**Draft baseline and monitoring methodology AM00XX**

"Baseline and monitoring methodology for project activities using alternative raw materials that contain carbonates in clinker manufacturing in cement kilns"

# I. SOURCE AND APPLICABILITY

## Source

This methodology is based on the project activity "Use of calcined ashes and fluorite for clinker production in the Cement Plant of Huichapan, Mexico", whose baseline and monitoring methodology and project design document were prepared by "MGM International".

For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0163: "Use of calcined ashes and fluorite for clinker production in the Cement Plant of Huichapan, Mexico" on 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" and ACM0002: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"[1].

## Selected approach from paragraph 48 of the CDM modalities and procedures

"Actual or historical emissions, as applicable"

## Applicability

This methodology is applicable to cement industry projects (sectoral scope 4: Manufacturing Industry) that reduce $CO_2$ emissions in cement kilns by using alternative raw materials in clinker manufacturing. The *alternative raw materials for clinker manufacturing (AMC)* are defined as any mineral or synthetic substances or compounds that are obtained from mining, transformation or as by-products of other industrial processes that chemically react with commonly used raw materials for clinker production. These alternative raw materials could include, among others: waste ash from fuel combustion in thermal power plants, blast furnace slag, gypsum, anhydrite, and fluorite etc. that are not used in normal production conditions. The use of alternative raw materials in clinker manufacturing may also result in the reduction of $CO_2$ emissions due to the reduction in consumption of raw materials and/or consumption of energy (fuels and electricity).

This methodology is applicable under the following conditions:

- Use of alternative raw materials partially substitutes calcium and/or magnesium carbonate contents in raw material for clinker manufacturing.
- Use of alternative materials shall increase neither the capacity of clinker production nor the lifetime of equipment.
- Alternative raw materials have never been used in the clinker manufacturing facility prior to the implementation of the project activity.
- The quantity of alternative materials available shall be at least 1.5 times the quantity required for meeting the demand from all existing users consuming the same alternative raw materials in the

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

project area, i.e. the total quantity required for the project as well as other users of the alternative raw materials. Project area in this context is defined as the area within a radius of 200km around the project activity.
- There is sufficient historical information about the clinker manufacturing facility, the raw materials used, and energy performance of the kiln.

This methodology is not applicable for the following activities:

- Energy efficiency initiatives for improvements in process equipment (up-grade towers, grinding separators, burners, expert control systems, etc.).
- Fuel switching.

<u>NOTE: The quantity of clinker used for manufacturing new varieties of cement following project implementation is excluded from calculation of emissions, since these new varieties do not belong to the common-practice cement category.</u>

**Project boundary**

The project boundary includes all unit processes related to the manufacturing of clinker in the cement kiln, from reception of raw materials and fuel to the delivery of clinker in the cooler.

Project participants shall account for the following emission sources:

- ✓ Emissions from the cement kiln from fuel use:
    - Burning of fuels in the kiln (main burner and pre-calcinator).
    - Burning of fuel for preparing alternative raw materials and/or fuels, (e.g. drying of materials or fuels using external dryers), if applicable.
- ✓ Direct emissions for calcination of carbonates in limestone and clay from raw materials.
- ✓ Emissions for the potential changes in energy consumption inside the project boundary due to:
    - Consumption during crushing and adaptation of raw materials and fuels for clinker manufacturing.
    - In the operation of equipments related to the kiln (engines, compressors, fans, etc.).

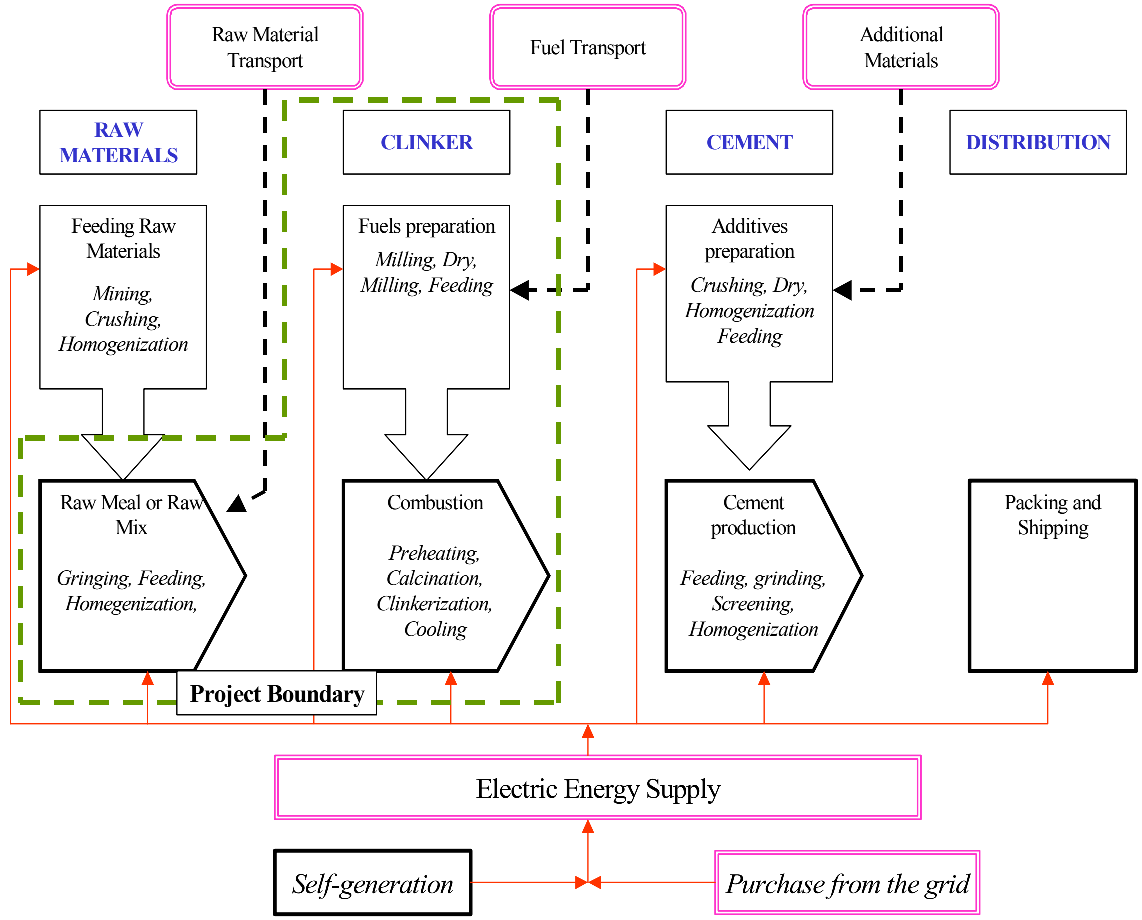
Transportation of raw materials, alternative raw materials, fuels and electricity generation sources are excluded from the project boundary. Emissions generated from transportation and electricity consumption in cement production, and potential effects due to a higher consumption of clinker when manufacturing the different kinds of cement, will be calculated and considered as leakage.

**Emissions sources included in or excluded from the project boundary are shown in Table 1 below.**

**Table 1: Summary of gases and sources included in the project boundary**

| | Source | Gas | Included? | Explanation |
|---|---|---|---|---|
| **Baseline** | Calcination of raw materials | $CO_2$ | Yes | Direct emission from clinker kiln. It includes effects for By-pass and Clinker Kiln Dust productions systems. |
| | | $CH_4$ | No | Emissions negligible, excluded for simplification |
| | | $N_2O$ | No | Emissions negligible, excluded for simplification |
| | Use of fuels (fossil, alternative fossil and non-fossil) | $CO_2$ | Yes | Direct emissions from clinker kiln. |
| | | $CH_4$ | No | Emissions negligible, excluded for simplification |
| | | $N_2O$ | No | Emissions negligible, excluded for simplification |

| | Source | Gas | Included? | Explanation |
|---|---|---|---|---|
| | Use of fuels in other processes different from kiln. | $CO_2$ | Yes | Only if there exists an additional consumption of fuel during the preparation of raw materials or fuel, for example, drying of materials using burners. |
| | | $CH_4$ | No | Emissions negligible, excluded for simplification |
| | | $N_2O$ | No | Emissions negligible, excluded for simplification |
| | Electricity, raw materials and fuel consumption. | $CO_2$ | Yes | Changes in feeding system and preparation of materials. |
| | | $CH_4$ | No | Emissions negligible, excluded for simplification |
| | | $N_2O$ | No | Emissions negligible, excluded for simplification |
| **Project Activity** | Calcination of raw materials | $CO_2$ | Yes | Direct emission from clinker kiln. It includes effects for By-pass and Clinker Kiln Dust productions systems. |
| | | $CH_4$ | No | Emissions negligible, excluded for simplification |
| | | $N_2O$ | No | Emissions negligible, excluded for simplification |
| | Use of fuels (fossil, alternative fossil and non-fossil) | $CO_2$ | Yes | Direct emission from clinker kiln. |
| | | $CH_4$ | No | Emissions negligible, excluded for simplification |
| | | $N_2O$ | No | Emissions negligible, excluded for simplification |
| | Use of fuels in other processes different from kiln | $CO_2$ | Yes | Only if the new material would have a fuel consumption specific component for the adaptation of material, for instance, drying. |
| | | $CH_4$ | No | Emissions negligible, excluded for simplification |
| | | $N_2O$ | No | Emissions negligible, excluded for simplification |
| | Electricity, raw materials and fuel consumption. | $CO_2$ | Yes | Changes in feeding system and preparation of materials. |
| | | $CH_4$ | No | Emissions negligible, excluded for simplification |
| | | $N_2O$ | No | Emissions negligible, excluded for simplification |




The green dotted line represents the project boundary

Procedure for the identification of the most plausible baseline scenario

**STEP 1. Identification of alternative scenarios to the proposed CDM project activity that are consistent with current laws and regulations**

Identify all realistic and credible alternatives to the project activity that are consistent with current laws and regulations. In doing so, project participants shall consider all realistic and credible production scenarios for the relevant clinker type that are consistent with current rules and regulations, including the existing practice of clinker production, the proposed project activity not undertaken as a CDM project activity and practices in other manufacturing plants in the region[2] using similar input/raw materials, and facing similar economic, market and technical circumstances.

