Draft approved baseline methodology AM00XX

"Use of non-carbonated calcium sources in the raw mix for cement processing"

Source

This baseline methodology is based on NM0123-rev "Methodology for use of non-carbonated calcium sources in the raw mix for cement processing" proposed by Lafarge Brasil, whose baseline study was prepared by Lafarge Brasil and ICF Consulting.

For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0123-rev http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

This methodology also refers to the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the Executive Board and available at the UNFCCC website.[1]

Selected Approach from Paragraph 48 of the CDM Modalities and Procedures

"Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment"

Applicability

This methodology is applicable to project activities in the cement industry, which is to switch a part of raw material used for clinker production to a non-carbonated calcium sources from limestone and clay that would otherwise continue to be used during the crediting period.

The methodology is applicable under the following conditions:

- CO_2 emissions reductions relate to CO_2 generated from decarbonisation of raw materials (typically $CaCO_3$ and $MgCO_3$) and are unrelated to the CO_2 emissions generated from fossil fuel burning
- Usual raw materials (limestone and clay) used as a raw material for clinker production are partially replaced by non-carbonated calcium sources, where non-carbonated raw materials availability in the region (defined as the area including at least the ten cement plants nearest to the plant of the project activity) or country is such that leakages in other uses of these non-carbonated raw materials will not occur
- Type and quality of produced clinker remain the same in both baseline and project cases
- GHG emissions intensity from energy use for clinker production cannot increase with the implementation of the project activity

This baseline methodology shall be used in conjunction with the approved monitoring methodology AM00XX (Use of non-carbonated calcium sources in the raw mix for cement processing).

Identification of the Baseline Scenario

Two alternative scenarios for non-carbonated calcium source are identified:

- A continuation of current practice, i.e., a scenario in which the company continues cement production using the existing technology, fuel mix and raw materials.

[1] Please refer to: < http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>

- Define a scenario in which traditional raw materials, limestone and clay, are partially substituted by non-carbonated calcium source. If relevant, develop different scenarios varying degrees of raw material switch from traditional ones. These scenarios should reflect all relevant policies and regulations.

The methodology determines the baseline scenario through one of the following analysis:
1: Selection of baseline scenario through financial analysis; or
2: Selection of baseline scenario through barrier analysis

1. Select baseline scenario through financial analysis

The following steps should be followed for baseline selection:
- Calculate the financial costs (e.g. capital and variable costs) and account cost savings due to net energy gains from project activity.
- A sensitivity analysis should be performed to assess the robustness of the selection of the most likely future scenario to reasonable variations in critical assumptions and to establish that the project is not the baseline. The financial indicator is calculated conservatively if assumptions tend to make the CDM project's indicators more attractive and the alternatives' indicators less attractive.
- The baseline scenario should take into account relevant national/local and sectoral policies and circumstances, and the proponent should demonstrate that the key factors, assumptions and parameters of the baseline scenario are conservative

2. Select baseline scenario through barriers analysis

Each non-carbonated calcium source should be assessed via the barriers analysis step of the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the Executive Board and available at the UNFCCC website.

Additionality

The additionality of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the Executive Board and available at the UNFCCC website. Additionality can be demonstrated through financial analysis or through barrier analysis.

If the financial analysis is chosen project participants shall demonstrate that the use of non-carbonated calcium sources in the region or country is non-profitable using the net present value (NPV) analysis and explicitly state the following parameters:
- Investment requirements for raw material switching
- A discount rate appropriate to the country and sector
- Current price and projected price (variable costs) of non-carbonated calcium source;
- Revenues due to the substitution of limestone and clay by non-carbonated calcium source
- Lifetime of the project, equal to the remaining lifetime of the existing equipment(s)
- Cost savings accounting fuel consumption reduction due to energy gains of a non-occurrence of some chemical reactions that were expected in the regular way of clinker processing.

The project is additional if the NPV of the project activity is negative

If the barriers analysis is chosen, the project participants shall demonstrate that the use of non-carbonated calcium sources in the region or country is the "first of its kind" and no project activity of this type is currently operational in the host country or region. ("Region" is also defined here as the area including at least the ten cement plants nearest to the plant of the project activity.)

Project Boundary

The project boundary is defined as the considered clinker process.

