Approved baseline methodology AMXXXX

"Emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture"

Source

This methodology is based on two cases "Replacement of Fossil Fuel by Palm Kernel Shell biomass in the production of Portland cement" NM0040, prepared by Lafarge Asia, and "Indocement's Sustainable cement Production Project" NM0048, prepared by Indocement. For more information regarding the proposals and their consideration by the Executive Board please refer to cases NM0040 and NM0048 on http://cdm.unfccc.int/methodologies/approved.

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

The methodology is applicable to the cement industry with the following conditions:

- Fossil fuel(s) used in cement manufacture are partially replaced by alternative fuels, including renewable biomass[1], where renewable biomass residues are in surplus and leakages in other uses of the renewable biomass will not occur;
- CO_2 emissions reduction relates to CO_2 emissions from fuel burning requirements only and is unrelated to the CO_2 emissions from decarbonisation of raw materials (i.e. $CaCO_3$ and $MgCO_3$ bearing minerals);
- The methodology is applicable only for existing (i.e. by the start of project activity) production capacity (tonnes clinker/year) at this plant, which is defined as the maximum (annual) production of clinker during any of the last four (4) years from the beginning of 2000 and end of 2004;
- The amount of alternative fuels available for the project is 1.5 times the amount required to meet the consumption of all users consuming the same alternative fuels, i.e. the project and other alternative fuel users.

This baseline methodology shall be used in conjunction with the approved monitoring methodology AMXXXX ("Monitoring methodology for emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture").

Project boundary

The physical project boundary covers all production processes related to clinker production. The specific production step associated with GHG emissions that will define the project boundary primarily includes pyro-processing. In terms of gases covered, within the project boundary only CO_2 emissions from the

[1] Renewable biomass residues are such that they do not contribute to global warming. The Executive Board may further define renewable biomass based on recommendations from the Meth Panel and the AR WG.

combustion of fuels are considered, because the cement manufacturing process involves high combustion temperatures and long residence times that would limit production of other GHG emissions.

Additionality and baseline scenario selection

This section is based on the Executive Board's approved "Tool for the demonstration and assessment of additionality". The text in this section described in more detail how this tool is applied to the alternative fuels projects in cement manufacturing.

1. Define alternative scenarios

- Define a continuation of current practice scenario, i.e. a scenario in which the company continues cement production using the existing technology, materials and fuel mix. Quantify the amount of fossil fuel(s) that would be used for clinker production over the project period.
- Define scenario(s) reflecting the likely level of investment and efficiency improvement motivated by potential for cost savings, which takes into account likely future technology improvements as well as evolving fuel mix portfolios.[2] The scenario(s) may be based on one fuel or a different mixes of fuels. Quantify the amount of fossil fuel(s) that is expected to be used for clinker production over the project period.
- Define a scenario in which traditional fuels are partially substituted with alternative fuels (i.e. the proposed project). If relevant, develop different scenarios with different mix of alternative fuels and varying degrees of fuel-switch from traditional to alternative fuels. These scenarios should reflect all relevant policies and regulations[3]. Quantify the amounts of fossil fuels and alternative fuels that would be used for clinker production over the project period.

2. Select baseline scenario through financial analysis

The baseline scenario defines the most likely situation in the absence of the proposed project. A key assumption of this methodology is that the cement company is taking decisions to maximise its revenues. The baseline scenario for a fuel-switch project implemented in the cement sector, therefore, should be selected from among the alternative scenarios by conducting the following financial tests:

- Calculate the financial costs (e.g. capital and variable costs) of the different alternatives.
- For all relevant project scenarios, compare the scenarios on the basis of NPV, IRR, or an alternative indicator of financial attractiveness of investment. Compute the financial indicator using net incremental cash flow but excluding potential CER revenue.
- Based upon this comparison, select the most cost-effective scenario from the list of alternative scenarios. The scenario with the most attractive economics, as measured by the chosen financial indicator (e.g. highest IRR, highest NPV), should be selected as the baseline scenario.
- A sensitivity analysis should be performed to assess the robustness of the selection of the most likely future scenario to reasonable variations in critical assumptions and to establish that the project is not the baseline. The financial indicator is calculated conservatively if assumptions tend to make the CDM project's indicators more attractive and the alternatives' indicators less attractive.

The baseline scenario should take into account relevant national/local and sectoral policies and circumstances, and the proponent should demonstrate that the key factors, assumptions and parameters of the baseline scenario are conservative.