[2] Region in this context is defined as the geographic area around the project activity covering at least 10 cement plants.

**STEP 2. Barrier analysis to eliminate alternatives to the project activity that face prohibitive barriers**

Establish a complete list of barriers that would prevent alternative scenarios in the absence of the CDM, using the guidance in Step 3 (barrier test) of the latest version of the "*Tool for the demonstration and assessment of additionality*".

Since the "proposed project activity not being registered as a CDM project activity" shall be one of the considered alternatives, any barrier that may prevent the project activity to occur shall be included in that list. Show which alternatives are prevented by at least one of the barriers previously identified and eliminate those alternatives from further consideration. All alternatives shall be evaluated for a common set of barriers.

If there is only one alternative that is not prevented by any barrier then this alternative is identified as the baseline scenario. Where more than one credible and plausible alternative remains, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario, or conduct an investment analysis (Step 3).

**STEP 3. Investment analysis (optional)**

Conduct an investment analysis, consistent with the guidance in Step 2 of the latest version of the "Tool for the demonstration and assessment of additionality" for all combinations of alternatives that are remaining after the previous step. The economically most attractive combination of alternatives is deemed as the most plausible baseline scenario.

This methodology is applicable only if the most likely baseline scenario is the continuation of the production practice using current processes.

**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 CDM Executive Board, which is available on the UNFCCC website.[3]

Either use step 2 (investment analysis) or demonstrate the existence of "first of its kind" barrier when using step 3 (barrier test). If the project participant faces other barriers than being the "first of its kind", they should use step 2 (investment analysis) by monetized these barriers and including them in the investment analysis.

"First of its kind" barrier is defined as follows:

- The project activity is the "first of its kind": The new alternative raw materials are not currently used for clinker manufacturing in the host country or region[4].

Project participants shall demonstrate that the identified barriers prevent the implementation of the proposed project activity and can only be overcome by registering the project as a CDM project activity.

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

[4] Region in this context is defined as the geographic area around the project activity covering at least 10 cement plants.

**Baseline emissions**

The baseline emissions under this methodology shall be calculated using the $CO_2$ emission factor for the clinker produced in the project situation. Clinker based method is used in this methodology, as suggested in the revised IPCC guidelines for national GHG inventories of 2006, that considers the volume and composition of clinker produced plus dust leaving the kiln system. The emission factor shall be determined as follows:

$$BE_{Clinker,y} = BE_{Calcin} + BE_{FC\_Calcin} + BE_{Dust} + BE_{FC\_Dry} + BE_{Elec\_Grid} + BE_{Elec\_SG} \quad \textbf{(1)}$$

Where:

| | |
|---|---|
| $BE_{Clinker,y}$ | is the baseline $CO_2$ emission factor for clinker production for the year *y* ($tCO_2$/tonne clinker) |
| $BE_{Calcin}$ | is the baseline $CO_2$ emissions from calcination of calcium carbonate and magnesium carbonate ($tCO_2$/tonne clinker) |
| $BE_{FC\_Calcin}$ | is the baseline $CO_2$ emissions factor for combustion of fuels in clinker production ($tCO_2$/tonne clinker) |
| $BE_{Dust}$ | is the baseline $CO_2$ emissions factor due to discarded dust from bypass and dedusting units (CDK) system ($tCO_2$/tonne clinker) |
| $BE_{FC\_Dry}$ | is the baseline $CO_2$ emissions factor due to fuel consumption for drying of raw material or fuel preparation ($tCO_2$/tonne clinker) |
| $BE_{Elec\_Grid}$ | is the baseline $CO_2$ emissions factor for the grid electricity consumption for clinker production ($tCO_2$/tonne clinker) |
| $BE_{Elec\_SG}$ | is the baseline $CO_2$ emissions for self-generated electricity used for clinker production (t $CO_2$/tonne clinker) |

Each of the above baseline emission components shall be calculated as follows:

*(a) Baseline $CO_2$ emissions from Calcination of carbonates ($BE_{Calcin}$):*

For estimation of $CO_2$ emissions resulting from calcination, only the proportion of calcium oxides and magnesium oxides present in the produced clinker will be considered. Measured values of CaO and MgO contents, corrected for the non-carbonate sources (for example, deducting any calcium that comes from use of calcium silicates or fly ash used as raw materials) shall be used. $CO_2$ emissions from calcination with correction for non-carbonate sources shall be determined as follows:

$$BE_{Calcin} = \frac{\left[0.785\left(CaO_{CLNK,BSL} - CaO_{RM,BSL}\right) + 1.092\left(MgO_{CLNK,BSL} - MgO_{RM,BSL}\right)\right]}{CLNK_{BSL}} \quad \textbf{(1.1)}$$

Where:

| | |
|---|---|
| 0.785 | is the Stoichiometric emission factor for CaO ($tCO_2$/tCaO) |
| 1.092 | is the Stoichiometric emission factor for MgO ($tCO_2$/tMgO) |
| $CaO_{RM,BSL}$ | is the non-carbonate CaO content (%)in the raw meal used in the baseline scenario (If applicable). These non-carbonate sources must to be different of non-carbonate materials of project activity. |
| $CaO_{CLNK,BSL}$ | is the CaO content (%)in the clinker produced |
| $MgO_{RM,BSL}$ | is the non-carbonate MgO content (%) in the raw meal used in the baseline |

| | |
|---|---|
| | scenario (If applicable). These non-carbonate sources must to be different of materials of project activity |
| $MgO_{CLNK,BSL}$ | is the MgO content (%) in the clinker produced |
| $RM_{BSL}$ | is the annual consumption of raw meal in the base year (tonne of raw meal) |
| $CLNK_{BSL}$ | is the annual production of clinker in the base year (tonne of clinker) |

*(b) Baseline $CO_2$ emissions from combustion of fuels in the kiln for calcination ($BE_{FC\_Calcin}$):*

In order to calculate the $CO_2$ emission factor per tonne of clinker produced related to fuel consumption, the "historical kiln energy consumption performance values" shall be used.

$$BE_{FC\_Calcin} = \frac{SKC_{BSL} \cdot \sum \left(FC_{i,Calcin,y} \cdot EF_{CO2,i}\right)}{\sum FC_{i,Calcin,y}} \qquad \textbf{(1.2)}$$

Where:

| | |
|---|---|
| $SKC_{BSL}$ | is the Specific Kiln Calorific Consumption for the baseline scenario (GJ/tonne clinker) |
| $FC_{i,Calcin}$ | is the fuel type *i* consumed for calcination in clinker production during the year *y*. (See Formula 2.2.3 below) |
| $EF_{CO2,i}$ | is the $CO_2$ emission factor for fossil or alternative fuel type *i* ($tCO_2/GJ$) used in the kiln in year y; (See Formula 2.2.3 below) |

1. In order to ensure that emission reductions for fuel switching measures, if any undertaken during the project activity, are not claimed the types of fuel used during project activity are used to estimate $BE_{FC\_Calcin}$.[5]

*(c) Baseline $CO_2$ emissions due to discarded dust from bypass and dedusting units (CDK) system ($BE_{Dust}$):*

If there is a discarded dust from the bypass and dedusting unit (CDK), the baseline emissions due to discarded dust shall be determined as follows:

$$BE_{Dust} = \frac{\left\{\left(BE_{Calcin} \cdot ByPass\right) + \frac{BE_{Calcin} \cdot d}{\left[BE_{Calcin}(1-d)+1\right]} CKD\right\}}{CLNK_{BSL}} \qquad \textbf{(1.3)}$$

Where:

| | |
|---|---|
| ByPass | is the annual production of Bypass dust leaving kiln system (tonnes) |
| CKD | is the annual production of CKD dust leaving kiln system (tonnes) |
| d | is the CKD calcination rate % (released $CO_2$ expressed as a fraction of the total carbonate $CO_2$ in the raw meal) |
| $CLNK_{BSL}$ | is the annual production of clinker in the base year (tonne of clinker) |

*(d) Baseline $CO_2$ emissions from fuel consumption for drying of raw material or fuel preparation ($BE_{FC\_Dry}$):*

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[5] In this way, fuel switching is not precluded from the project activity but it is assumed that this fuel switching would have occurred anyway in the baseline, and thus no emission reductions are accounted for in this case.

