Draft baseline methodology AM00XX

"Baseline methodology for greenhouse gas reductions through waste heat recovery and utilization for power generation at cement plants"

Source

This baseline methodology is based on the "Taishan Huafeng Cement Works Waste Heat Recovery and Utilisation for Power Generation Project" in China, whose baseline study, monitoring and verification plan and Project Design Document were prepared by Westlake Associates Ltd and Natsource Europe Ltd. For more information regarding the proposals and their consideration by the Executive Board, please refer to case NM0079-rev: "Taishan Huafeng Cement Works Waste Heat Recovery and Utilisation for Power Generation Project, China" on http://cdm.unfccc.int/methodologies/approved.

This methodology also refers to the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002) and the latest version of the "Tool for the demonstration and assessment of additionality".

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 projects that:

- Use waste heat gas generated in clinker making process to produce electricity.
- Electricity produced is used in the cement works where the proposed project is located and excess electricity is supplied to the grid displacing electricity generation with fossil fuels in the electricity grid or an identified specific generation source.

The methodology is applicable under the following conditions:

1) Waste heat is generated in the cement kilns;
2) Recovered waste heat is used to generate electricity under the proposed project;
3) The electricity produced is used within the cement works where the proposed project is located and excess electricity is supplied to the grid; it is assumed that there is no electricity export to the grid in the baseline scenario (in case of existing captive power plant);
4) Electricity generated under the project activity displaces either grid electricity or from an identified specific generation source. Identified specific generation source could be either expansion of an existing captive power generation source or installation of new generation source;
5) The grid or identified specific generation source option is clearly identifiable;
6) Waste heat is only to be used in the project activity;
7) In the baseline scenario, the recycling of waste heat is possible only within the boundary of the clinker making process (e.g. clinker production lines in baseline scenario could include some heat recovery systems to capture a portion of the waste heat from the cooler end of the clinker kiln and use this to heat up the incoming raw materials and fuel - Type 1 Waste Heat Utilization as described in explanatory note below).

This methodology is NOT applicable to project activities,
1) Where the current use of waste heat or the identified alternative business as usual use of waste heat is located outside of the clinker making process (Type 2 Waste heat utilization as described in explanatory note below);
2) That affect process emissions from cement plants.

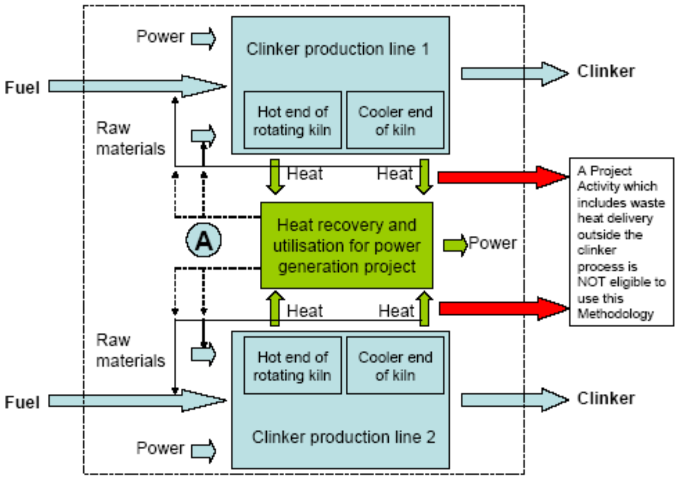

Figure 1. Schematic of sample Project Activity

Explanatory Note to applicability criteria (7) above

Figure 1 shows an example of a project activity where two clinker production lines are connected to a waste heat recovery and utilization for power generation project to explain the concept of Type 1 and Type 2 waste heat utilization.

a) The project activity instead of venting the waste heat from the clinker making process, produces electricity from heat captured at the hot end and cooler end of the kiln using heat recovery boiler(s) and generation unit(s).
b) Clinker production lines are sometimes designed with some heat recovery systems already in place to capture a portion of the waste heat from the cooler end of the clinker kiln and use this to heat up the incoming raw materials and fuel. This is shown in Figure 1 as the thin solid lines. The waste heat is sometimes de-tempered prior to use in warming up the incoming coal to the milling machines.
c) After a Project activity is installed then the waste heat from the project activity itself (i.e. exhaust from the heat recovery boiler) can be used instead to pre-heat the raw materials and fuel. This is shown as the dotted lines at point marked A.
d) Before and after measurements of the specific fuel consumption per unit clinker output of the clinker lines connected to the project activity would, by definition, capture the real impact of any change in emissions resulting from this change in waste heat flows.
e) For the purposes of assessing the conditions under which the methodology is applicable, the potential use of waste heat in the baseline scenario is divided into two categories:
    I. Type 1 Waste Heat Utilization: This is when waste heat is used in the baseline scenario within the energy balance boundary of the clinker making process and which is reflected in the specific fuel consumption of the clinker line per unit output of clinker.