Table 1: Emissions sources included or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Transportation of raw materials from reserves to the plant	CO_2	Excluded	Not significant
		CH_4	Excluded	Not related
		N_2O	Excluded	Not related
	Decarbonation reaction	CO_2	Included	Main emission source
Project Activity	Transportation of raw materials from reserves to the plant	CO_2	Excluded	Not significant
		CH_4	Excluded	Not related
		N_2O	Excluded	Not related
	Energy required during decarbonation reaction	CO_2	Excluded	Positive effect but not directly measured.
		CH_4	Excluded	Not related
		N_2O	Excluded	Not related
	Decarbonation reaction	CO_2	Included	Main emission source
		CH_4	Excluded	Not related
		N_2O	Excluded	Not related

See leakage chapter for emissions sources included in leakage.

Baseline Emissions

- Reaction-based CO_2 Generation – the thermo chemical decomposition reaction involving decarbonation of the limestone of the raw mix (comprised of limestone and clay), producing CO_2 as an industrial process emission source ($CaCO_3 \xrightarrow{\Delta} CaO + CO_2$; i.e., the decarbonation reaction of one $CaCO_3$ molecule[2] generates one CaO molecule and one CO_2 molecule)

The calculation takes into account the percentage of the limestone and clay decarbonated. It also considers the fact that a certain amount of the limestone and clay will-become part of the clinker (CaO) and the rest will turn into CO_2.

So, the first step for determining the CO_2 emissions from the decarbonation reaction is to perform a lab analysis to identify the 'Loss of Ignition' (LOI)[3] of the raw mix , which quantifies the amount of CO_2 generated from one kilogram of the raw mix, based on a principle of difference in mass before and after the

[2] The atomic weight of one molecule of: $CaCO_3$ is 100 (i.e., Ca atomic weight, 40 + C atomic weight, 12 + O atomic weight * 3, 48); CaO is 56 (i.e., Ca atomic weight, 40 + O atomic weight, 16); and CO_2 is 44 (i.e., C atomic weight, 12 + O atomic weight * 2, 32)

[3] LOI refers to a common and widely used method to estimate carbonate content of materials. The weight loss is measured by weighting the samples before and after heating (T > 900ºC) and is correlated to carbonated content.

ignition process, corrected for moisture content. The size and frequency of sampling for this lab analysis should be statistically significant with an maximum uncertainty range of 20% at a 95% confidence level, and possible impurities in the raw mix should be monitored and reported so as to guarantee that the difference in mass can be attributed to CO_2 emissions only, or corrected otherwise.
The arithmetic mean of LOIs of the raw mix used during the year previous to project implementation (at least twelve montly measurement campaigns) shall be used for defining the baseline emissions.

$$\mathbf{LOI = ((M_1 - M_2)/M_1)} \qquad \mathbf{(1)}$$

where:

M_1 - initial weight of dry sample in baseline scenario, kg
M_2 - residual weight of sample after heating in baseline scenario, kg
LOI – the amount of CO_2 per unit of raw mix in baseline scenario, $kgCO_2$/kg raw mix

Using the formulae presented above, we quantify the amount of CO_2 generated from one kilogram of the raw mix, based on the principle of difference in mass before and after the ignition process.

Once LOI is calculated, it is possible to determine 'coefficient raw mix/ clinker ($C_{rm/kk}$)', which defines the relation between the amounts of raw mix needed to produce a certain amount of clinker. The following formula should be used:

$$C_{rm/kk} = \frac{1}{(1 - LOI)} \qquad \mathbf{(2)}$$

Finally, applying the equations (1) and (2), the quantity of CO_2 emitted from decarbonation reaction per tonnes of clinker produced, can be determined as follows:

$$Q_{co2} = LOI * C_{rm/kk} \qquad \mathbf{(3)}$$

Where:

Q_{co2} – CO_2 emissions due to decarbonation reaction in baseline scenario, kg CO_2/kg clinker.
LOI – loss of ignition, $kgCO_2$/kg raw mix
$C_{rm/kk}$ – relation between raw mix and clinker, kg raw mix/kg clinker

Project Emissions

Project emissions derive from the same source described above and use the same formulae to calculate the emissions:

Reaction-based CO_2 Generation – the thermo chemical decomposition reaction or decarbonation of the limestone of the raw mix (comprised of air-cooled slag, limestone and clay) produces CO_2 as an industrial process emission source ($CaCO_3 \xrightarrow{\Delta} CaO + CO_2$; i.e., the decarbonation reaction of one $CaCO_3$ molecule generates one CaO molecule and one CO_2 molecule)

Although the same basic chemical formula is used, less limestone needs to undergo decarbonation due to the replacement by non-carbonated calcium source resulting in lower CO_2 emissions.