$$BE_{FC\_Dry} = \frac{\sum \left( FC_{Dry,i} \cdot EF_{CO2,i} \cdot NCV_i \right)}{CLNK_{BSL}} \quad \textbf{(1.4)}$$

Where:

| | |
|---|---|
| $FC_{Dry,i}$ | is the i[th] fossil fuel consumed for drying raw materials or fuel preparation (tonnes) in the baseline |
| $EF_{CO2,i}$ | $CO_2$ emission factor for the i[th] fossil fuel type ($tCO_2/GJ$) |
| $NCV_i$ | is the Net Calorific Value of the fuel type *i* (GJ/tonne of additional fuel) |
| $CLNK_{BSL}$ | is the annual production of clinker in the base year (tonne of clinker) |

*(e) Baseline $CO_2$ emissions from grid electricity consumption for clinker production ($BE_{Elec\_Grid}$):*

$$BE_{Elec\_Grid} = \frac{\left( EC_{RM,Grid} + EC_{Feed,Grid} + EC_{KO,Grid} \right) \cdot EF_{CO2,Elec\_Grid}}{CLNK_{BSL}} \quad \textbf{(1.5)}$$

Where:

| | |
|---|---|
| $EC_{RM,Grid}$ | is the baseline grid electricity consumption for raw meal grinding (MWh) |
| $EC_{Feed,Grid}$ | is the baseline grid electricity consumption for fuel feeding (MWh) |
| $EC_{KO,Grid}$ | is the baseline grid electricity consumption for kiln operation (MWh) |
| $EF_{CO2,Elec\_Grid}$ | is the $CO_2$ emission factor of the grid ($t\ CO_2/MWh$) |
| $CLNK_{BSL}$ | is the annual production of clinker in the base year (tonne of clinker) |

$CO_2$ emission factor of the grid ($EF_{CO2,Elec\_Grid}$) shall be calculated in accordance with the procedures and guidelines provided in latest version of the approved methodology ACM0002: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources".

*(f) Baseline $CO_2$ emissions from self-generation of electricity for clinker production ($BE_{Elec\_SG}$):*

$$BE_{Elec\_SG} = \left( EC_{RM,SG} + EC_{Feed,SG} + EC_{KO,SG} \right) \cdot EF_{CO2,Elec\_SG} / CLNK_{BSL} \quad \textbf{(1.6)}$$

Where:

| | |
|---|---|
| $EC_{RM,SG}$ | is the baseline self-generated electricity consumed for raw meal grinding (MWh) |
| $EC_{Feed,SG}$ | is the baseline self-generated electricity consumed for fuel feeding (MWh) |
| $EC_{KO,SG}$ | is the baseline self-generated electricity consumed for kiln operation (MWh) |
| $EF_{CO2,Elec\_SG}$ | is the $CO_2$ emission factor of self generated electricity ($t\ CO_2/MWh$) |
| $CLNK_{BSL}$ | is the annual production of clinker in the base year (tonne of clinker) |

$CO_2$ emission factor for self-generated electricity ($EF_{CO2,Elec\_SG}$) shall be determined as the generation-weighted average emissions per electricity unit ($tCO_2/MWh$) of all self-generating sources in the project boundary serving the facility.

$$EF_{CO2,Elec\_SG} = \frac{\sum_{i,j} F_{i,j} \cdot COEF_{i,j}}{\sum_{j} GEN_j} \quad \textbf{(1.6a)}$$

Where:

$F_{i,j}$ = Amount of fuel i (in a mass or volume unit) consumed by relevant power sources *j*

*j* = *On-site* power sources

$COEF_{i,j}$ = $CO_2$ emission coefficient of fuel *i* ($tCO_2$ / mass or volume unit of the fuel, estimated using equation 1.6b below

$GEN_j$ = Electricity (MWh) generated by the source *j*

The $CO_2$ emission coefficient $COEF_i$ is obtained as:

$$COEF_i = NCV_i \cdot EF_{CO_2,i} \cdot OXID_i \quad \textbf{(1.6b)}$$

Where:

$NCV_i$ = Net calorific value (energy content) per mass or volume unit of a fuel *i*

$OXID_i$ = Oxidation factor of the fuel *i* (see Table 1-4 in the 2006 IPCC Guidelines, Vol. 2, page 1.25, for default values)

$EF_{CO2,I}$ = $CO_2$ emission factor per unit of energy of the fuel *i*

**Project Emissions**

Similar to the baseline emissions, project activity emissions shall be expressed as $CO_2$ emission factor per ton of clinker produced, as follows:

$$PE_{Clinker,y} = PE_{Calcin,y} + PE_{FC\_Calcin,y} + PE_{Dust} + PE_{FC\_Dry,y} + PE_{Elec\_Grid,y} + PE_{Elec\_SG,y} \quad \textbf{(2)}$$

Where:

$$PE_{Calcin} = \frac{\left[0.785 \cdot \left(CaO_{\cdot CLNK,y} - CaO_{RM,y}\right) + 1.092 \cdot \left(MgO_{\cdot CLNK,y} - MgO_{\cdot RM,y}\right)\right]}{CLNK_y} \quad \textbf{(2.1)}$$

$$PE_{FC\_Calcin,y} = \frac{SKC_y \cdot \sum\left(FC_{i,Calcin,y} \cdot EF_{CO2,i}\right)}{\sum\left(FC_{i,Calcin,y}\right)} \quad \textbf{(2.2)}$$

As this methodology is restricted to the use of new alternative material for clinker manufacturing and not to efficiency improvement measures that could take place at the same time as the project activity, the following procedure shall be used to ensure the emission reductions from project activity are claimed only for the alternative materials used. Diagram 1.1 below, gives a graphic description of comparative procedure for project emission calculation. The procedures is based on comparison of the actual kiln energy performance in the year "y" ($SKC_{y,measured}$) with the baseline kiln energy performance ($SKC_{BSL}$) and the expected value with the project activity ($SKC_{ex}$). $SKC_{ex}$ shall be estimated by means of industrial samples that follow an ex-ante monitoring procedure described in Annex to this methodology. The following rule (also explained in the diagram 1.1) apply for assigning value to $SKC_y$ in equation 2.2:

(i) If $SKC_{y,measured} \geq SKC_{BSL}$ then $SKC_y = SKC_{y,measured}$

(ii) If $SKC_{y,measured} < SKC_{BSL}$

a) If $\%AMC_y$ falls out of "%AMC optimal range", then

$\underline{SKC_y = SKC_{BLS}}$

b) If $\%AMC_y$ falls between the "%AMC optimal range" and

   a. $SKC_{y,measured}$ falls between "$SKC_{ex}$ optimal range", respectively, then

      $\underline{SKC_y = SKC_{y,measured}}$

   b. If $SKC_{y,measured}$ is lower than any value of the interval "$SKC_{ex}$ optimal range" $SKC_y$ shall be calculated as follows:

$SKC_y = \overline{SKC_j}$ ("j" runs from 1 to "y-1" years following project implementation)

This average shall exclude $SKC_j$ values that were higher than $SKC_{BSL}$, i.e. allowed $SKC_j$ values fall within the following range:

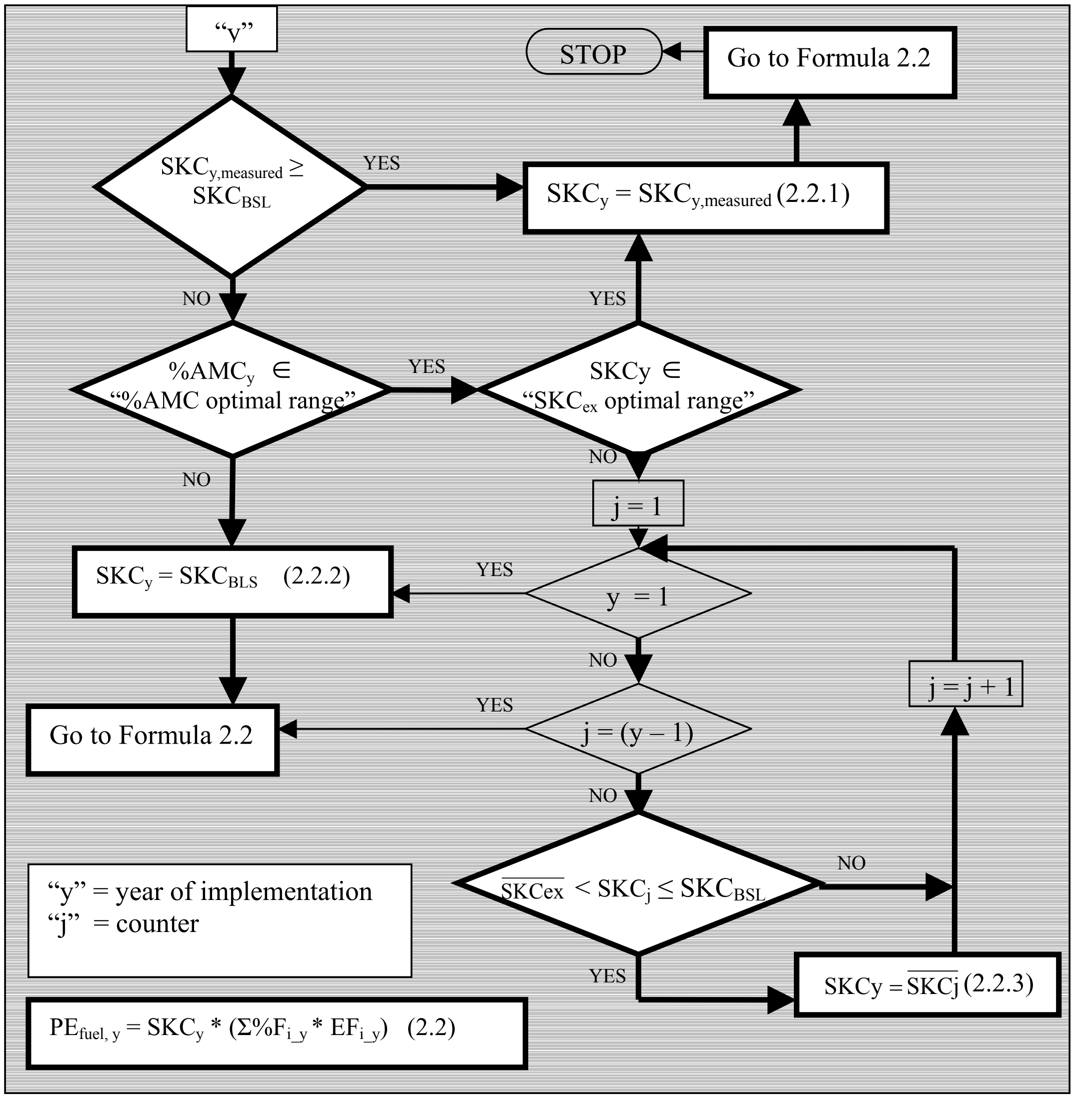
$\overline{SKC_{ex}} < SKC_j \leq SKC_{BSL}$