[2] If relevant, construction of a new cement kiln or plant using alternative fuels could be included as a possible scenario. Note that the clinker production capacity should remain constant.
[3] See Executive Board guidance on national policies http://cdm.unfccc.int/EB/Meetings/016/eb16repan3.pdf

3. Impact of CDM Registration

Explain how the approval and registration of the project as a CDM activity, and the attendant benefits and incentives derived from the project activity, will alleviate the economic and financial hurdles and thus enable the project to be undertaken. The benefits and incentives can be of various types, such as:

- Anthropogenic greenhouse gas emission reductions,
- The financial benefit of the revenue obtained by selling CERs,
- Attracting new players who are not exposed to the same barriers, or can accept a lower IRR (for instance because they have access to cheaper capital),
- Attracting new players who bring the capacity to implement a new technology, and
- Reducing inflation/exchange rate risk affecting expected revenues and attractiveness for investors.

Since a key assumption of this methodology is that the cement company is taking decisions to maximise its revenues, the financial indicator (NPV, IRR, or other) computed with the expected revenues from CERs should be compared to the baseline scenario, and the CDM project including CER revenues has to be financially more attractive than the selected baseline case. If this is still not the case, the Project Participant should explain which additional benefit of the CDM registration is helping to enable the project to be undertaken.

4. Conduct common practice analysis

The above investment analysis shall be complemented with an analysis of the extent to which the proposed project practice has already diffused in the relevant sector and region.

4.1 Analyse other activities similar to the proposed project:

Provide an analysis of any other activities implemented previously or currently underway that are similar to the proposed project activity. Projects are considered similar if they are in the same country and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc. Other CDM project activities are not to be included in this analysis. Provide quantitative information where relevant.

4.2. Discuss any similar options that are occurring:

If similar activities are widely observed and commonly carried out, then it is necessary to demonstrate why the existence of these activities does not contradict the claim that the proposed project activity is financially unattractive. This can be done by comparing the proposed project to other similar activities, and pointing out and documenting essential distinctions between them that explain why the similar activities enjoyed certain benefits that rendered them financially attractive (e.g., subsidies or other financial flows) or did not face the barriers to which the proposed project activity is subject.

Essential distinctions may include a serious change in circumstances under which the proposed CDM project will be implemented when compared to circumstances under which similar projects were carried out. For example, new barriers may have arisen, or promotional policies may have ended, leading to a situation in which the proposed CDM project would not be implemented without the incentive provided by the CDM. The change must be fundamental and verifiable.

If Sub-steps 4.1 and 4.2 are satisfied, as well as Step 3, the proposed project is not the baseline scenario and is considered additional.

Baseline and project emissions calculations

This methodology assumes that the baseline scenario resulting from steps 1 and 2 will include the use of fossil fuels in clinker production. If it is not the case, the project proponent should use or propose for approval another methodology.

The project reduces CO_2 emissions from burning fossil fuel in cement kilns. The energy-related emission reductions are calculated as the amount of energy supplied by the alternative fuels in the project activity times the CO_2 emission factor for the fossil fuel(s) consumed in the baseline scenario. CH_4 emissions from kilns are negligible and are ignored. The project activity also generates CO_2, CH_4, and N_2O emissions due to on-site transportation of biomass and other alternative fuels.

Other emissions outside of the project boundary include CH_4 emissions from burning of biomass in open fields and CH_4 emissions due to anaerobic decomposition of wastes in landfills in the baseline. These are covered under the section on leakage. Emissions of CO_2, CH_4, and N_2O due to off-site transport and preparation of alternative fuels and fossil fuels to the cement plants are also addressed in the leakage section below.

Step 1. Calculate project heat input from alternative fuels

Heat input from alternative fuels with significant moisture content is calculated first to allow for the calculation of a project-specific moisture "penalty" for alternative fuel heat input requirements.

$$HI_{AF} = \sum Q_{AF} \times HV_{AF} \quad \textbf{(1)}$$

Where:
HI_{AF} = heat input from alternative fuels (TJ/yr)
Q_{AF} = quantity of each alternative fuel (tonnes/yr)
HV_{AF} = lower heating value of the alternative fuel(s) used (TJ/tonne fuel).

Step 2. Calculate alternative heat input as a share of total baseline fossil fuel heat input

$$S_{AF} = \frac{HI_{AF}}{\sum Q_{FF} \times HV_{FF}} \quad \textbf{(2)}$$

Where:
S_{AF} = alternative heat input share of total baseline fossil fuel heat input
HI_{AF} = heat input from alternative fuels (TJ/yr)
Q_{FF} = quantity of each fossil fuel used in baseline (tonnes/yr)
HV_{FF} = lower heating value of the fossil fuel(s) used in baseline (TJ/tonne fuel).