II. Type 2 Waste Heat Utilization: This is current or identified alternative business as usual use of waste heat supplied to applications outside the boundary of the clinker making process e.g. to other local industrial users, local heating schemes, etc.

This baseline methodology shall be used in conjunction with the approved monitoring methodology for "greenhouse gas reductions through waste heat recovery and utilization for power generation at cement plants" (AM00XX).

Identification of the baseline scenario

The baseline scenario for the project will be identified through the following steps:

- Step 1: Determination of technically feasible alternatives to the project activity.
  - 1.A Identify and list, within the local context, the current business as usual utilization of and options technically feasible for waste heat utilization. Include an assessment of potential use of waste heat in the cement work. For identifying and assessing the potential alternative waste heat uses in the baseline, the following approach should be used:
    - o Identify the current use of waste heat from the kilns at the cement works and identify the normal uses for waste heat in the cement production process in the local context, which would be replaced by the project activity.
    - o Establish whether there are other demands for any additional waste heat use that should be considered as part of the baseline.
    - o Demonstrate that this waste heat is within the energy balance boundary of the clinker making process (Type 1 waste heat utilization as earlier defined which is a condition of applicability of this methodology).
  - 1.B Identify and list the source of electric energy supply for the cement plants, in the local context. The current and future situation of the electricity demand and supply to the cement plant, where the project activity is located, should be included in the CDM-PDD in order to determine what electricity supply is likely to be displaced by the project activity.
    - o For identifying the current electricity supply and demand baseline, the following should be used:
      - i. E_{CEMENT} and E_{LOAD} are the electricity demand of the cement works and other local loads, which should be included in the Project Design Document for at least two years prior to the start date of the project activity. Ex-ante projection of these demands over the crediting period should be presented. The meter records and production plan of the cement works and load design data of the cement works can be used for this estimate as can the data for other local loads (if any).
      - ii. $EG_{ATEXIST}$ is the baseline electricity generation of the existing captive power plant (if existing). Production data for at least the two years prior to the start date of the project activity should be included in the Project Design Document. Ex-ante projection of production capacity for the crediting period too should be included. The production records and plan of the captive power plant can be used for this estimate.
      - iii. The data in (i) and (ii) above should be collected once at the start of each crediting period of the project activity and can be analyzed to see if there is a trend in favouring supply from the grid to meet local loads or building and using alternative captive power sources.

- The following broad categories of options should be analyzed to identify baseline electricity options:
  - Supply from grid;
  - Expansion of captive power generation source, if one exists; and
  - Construction of a captive plant with different fuel options.
- Step 2: Compliance with regulatory requirements: Delete those options, identified after administrating Step 1, that do not meet the regulatory requirements. Typical policies and laws that should be considered while evaluating regulatory compliance are: energy efficiency / conservation laws; laws on cleaner production; and environmental protection laws.
- Step 3: Undertake economic analysis of all options that meets the regulatory requirements.
  - Option with highest IRR is the baseline scenario option for waste heat recovery and electricity supply to the cement works;
  - If the waste heat recovery option with highest IRR is different from the existing waste heat recovery in the clinker production, of the cement works where the proposed project will be implemented, then this methodology is not applicable.

If existing waste heat recovery for use within the clinker making process, in the cement works, where the project activity is being implemented, is less than the identified business as usual waste heat recovery in clinker production, then the methodology is not applicable to the proposed project activity.

Project boundary

For the purpose of determining GHG emissions of the **project activity**, project participants shall include the following emissions sources:

- CO_2 emissions from on-site fuel consumption of fossil fuels.

For the purpose of determining the **baseline**, project participants shall include the following emission sources:

- On-site fossil fuel consumption within project boundary; and
- From electricity generation, either in captive power generation source or the generation sources connected to grid that serves the proposed project site, as in the identified baseline scenario.

The physical boundary includes the facilities constructed/erected on account of the project activity at the cement plant. In the case of displaced grid electricity, it further includes the local power grid system connected to the project activity; in the case of captive power, it also includes the "inside the fence" electrical system.

The spatial extent of the project electricity system, including issues related to the calculation of the build margin (BM) and operating margin (OM), as further defined in the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002).
Table 1 illustrates which emissions sources are included and which are excluded from the project boundary for determination of both baseline and project emissions.

Table 1: Overview on emissions sources included in or excluded from the project boundary

	Source	Gas		Justification / Explanation
Baseline	Grid electricity generation/ identified specific generation source	CO_2	Included	Main emission source.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
Project activity	On-site fossil fuel consumption due to the project activity	CO_2	Included	May be an important emission source.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.

Emission Reduction

The project activity reduces CO_2 emissions either by the grid or generated from an identified specific electricity generation source from use of waste heat to produce electricity. The emission reduction, ERy, during a given year y[1] is given by:

$$ER_y = EB_y - PE_y \quad (1)$$

where:

EBy are the avoided baseline emissions in year y, expressed in tCO_2.
PEy are the project emissions due to fuel consumption changes in the cement kilns, of the cement works where the proposed project is located, as a result of the project activity in year y, expressed in tCO_2.