Where:

| | | |
|---|---|---|
| $SKC_y$ | = | Specific Kiln Calorific Consumption for the year "y" (GJ/tonne clinker) |
| $SKC_{y,measured}$ | | Specific Kiln Calorific Consumption measured in the year "y" (GJ/tonne clinker) |
| $SKC_{BLS}$ | = | Baseline specific Kiln Calorific Consumption (GJ/tonne clinker) |
| $\overline{SKC_{ex}}$ | = | Arithmetic mean of Specific Kiln Calorific Consumption during ex-ante monitoring (GJ/tonne clinker). See Figure 1.1. |
| "$SKC_{ex}$ optimal range" | = | Interval of 95% of confidence for specific kiln calorific consumption during ex-ante monitoring (GJ/tonne clinker). See Figure 1.1. |
| $\overline{SKC_j}$ | = | Average of specific kiln calorific consumption following project activity prior to the year "y". Label "j" is a counter that runs from 1 to "y-1". (GJ/tonne clinker). If y = 1, $\overline{SKC_j} = SKC_{BLS}$ |
| $FC_{i,Calcin,y}$ | = | Annual fuel type i consumption for clinker production in year "y" (tonne fuel / year) |
| $EF_{CO2,i}$ | = | IPCC $CO_2$ Emission factor for fossil or alternative fuel i in year "y" ($tCO_2$/GJ) |
| $\%AMC_y$ | = | Percentage of ACM in the raw meal production in the year "y" due to project activity implementation. The %AMC could be %SO3 or %(SO3 and CaF2) or Lime Saturation Factor (LSF) or raw meal particle size (fineness) |
| $\overline{\%AMC_{ex}}$ | = | Arithmetic mean of %AMC in the raw meal during ex-ante monitoring. See Figure 1.1. |
| "$\%AMC_{ex}$ optimal range" | = | Interval of 95% of confidence for AMC content in the raw meal during ex-ante monitoring. See Figure 1.1. |

In case (ii) the project proponents shall demonstrate that the higher energy performance is only due to the utilization of alternative materials. To do so, the project proponents have to compare the actual specific kiln calorific consumption ($SKC_{y,measured}$) for the year "y" with the results of the ex-ante monitoring at the beginning of the project implementation ($SKC_{ex}$) (See Diagram 1.1). This ex-ante monitoring procedure is explained in Figure 1.1. The main purpose of this ex-ante monitoring procedure is to develop an industrial testing procedure (where kiln operational variables are under total control) that shows the highest specific consumption reduction ("optimum") that is possible to achieve during project implementation. The optimum values will only be used as reference.

Diagram 1.1 "Flowchart of comparative procedure for Project Emissions in the year "y"




$$PE_{Dust,y} = \frac{\left\{ \left( PE_{Calcin,y} \cdot ByPass \right) + \frac{PE_{Calcin,y} \cdot d}{\left[ PE_{Calcin,y}(1-d)+1 \right]} CKD_y \right\}}{CLNK_y} \quad \textbf{(2.3)}$$

$$PE_{FC\_Dry,y} = \frac{\sum \left( FC_{Dry\_Addl,i,y} \cdot EF_{CO2,i} \cdot NCV_i \right)}{CLNK_y} \quad \textbf{(2.4)}$$

$$PE_{Elec\_Grid,y} = \frac{\left( EC_{RM,Grid,y} + EC_{Feed,Grid,y} + EC_{KO,Grid,y} \right) \cdot EF_{CO2,Elec\_Grid,y}}{CLNK_y} \quad \textbf{(2.5)}$$

As this methodology is restricted to the use of new alternative raw materials only for clinker manufacturing and not for any reduction in electricity energy consumption for raw meal or kiln operations, the project $CO_2$ emissions from grid electricity consumption ($PE_{Elec\_grid,y}$) from the grid shall base on the following considerations. The value of $EC_{RM,Grid,y}$ and $EC_{KO\_Grid,y}$ shall be as follows.

$$EC_{RM,Grid,y} = \text{minimum of}\left(EC_{RM,Grid,y}\ ,\ EC_{RM,Grid}\right)$$
$$EC_{KO,Grid,y} = \text{minimum of}\left(EC_{KO,Grid,y}\ ,\ EC_{KO,Grid}\right) \qquad \textbf{(2.5a)}$$

$$PE_{Elec\_SG,y} = \frac{\left(EC_{RM.SG,y} + EC_{Feed,SG,y} + EC_{KO,SG,y}\right)\cdot EF_{CO2,Elec\_SG}}{CLNK_y} \qquad \textbf{(2.6)}$$

Similarly, for the formula 2.6 the value of $EC_{RM,SG,y}$ and $EC_{KO\_SG,y}$

$$EC_{RM,SG,y} = \text{minimum of}\left(EC_{RM,SG,y}\ ,\ EC_{RM,Grid}\right)$$
$$EC_{KO,SG,y} = \text{minimum of}\left(EC_{KO,SG,y}\ ,\ EC_{KO,Grid}\right) \qquad \textbf{(2.6a)}$$

1. In the above formulae, notations of all variables are analogous to the variables described for baseline emissions in formulae 1 and 1.1 through 1.6 respectively. The following shall be considered while estimating the project emissions using the above formulae.

2. Subscript '*y*' used in the above formulae represents the year during which the project emissions are accounted. The values of variables with subscript *y* shall be based on actual measurements conducted during the year *y*.

**Leakage**

The following emission sources shall be considered as leakage under this methodology:

- Any incremental increase in transportation of clinker raw material (limestone, clay and iron ore), fuels (fossil fuels and alternative fuels) and new alternative materials (blast furnace slag, fly ash, waste ash from fuel combustion in thermal power plants, gypsum and others) from offsite locations to the project plant site. Any decrease in transport-related emissions for existing clinker raw materials and fuels change shall not be accounted.
- Emissions due to transport of alternative raw materials will be accounted as leakage.
- Emissions from grid electricity consumption for conveyor system for alternative materials.
- Electricity consumption in cement raw material grinding, preparation and feeding for blended cement manufacture, due to indirect effects of the change of clinker conditions in cement production (i.e., the clinker could be harder to grind; therefore, the cement grinding needs more electricity consumption in order to produce the same quality of common-practice blended cement).
- Changes in clinker proportion in cement manufacture due to the same effects of the potential changes in the physical and mineralogical condition of clinker, in common-practice blended cement production (i.e. the proponents could need more or less clinker in order to produce the same quality of common-practice blended cement).

Another possible leakage is due to the diversion of alternative raw materials from existing uses. The project proponents shall demonstrate that the quantities of alternative raw materials used in the project are surplus. For this purpose the project participants need to conduct a survey to demonstrate that the alternative raw materials are available in the region by at least 1.5 times the demand for the same alternative raw materials from all existing users including the project plant. Otherwise, this methodology is not applicable.