Step 3. Application of project specific moisture "penalty"

A project specific "penalty" is applied, because the combustion of typically coarser biomass and other alternative fuels, as opposed to more finely ground coal, will reduce the heat transfer efficiency in the cement manufacturing process. This will therefore require a greater heat input to produce the same quantity and quality of cement clinker. The chemical content and ease of absorption into cement clinker of all fuel ashes also differs, and this also contributes to the need for a project specific penalty.

This project specific penalty (*mp*) should be determined by a comparison heat and mass balance for the cement manufacturing equipment when producing equal quantity and quality of cement clinker with and without alternative fuels. This penalty can be determined at an average % alternative fuel replacement and expressed as a relationship between the amounts of alternative fuel fired as % of total fuel input vs. amount of cement clinker produced. For example, for cement process requiring 3.3 MJ/kg cement clinker during baseline conditions and 3.4 MJ/kg cement clinker when using 10% of alternative fuel, the penalty is 0.1 MJ/kg clinker per 10% alternative fuel used. The product of this and the mass of clinker produced results in an absolute heat penalty per 10% alternative fuel for this specific alternative fuel in this specific process.

(3)

$$mp = \frac{HC_{AF}(i) - HC_{FF}}{S_i} \times 10$$

Where:
mp = moisture penalty (MJ/tonne/10% alternative fuel share of total heat input)
$HC_{AF}(i)$ = specific heat consumption using *i* % alternative fuel (MJ/tonne clinker)
HC_{FF} = specific heat consumption using fossil fuels only (MJ/tonne clinker)
S_i = alternative fuel heat input share of total baseline heat input in the moisture penalty test

The total moisture penalty is therefore calculated as follows:

(4)

$$MP_{Total} = \frac{S_{AF}}{10\%} \times C \times mp$$

Where:
MP_{total} = total moisture penalty (TJ/yr)
S_{AF} = alternative fuel heat input share of total baseline heat input
C = total clinker production (tonnes/yr)
mp = moisture penalty (MJ/tonne-10% alternative fuel share of total heat input)

Step 4 Calculate GHG emissions from the use of alternative fuels in kilns:

$$AF_{GHG} = \Sigma(Q_{AF} * HV_{AF} * EF_{AF}) \quad \textbf{(5)}$$

Where:

AF_{GHG}	=	GHG emissions from alternative fuels (tCO_{2e}/yr)
Q_{AF}	=	monitored alternative fuels input in clinker production (tonnes/yr).
HV_{AF}	=	heating value(s) of the alternative fuel(s) used (TJ/tonne fuel).
EF_{AF}	=	emission factor(s) of alternative fuel(s) used (tCO_{2e}/TJ).

When several alternative fuels are burned, the GHG emissions from each fuel are aggregated to determine AF_{GHG} using respective heating values and emission factors.

For biomass fuels, unless it is clearly demonstrated and documented that biomass consumed by the project will decompose anaerobically, it should be assumed that the biomass would be burned. CO_2 emissions from biomass burning should be considered CO_2-neutral, i.e. these emissions are part of the natural carbon cycle because the carbon released to the atmosphere during burning is reabsorbed during the next growing season. To be conservative, N_2O and CH_4 emissions from stockpiled biomass should be ignored.

For non-biogenic carbon (e.g. tires, plastics, textiles, and rubber/leather), unless it can be clearly demonstrated that incineration of these alternative fuels is the dominant practice in the area(s) from which the alternative fuels in the project activity are sourced, CO_2 emissions from these fuels should be included in project emissions. If these wastes are incinerated in the host country (in the baseline scenario), then they should be considered as CO_2-neutral fuels, unless the heat generated in the incineration plant is used for heating or electricity generation purposes. In this latter case, CO_2 emissions from these fuels are to be included in project emissions.

Step 5. Calculate the baseline GHG emissions from the fossil fuel(s) displaced by the alternative fuel(s)

$$FF_{GHG} = [(Q_{AF} * HV_{AF}) - MP_{total}] * EF_{FF} \quad \textbf{(6)}$$

Where:

FF_{GHG}	=	GHG emissions from fossil fuels displaced by the alternatives ($tCO_{2/yr}$)
$Q_{AF} * HV_{AF}$	=	total actual heat provided by all alternative fuels (TJ/yr)
MP_{total}	=	total moisture penalty (TJ/yr)
EF_{FF}	=	emissions factor(s) for fossil fuel(s) displaced (tCO_2/TJ).

EF_{FF} is the baseline value and would be the weighted average for the mix of fossil fuels if more than one fossil fuel is used.