In determining emission coefficients, emission factors or net calorific values in this methodology, guidance by the 2000 IPCC Good Practice Guidance for LULUCF should be followed where appropriate. Project participants may either conduct regular measurements or they may use accurate and reliable local or national data where available. Where such data is not available, IPCC default emission factors (country-specific, if available) may be used if they are deemed to reasonably represent local circumstances. All values should be chosen in a conservative manner and the choice should be justified.

[1] Throughout the document, the suffix y denotes that such parameter is a function of the year y, thus to be monitored at least annually.

Project activity

Project emission (PE_y) is the difference in CO_2 emission from use of fossil fuel in the clinker making process in cement manufacturing unit, where the project is being implemented, before and after the project implementation.
PE_y, for claiming credits, is determined as follows:

$$PEy = (EI_{P,y} - EI_B) * O_{clinker,y} * COEF_{fuel} \quad \textbf{(2)}$$

where:

EIB	is the baseline energy consumption per unit output of clinker in TJ/ton of clinker produced (i.e. measured before the Project activity goes into operation).
EIP,y	is the ex-post energy consumption per unit output of clinker for given year, y, in TJ/ton of clinker produced.
COEFfuel	is the carbon coefficient (tCO2 / TJ of input fuel) of the fuel used in the cement works to raise the necessary heat for clinker production.
$O_{clinker,y}$	Is the clinker output of the cement works in a given year y.

$$EI_B = \frac{F_B}{O_{clinker,B}} \quad \textbf{(3)}$$

where:

FB — is average annual energy consumption, expressed in TJ, of clinker making process prior to the start of operation of project activity. At least one full year of data should be used.
In situations where data for one year is not available the project proponents should use the conservative value of following:

- Design estimate of energy consumption; or
- Available measured data for the plant; or
- Product of Industry energy consumption norm of similar projects, if available, within the country multiplied by rated output of the project.

$O_{clinker,B}$ — is average annual output, expressed in tonnes, of clinker prior to the start of operation of project activity. At least one full year of data should be used.
In situations where data for one year is not available the project proponents should use the following output values to correspond to energy consumption data used:

- Design estimate of output; or
- Available production for the period for which energy consumption is available; or
- Design estimate of output.

$$EI_{P,y} = \frac{F_{P,y}}{O_{clinker,\,y}} \quad \textbf{(4)}$$

where:

$F_{P,y}$	is monitored annual energy consumption in a year y, expressed in TJ, of clinker making process;
$O_{clinker,y}$	is monitored annual output, expressed in a year y, in tonnes of clinker.

$$COEF_{Fuel} = NCV_{fuel} * EF_{CO_2,fuel} * Oxid_{fuel} \quad (5)$$

where:

NCVfuel	is the net calorific value (energy content) per mass or volume unit of a fuel used in clinker making process;
OXIDfuel	is the oxidation factor of the fuel (see Table 1-6, page 1.29 in the 1996 Revised IPCC Guidelines for default values), expressed as percentage;
$EFCO_2$,fuel	is the CO_2 emission factor per unit of energy of the fuel, expressed as tCO_2 per unit mass or volume unit.

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Local values of NCV_{fuel} and $EF_{CO2,\ fuel}$ should be used where available. If no such values are available, country-specific values (see e.g. IPCC Good Practice Guidance for LULUCF) are preferable to IPCC world-wide default values.

The project proponents should report ex-ante estimate of PE_y in the CDM Project Design Document (CDM-PDD). Ex-ante estimate of PE_y could be based on feasibility report for the project, where the impact of the project activity on the energy consumption of the kilns is analyzed. The ex-ante estimate of PEy can be calculated using the following formula:

$$PEy = \sum_i \Delta EI_i * [O_{clinker,i}] * COEF_{fuel,i} \quad (6)$$

where:

i	is the index for each clinker production line in the cement plant where the project is being implemented;
ΔEI_i	is the ex-ante design estimate of the change in the energy consumption of each clinker kiln in TJ / ton Clinker, due to project implementation.

Baseline emissions

Baseline is emissions from electricity generation source(s) that would have supplied to the cement works and due to the electricity exported to the grid, which would have otherwise been generated by the operation of grid-connected power plants in absence of the proposed CDM project. The baseline emissions during a given year y are calculated as:

$$EB_y = EG_{CP,y} * EF_{Elec,y} + EG_{Grid,y} * EF_{Grid,y} \quad (7)$$

where:

$EG_{CP,y}$	is the electricity supplied from the project activity to the cement plant , expressed in MWh;
$EF_{Elec, y}$	is the emissions factor of the baseline electricity supply source, expressed as tCO_2 / MWh.
$EG_{Grid, y}$	is the electricity supplied from the project activity to the grid , expressed in MWh;
$EF_{Grid,y}$	is the emissions factor of the electricity grid, expressed as tCO_2 / MWh.