The leakage from the project activity is expressed as

$$LE_y = LE_{trans,y} + LE_{Elec\_Conv,y} + LE_{ele\_cto,y} + LE_{Cto,y} \qquad \textbf{(3)}$$

Where:

| | |
|---|---|
| $LE_y$ | is the $CO_2$ emissions due to leakage during the year *y* (tonnes of $CO_2$) |
| $LE_{trans,y}$ | is the $CO_2$ leakage due to transportation of new materials during the year *y* (tonnes of is the $CO_2$ emissions from electricity consumption for conveyor systems for alternative materials (tonnes of $CO_2$)$CO_2$) |
| $LE_{Elec\_Conv,y}$ | |
| $LE_{ele\_cto,y}$ | is the $CO_2$ leakage due to additional electricity consumption in blended cements grinding during the year *y* (tonnes of $CO_2$) |
| $LE_{Cto,y}$ | is the $CO_2$ leakage due to lower clinker consumption in blended cements during the year *y* (tonnes of $CO_2$) |

*(a)Leakage due to transportation of new alternative raw materials ($LE_{trans}$):*

Transport-related emissions for alternative raw materials shall be determined as follows:

$$LE_{Trans} = \frac{\lfloor FC_{Trans,i} \cdot Dist \cdot EF_{CO2,i} \rfloor}{(Q_{Trip} \cdot 1000)} \cdot ALTM_y \qquad \textbf{(3.1)}$$

Where:

| | |
|---|---|
| $FC_{Trans,i}$ | is the fuel consumption of the vehicle per kilometer (kg of fuel/kilometer) |
| Dist | is the distance between the source of fuel and the project activity plant (km) |
| $EF_{CO2,i}$ | is the $CO_2$ emission factor for transport fuel type *i* (kg $CO_2$/kg of fuel) |
| $Q_{trip}$ | is the Quantity of alternative materials carried in one trip per vehicle (tonnes of alternative materials) |
| $ALTM_y$ | is the annual consumption of alternative materials in raw meal in year y (tonnes) |

*(b) Leakage from electricity consumption for conveyors system ($LE_{ElecConv,y}$):*

$$LE_{ElecConv,y} = EC_{Conv,y} \cdot EF_{CO2,Grid} \qquad \textbf{(3.2)}$$

Where:

| | |
|---|---|
| $EC_{Conv,y}$ | is the electricity consumed for conveyors during the year *y* (MWh) |
| $EF_{CO2,Grid,y}$ | Is the $CO_2$ emission factor of the grid electricity during the year *y* ($tCO_2$/MWh) |

$EF_{CO2,Grid,y}$ shall be determined using ACM0002: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"

(c) Leakage calculation due to change in electricity consumption in cement grinding and production

Since changes in electricity consumption in cement grinding and production cannot be determined precisely due to the new conditions of the clinker (for instance, harder to grind), for the purpose of calculating leakage in a conservative way, only the higher consumption is considered according to:

$$LE_{Ele\_cto,y} = \sum \left[EC_{Cto,y} - EC_{Cto,BSL}\right] \cdot EF_{CO2,Grid,y} \qquad \textbf{(3.3)}$$

Where:

| | |
|---|---|
| $EC_{Cto,BSL}$ | is the baseline electricity consumption for cement grinding (MWh) |
| $EC_{Cto,y}$ | is the electricity consumption for cement grinding in year "y" (MWh) |
| $EF_{CO2,grid,y}$ | Is the electricity grid emission factor ($tCO_2$/MWh) |

If $LE_{ele\_cto,y} < 0$, conservatively $LE_{ele\_cto}$ shall be taken as zero.

(d) Leakage calculation of a potential higher consumption of clinker in cement production

Leakage shall be quantified due to a potential higher consumption of clinker in cement production, according to the clinker factor of the project activity, as follows:

$$LE_{Cto} = \Sigma CTO_{m,y} * (P_{blend,y} - B_{blend}) * PE_{CLINKER,y} \qquad \textbf{(3.4)}$$

If $LE_{Cto} < 0$, conservatively $LE_{Cto}$ shall be taken as zero.

Where:

| | |
|---|---|
| $LE_{Cto}$ | is the $CO_2$ emissions due to higher consumption of clinker in Portland-type common-practice blended cement (tonnes of $CO_2$) |
| $PE_{CLINKER,y}$ | is the emissions of $CO_2$ per tonne of clinker in the project activity plant in year "y" ($tCO_2$/t clinker) |
| $CTO_{m,y}$ | is the annual production of common-practice blended cement by type "m" in year "y" (tonnes blended cement) |
| $B_{blend}$ | is the baseline percentage of clinker in common-practice Blended Cement (tonne clinker/ tonnes blended cement) |
| $P_{blend,y}$ | is the percentage of clinker in common-practice Blended Cement in year "y" (tonne clinker/ tonnes blended cement) |

Common-practice blended cement is defined as the types of cements that have been produced in the cement plant prior to project implementation. Blended cement is defined as a product with different uses that has gypsum and/or different additives and different clinker ratios (for example, limestone, pozzolana, blast furnace slag, silica flume, fly ash and others). The domestic and export types of cement are included if they are common-practice blended cement.

In accordance with these definitions, for the identification of the baseline percentage of clinker considered in common-practice cement production ($B_{blend}$), the project proponents shall monitor the annual weighted percentage of clinker consumed in the total of blended cement produced for three (3) years before implementing the project activity. To do this, the project proponents shall monitor the total clinker consumption and total cement produced by each blended cement type ("m") every year of the three (3)-year period before implementing the project activity. The definition of each blended cement type ("m") must be in accordance with the respective regulatory cement norm of the cement market where the common-practice cement product has been commercialized.

The percentage of clinker in common-practice cement production ($B_{blend}$) is calculated as follows:

$$B_{blend} = AVERAGE(\Sigma CLNK_{BSL\_CNSM,m} / \Sigma CTO_{BSL,m}) \quad \textbf{(3.5)}$$

Where:

| | |
|---|---|
| $B_{blend}$ | is the baseline average percentage of clinker in the total blended cement production of the last three years prior to project implementation (tonne clinker/ tonnes cement) |
| $CLNK_{BSL\_CNSM,m}$ | is the annual clinker consumption in each blended cement type "m" in the last three years prior to project implementation (tonnes of clinker) |
| $CTO_{BSL,m}$ | is the annual blended cement type "m" production in the last three years prior to project implementation (tonnes of blended cement) |

For the identification of the percentage of clinker in common-practice blended cement production in the year "y" following project implementation ($P_{blend,y}$), the project proponents shall monitor the total amount of clinker consumed and total blended cement production in the year "y" for each cement type "m" defined in the baseline as blended cement of common-practice (see formula 3.4).

The percentage of clinker in common-practice cement production ($P_{blend,y}$) in the year "y" is calculated as follows:

$$P_{blend,y} = AVERAGE(\Sigma CLNK_{CONSM,m,y} / \Sigma CTO_{m,y}) \quad \textbf{(3.6)}$$

| | |
|---|---|
| $P_{blend,y}$ | is the percentage of clinker in common-practice blended cement in the year "y" (tonne clinker/ tonnes blended cement) |
| $CLNK_{CONSM,m,y}$ | is the annual consumption of clinker of each common-practice blended cement type "m" in the year "y" (tonnes of clinker) |
| $CTO_{,m,y}$ | is the annual production of common-practice blended cement by type "m" in the year "y" (tonnes blended cement) |

**Emission reductions**

Quantification of $CO_2$ emission reductions for year "y" following project implementation shall be calculated as follows:

$$ER_y = \left(BE_{Clinker} - PE_{Clinker,y}\right) \cdot CLNK_y - LE_y \quad \textbf{(4)}$$

Where:

| | |
|---|---|
| $ER_y$ | is the emission reductions in year "y" due to project activity (tonnes of $CO_2$) |
| $BE_{CLINKER}$ | is the baseline emissions of $CO_2$ per tone of clinker in the project activity plant ($tCO_2$/tonne clinker) |
| $PE_{CLINKER,y}$ | is the emissions of $CO_2$ per tone of clinker in the project activity plant in year "y" ($tCO_2$/tonne clinker) |
| $LE_y$ | is the $CO_2$ emissions due to leakage (tonnes of $CO_2$) |
| $CLNK_y$ | is the annual clinker production in the year "y" (tonnes of clinker) |

The total annual consumption of clinker in type "*m"* of common-practice blended cement production in year "y" (tonnes of clinker) must be determined according to the procedure of (d) of Leakage section above.

**Changes required for methodology implementation in 2nd and 3rd crediting periods**

No changes are required for methodology implementation in 2$^{nd}$ and 3$^{rd}$ Crediting Periods.