Step 6. Calculate GHG emissions due to on-site transportation and drying of alternative fuels **(7)**

$$OT_{GHG} = OF_{AF} * (VEF\_CO_2 + VEF\_CH_4 * GWP\_CH_4/1000 + VEF\_N_2O * GWP\_N_2O/1000) + (FD * FD\_HV * VEF_D)$$

Where:

OT_{GHG}	=	GHG emissions from on-site transport and drying of alternative fuels (tCO_{2e}/yr)
OF_{AF}	=	transportation fuel used for alternative fuels on-site during the year (t/yr),
VEF_CO_2	=	CO_2 emission factor for the transportation fuel (tCO_2/tonne),
VEF_CH_4	=	CH_4 emission factor for the transportation fuel (kg CH_4/tonne),
VEF_N_2O	=	N_2O emission factor for the transportation fuel (kg N_2O/tonne),
GWP_CH_4	=	global warming potential for CH_4 (21),
GWP_N_2O	=	global warming potential for N_2O (310),
FD	=	fuel used for drying alternative fuels (t/yr),
FD_HV	=	heating value of the fuel used for drying (TJ/t fuel), and
VEF_D	=	emission factor of the fuel used for drying (tCO_2/TJ)

Step 7. Calculate emission savings from reduction of on-site transport of fossil fuels

$$OT\_GHG_{FF} = OF_{FF} * EF_{T\ CO2e} \quad \textbf{(8)}$$

Where:

$OT\text{-}GHG_{FF}$	=	emissions from reduction of on-site transport of fossil fuels ($tCO2_e$)
OF_{FF}	=	fuel saving from on-site transportation of fossil fuels (t/yr)
$EF_{T\ CO2e}$	=	emission factor of fuel used for transportation (tCO_{2e}/t fuel),

Leakage

Leakage emissions considered are methane emissions due to biomass that would be burned or compose anaerobically in landfills in the absence of the project, as well as CO_2 emissions from off-site transport of fuels and off-site preparation of alternative fuels.

Another potential source of leakage is that the project may deprive other users of alternative fuels and thereby increase fossil fuel use. To ensure that the proposed project activity will not reduce the amount of alternative fuels available to other alternative fuels users, the project proponent should demonstrate that the amount of alternative fuels is 1.5 times the amount required to meet the consumption of all users consuming the same alternative fuels, i.e. the project and other alternative fuel users.

Step 1. Calculate CH_4 emissions due to biomass that would be burned in the absence of the project.

$$BB_{CH4} = Q_{AF-B} * BCF * CH_4F * CH_4/C * GWP\_CH_4 \quad \textbf{(9)}$$

Where:
BB_{CH4} = GHG emissions due to burning of biomass that is used as alternative fuel (tCO_{2e}/yr)
Q_{AF-B} = amount of biomass used as alternative fuel that would have been burned in the open field in the absence of the project (t/yr)
BCF = carbon fraction of the biomass fuel (tC/t biomass) estimated on basis of default values,
CH_4F = fraction of the carbon released as CH_4 in open air burning (expressed as a fraction),[4]
CH_4/C = mass conversion factor for carbon to methane (16 tCH_4/12 tC), and
GWP_CH_4 = global warming potential of methane (21).

Step 2. Calculate the CH_4 emissions due to anaerobic decomposition of wastes in landfills.

This step will only be relevant for a project activity that burns waste that would otherwise be landfilled. The emission reductions are achieved by avoiding CH_4 emissions from anaerobic decomposition of waste. There is a possibility that the methane is completely or partially flared in the baseline scenario. If all landfill gas is being flared, then CH_4 emission reductions cannot be claimed. If a portion of the methane is flared, then only the non-flared portion (NFL) of the CH_4 can be claimed by the project proponent.

$$LW_{CH4} = Q_{AF-L} * DOC * DOC_F * MCF * F * C * (1-OX) * NFL * GWP\_CH_4 \quad \textbf{(10)}$$

Where:
LW_{CH4} = baseline GHG emissions due to anaerobic decomposition of biomass wastes in landfills (tCO_{2e}/yr)
Q_{AF-L} = amount of wastes (e.g. biomass) used as alternative fuel that would be landfilled in the absence of the project (t/yr)
DOC = degradable organic carbon content of the waste (%)
DOC_F = portion of DOC that is converted to landfill gas (0.77 default value)
MCF = methane conversion factor for landfill (%)
F = fraction of CH_4 in landfill gas (0.5 default value)
C = carbon to methane conversion factor (16/12)
OX = oxidation factor (fraction – default is 0)
NFL = non-flared portion of the landfill gas produced (%)
GWP_CH_4 = global warming potential of methane (21).

Step 3. Calculate emissions from off-site transport of alternative and fossil fuels.