Emission Factor (EF) if the baseline electricity supply source is Grid.

The emission factor estimation method for displacing grid sourced electricity is based on approved methodology "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002).
The emission factor EF_y is weighted average of the Operating Margin, EF_OM_y, and the Build Margin, EF_BM_y, as follows:

$$EF_{Grid, y} = w_{OM} * EF\_OM_y + w_{BM} * EF\_BM_y \quad \textbf{(8)}$$

such that $w_{OM} + w_{BM} = 1$

Default values for the weights can be taken as 0.5.

Calculation of the **<u>Operating Margin Emission Factor</u>** is based on one of the four following methods:
(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch Data Analysis OM, or
(d) Average OM.

Each method is described below.

Dispatch data analysis should be the first methodological choice. Where this option is not selected, project participants shall justify why and may use the simple OM, the simple adjusted OM or the average emission rate method taking into account the provisions outlined hereafter.

The Simple OM method (a) can only be used where low-cost/must run resources[2] constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term normals for hydroelectricity production.

[2] Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants.

The average emission rate method (d) can only be used

- where low-cost/must run resources constitute more than 50% of total grid generation and detailed data to apply option (b) is not available; and
- where detailed data to apply option (c) above is unavailable.

(a) *Simple OM.* The Simple OM emission factor (*EFOM,simple,y*) is calculated as the generation-weighted average emissions per electricity unit (tCO_2/MWh) of all generating sources serving the system, not including low-operating cost and must-run power plants:

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}} \tag{9}$$

where:

Fi ,j, y is the amount of fuel *i* (in a mass or volume unit) consumed by relevant power sources *j* in year(s) *y*; *j* refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports[3] to the grid, *COEFi,j y* is the 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(s) y, and *GENj,y* is the electricity (MWh) delivered to the grid by source *j*.

The CO_2 emission coefficient *COEFi* is obtained as

$$COEF_i = NCV_i \cdot EF_{CO2,i} \cdot OXID_i \tag{10}$$

where:

NCVi is the net calorific value (energy content) per mass or volume unit of a fuel *i*, *OXIDi* is the oxidation factor of the fuel (see page 1.29 in the 1996 Revised IPCC Guidelines for default values), *EFCO2,i* is the CO_2 emission factor per unit of energy of the fuel *i*. Where available, local values of *NCVi* and *EFCO2,i* should be used. If no such values are available, country-specific values (see e.g. IPCC Good Practice Guidance for LULUCF) are preferable to IPCC world-wide default values.

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[3] As described above, an import from a connected electricity system should be considered as one power source *j*.

The Simple OM emission factor can be calculated using either of the two following data vintages for years(s) *y*:

- A 3-year average, based on the most recent statistics available at the time of CDM-PDD submission; or
- The year in which project generation occurs, if *EFOM,y* is updated based on ex post monitoring.

(b) *Simple Adjusted OM.* This emission factor (*EFOM,simple adjusted,y*) is a variation on the previous method, where the power sources (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*j*):

$$EF_{OM,simple\ adjusted,y} = \left(1-\lambda_y\right)\cdot\frac{\sum_{i,j} F_{i,j,y}\cdot COEF_{i,j}}{\sum_j GEN_{j,y}} + \lambda_y\cdot\frac{\sum_{i,k} F_{i,k,y}\cdot COEF_{i,k}}{\sum_k GEN_{k,y}} \quad \textbf{(11)}$$

where *Fi,k,y*, *COEFi,k* and *GENk* are analogous to the variables described for the simple OM method above for plants *k*; the years(s) *y* can reflect either of the two vintages noted for simple OM above, and

$$\lambda_y\ (\%) = \frac{\text{Number of hours per year for which low - cost/must - run sources are on the margin}}{\text{8760 hours per year}} \quad \textbf{(12)}$$

where lambda should be calculated as follows (see figure 2 below):

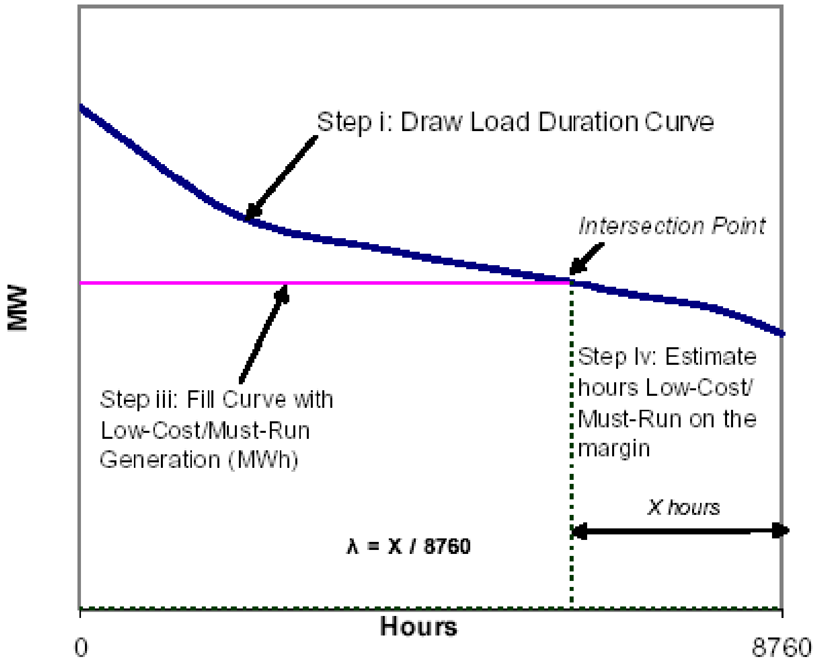
Step i) Plot a Load Duration Curve. Collect chronological load data (typically in MW) for each hour of a year, and sort load data from highest to lowest MW level. Plot MW against 8760 hours in the year, in descending order.