**Data and parameters not monitored**

| | |
|---|---|
| ID Number: | |
| **Parameter:** | $EF_{CO2,i}$ |
| Data unit: | $tCO_2/GJ$ |
| Description: | $CO_2$ Emission factor for fossil or alternative fuel type *i* ($tCO_2/GJ$); |
| Source of data: | The value should be based on site-specific values or national values. If such data is not available, then IPCC defaults can be used. |
| Measurement procedures (if any): | |
| Any comment: | |

| | |
|---|---|
| ID Number: | PE-37 |
| **Parameter:** | $COEF_{i,j\ y}$ |
| Data unit: | $tCO_2$/tonne of fuel i |
| Description: | $CO_2$ emission coefficient of fuel *i* ($tCO_2$ / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources *j* and the percent oxidation of the fuel in year "*y"* |
| Source of data: | The value is estimated using values of NCV, OXID (oxidation factor) and EF ($CO_2$ emission factor of the fuel). The value of NCV and EF should be based on site-specific values or national values. If such data is not available, then IPCC defaults can be used. IPCC default for OXID shall be taken from see Table 1-4 in the 2006 IPCC Guidelines, Vol. 2, page 1.25, for default values) |
| Measurement procedures (if any): | |
| Any comment: | |

| | |
|---|---|
| **Data / Parameter:** | $CaO_{CLNK,\ BSL}$ |
| Data unit: | (%) |
| Description: | CaO content of the clinker produced |
| Source of data: | It is determined base on historical data for previous at least 3 years as part of laboratory quality control procedure |
| Measurement procedures (if any): | Sampling of at least 3 years preceding the start of the project activity. |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| | |
|---|---|
| **Data / Parameter:** | $CaO_{RM,\ BSL}$ |
| Data unit: | (%) |
| Description: | CaO content of the raw meal due to non-carbonate sources before of project implementation. (If is applicable) These non-carbonate sources must to be different of non-carbonate materials of project activity |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is based on laboratory quality control procedures. |
| Measurement procedures (if any): | Sampling. Historical data of the previous 3 years Plant records |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |

| | |
|---|---|
| Any comment: | |

| **Data / Parameter:** | $MgO_{CLNK, BSL}$ |
|---|---|
| Data unit: | (%) |
| Description: | MgO content of the clinker produced |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is based on laboratory quality control procedures. |
| Measurement procedures (if any): | Sampling at previous 3 years. |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $MgO_{RM,BSL}$ |
|---|---|
| Data unit: | (%) |
| Description: | MgO content of the raw meal due to non-carbonate sources via calcium silicates or raw materials. (If is applicable) These non-carbonate sources must to be different of materials of project activity |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is based on laboratory quality control procedures. |
| Measurement procedures (if any): | Sampling. Historical data at previous 3 years |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $RM_{BSL}$ |
|---|---|
| Data unit: | tonne of raw meal |
| Description: | Annual consumption of raw meal in the base year |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is based on inventories. |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge/Stockpile control at previous 3 years |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $CLNK_{BSL}$ |
|---|---|
| Data unit: | tonne of clinker |
| Description: | Annual production of clinker in the base year |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from inventories control procedures |
| Measurement procedures (if any): | Weighfeeders/Stockpile control at previous 3 years |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC |

| | |
|---|---|
| | requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $SKC_{BSL}$ |
|---|---|
| Data unit: | GJ/tonne clinker |
| Description: | Specific Kiln Calorific Consumption for the baseline |
| Source of data: | Calculated as part of energy efficiency evaluation in baseline (at least three previous year) |
| Measurement procedures (if any): | Historical data of the Plant records |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be calculated as part of normal plant level operations for energy performance evaluation. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | The specific fuel consumption of a kiln is arguably the most important operating parameter |

| **Data / Parameter:** | ByPass |
|---|---|
| Data unit: | tonne of Bypass Dust |
| Description: | Annual production of Bypass dust leaving kiln system |
| Source of data: | It is determined base on historical data for previous 3 years as part of production control procedures |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge at previous 3 years |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | d |
|---|---|
| Data unit: | %(released $CO_2$ expressed as a fraction of the total carbonate $CO_2$ in the raw meal) |
| Description: | CKD calcination rate |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from inventories control procedures |
| Measurement procedures (if any): | Sampling at previous 3 years |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | It could be estimated |

| **Data / Parameter:** | CKD |
|---|---|
| Data unit: | tonne of CKD Dust |
| Description: | Annual production of CKD dust leaving kiln system |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from production control procedures. |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge at previous 3 years |
| Monitoring frequency: | Monthly (Recorded) |

| | |
|---|---|
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | **$FC_{Dry,i}$** |
|---|---|
| Data unit: | tonne of additional fuel |
| Description: | Additional fossil fuel consumption for drying raw materials or fuel preparation in the baseline |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from production control procedures. |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge/Stockpile control at previous year |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | **$EC_{RM,Grid}$** |
|---|---|
| Data unit: | MWh |
| Description: | Baseline grid electricity consumption due to raw meal grinding |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from production control procedures. |
| Measurement procedures (if any): | Field instruments at previous 3 years |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{Feed,Grid}$ |
|---|---|
| Data unit: | MWh |
| Description: | Baseline grid electricity consumption due to fuel feeding |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from production control procedures. |
| Measurement procedures (if any): | Field instruments at previous 3 years |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | **$EC_{KO,Grid}$** |
|---|---|
| Data unit: | MWh |
| Description: | Baseline grid electricity consumption due to kiln operation |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from production control procedures. |
| Measurement procedures (if any): | Field instruments at previous 3 years |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC |

| | |
|---|---|
| | requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{RM,SG}$ |
|---|---|
| Data unit: | MWh |
| Description: | Baseline self-generated electricity consumption due to raw meal grinding |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from production control procedures. |
| Measurement procedures (if any): | Field instruments at previous 3 years |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{Feed,SG}$ |
|---|---|
| Data unit: | MWh |
| Description: | Baseline self-generated electricity consumption due to fuel feeding |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from production control procedures. |
| Measurement procedures (if any): | Field instruments at previous 3 years |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{KO,SG}$ |
|---|---|
| Data unit: | MWh |
| Description: | Baseline self-generated electricity consumption due to kiln operation |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from production control procedures. |
| Measurement procedures (if any): | Field instruments at previous 3 years |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{Cto,BSL}$ |
|---|---|
| Data unit: | MWh |
| Description: | Baseline electricity consumption for cement grinding |
| Source of data: | It is determined base on historical data for at least 3 years preceding the start of the project activity. The data is sourced from production control procedures. |
| Measurement procedures (if any): | Field instruments at previous 3 year |
| Monitoring frequency: | Annually |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

## III. MONITORING METHODOLOGY

### Monitoring procedures

### Data and parameters monitored

BASELINE

| **Data / Parameter:** | $FC_{i,Calcin}$ |
|---|---|
| Data unit: | Tonnes |
| Description: | Average of fuel type i consumed for clinker production in the baseline; it will be the same value as the one measured following project implementation |
| Source of data: | It is determined base on historical data for previous year as part of inventories control procedure |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge/Stockpile control at previous year |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $FC_{Total,Calcin}$ |
|---|---|
| Data unit: | tonne fuel/year |
| Description: | Average amount of total fuel consumed for clinker production in the baseline. It will be the same value as the one measured following project implementation.(See Formula 2.2.3) |
| Source of data: | It is determined base on historical data for previous year as part of inventories control procedure |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge/Stockpile control at previous year |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $FC_{Total,Calcin}$ |
|---|---|
| Data unit: | tonne fuel/year |
| Description: | Average amount of total fuel consumed for clinker production in the baseline. It will be the same value as the one measured following project implementation.(See Formula 2.2.3) |
| Source of data: | It is determined base on historical data for previous year as part of inventories control procedure |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge/Stockpile control at previous year |
| Monitoring frequency: | Monthly (Recorded) |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EF_{CO2,Elec\_Grid}$ |
|---|---|
| Data unit: | $tCO_2/MWh$ |
| Description: | Electricity grid emission factor |
| Source of data: | ACM0002 will be used to determine electricity emissions |
| Measurement procedures (if any): | Estimated |
| Monitoring frequency: | One time |
| QA/QC procedures: | N/A |
| Any comment: | |

| **Data / Parameter:** | $EF_{CO2,Elec\_SG}$ |
|---|---|
| Data unit: | $t\ CO_2/MWh$ |
| Description: | Electricity self-generation emission factor |
| Source of data: | calculated as the generation-weighted average emissions per electricity unit ($tCO_2/MWh$) of all self-generating sources |
| Measurement procedures (if any): | Calculated |
| Monitoring frequency: | One time |
| QA/QC procedures: | N/A |
| Any comment: | |