As in the baseline case, the CO_2 emission calculation takes into account the percentage of the limestone and clay decarbonated with some minor modifications due to the use of non-carbonated calcium source. It also considers the fact that a certain amount of the limestone and clay will become part of the clinker (CaO) and the rest will turn into CO_2

'Loss of Ignition' (LOI) is determined by laboratory analysis, which quantifies the amount of CO_2 generated from one kilogram of the raw mix, based on a principle of difference in mass before and after the ignition process, corrected for moisture content. Here as before, the size and frequency of sampling for this lab analysis should be statistically significant with an maximum uncertainty range of 20% at a 95% confidence level, and possible impurities in the raw mix should be monitored and reported so as to guarantee that the difference in mass can be attributed to CO_2 emissions only, or corrected otherwise.

$$LOI^* = ((M_1^* - M_2^*)/M^*_1) \quad \textbf{(4)}$$

Where

M_1^* - initial dry weight of sample for project activity, kg
M_2^* - residual weight of sample for project activity, kg
LOI^* – the amount of CO_2 per unit of raw mix for project activity, $kgCO_2$/kg raw mix

Once LOI^* is calculated, it is possible to determine 'coefficient raw mix/ clinker ($C_{rm/kk}^*$)' using the equation below:

$$C^*_{rm/kk} = \frac{1}{(1 - LOI^*)} \quad \textbf{(5)}$$

where

$C^*_{rm/kk}$ – amount of raw mix necessary to produce one unit of clinker, kg rawmix/kg clinker

LOI^* – the amount of CO_2 per unit of raw mix for project activity, $kgCO_2$/kg raw mix

For determining the CO_2 emission related to project activity, equations (4) and (5) are used and the quantity of CO_2 emitted from decarbonation reaction per tonnes of clinker produced during project activity is calculated, as follows:

$$Q^*_{CO2} = LOI^* * C^*_{rm/kk} \quad \textbf{(6)}$$

Where:
Q^*_{CO2} – CO_2 emissions due to decarbonation reaction during project activity, kg CO_2/kg clinker.
LOI^* – loss of ignition, $kgCO_2$/kg raw mix
$C^*_{rm/kk}$ – relation between raw mix and clinker, kg raw mix/kg clinker

Leakage

Leakage emissions considered are CO_2 emissions from off-site transport of non-carbonated calcium source to the cement plant.

The emissions from transportation should be calculated as follows:

$$Q^t_{co_2} = \left[\left(\frac{Q_e}{q} \right) \times d_{me} \right] \times E_{co2} \Big/ 1000 \qquad \textbf{(7)}$$

where:

Q^t_{co2}= leakage from transport of non carbonated calcium source (tCO2/yr)
Q_e= quantity of non carbonated calcium source (tonnes)
q = average truck or ship capacity (tonnes/truck or ship)
d_{me} average round-trip distance between the non-carbonated calcium source supply sites and the cement plant sites (km/truck or ship)
E_{co2}= emission factor from fuel use due to transportation (kg CO_2/km) estimated as:

where:

$$Q_e = P_{kk} \times C_{rm/kk} \times \%_{\mathrm{e}} \qquad \textbf{(8)}$$

where:

Q_e= quantity of non-carbonated calcium source, ton
P_{kk}= Production of clinker, ton
$C_{rm/kk}$ = Coefficient Raw mix/clinker
$\%_e$= Percentage of non-carbonated calcium source in the raw mix', %

Emission Reduction

Project Life-time Emission Reductions $= \Sigma_{\mathrm{yr}}$ (Annual Emissions Reductions)
$= \Sigma_{\mathrm{yr}} [(Q_{CO_2} - Q^*_{CO2}) + Q^t_{co_2}]$

where:

Q_{CO_2} = baseline emissions, tons

Q^*_{CO2} = project emissions, tons

$Q^t_{co_2}$= leakage emissions, tons of CO_2

Yr = project years

Draft approved monitoring methodology AM00XX

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For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0123-rev http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

Applicability

This monitoring methodology shall be used in conjunction with the approved baseline methodology AM00 XX (Use of non-carbonated calcium sources in the raw mix for cement processing). The same applicability conditions as in baseline AM00XX apply.

