

U

UNFCCC

United Nations Framework Convention on Climate Change

United Nations Framework Convention on Climate Change

Parties to the United Nations Framework Convention on Climate Change (UNFCCC) are those nations which have signed the convention.

W

WBCSD

World Business Council for Sustainable Development

World Business Council for Sustainable Development

The WBCSD is a CEO-led, global coalition of some 200 companies advocating for progress on sustainable development. Its mission is to be a catalyst for innovation and sustainable growth in a world where resources are increasingly limited. The Council provides a platform for companies to share experiences and best practices on sustainable development issues and advocate for their implementation, working with governments, non-governmental and intergovernmental organizations. The membership has annual revenues of USD 7 trillion, spans more than 35 countries and represents 20 major industrial sectors. The Council also benefits from a network of 60 national and regional business councils and partner organizations, a majority of which are based in developing countries.

World Resources Institute

The World Resources Institute (WRI) is an environmental think tank founded in 1982 based in Washington, D.C. in the United States. WRI is an independent, non-partisan and non-profit organisation with a staff of more than 100 scientists, economists, policy experts, business analysts, statistical analysts, mapmakers, and communicators developing and promoting policies with the intention of protecting the Earth and improving people's lives.

WRI

World Resources Institute

6.7.2 Abbreviations for chemical compounds

CH_4	Methane
N_2O	Nitrous Oxide
CO_2	Carbon Dioxide
CO	Carbon Monoxide
NO_x	Nitrogen Oxides
NMVOC	Non-Methane Volatile Organic Compound
NH_3	Ammonia
CFCs	Chlorofluorocarbons
HFCs	Hydrofluorocarbons
PFCs	Perfluorocarbons
SO_2	Sulphur Dioxide
SF_6	Sulphur Hexafluoride
CCl_4	Carbon Tetrachloride
C_2F_6	Hexafluoroethane

Table 5: Abbreviations for chemical compounds

6.7.3 Units and abbreviations

cubic metre	m^3
hectare	ha
gram	g
tonne	t
joule	J
degree Celsius	°C
calorie	cal
year	yr
capita	cap
gallon	gal
dry matter	dm

Table 6: Units and abbreviations

6.8. Bibliography

6.9. List of Equations

6.10. List of Figures

6.11. List of Tables

6.12. Index