PROJECT EMISSIONS

| **Data / Parameter:** | $OutCaO_y$ |
|---|---|
| Data unit: | % |
| Description: | CaO content (%) of the clinker produced |
| Source of data: | It will be measured as part of laboratory quality control procedure |
| Measurement procedures (if any): | Sampling |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $InCaO_y$ |
|---|---|
| Data unit: | % |
| Description: | CaO content (%) of the raw material in year “y” the due to the non-carbonate sources of new non-carbonate materials of the project activity |
| Source of data: | It will be measured as part of laboratory quality control procedure |
| Measurement procedures (if any): | Sampling |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $OutMgO_y$ |
|---|---|
| Data unit: | % |
| Description: | MgO content (%) of the clinker produced |
| Source of data: | It will be measured as part of laboratory quality control procedure |
| Measurement procedures (if any): | Sampling |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $InMgO_y$ |
|---|---|
| Data unit: | % |
| Description: | MgO content (%) of the raw material in year "y" the due to the non-carbonate sources of new non-carbonate materials of the project activity |
| Source of data: | It will be measured as part of laboratory quality control procedure |
| Measurement procedures (if any): | Sampling |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $RM_y$ |
|---|---|
| Data unit: | tonne of raw meal consumed/year |
| Description: | Annual consumption of raw meal in year "y" |
| Source of data: | It will be measured with field instruments and checked with inventories control procedure |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge/Stockpile control |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $CLNK_y$ |
|---|---|
| Data unit: | tonnes of clinker produced/year |
| Description: | Annual production of clinker in year "y" |
| Source of data: | It will be measured with field instruments and checked with inventories control procedure |
| Measurement procedures (if any): | Weighfeeders /Stockpile control |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $FC_{i,Calcin,y}$ |
|---|---|
| Data unit: | tonne fuel i / year |
| Description: | Annual fuel type i consumption for clinker production in year "y" |
| Source of data: | It will be measured with field instruments and checked with inventories control procedure |
| Measurement procedures (if any): | Weighfeeders /Stockpile control |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $FC_{Total,Calcin,y}$ |
|---|---|
| Data unit: | Tonne of fuels/year |
| Description: | Total fuel consumption in year "y" |
| Source of data: | It will be measured with field instruments and checked with inventories control procedure |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge/Stockpile control |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $SKC_y$ |
|---|---|
| Data unit: | GJ/tonne clinker produced |
| Description: | Specific Kiln Calorific Consumption for the year "y" |
| Source of data: | Calculated as part of project emission results |
| Measurement procedures (if any): | Plant records |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $SKC_{y,measured}$ |
|---|---|
| Data unit: | GJ/tonne clinker produced |
| Description: | Specific Kiln Calorific Consumption measured in the year "y" |
| Source of data: | Calculated as part of energy efficiency evaluation in year "y" |
| Measurement procedures (if any): | Plant records |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | Daily $SKC_{ex}$ |
|---|---|
| Data unit: | GJ/tonne clinker produced/day |
| Description: | Daily Specific Kiln Calorific Consumption in each 30 day of ex-ante monitoring |
| Source of data: | Calculated as part of ex-ante monitoring procedure |
| Measurement procedures (if any): | Ex-ante monitoring procedure record |
| Monitoring frequency: | Daily |
| QA/QC procedures: | QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $\overline{SKC_{ex}}$ |
|---|---|
| Data unit: | GJ/tonne clinker produced |
| Description: | Arithmetic mean of Specific Kiln Calorific Consumption during each day of 30 days of continuous operation |
| Source of data: | Calculated as part of ex-ante monitoring procedure |
| Measurement procedures (if any): | Ex-ante monitoring procedure record |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $SKC_{ex}$ optimal range |
|---|---|
| Data unit: | (GJ/tonne clinker) |
| Description: | Interval of 95% of confidence for specific kiln calorific consumption during ex-ante monitoring |
| Source of data: | Result data of ex-ante monitoring procedure |
| Measurement procedures (if any): | Ex-ante monitoring procedure record |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $\overline{SKC_j}$ |
|---|---|
| Data unit: | (GJ/tonne clinker). |
| Description: | Average of specific kiln calorific consumption of project activity before of the year "y". The term "j" is a counter and goes from 1 to "y-1". If "y-1" is equal of "cero" $\overline{SKC_j} = SKC_{BLS}$ |
| Source of data: | Calculated as part of energy efficiency evaluation for project activity |
| Measurement procedures (if any): | Plant records |
| Monitoring frequency: | Annually |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $\%AMC_y$ |
|---|---|
| Data unit: | % |
| Description: | Percentage of ACM in the raw meal production in the year "y" due to project activity implementation The %AMC could be %SO3 or %(SO3 and CaF2) or Lime Saturation Factor (LSF) or raw meal particle size (fineness) |
| Source of data: | It will be measured as part of laboratory quality control procedure for project activity |
| Measurement procedures (if any): | Sampling |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | Daily $\%AMC_{ex}$ |
|---|---|
| Data unit: | % |
| Description: | Daily percentage of alternative material composition in clinker production due to the implementation of project activity in 30 days of continuous operation. The %AMC could be $\%SO_3$ or $\%(SO_3$ and $CaF_2)$ or Lime Saturation Factor (LSF) or raw meal particle size (fineness) |
| Source of data: | It will be measured as part of ex-ante monitoring data |
| Measurement procedures (if any): | Sampling |
| Monitoring frequency: | Hour |
| QA/QC procedures: | QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $\overline{\%AMC}ex$ |
|---|---|
| Data unit: | % |
| Description: | Arithmetic mean of %AMC in the raw meal during ex-ante monitoring |
| Source of data: | Result data of ex-ante monitoring procedure |
| Measurement procedures (if any): | Ex-ante monitoring procedure record |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $\%AMC_{ex}$ optimal range |
|---|---|
| Data unit: | % (interval) |
| Description: | Interval of 95% of confidence for %AMC content in the raw meal during ex-ante monitoring |
| Source of data: | Result data of ex-ante monitoring procedure |
| Measurement procedures (if any): | Ex-ante monitoring procedure record |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | Daily $FF_{ex\ i}$ |
|---|---|
| Data unit: | (tonne fuel/day) |
| Description: | Daily consumption of fuel type i 30 days of continuous operation |
| Source of data: | It will be measured as part ex-ante monitoring procedure through weighfeeders |
| Measurement procedures (if any): | Weighfeeders.Ex-ante monitoring procedure record |
| Monitoring frequency: | Daily |
| QA/QC procedures: | QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | Daily $CLNK_{ex}$ |
|---|---|
| Data unit: | Tonne of clinker produced/day |
| Description: | Daily clinker production in 30 days of continuous operation |
| Source of data: | It will be measured as part ex-ante monitoring procedure through field instruments |
| Measurement procedures (if any): | Weighfeeders. Ex-ante monitoring procedure record |
| Monitoring frequency: | Daily |
| QA/QC procedures: | QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $ByPass_y$ |
|---|---|
| Data unit: | tonnes of Bypass Dust |
| Description: | Annual production of Bypass dust leaving kiln system in year "y" |
| Source of data: | It will be measured as part of normal operations |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | d |
|---|---|
| Data unit: | (released $CO_2$ expressed as a fraction of the total carbonate $CO_2$ in the raw meal) |
| Description: | CKD calcination rate % in year "y" |
| Source of data: | It will be measured as part of normal operations |
| Measurement procedures (if any): | Sampling |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | This parameter could be estimated |

| **Data / Parameter:** | $CKD_y$ |
|---|---|
| Data unit: | tonne of CKD Dust |
| Description: | Annual production of CKD dust leaving kiln system in year "y" |
| Source of data: | It will be measured as part of normal operations |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $FC_{Dry\_addl,i,y}$ |
|---|---|
| Data unit: | tonnes of additional fuel |
| Description: | Additional Fossil fuel consumption for drying raw materials or fuels in year "y" |
| Source of data: | It will be measured with field instruments and checked with inventories control procedure |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge/Stockpile control |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{RM,Grid,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Grid electricity consumption due to raw meal grinding in year "y" |
| Source of data: | It will be measured with field instruments and checked with production control procedures |
| Measurement procedures (if any): | Field/automatic instruments |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{Feed,Grid,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Grid electricity consumption due to fuel feeding in year "y" |
| Source of data: | It will be measured with field instruments and checked with production control procedures |
| Measurement procedures (if any): | Field/automatic instruments |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{KO,Grid,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Grid electricity consumption due to kiln operation in year "y" |
| Source of data: | It will be measured with field instruments and checked with production control procedures |
| Measurement procedures (if any): | Field/automatic instruments |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{RM,SG,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Electricity self-generation consumption due to raw meal grinding in year "y" |
| Source of data: | It will be measured with field instruments and checked with production control procedures |
| Measurement procedures (if any): | Field/automatic instruments |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{Feed,SG,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Electricity self-generation consumption due to fuel feeding in year "y" |
| Source of data: | It will be measured with field instruments and checked with production control procedures |
| Measurement procedures (if any): | Field/automatic instruments |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{KO,SG,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Electricity self-generation consumption due to kiln operation in year "y" |
| Source of data: | It will be measured with field instruments and checked with production control procedures |
| Measurement procedures (if any): | Field/automatic instruments |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $F_{i,j,y}$ |
|---|---|
| Data unit: | Tonne fuel i / year |
| Description: | Amount of fuel i (in a mass or volume unit) consumed by relevant power sources *j* in year *y* |
| Source of data: | It will be measured with field instruments and checked with inventories control for self power generation |
| Measurement procedures (if any): | Weighfeeders/ Weighbridge/Stockpile control |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $GEN_{j,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Electricity (MWh) generated by the source *j* |
| Source of data: | It will be measured with field instruments and checked with inventories control for self generation |
| Measurement procedures (if any): | Field /automatic instruments |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $CLNK_{CONSM,m,y}$ |
|---|---|
| Data unit: | tonnes of clinker |
| Description: | Annual consumption of clinker in each common-practice blended cement type “m” in the year “y” |
| Source of data: | It will be measured with field instruments and checked with production control procedures |
| Measurement procedures (if any): | Weighfeeders / Stock piles control |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal plant level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