Step ii) Organize Data by Generating Sources. Collect data for, and calculate total annual generation (in MWh) from low-cost/must-run resources (i.e. ∑*kGENk,y*).

Step iii) Fill Load Duration Curve. Plot a horizontal line across load duration curve such that the area under the curve (MW times hours) equals the total generation (in MWh) from low-cost/must-run resources (i.e. ∑*kGENk,y*).

Step iv) Determine the number of hours per year for which low-cost/must-run sources are on the margin. First, locate the intersection of the horizontal line plotted in step (iii) and the load duration curve plotted in step (i). The number of hours (out of the total 8760 hours) to the right of the intersection is the number of hours for which low-cost/must-run sources are on the margin. If the lines do not intersect, then one may conclude that low-cost/must-run sources do not appear on the margin and λ*y* is equal to zero. Lambda (λ*y*) is the calculated number of hours divided by 8760.

Figure 2: Illustration of Lambda Calculation for Simple Adjusted OM Method



Note: Step (ii) is not shown in the figure, it deals with organizing data by source.

(c) *Dispatch Data Analysis OM.* The Dispatch Data OM emission factor (*EFOM,Dispatch Data,y*) is summarized as follows:

$$EF_{OM,Dispatch\ Data,y} = \frac{E_{OM,y}}{EG_y} \quad \textbf{(13)}$$

where *EGy* is the generation of the project (in MWh) in year *y*, and *EOM.y* are the emissions (tCO2) associated with the operating margin calculated as

$$E_{OM,y} = \sum_h EG_h \cdot EF_{DD,h} \quad \textbf{(14)}$$

where *EGh* is the generation of the project (in MWh) in each hour *h* and *EFDD,h* is the hourly generation-weighted average emissions per electricity unit (tCO2/MWh) of the set of power plants (*n*) in the top 10% of grid system dispatch order during hour *h*:

$$EF_{DD,h} = \frac{\sum_{i,n} F_{i,n,h} \cdot COEF_{i,n}}{\sum_{n} GEN_{n,h}} \qquad \textbf{(15)}$$

where *F*, *COEF* and *GEN* are analogous to the variables described for the simple OM method above, but calculated on an hourly basis for the set of plants (*n*) falling within the top 10% of the system dispatch. To determine the set of plants (*n*), obtain from a national dispatch center: a) the grid system dispatch order of operation for each power plant of the system; and b) the amount of power (MWh) that is dispatched from all plants in the system during each hour that the project activity is operating (*GENh*). At each hour *h*, stack each plant's generation (*GENh*) using the merit order. The set of plants (n) consists of those plants at the top of the stack (i.e., having the least merit), whose combined generation (∑ *GENh*) comprises 10% of total generation from all plants during that hour (including imports to the extent they are dispatched).

(d) *Average OM*. The average Operating Margin (OM) emission factor (*EFOM,average,y*) is calculated as the average emission rate of all power plants, using equation (1) above, but including low-operating cost and must-run power plants. Either of the two data vintages described for the simple OM (a) may be used.

The **Build Margin Emission Factor** EF_BMy is the generation-weighted average emission factor of the selected set of power plants m, as follows:

$$EF\_BMy = \frac{\sum_{i}\sum_{k} F_{ik,y} * COEF_{i}}{\sum_{k} GEN_{k,y}} \qquad \textbf{(16)}$$

where:

$F_{ik,,y}$	is fuel 'i' consumed in 'k' generating source included in the BM set (k either ranges from 1 to 5 or 1 to K), expressed as TJ.
$COEF_i$	is emission coefficient of fuel 'i', expressed as tCO_2/TJ. It is estimated as defined in Equation 7 above.
$GEN_{k,y}$	is generation of 'k' generating source included in the BM set (k either ranges from 1 to 5 or 1 to K) for year y, expressed in MWh.

Project participants shall choose between one of the following two options:

Option 1. Calculate the Build Margin emission factor EF_BM,y *ex ante* based on the most recent information available on plants already built for sample group *m* at the time of CDM_PDD submission. The sample group *m* consists of either:

- The five power plants that have been built most recently; or
- The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently. Project participants should use from these two options that sample group that comprises the larger annual generation.