The emissions from transportation should be calculated as follows:

$$LK_{trans} = LK_{AF} - LK_{FF} \quad \textbf{(11)}$$
$$LK_{AF} = (Q_{AF}/CT_{AF}) * D_{AF} * EF_{CO2e}/1000 \quad \textbf{(12)}$$
$$LK_{FF} = (Q_{FF}/CT_{FF}) * D_{FF} * EF_{CO2e}/1000 \quad \textbf{(13)}$$

[4] The IPCC 1996 guidelines recommend using 0.005% as a default value.

Where:
LK_{trans} = leakage from transport of alternative fuel less leakage due to reduced transport of fossil fuels (tCO_2/yr)
LK_{AF} = leakage resulting from transport of alternative fuel (tCO_2/yr)
LK_{FF} = leakage due to reduced transport of fossil fuels (tCO_2/yr)
Q_{AF} = quantity of alternative fuels (tonnes)
CT_{AF} = average truck or ship capacity (tonnes/truck or ship)
D_{AF} = average round-trip distance between the alternative fuels supply sites and the cement plant sites (km/truck or ship)
Q_{FF} = quantity of fossil fuel (tonnes) that is reduced due to consumption of alternative fuels.
CT_{FF} = average truck or ship capacity (tonnes/truck or ship)
D_{FF} = average round-trip distance between the fossil fuels supply sites and the cement plant sites (km/truck or ship)
EF_{CO2e} = emission factor from fuel use due to transportation (kg CO_{2e}/km) estimated as:

$$EF_{CO2e} = EF_{T\ CO2} + (EF_{T\ CH4} * 21)+(EF_{T\ N2O} * 310) \quad (14)$$

Where:
$EF_{T\ CO2}$ = emission factor of CO_2 in transport (kg CO_2/km)
$EF_{T\ CH4}$ = emission factor of CH_4 in transport (kg CH_4/km)
$EF_{T\ N2O}$ = emission factor of N_2O in transport (kg N_2O/km)

21 and 310 are the Global Warming Potential (GWP) of CH_4 and N_2O respectively

Step 4. Calculate emissions from off-site preparation of alternative fuels

The GHG emissions generated during the preparation of alternative fuels outside the project site are estimated as follows:

$$GHG_{PAFO} = FD_{AFO} * HV_{FDAFO} * EF_{FDAFO} + PD_{AFO} * EF_{pO} \quad (15)$$

Where:
GHG_{PAFO} = GHG emissions that could be generated during the preparation of alternative fuels outside the project site (tCO_2/yr)
FD_{AFO} = fuel used in drying of alternative fuels outside the project site (t/yr)
HV_{FDAFO} = heating value of fuel used for drying alternative fuels outside the project site (TJ /tonne)
EF_{FDAFO} = emission factor for the fuel used for drying of alternative fuels outside the project site (tCO_2/TJ)
PD_{AFO} = power consumption in drying the alternative fuels (MWh/yr) outside the project site
EF_{pO} = CO_2 emission factor due to power generation outside the project where the drying of alternative fuels takes place, determined according to the methodology presented in AM0002 (tCO_2/MWh).

Emission Reductions

Total emission reductions are given by the following formula

$$AF_{ER} = FF_{GHG} - AF_{GHG} - OT_{GHG} - LK_{trans} + OT\_GHG_{FF} + BB_{CH4} + LW_{CH4} - GHG_{PAFO} \quad (16)$$

Where:
FF_{GHG} = GHG emissions from fossil fuels displaced by the alternatives ($tCO_{2/yr}$)

AF_{GHG}	=	GHG emissions from alternative fuels (tCO_{2e}/yr)
OT_{GHG}	=	GHG emissions from on-site transport and drying of alternative fuels (tCO_{2e}/yr)
LK_{trans}	=	leakage from transport of alternative fuel less leakage due to reduced transport of fossil fuels (tCO_2/yr)
$OT\text{-}GHG_{FF}$	=	emissions from reduction of on-site transport of fossil fuels ($tCO2_e$)
BB_{CH4}	=	GHG emissions due to burning of biomass that is used as alternative fuel (tCO_{2e}/yr)
LW_{CH4}	=	baseline GHG emissions due to anaerobic decomposition of biomass wastes in landfills (tCO_{2e}/yr)
GHG_{PAFO}	=	GHG emissions that could be generated during the preparation of alternative fuels outside the project site (tCO_2/yr)

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Applicability

- To be used in conjunction with baseline methodology of the same name
- Fossil fuel(s) used in cement manufacture are partially replaced by alternative fuels, including renewable biomass, where biomass availability is such that leakages in other uses of the biomass will not occur
- CO_2 emission reduction relates to CO_2 emissions generated from fuel burning requirements only and is unrelated to the CO_2 emission from decarbonisation of raw materials (typically $CaCO_3$ and $MgCO_3$ bearing minerals)
- The methodology is applicable only for existing (i.e. by the start of project activity) production capacity (tonnes clinker/year) at this plant, which is defined as the maximum (annual) production of clinker during any of the last four (4) years from the beginning of 2000 and end of 2004.
- The amount of alternative fuels available for the project is 1.5 times the amount required to meet the consumption of all users consuming the same alternative fuels, i.e. the project and other alternative fuel users.

This monitoring methodology shall be used in conjunction with the approved monitoring methodology AMXXXX ("Baseline methodology for emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture").

Monitoring methodology

Baseline and project emissions

ID number	Data Type	Data Variable	Symbol	Data Unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of Data to be Monitored	How Will the Data be Archived (electronic/paper)	For How Long is the Archived Data Kept?	Comment	Instrument used to record
Monitoring of parameters related to clinker production											
1	Mass	Clinker production	C	Ton	M, C	Recorded/ calculated and reported monthly	100%	Electronic, paper	2 years after the end of the crediting period		Weighing feeders
Monitoring of emissions related to the use of alternative fuels in kilns during the crediting period (for each type of fuels - and each kiln independently)											
2	Quantity	Fuel type	$Q_{AF,}$	Units of mass or volume	M	Recorded continuously and reported monthly and adjusted according to stock change	100%	Electronic, paper	2 years after the end of the crediting period		Scale
3	Heat Value	Fuel Heating value	HV_{AF}	TJ/tonne	M, C	Monthly	100%	Electronic, paper	2 years after the end of the crediting period		Calorimeter
4	Heat	Alternative fuel heat input	HI_{AF}	TJ	C	Calculated and reported monthly	100%	Electronic, paper	2 years after the end of the crediting period	For each kiln	
5	Emission Factor	Emission Factor	EF_{AF}	$tCO2/TJ$	IPCC default	Fixed	100%	Electronic, paper	The entire crediting period		
6	Fraction	Share of heat input from alternative fuels	S_{AF}	%	C	Calculated monthly	100%	Electronic, paper	2 years after the end of the crediting period		
7	Ratio	Moisture penalty	mp	MJ/tonne/ 10% alt fuel share	C	At start of crediting period	100%	Electronic, paper	2 years after the end of the crediting period		

ID number	Data Type	Data Variable	Symbol	Data Unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of Data to be Monitored	How Will the Data be Archived (electronic/paper)	For How Long is the Archived Data Kept?	Comment	Instrument used to record
Monitoring of emissions related to the baseline GHG emissions from the fossil fuel(s) displaced by the alternative fuel(s)											
8	Quantity	Fuel type	Q_{FF}	Units of mass or volume	M	Recorded continuously and reported monthly and adjusted according to stock change	100%	Electronic, paper	2 years after the end of the crediting period		Scale
9	Heat Value	Fuel Heating value	HV_{FF}	TJ/tonne	M, C	Monthly	100%	Electronic, paper	2 years after the end of the crediting period		Calorimeter
10	Emission Factor	Emission Factor	EF_{FF}	tCO2/TJ	IPCC default	Fixed	100%	Electronic, paper	The whole crediting period		
/Monitoring of emissions related to on-site transportation and drying of alternative fuels											
11	Quantity	Transportation of fuel used on-site	OFv	Kg	M	Recorded and reported monthly	100%	Electronic, paper	2 years after the end of the crediting period		Fuel record
12	Emission Factor	Emission Factor	VEF_{CO2}	g CO2/kg	IPCC default	Fixed	100%	Electronic, paper	The whole crediting period	Ref. notes below	
13	Emission Factor	Emission Factor	VEF_{CH4}	g CH4/kg	IPCC default	Fixed	100%	Electronic, paper	The whole crediting period	Ref. notes below	
14	Emission Factor	Emission Factor	VEF_{N2O}	g N2O/kg	IPCC default	Fixed	100%	Electronic, paper	The whole crediting period	Ref. notes below	
15	Quantity	Fuel used for any drying of alternative fuels	FD	Kg	M	Recorded and reported monthly	100%	Electronic, paper	2 years after the end of the crediting period		Flowmeter, weigher
16	Heat	Heating Value for fuel for drying alt. Fuels	FD_HV	TJ/tonne	M, C	Monthly	100%	Electronic, paper	2 years after the end of the crediting period		Calorimeter

ID number	Data Type	Data Variable	Symbol	Data Unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of Data to be Monitored	How Will the Data be Archived (electronic/paper)	For How Long is the Archived Data Kept?	Comment	Instrument used to record
17	Emission factor	Emission factor for the fuel used for drying	VEF_D	tCO2/TJ	IPCC default	Fixed	100%	Electronic, paper	The whole crediting period	Ref. notes below	
Monitoring of emissions reduction from reduction of on-site transport of fossil fuel											
18	Quantity	Fuel saving from on-site transportation of fossil fuel	OF_{FF}	kg	M	Measured monthly and reported monthly	100%	Electronic, paper	2 years after the end of the crediting period		Fuel consumption records
19	Emission factor	Fuel emission factor	$EF_{T\ CO2e}$	$kgCO_{2e}$ /kg fuel	Default value		100%	Electronic, paper	2 years after the end of the crediting period		NA

Leakage

ID number	Data Type	Data Variable	Symbol	Data Unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of Data to be Monitored	How Will the Data be Archived (electronic/paper)	For How Long is the Archived Data Kept?	Comment	Instrument used to record
Monitoring of emissions due to burning of biomass in the field in the baseline scenario											
20	Quantity	Biomass fuel which would have been burnt in the absence of the project	$Q_{AF -D/B}$	Tonnes	Measured	Monthly	100%	Electronic, paper	2 years after the end of the crediting period		
21	Fraction	Carbon fraction of the biomass	BCF	Tonnes C per tonnes biomass	IPCC default						
22	Fraction	Carbon released as CH_4 in open air burning	CH_4F		IPCC default						
Monitoring of emissions due to landfilling of biomass in the baseline scenario											
23	Quantity	Biomass fuel that would have been landfilled without project	Q_{AF-L}	Tonnes	Measured	Monthly	100%	Electronic, paper	2 years after the end of the crediting period		
24	Fraction	Methane conversion factor	MCF		IPCC default				2 years after the end of the crediting period	Default = 0.4 for un-managed shallow waste sites under 5 m.	

ID number	Data Type	Data Variable	Symbol	Data Unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of Data to be Monitored	How Will the Data be Archived (electronic/paper)	For How Long is the Archived Data Kept?	Comment	Instrument used to record
25	Fraction	Degradable organic carbon content of the biomass	DOC	tC/tones of biomass.	IPCC default				2 years after the end of the crediting period	Default value is 0.3.	
26	Fraction	Portion of DOC that is converted to landfill gas	DOC_F		IPCC default				2 years after the end of the crediting period	Default value is 0.77.	
27	Fraction	CH_4 in landfill gas	F		IPCC default				2 years after the end of the crediting period	Default value is 0.5.	
28	Fraction	CH_4 that is oxidized	OX		IPCC default				2 years after the end of the crediting period	Default value is 0.	
29	Fraction	Landfill gas portion that is flared	NFL		E				2 years after the end of the crediting period	Obtained from host country	
Monitoring of emissions due to off-site transport of fuels											
30	Quantity	Alternative Fuels	Q_{AF}	Ton	M	Recorded continuously and reported monthly based on actual silo stock level changes	100%	Electronic, paper	2 years after the end of the crediting period		Weighing feeders
31	Specific Quantity	Average truck capacity for transport of alternative fuels	CT_{AF}	Tonnes per truck	C	Monthly	100%	Electronic, paper	2 years after the end of the crediting period	The quantity can be estimated based on additive material hauling distance and estimated fuel consumption per shipment	

ID number	Data Type	Data Variable	Symbol	Data Unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of Data to be Monitored	How Will the Data be Archived (electronic/paper)	For How Long is the Archived Data Kept?	Comment	Instrument used to record
32	Distance	Average distance for transport of alternative fuels	D_{AF}	Km/truck	C	Monthly	100%	Electronic, paper	2 years after the end of the crediting period	In certain cases other means of transportation which require that other formulas be used	
33	Emission Factors	Emission factors	EF_{CO2e}	Kg CO2eq per km or per kg of fuel	C	Monthly	100%	Electronic, paper	2 years after the end of the crediting period	Ref. notes below	
34	Quantity	Fossil fuels which is reduced due to consumption of alternative fuels	Q_{FF}	Ton	C	Recorded continuously and reported monthly based on actual silo stock level changes	100%	Electronic, paper	2 years after the end of the crediting period	Raw materials replaced by additive materials	Weighing feeders
35	Specific Quantity	Average truck capacity for transport of Q_{FF}	CT_{FF}	Tonnes per truck	C	Monthly	100%	Electronic, paper	2 years after the end of the crediting period		
36	Distance	Average distance for transport of Q_{FF}	D_{FF}	Km/truck	C	Monthly	100%	Electronic, paper	2 years after the end of the crediting period	In certain cases other means of transportation which require other formulas be used	

ID number	Data Type	Data Variable	Symbol	Data Unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of Data to be Monitored	How Will the Data be Archived (electronic/paper)	For How Long is the Archived Data Kept?	Comment	Instrument used to record
Monitoring of alternative fuel reserves that may be used by other users (data to be completed for each type of fuel independently)											
37	Quantity	Alternative fuel used by other users		Ton	E	Yearly	100%	Electronic, paper	2 years after the end of the crediting period	Track whether project activity reduces alternative fuel available to other users groups so that their GHG emissions will increase.	Based on data from local, national, and/or international government institutions; industry associations; and other reliable sources of information
38	Quantity	Alternative fuel reserve available in the region		Ton	E	Yearly	100%	Electronic, paper	2 years after the end of the crediting period		
Monitoring of preparation of alternative fuel outside the project site/outside the cement plant sites											
39	*Quantity*	Fuel used in drying of alternative fuels outside the project site	FD_{AFO}	Ton, kg or litre	M	Monthly	100%	Electronic, paper	2 years after the end of the crediting period	To be estimated for each type of fuel indepen-dently	
40	*Heat*	Heating Value of fuel used for drying alternative fuels outside the project site	HV_{FDADO}	TJ or Tcal/unit of fuel	E	Monthly	100%	Electronic, paper	2 years after the end of the crediting period	To be estimated for each type of fuel indepen-dently	

ID number	Data Type	Data Variable	Symbol	Data Unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of Data to be Monitored	How Will the Data be Archived (electronic/paper)	For How Long is the Archived Data Kept?	Comment	Instrument used to record
41	*Emission factor*	Emission factor for the fuel used for drying of alternative fuels outside the project site	EF_{ADO}	T of CO2/TJ	Calculated based on default value	Monthly	100%	Electronic, paper	2 years after the end of the crediting period	To be estimated for each type of fuel indepen-dently	
42	*Quantity*	Power consumption of drying the alternative fuels outside the project site	PD_{ADO}	Kwh	M	Monthly	100%	Electronic, paper	2 years after the end of the crediting period		
43	Emission factor	Emission factor for power generation outside the project site where drying of alternative fuels takes place	EFpO	Ton CO_2 per MWh	C	Calculated and reported yearly	100%	Electronic, paper	2 years after the end of the crediting period	To be calculated from each type of fuel	

Notes:

1. Emission factors to be used to calculate leakage from transportation emissions:

Transportation emissions from trucks*	Truck capacity	To be measured
	Return trip distance	To be measured
	CO_2 emission factor[a]	1097 g/km 3172.31 g/kg
	CH_4 emission factor[a]	0.06 g/km 0.18 g/kg
	N_2O emission factor[a]	0.031 g/km 0.09 g/kg

* These values are illustrative examples and should be replaced by corresponding specific project data, as necessary.

[a] IPCC default values for US heavy diesel vehicles, uncontrolled.

Due to fuel sourcing from various locations even within a single fuel type (e.g. coal from 2 regions), distances for each source should be measured, and any changes due to contract renewal also reflected.

2. If ships are used to deliver fuels, then assume that ship fuel is HFO380 with a heat content of 41.868 GJ/tonne and emission factor of 77.4 kgCO_2/GJ, as per IPPC default values. Ships are collecting another material close by and so fuel is for one-way trip.

3. ID.37-38. This monitoring task tracks whether the project activity may reduce the amount of biomass available to other users groups so that they might shift their productive or other activities in ways that would lead to increased GHG emissions. To demonstrate that there is an abundance of surplus biomass a proposed project activity should demonstrate that: The amount of biomass for which there are no users/off-takers should be 1.5 times the amount required to meet the consumption of all users consuming the same biomass.

4. Power system data and information: If available, data and information on generation, fuel types, fuel consumption, energy content and carbon emission factors from government ministries and agencies should be used. If unavailable, information from neighbouring countries may be used. If the latter is unavailable, international best practice data may be used together with IPCC default calorific values and carbon emission factors.

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

Data	**Uncertainty level of data (High/Medium/Low)**	**Are QA/QC procedures planned for these data?**	**Outline explanation why QA/QC procedures are or are not being planned.**
1-3, 11, 15-16, 18	Low	Yes – According to ISO 9000 or similar quality systems	
20-23, 29	Medium	No	Fraction of biomass that would have been decayed/burnt and/or landfilled will be estimated
5, 10, 12-14. 17, 19, 21-22, 24-28	Low	No	While IPCC fractions are reliable defaults, the project proponent should validate these default values
Other leakage data	Medium	No	An independent expert should validate the data quality.