LEAKAGE

| **Data / Parameter:** | $FC_{Trans}$ |
|---|---|
| Data unit: | kg of fuel/kilometer |
| Description: | Fuel consumption of the vehicle per kilometer |
| Source of data: | Estimated as part of fuel consumption evaluation of logistic department or data from external suppliers |
| Measurement procedures (if any): | Logistic registered data or third part |
| Monitoring frequency: | Annually |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | Dist |
|---|---|
| Data unit: | km |
| Description: | Distance between the source of fuel and the project activity plant |
| Source of data: | It will be registered on logistic department as part of inventories control |
| Measurement procedures (if any): | Logistic records or purchased tickets |
| Monitoring frequency: | Per trip |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $Q_{trip}$ |
|---|---|
| Data unit: | Tonnes materials /vehicle |
| Description: | |
| Source of data: | It will be registered on logistic department as part of inventories control |
| Measurement procedures (if any): | Weighbridge data and purchase receipts |
| Monitoring frequency: | Per trip |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $InALTM_y$ |
|---|---|
| Data unit: | Tonne alternative materials |
| Description: | Annual consumption of alternative materials in raw meal in year y |
| Source of data: | It will be registered as part of inventories control |
| Measurement procedures (if any): | Weighbridge/Stockpile control data |
| Monitoring frequency: | Per trip |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{Conv,y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Annual Electricity consumption for conveyor system for alternative materials |
| Source of data: | It will be measured with field instruments and checked with production control procedures |
| Measurement procedures (if any): | Field instruments |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $EC_{Cto,\ y}$ |
|---|---|
| Data unit: | MWh |
| Description: | Electricity consumption for cement grinding in year “y” |
| Source of data: | It will be determined as part of production control procedures |
| Measurement procedures (if any): | Field instruments |
| Monitoring frequency: | Annually |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $P_{blend,y}$ |
|---|---|
| Data unit: | tonne clinker/ tonnes blended cement |
| Description: | Percentage of clinker in common-practice Blended Cement in year “y” |
| Source of data: | Result of project emission calculation |
| Measurement procedures (if any): | Plant records of project activity |
| Monitoring frequency: | Annually |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $B_{blend}$ |
|---|---|
| Data unit: | (tonne clinker/ tonnes blended cement) |
| Description: | Baseline percentage of clinker in common-practice Blended Cement |
| Source of data: | It is determined base on historical data for previous 3 year |
| Measurement procedures (if any): | Plant records at previous 3 year |
| Monitoring frequency: | Annually |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $CTO_{BSL,m}$ |
|---|---|
| Data unit: | tonne cement |
| Description: | Annual blended cement type "m" production on the last three years before of project implementation |
| Source of data: | It is determined base on historical data for previous 3 year as part of production control procedures |
| Measurement procedures (if any): | Weighfeeders/field instruments at previous 3 year |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $CTO_{m,y}$ |
|---|---|
| Data unit: | tonne cement |
| Description: | Annual production of common-practice blended cement by type "m" in year "y" |
| Source of data: | It will be determined as part of production control procedures |
| Measurement procedures (if any): | Weighfeeders/field instruments |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

| **Data / Parameter:** | $CLNK_{BSL\_CNSM,m}$ |
|---|---|
| Data unit: | tonnes clinker consumed |
| Description: | Annual clinker consumption in each blended cement type "m" on the last three years before of project implementation |
| Source of data: | It is determined base on historical data for previous 3 year as part of production control procedures |
| Measurement procedures (if any): | Weighfeeders/field instruments at previous 3 year |
| Monitoring frequency: | Monthly |
| QA/QC procedures: | These data will be collected as part of normal logistic level operations. QA/QC requirements according to ISO 9000 or similar quality systems |
| Any comment: | |

## Annex 1

Procedure for ex ante determination of Specific Kiln Calorific Consumption

***Title: Procedure for ex-ante monitoring to be implemented at the beginning of the project implementation***

***1. Objective***

The main purpose of this ex-ante monitoring is to develop an industrial testing procedure (where kiln operational variables are under total control) that shows the highest specific consumption reduction that is possible to be achieved during project implementation.

***2. Development***

***2.1 Laboratory research and Protocol of sampling definition***

2.1.1. Develop a burnability analysis of raw meal(1) in order to identify the theoretical "optimum-range" of concentration of new raw materials and the design of the raw meal that would permit the reduction of energy consumption for clinker preparation

2.1.2 The outputs of the burnability analysis are the "Free Lime vs. Concentration of alternative materials (%AMC)" and "Free Lime vs. Temperature" graphics.

2.1.3 Design the Industrial testing Protocol. The Protocol must follow all the Plant procedures for quality control (QC) and quality assurance (QA) in order to guarantee the representative sampling in terms of size, frequency, chemical and physical analysis with its respective quality index control (2). The Protocol has to define the equipment involved, all material specifications and requirements of data records. The Protocol for ex-ante monitoring shall consider the following points

***2.2. Initial operational adjustments and production of new raw meal***

2.2.1 Develop a program for total consumption of the inventory of raw meal produced for clinker manufacturing prior to project implementation and replacement with the new raw material according to a laboratory design.

2.2.2 Develop operational adjustments and stabilization of operating conditions. The period of time for 2.2. And 2.3 could be adjustable according to the particular operating conditions of each cement plant.

***2.3. The operational transitional process***

2.3.1. Start the kiln operation with the new design of raw materials according burnability test results (project activity)

2.3.2. Daily follow-up of the operational data obtained and recording the global results. The principal records of the Plant during the monitoring procedure are:

- Concentration of alternative material (%AMC) in the raw meal feeding, The %AMC could be $\%SO_3$ or $\%(SO_3$ and $CaF_2)$ or Lime Saturation Factor (LSF) or raw meal particle size (fineness)
- Fuel consumption with its LHV
- Total clinker production
- The main operational variables of the kiln as indicators of general conditions of operations

***2.4. Kiln operation under total control of the operational variables***

2.4.1. Guarantee the stabilization and operation at as regular operational conditions as possible – 30-day of continuous operation (3)

2.4.2. Follow up the same daily data of the operational transitional process parameters defined above.

The objective is to seek a repetition of the previous month values.

2.4.3. Register the "optimal range" with 95% of statistical confidence level of the 30 –day samples of the concentration of alternative material used (AMC) in the raw meal and the specific consumption in the kiln (SKCex) during 30 days continuous operational samples.

2.4.4. Make the final report with the analysis of the results and carry out the analysis to show that these results have been proved to be with the theoretical research and quality control, as well as with quality assurance procedures.(4)

***3. Results***

***3.1 Obtain and record the following data:***

| | | |
|---|---|---|
| Daily $SKC_{ex}$ | = | Daily Specific Kiln Calorificfic Consumption in each 30-day period of ex-ante monitoring (GJ/tonne clinker / day).<br>Daily $SKC_{ex\text{-}ante} = \Sigma$ ( Daily $FF_{ex}$ i * $LHV_{ex}$i ) / Daily $CLNK_{ex}$ (3.1) |
| Daily $\%AMC_{ex}$ | = | Daily percentage of alternative material composition in clinker production due to the implementation of project activity in 30 days of continuous operation The %AMC could be %SO3 or %(SO3 and CaF2) or Lime Saturation Factor (LSF) or raw meal particle size (fineness) |
| Daily $FF_{ex}$ i | = | Daily consumption of fuel type i 30 days of continuous operation (tonne fuel/day) |
| $LHV_{ex}$i | = | Daily low heating value of fuel type i in 30 days of continuous operation (GJ / tonne fuel /day) |
| $DailyCLNK_{ex}$ | = | Daily clinker production in 30 days of continuous operation (tonne clinker /day) |
| $\overline{SKC_{ex}}$ | = | Arithmetic mean of Specific Kiln Calorific Consumption during each day of 30 days of continuous operation (GJ/tonne clinker) |
| $\overline{\%AMC_{ex}}$ | = | Arithmetic mean of %AMC in the raw meal during ex-ante monitoring |
| $\sigma$ | | Standard deviation of 30 days of continuous operation |
| $1.96\frac{\sigma}{\sqrt{30}}$ | = | Interval of 95% of confidence of 30 samples in ex-ante monitoring |
| "$\%AMC_{ex}$ optimal range" | $\overline{\%AMCex} \pm 1.96\frac{\sigma}{\sqrt{30}}$ | Interval of 95% of confidence for %AMC content in the raw meal during ex-ante monitoring |
| "$SKC_{ex}$ optimal range" | $\overline{SKCex} \pm 1.96\frac{\sigma}{\sqrt{30}}$ | Interval of 95% of confidence for specific kiln calorific consumption during ex-ante monitoring (GJ/tonne clinker) |

***4. References and Notes***

(1) "Burnability" is the term used to describe how easily the clinker transformation happens and the behavior of the raw meal in the sintering process (clinker phases formation). The burnability analysis is a common procedure in Cement Industry and was developed by F.L.Smidth (Fundal 1979 and Theisen 1992) that helps to optimize the raw meal design, with regard to chemical and mineral composition and fineness of the material.

(2) The minimum quality control procedures are described in "The Cement Plant Operations Handbook 4th Edition", International Cement Review, 2005, Chapter 6.

(3) Thirty continuously days of sample (one month) is the minimum amount of daily average values that reflect the operational conditions and evaluate if the process complies with the minimum quality assurance specifications. Besides, the standard unit of time for Cement Industry is a month. Plant operational records are normally measured in this period of time (i.e. raw material inventories, fuel consumption and kiln energy performance)

(4) The consistency between industrial testing and the laboratory research results guarantees that project activity are related only by means of new alternative materials and not as the results of other energy efficiency measures or fuel switching options that may occur at the same time as the project implementation.