Option 2. For the first crediting period, the Build Margin emission factor *EFBM,y* must be updated annually *ex post* for the year in which actual project generation and associated emissions reductions occur. For subsequent crediting periods, *EFBM,y* should be calculated *ex-ante*, as described in option 1 above. The sample group *m* consists of either:

- The five power plants that have been built most recently; or
- The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently. Project participants should use from these two options that sample group that comprises the larger annual generation.

Power plant capacity additions registered as CDM project activities should be excluded from the sample group *m*.
The project participants can apply their own sampling method for identifying power generation source to estimate EF_BM, if it is demonstrated (to the Designated Operational Entity) that the sampling method used is more accurate than one mentioned in this methodology.

Emission Factor (EF) if the baseline electricity supply source is an identified specific generation source

The baseline emission factor EF_y is estimated ex-ante as follows:

$$EF_y = EF_{IGS} = [FI_{IGS} * COEF_{IGS}] \quad \textbf{(17)}$$

where:

FI_{IGS} is the fossil fuel consumption rate of the identified generation source (IGS) to supply EG_Y, expressed as GJ per MWh.
$COEF_{IGS}$ is the emission coefficient of the fuel used in identified generation source, expressed as tCO_2/ per GJ lower heating value. This can be estimated using the formulae described in Equation 7 above.

The EF_{IGS} should be calculated at the start of the crediting period and be fixed for the whole crediting period.

If the identified generation source is expansion of an existing captive generation plant, F_{IGS} is estimated using recorded data.

$$FI_{IGS} = \frac{F_{IGS}}{GEN_{IGS}} \quad \textbf{(18)}$$

where:

F_{IGS} is the annual average fossil fuel consumption of the identified generation source (IGS), expressed as GJ. At least one year's data prior to start of the project should be used.
GEN_{IGS} is the annual average generation of the identified generation source, expressed as MWh. At least one year's data prior to start of the project should be used.

If the baseline scenario is construction of a new power plant to supply electricity to the cement works, then the FI_{IGS} can be based on design net hear rate for plants of similar capacity and using the same fuel as available from technology providers.
$COEF_{IGS}$ should be calculated using equation 5 using fuel specific local values. If local data is not available then IPCC values can be used giving preference country specific IPCC defaults. If baseline scenario is expansion of existing captive generation source, the project developer should measure the calorific value and carbon content of the "as–used fuels" and compare these values against IPCC reference values and demonstrate the conservativeness of the values used.

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, available at the UNFCCC CDM web site* [4].

Leakage

The project proponents will address the following leakages:

Construction and fuel handling: the main indirect emissions potentially giving rise to leakage in the context of electric sector projects are emissions arising due to activities such as power plant construction, fuel handling (extraction, processing, and transport), and land inundation (for hydroelectric projects). Corresponding emissions are negligible and could be neglected.

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

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Applicability

This monitoring methodology shall be used in conjunction with the approved baseline methodology "Greenhouse gas reduction through waste heat recovery and utilization for power generation at cement plants" (AM00XX).

The methodology is applicable to the projects that meet the applicability conditions mentioned in the associated baseline methodology.

Monitoring Methodology

The monitoring methodology should monitor the following parameters during project operation:
Baseline

- Electricity demand of cement works and other local loads within the complex of cement works prior to start of the project.
- Electricity generation of existing captive power generation, if any.
- Waste heat use within the cement works and normal uses of waste heat in cement production commonly practiced in the region or host country.
- Regulations and/or policy that could influence the use of waste heat and generation of power in the region.
- Project electricity generation.
- If the baseline is supply of electricity from the grid:
    - Electricity generation, fuel consumption, and fuel specific energy content and emission factor of power generation sources connected to the grid to estimate operating margin and build margin.
    - Electricity imports and exports.
    - Electricity generation from the proposed project activity.

- Annual determination of the emission factor of the grid (weighted average excluding zero and low cost sources) to recalculate the operating margin with monitored data.
- Annual determination of the emission factor of the grid (weighted average of recently built plants - represented by the 5 most recent plants or the most 20% of the generating units built) to recalculate the build margin with monitored data.
- Annual determination of the combined margin.
- Confirmation to meet applicability especially for additionality at the renewal of the crediting period.