Project Emissions Parameters

All monitored data has to be archived for 2 years following the end of the crediting period.

ID number *(Please use numbers to ease cross-referencing to table B.7)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1	Percentage of non-carbonated calcium source used in raw mix	*Production Report*	%	M (on-site device)	Daily	100%	Electronic (project lifetime) and Paper (5y)	Monitoring data have to be archived for 2 years following the end of the crediting period.
2	LOI of raw mix[4]	*Quality Report*	%	C (Based on formula provided)	Monthly	100%	Electronic (project lifetime) and Paper (5y)	Monitoring data have to be archived for 2 years following the end of the crediting period.
3	Production of Clinker at the Plant	*Production Report*	Ton	M (Quantity of clinker produced)	Monthly	100%	Electronic (project lifetime) and Paper (5y)	Monitoring data have to be archived for 2 years following the end of the crediting period.
4	Clinker quality	*Quality Report*	%	M	Monthly	100%	Electronic (project lifetime) and Paper (5y)	Monitoring data have to be archived for 2 years following the end of the crediting period.

[4] The size and frequency of sampling for the lab analysis for calculating LOI should be statistically significant with an maximum uncertainty range of 20% at a 95% confidence level, and possible impurities in the raw mix should be monitored and reported so as to guarantee that the difference in mass can be attributed to CO_2 emissions only, or corrected otherwise.

Baseline Emission Parameters

All monitored data has to be archived for 2 years following the end of the crediting period.

ID number *(Please use numbers to ease cross-referencing to table B.7)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
5	Percentage of non-carbonated calcium source used in raw mix		%	M (on-site device)	Daily	100%	Electronic (project lifetime) and Paper (5y)	Monitoring data have to be archived for 2 years following the end of the crediting period.
6	LOI of raw mix[5]		%	C (based on formula provided)	Monthly during the twelve months previous to project implementation	100%	Electronic (project lifetime) and Paper (5y)	Monitoring data have to be archived for 2 years following the end of the crediting period.

Leakage

All monitored data has to be archived for 2 years following the end of the crediting period.

[5] The size and frequency of sampling for the lab analysis for calculating LOI should be statistically significant with an maximum uncertainty range of 20% at a 95% confidence level, and possible impurities in the raw mix should be monitored and reported so as to guarantee that the difference in mass can be attributed to CO2 emissions only, or corrected otherwise.

ID number *(Please use numbers to ease cross-referencing to table B.7)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
7	Quantity of non-carbonated calcium transported	-	tonnes	C	Monthly	100%	Electronic (project lifetime) and Paper (5y)	Monitoring data have to be archived for 2 years following the end of the crediting period.
8	Truck capacity	-	Tonnes /truck	C	Monthly	100%	Electronic (project lifetime) and Paper (5y)	-
9	Distance	-	Km/truck	C	Monthly	100%	Electronic (project lifetime) and Paper (5y)	In certain cases other means of transportation which require other formulas be used iod.
10	Emission factors	-	Kg CO_2eq per km	C	Monthly	100%	Electronic (project lifetime) and Paper (5y)	

Quality Control (QC) and Quality Assurance (QA) Procedures

Data	Uncertainty Level of Data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary
1	low	Accuracy of the balance used, following ISO9000 standards
2	low	Accuracy of the balance, following ISO9000 standards
3	low	Accuracy of the balance used, following the ISO9000 standards
4	low	X-rays diffraction, microscopy
5	low	Accuracy of the balance used, following ISO9000 standards
6	low	Accuracy of the balance, following ISO9000 standards
7	low	Accuracy of the balance used, following ISO9000 standards
8	low	Accuracy of the balance used, following ISO9000 standards
9	low	Accuracy of the balance used, following ISO9000 standards
10	low	Literature data should be used