- If the baseline is an identified generation source:
    - Fuel consumption and electricity of identified generation sources

<u>Project Emissions</u>

- Fuel consumption, emission factor and energy content used in operation of clinker making process post project implementation.
- Fuel consumption in clinker making process prior to project implementation.
- Electricity generated by the project

Project emissions parameters

ID number	Data Type	Data Variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
1. PE_y	Emissions	Project emissions	tCO_2	c	Annually	100%	Electronic and paper	During the credit period	It is calculated using formulae described in Equation 4, in the baseline methodology.
2. $COEF_{fuel}$	Emission factor	Emissions Factor for fuel used in Clinker production	tCO_2/TJ	c	Monthly	100%	Electronic and paper	During the credit period	It should be calculated using formulae described in baseline methodology.
3. NCV_{fuel}	Calorific Value	Calorific Value of fuel used in Clinker Production	TJ/ unit mass or volume	m	Monthly	100%	Electronic and paper	During the credit period	The NCV value will be based on measurement on site.
4. $EF_{CO2,fuel}$	Emission factor	Emission factor of fuel used in Clinker production	tCO_2/ unit mass or volume	m	Monthly	100%	Electronic and paper	During the credit period	
5. $OXID_{fuel}$	Fraction	Oxidation ratio of fuel used in Clinker Production	Fraction	e	At start of project	100%	Electronic and paper	During the credit period	The default IPCC values can be used.
6. EI_B	Energy Intensity	Energy consumption per unit clinker production prior to project implementation	TJ/ ton Clinker	c	Annually	100%	Electronic and paper	During the credit period	The value is calculated using Equation 5 described the Baseline methodology. If project specific data is not available, data from industrial norm in the host country could be used.

ID number	Data Type	Data Variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
7. F_B	Energy	Average annual energy (fuel) consumption of clinker making process prior to project implementation.	TJ	m	At the start of project	100%	Electronic and paper	During the credit period	
8. $O_{clinker, B}$	Quantity	Average annual production of Clinker prior to implementation of project.	Ton	m	At the start of the project	100%	Electronic and paper	During the credit period	
9. $EI_{P,y}$	Energy Intensity	Energy (fuel) consumption per unit Clinker production after project implementation.	TJ/ton Clinker	c	Annually	100%	Electronic and paper	During the credit period	The quantity is estimated using Equation 6, described in the baseline methodology.
10. $F_{P,y}$	Energy	Energy (fuel) consumption of clinker making process after project implementation.	TJ	m	Continuously	100%	Electronic and paper	During the credit period	

ID number	Data Type	Data Variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
11. $O_{clinker, y}$	Quantity	Production of Clinker after implementation of project.	Ton	m	Continuously	100%	Electronic and paper	During the credit period	

Baseline emission parameters
Note that data required to calculate the emissions factor for displacement of electricity ($EF_{G,y}$) is based on the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002).

ID number	Data Type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
12. $EG_{ATEXIST}$	Electricity quantity	Net Electricity generation of existing captive generation plant prior to project	MWh	m	Once at start of project	100%	Electronic	During the crediting period	At least two years data should be reported in CDM-PDD. This data is used to ex-ante projection of future electricity demand.
13. E_{cement}	Electricity quantity	Electricity consumption of cement works prior to project	MWh	m	Once at start of project	100%	Electronic	During the crediting period	At least two years data should be reported in CDM-PDD. This data is used to ex-ante projection of future electricity demand.

ID number	Data Type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
14. E_{load}	Electricity quantity	Electricity consumption of other load in the Cements work complex prior to project	MWh	m	Once at start of project	100%	Electronic	During the crediting period	At least two years data should be reported in CDM-PDD. This data is used to ex-ante projection of future electricity demand.
15.	Document ary evidence	Documentary evidence of alternatives possible for waste heat and power generation			Once at start of project	100%	Electronic	During the crediting period	Documents could include research reports, sectoral study reports, expert analysis sought by project proponents, survey reports of practices in the sector, cement association reports highlighting common practices, etc.
16.	Document ary evidence	Documents pertaining to regulations and/or policies that could influence waste heat use and choice of power plant.			Once at start of project	100%	Electronic	During the crediting period	
17. EB_y	Emission quantity	Baseline emission for year y	tCO_2	c	Annually	100%	Electronic	During the crediting period	The quantity is estimated using formulae described in Equation 8 in the baseline methodology.

ID number	Data Type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
18. EG_y	Electricity quantity	Quantity of electricity supplied to cement plant	MWh	m	Continuously	100%	Electronic	During the crediting period	
19. $EF_{Elec, y}$	Emission Factor	Emission factor of electricity displaced by project implementation	tCO_2/MWh	c	Annually	100%	Electronic	During the crediting period	Emission factor is estimated, depending on what is the source of Baseline electricity supply.
20. $EG_{Grid, y}$	Electricity quantity	Quantity of electricity supplied to the grid	MWh	m	Continuously	100%	Electronic	During the crediting period	
21. $EF_{Grid, y}$	Emission Factor	Emission factor of grid electricity displaced by project implementation	tCO_2/MWh	c	Annually	100%	Electronic	During the crediting period	

ID number	Data Type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
22. EF_OM_y	Emission Factor	GHG emission factor for electricity generation sources in the grid that constitute the operating margin	tCO_2/MWh	c	Annually	100%	Electronic	During the crediting period	Estimated using Equation 10 described in the baseline methodology.
23. $F_{ij/ik}$, y	Fuel quantity	Consumption of Fuel ‘i’ in the ‘j’ power generation sources in the operating margin or ‘k’ power generation source in the build margin	TJ	e	Annually	100%	Electronic	During the crediting period	Obtained from power producers, dispatch centers or latest local statistics.

ID number	Data Type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
24. $COEF_{i/igs}$	Emission coefficient	Emission coefficient of fuel 'i' used for power generation or for identified generation source (igs)	tCO_2/TJ	c	Annually	100%	Electronic	During the crediting period	
25. $NCV_{i/igs}$	Calorific Value	Calorific Value of fuel 'i' used for power generation for identified generation source (igs)	TJ/ unit mass or volume	e	Annually	100%	Electronic	During the crediting period	Country specific values should be used from published sources (e.g. National Communications). In absence of a country specific data IPCC values could be used.
26. $EF_{i/igs}$	Emission factor	Emission factor of fuel 'i' used for power generation for identified generation source (igs)	tCO_2/TJ	e	Annually	100%	Electronic	During the crediting period	Country specific values should be used from published sources (e.g. National Communications). In absence of a country specific data IPCC values could be used.

ID number	Data Type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
27. $OXID_{Fuel/igs}$	Fraction	Oxidation ratio of fuel 'i' used for power generation for identified generation source (igs)	Fraction	e		100%	Electronic	During the crediting period	The default IPCC values can be used
28. $GEN_{j/k,y}$	Electricity quantity	Annual generation of power generation source 'j' in the grid considered as operating margin and 'k' considered in the build margin	MWh	e	Annual	100%	Electronic	During the crediting period	Obtained from power producers, dispatch centers or latest local statistics.
29. 'j'	Plant name	List of power generation sources that are connected to grid identified as operating margin for year 'y'	List	e	Annually	100%	Electronic	During the crediting period	List of plants identified as being in the operating margin. Information should be sourced from most recent statistics.

ID number	Data Type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
30. ‘k’	Plant name	List of power generation sources identified to be in the Build Margin for year ‘y’	List	e	Annually	100%	Electronic	During the crediting period	List of plants identified as being in the Build margin. Information should be sourced from most recent statistics.
31. λ y	Parameter	Fraction of time during which low-cost/ must-run sources are on the margin	Number	c	Annually	100%	Electronic	During the crediting period and two years after	Factor accounting for number of hours per year during which low-cost/must-run sources are on the margin
32.	Merit order	The merit order in which power plants are dispatched by documented evidence	Text	m	Annually	100%	paper for original documents, else electronic	During the crediting period and two years after	Required to stack the plants in the dispatch data analysis
33. GEN j/k/ll,y *IMPORTS*	Electricity quantity	Electricity imports to the project electricity system	kWh	c	Annually	100%	Electronic	During the crediting period and two years after	Obtained from the latest local statistics. If local statistics are not available, IEA statistics are used to determine imports.

ID number	Data Type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
34. COEF i,j,y *IMPORTS*	Emission factor coefficient	CO_2 emission coefficient of fuels used in connected electricity systems (if imports occur)	tCO_2 / mass or volume unit	c	Annually	100%	Electronic	During the crediting period and two years after	Obtained from the latest local statistics. If local statistics are not available, IPCC default values are used to calculate.
35. W_{om}	Weight	Weight factor for OM	Fraction	e	Annually	100%	Electronic	During the crediting period	Default value is 0.5
36. W_{BM}	Weight	Weight factor for BM	Fraction	e	Annually	100%	Electronic	During the crediting period	Default value is 0.5
37. EF_{IG}	Emission factor	Emission factor if the baseline electricity supply is from an identified electricity supply source	tCO_2/MWh	c	Once at the start of the credit period and each renewal thereof	100%	Electronic	During the crediting period	If the identified generation source is expansion of existing captive generation source, actual captive plant specific data should be used to estimate the emission factor, else, heat rate data corresponding to identified generation source could be used.

ID number	Data Type	Data variable	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
38. FI_{IGS}	Fuel intensity	Fuel intensity of power generation for identified generation source	TJ/MWh	m or e	Once at the start of the credit period and each renewal thereof	100%	Electronic	During the crediting period	If the identified generation source is expansion of existing captive generation source, captive plant specific annual fuel consumption and net electricity generation data should be used to estimate the emission factor, else, heat rate data of most efficient plant similar to identified generation source could be used.

Leakage

The potential leakage due to construction and fuel handling is negligible and could be neglected.

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

All variables used to calculate project and baseline emissions are directly measured or are from publicly available official data. To ensure the quality of the data, in particular those that are measured, the data are double-checked against commercial data. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning. QA/QC procedures for the parameters to be monitored are illustrated in the following table.

Data	Uncertainty Level of Data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation how QA/QC procedures are planned
1., 30.	Low	Yes	Any direct measurements with mass or volume meters at the plant site should be cross-checked with an annual energy balance that is based on purchased quantities and stock changes.
3., 4.	Low	Yes	Check consistency of measurements and local / national data with default values by the IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements.