Draft revision to the approved consolidated methodology ACM0001

"Flaring or use of landfill gas"

I. SOURCE, DEFINITIONS AND APPLICABILITY

Sources

This consolidated baseline and monitoring methodology is based on elements from the following approved baseline and monitoring methodologies:

- AM0002: Greenhouse Gas Emission Reductions through Landfill Gas Capture and Flaring where the Baseline is established by a Public Concession Contract (approved based on proposal NM0004-rev: Salvador da Bahia LFG project, whose project design document and baseline study, monitoring and verification plans were developed by ICF Consulting (version 03, June 2003);
- AM0003: Simplified financial analysis for LFG capture projects (approved based on proposal NM0005: Nova Gerar LFG to energy project, whose project design document and baseline study, monitoring and verification plans were developed by EcoSecurities Ltd. (version 14, July 2003) for the Carbon Finance Unit of the World Bank);
- AM0010: Landfill gas capture and electricity generation projects where LFG capture is not mandated by law (approved based on proposal NM0010-rev: Durban-landfill-gas-to-electricity project, whose project design document and baseline study, monitoring and verification plans were developed by Prototype Carbon Fund of the World Bank (April 2003);
- AM0011: Landfill gas recovery with electricity generation and no capture or destruction of methane in the baseline scenario (approved based on proposal NM0021: Cerupt methodology for LFG recovery, whose project design document and baseline study, monitoring and verification plans were developed by Onyx (July 2003).

The methodology also refers to the latest approved version of the following methodological tools:

- "Tool to determine project emissions from flaring gases containing methane";
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption";
- "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion";
- "Combined tool to identify the baseline scenario and demonstrate additionality";
- "Emissions from solid waste disposal sites";
- "Tool to determine the remaining lifetime of equipment";
- "Tool to determine the baseline efficiency of thermal or electric energy generation systems";
- "Tool to determine the mass flow of a greenhouse gas in a gaseous stream".

For more information regarding the approved methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable", or

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

Definitions

For the purpose of this methodology the following definitions apply:

Available technology. A technology which is installed and commercially operated in the host country[1] and which is also accessible to be implemented in the project situation, taking into account the economic and technical conditions required to make the technology viable.

Best available technology (BAT). The available technology that is the least GHG intensive technology among all the available technologies that can achieve the specified service level. The assessment of carbon intensity takes into account the available technology's design, construction, maintenance and method of operation. In this methodology, the specified level of service relates to the firing of bricks.

Landfill gas (LFG). The gas generated by decomposition of waste in a SWDS. LFG is mainly composed of methane and carbon dioxide.

Normal Temperature and Pressure (NTP). Air at 20°C (293.15 K, 68°F) and 1 atm (101.325 kN/m^2, 14.7 psia, 0 psig, 29.92 in Hg, 760 torr) corresponding to a density of 1.204 kg/m^3 (0.075 pounds per cubic foot).

Solid waste. Material that is unwanted and insoluble (including gases or liquids in cans or containers). Hazardous waste is not included in the definition of solid waste.

Solid waste disposal site (SWDS). Designated areas intended as the final storage place for solid waste.

Applicability

This methodology is applicable to project activities which install a new LFG capture system in a new or existing SWDS, or make an investment to increase the recovery rate at an existing LFG capture system.

In the project activity, the captured LFG is used in any combination of the following ways:

- Flared; and/or
- Used to generate electricity; and/or
- Used to produce thermal energy in a boiler, air heater or kiln (brick firing only);[2] and/or
- Supplied to consumers through a natural gas distribution network.

[1] If relevant data on available technologies in the host country is not available, then data from the region of the host country or the international level can be used for the assessment.

[2] For claiming emission reductions for other thermal energy equipment (including other products in kilns), project participants may submit a revision to this methodology.

This methodology cannot be used in combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln, where the purpose of the CDM project activity is to implement energy efficiency measures at the kiln.

This methodology is not applicable if the management of the SWDS in the project activity is deliberately changed, compared to the situation prior to the implementation of the project activity, to increase methane generation. For example, this applies to the addition of liquids to a SWDS or the pre-treating waste to seed it with bacteria for the purpose of increasing the anaerobic degradation environment of the SWDS.

In the case that a LFG collection system was already installed prior to the implementation of the project activity, the methodology is only applicable if:

(a) Historical data on the amount of LFG collected and flared is available; and

(b) The collected LFG was only vented or flared and not used.

Furthermore, the methodology is only applicable if the implementation of the project activity does not reduce the amount of organic waste that would be recycled in the absence of the project activity.

If during the project activity the project participant wishes to change the use of the captured LFG, for instance from flaring to energy generation, then the latest version of the "Procedures for notifying and requesting approval of changes from the project activity as described in the registered Project Design Document*"* must be applied.

The applicability conditions included in the tools referred to above also apply.

Finally, this methodology is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is partial or total release of the LFG from the SWDS and, in the case that the LFG is used

(a) For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or

(b) For thermal power generation: that thermal power would be generated using fossil fuels in on-site equipment.

II. BASELINE METHODOLOGY

Project Boundary

The project boundary of the project activity shall include the site where the LFG is captured and, as applicable:

- Sites where the LFG is flared or used (e.g. flare, power plant, boiler, air heater, kiln or natural gas distribution network);
- Captive power plant(s) or power generation sources connected to the grid, which are supplying electricity to the project activity; and
- Captive power plant(s) or power generation sources connected to the grid, which are supplying electricity in the baseline that is displaced by electricity generated by captured LFG in the project activity.

100
101 **Table 1: Summary of greenhouse gases and sources included in and**
102 **excluded from the project boundary**

	Source	Gas	Included?	Justification / Explanation
Baseline	Emissions from decomposition of waste at the SWDS site	CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from SWDS. This is conservative.
		CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted since the CO_2 is also released under the project activity
	Emissions from electricity generation	CO_2	Yes	Major emission source if power generation is included in the project activity
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from thermal energy generation	CO_2	Yes	Major emission source if thermal energy generation is included in the project activity
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from the use of natural gas	CO_2	Yes	Excluded for simplification. This is conservative
		CH_4	No	Major emission source if supply of LFG through a natural gas distribution network is included in the project activity
		N_2O	No	Excluded for simplification. This is conservative.
Project Activity	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from electricity consumption due to the project activity	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

Procedure for estimating the end of the remaining lifetime of existing equipment

This procedure applies if LFG is used in equipment that was in operation prior to the implementation of the project activity (e.g. in an existing power plant or boiler).

For each item of equipment which was in operation prior to the implementation of the project activity and in which the captured LFG is used after the implementation of the project activity[3], project participants shall estimate its remaining lifetime by applying the latest version of the "Tool to determine the remaining lifetime of equipment". These items of equipment and their remaining lifetime shall be recorded in the CDM-PDD.

At the end of the remaining lifetime of each item of equipment, the procedure for the selection of the most plausible baseline scenario related to electricity generation and/or thermal energy production shall be updated in order to determine the most plausible baseline fuel that would be used after installation of the new equipment in the absence of the CDM project activity. At this same time, the parameters related to this item of equipment shall also be updated according to the procedures in this methodology.

Procedure for the selection of the most plausible baseline scenario and demonstrate additionality

The latest version of the "Combined tool to identify the baseline scenario and demonstrate additionality" shall be applied to identify the baseline scenario and demonstrate additionality.

Step 1: Identification of alternative scenarios

In applying Step 1 of the tool, baseline alternatives should take into consideration the possible flaring or the use of the LFG to produce electricity and/or heat.

Alternatives for the destruction of LFG in the absence of the project activity , i.e. the scenario relevant for estimating baseline methane emissions, shall include, *inter alia*:

- The project activity (i.e. capture and flaring or use of LFG) implemented without being registered as a CDM project activity;
- Atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns;
- The LFG is partially not generated, as the organic fraction of the solid waste is not disposed in the SWDS but it is recycled.

In addition to the alternative baseline scenarios identified for the destruction of LFG, project participants should also identify alternative scenarios for the use of LFG.

For electricity generation, alternative(s) may include, *inter alia*:

- Electricity generation from LFG undertaken without being registered as CDM project activity;
- Electricity generation in existing or new on-site or off-site fossil fuel fired cogeneration plant(s);
- Electricity generation in existing or new on-site or off-site renewable based cogeneration plant(s);

[3] Depending on the project activity, relevant items of equipment may include power plants, boilers, air heaters or kilns.

- Electricity generation in existing or new on-site or off-site fossil fuel fired captive power plant(s);
- Electricity generation in existing or new on-site or off-site renewable based captive power plant(s);
- Electricity generation in existing and/or new grid-connected power plants.

For thermal energy generation, alternative(s) may include, *inter alia*:

- Heat generation from LFG undertaken without being registered as CDM project activity;
- Heat generation in existing or new on-site or off-site fossil fuel fired cogeneration plant(s);
- Heat generation in existing or new on-site or off-site renewable based cogeneration plant(s);
- Heat generation in existing or new on-site or off-site fossil fuel based boiler(s), air heater(s) or kiln(s);
- Heat generation in existing or new on-site or off-site renewable energy based boiler(s), air heater(s) or kiln(s);
- Any other source, such as district heat; and
- Other heat generation technologies (e.g. heat pumps or solar energy).

For the supply of LFG to a natural gas distribution network, the baseline is assumed to be the supply with natural gas.

Identification of the fuel of the baseline choice of energy source taking into account the national and/or sectoral policies as applicable

Project participants shall demonstrate that the identified baseline fuel used for generation of electric and/or thermal energy is available in abundance in the host country and there is no supply constraint. In case of partial supply constraints (seasonal supply), the project participants shall consider for the period of partial supply among potential alternative fuel(s) the one that results in the lowest baseline emissions.

As a conservative approach, the lowest carbon intensive fuel, such as natural gas, may be used through out all period of the year. Detailed justifications shall be provided and documented in the CDM-PDD for the selected baseline fuel.

Baseline emissions

Baseline emissions are determined according to equation 1 and comprise the following sources:

(A) Methane emissions from the SWDS in the absence of the project activity;

(B) Electricity produced using fossil fuels in the absence of the project activity;

(C) Thermal energy produced using fossil fuels in the absence of the project activity, and

(D) Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{TH,y} + BE_{NG,y} \quad (1)$$

Where:

BE_y	=	Baseline emissions in year y (t CO_2e / yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year y (t CO_2e / yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year y (t CO_2e / yr)
$BE_{TH,y}$	=	Baseline emissions associated with thermal energy production in year y (t CO_2e / yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year y (t CO_2e / yr)

Step (A): Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Baseline emissions of methane from the SWDS are determined based on the amount of methane that is captured and flared or used under the project activity and the amount that would also be captured and flared or used in the baseline (e.g. due to regulations). In addition, two different methane oxidation effects are taken into account:

(a) In the absence of the project, a fraction of the LFG would oxidize in the top layer of the landfill. Under the project activity, this effect is reduced as the LFG is collected through a system of pipes. This effect is also considered in the methodological tool "Emissions from solid waste disposal sites"

(b) The installation of a LFG collection system under the project activity may suction additional air into the SWDS. This air can decrease the amount of methane that is generated compared to the situation in the baseline

Note: The Meth Panel invites stakeholders in particular to provide in their submission information on the magnitude of these two effects

Baseline emissions are calculated as follows:

$$BE_{CH4,y} = \left(\left(1 - OX_{top\_layer} + MR_{air}\right) F_{CH4,used} - F_{CH4,BL,y}\right) GWP_{CH4} \quad (2)$$

Where:

$BE_{CH4,y}$	=	Baseline emissions of LFG from the SWDS in year y (t CO_2e / yr)
OX_{top_layer}		Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
MR_{air}		Reduction in methane generation due to additional air suctioned into the SWDS under the project activity (dimensionless)
$F_{CH4,used,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH_4 / yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared and/or used in the baseline in year y (t CH_4 / yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e / t CH_4)

Step A.1: Ex-post Determination of $F_{CH4,used,y}$

During the crediting period, $F_{CH4,used,y}$ is determined by metering the quantity of captured methane that is actually flared and/or used under the project activity. It is determined as the sum of the quantities of

methane destroyed in the flare(s) and used in power plant(s), boiler(s), air heater(s), kiln(s) and supplied to the natural gas distribution network, as follows:

$$F_{CH4,used,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,TH,y} + F_{CH4,NG,y} \quad \textbf{(3)}$$

Where:

$F_{CH4,used,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4 / yr)

$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4 / yr)

$F_{CH4,EL,y}$ = Amount of methane in the LFG which is used for generation of electricity in year *y* (t CH_4 / yr)

$F_{CH4,TH,y}$ = Amount of methane in the LFG which is used for generation of thermal energy in year *y* (t CH_4 / yr)

$F_{CH4,NG,y}$ = Amount of methane in the LFG which is sent to the natural gas distribution network in year *y* (t CH_4 / yr)

The working hours of the power plant(s), boiler(s), air heater(s) and kiln(s) should be monitored and no emission reduction should be claimed for methane destruction during non-working hours.

$F_{CH4,EL,y}$, $F_{CH4,TH,y}$ and $F_{CH4,NG,y}$ are determined directly using the latest version of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream".

Amount of methane destroyed by flaring ($F_{CH4,flared,y}$)

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare and any methane emissions from the flare, as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}} \quad \textbf{(4)}$$

Where:

$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4 / yr)

$F_{CH4,sent\_flare,y}$ = Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4 / yr)

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year *y* (t CO_2e / yr)

GWP_{CH4} = Global warming potential of CH_4 (t CO_2e / t CH_4)

$F_{CH4,sent\_flare,y}$ is determined directly using the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

$PE_{flare,y}$ shall be determined using the "Tool to determine project emissions from flaring gases containing methane". If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

Step A.2: Ex ante estimation of $F_{CH4,used,y}$

An *ex-ante* estimate of the amount of methane in the LFG which is flared and/or used by the project activity in year *y* ($F_{CH4,used,y}$) is required to estimate the emission reductions of the proposed project activity in the CDM-PDD. It is determined as follows:

$$F_{CH4,used,y} = \eta_{PJ} \cdot BE_{CH4,SWDS,y}/GWP_{CH4} \quad \textbf{(5)}$$

Where:

$F_{CH4,used,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4 / yr)

$BE_{CH4,SWDS,y}$ = Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (t CO_2e / yr)

η_{PJ} The efficiency of the capturing system that will be installed in the project activity

GWP_{CH4} = Global warming potential of CH_4 (t CO_2e / t CH_4)

$BE_{CH4,SWDS,y}$ is determined using the latest version of the methodological tool "Emissions from solid waste disposal sites". The tool estimates methane generation, using adjustment factor (f) to account for LFG in the baseline that would have been captured and destroyed to comply with relevant regulations or contractual requirements, or to address safety and odour concerns.

The following guidance should be taken into account when applying the tool:

- f in the tool shall be assigned a value of 0.
- In the tool, x begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation); and
- Sampling to determine the fractions of different waste types is not necessary because the waste composition can be obtained from previous studies.

Step A.3: Determination of $F_{CH4,BL,y}$

This step provides a procedure to determine the amount of methane that would have been flared and/or used in the baseline due to regulatory and/or contractual requirements, or to address safety and odour concerns. The following cases must be considered:

Case A: No contractual or regulatory requirements and no existing LFG collection system

In the situation that:

(a) No regulations or contractual requirements to collect LFG are in place at the start of the project activity; and

(b) No system to collect LFG was installed or operated prior to the implementation of the project activity.

$$F_{CH4,BL,y} = 0 \quad \textbf{(6)}$$

Case B: Contractual or regulatory requirements exist and no existing LFG collection system

In the situation that:

(a) Regulations or contractual requirements to collect LFG are in place at the start of the project activity; and

(b) No system to collect LFG was installed or operated prior to the implementation of the project activity.

$$F_{CH4,BL,y} = F_{CH4,BL,R,y} \quad \textbf{(7)}$$

$F_{CH4,BL,R,y}$ is determined as follows:

- If contract or regulation requirements specify the amount of methane that must be flared and/or used, then that amount shall be used as $F_{CH4,BL,R,y}$.
- If contract or regulation requirements specify a percentage of the LFG that is required to be flared, the amount shall be calculated as follows:

$$F_{CH4,BL,R,y} = \eta_{reg} \cdot F_{CH4,used,y} \quad \textbf{(8)}$$

Where:

η_{reg} = Percentage of LFG that is required to be flared due to contract or regulation requirements

- If contract or regulation requirements do not specify any amount or percentage of LFG that should be destroyed but require the installation of a capture system, without requiring to flare or use the LFG, then:

$$F_{CH4,BL,R,y} = 0 \quad \textbf{(9)}$$

- If contract or regulation requirements do not specify any amount or percentage of LFG that should be destroyed but require the installation of a system to collect and flare the LFG, then a typical destruction rate of 20% is assumed:

$$F_{CH4,BL,R,y} = 20\% \cdot F_{CH4,used,y} \quad \textbf{(10)}$$

Case C: An existing LFG collection system and no contractual and regulatory requirements

In the situation that

(a) Regulations or contractual requirements to collect LFG are not in place at the start of the project activity; and

(b) A system to collect LFG was installed or operated prior to the implementation of the project activity.

$$F_{CH4,BL,y} = F_{CH4,hist,y} \quad \textbf{(11)}$$

$F_{CH4,hist}$ is determined as follows:

If measurements of the amount of methane that was flared and/or used are available, then these measurements shall be used to estimate $F_{CH4,BL,y}$. In determining $F_{CH4,BL,y}$ it is assumed that the fraction of LFG that was recovered in the year prior to the implementation of the project activity will also recovered under the project activity:

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,used,y} \quad \textbf{(12)}$$

Where:

$F_{CH4,hist,y}$ = Historical amount of methane in the LFG which is collected and destroyed

$F_{CH4,BL,x-1}$ = Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity

$F_{CH4,x-1}$ = Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity

***Estimation of* $F_{CH4,x-1}$**

$F_{CH4,x-1}$ shall be estimated using latest version of the methodological tool "Emissions from solid waste disposal sites". The following guidance should be taken into account when applying the tool:

- In the tool, *x* begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation); and
- Sampling to determine the fractions of different waste types is not necessary because the waste composition can be obtained from previous studies.

Case D: Contractual or regulatory requirements and an existing LFG collection system

In the situation that

(a) Regulations or contractual requirements to collect LFG are in place at the start of the project activity; and

(b) A system to collect LFG was installed or operated prior to the implementation of the project activity.

Then $F_{CH4,BL,y}$ shall be determined based on information in contract of regulation requirements and historical data, as follows:

$$F_{CH4,BL,y} = \max\left\{F_{CH4,BL,R,y};\ F_{CH4,hist,y}\right\} \quad \textbf{(13)}$$

Where:

$F_{CH4,BL,R,y}$ = Regulatory requirements relating to LFG

$F_{CH4,hist,y}$ = Historical amount of methane in the LFG collected and destroyed prior the implementation of the project activity

Step (B): Electricity produced using fossil fuels in the absence of the project activity ($BE_{EC,y}$)

The baseline emissions from consumption of electricity in the absence of the project activity ($BE_{EC,y}$) shall be calculated using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". When applying the tool:

- Electricity sources *k* in the tool corresponds to the sources of electricity generated identified in the selection of the most plausible baseline scenario; and
- $EC_{BL,k,y}$ in the tool is equivalent to the net amount of electricity generated using LFG in year y ($EC_{LFG,y}$).

Step C: Thermal energy produced using fossil fuels in the absence of the project activity ($BE_{TH,y}$)

To determine the amount of thermal energy that would be produced in the absence of the project activity is necessary to have information on the thermal energy generated by boiler heater using LFG as well as the fuel consumption in the kiln. The fuel consumption is determined as the minimum between the fossil fuel used in the kiln that is replaced by LFG and the energy requirements of the BAT kiln.

$$BE_{TH,y} = fd_{CH4} \cdot LFG_{HG,y} \cdot NCV_{LFG,y} \cdot EF_{CO2,BL,HG,y} \cdot \min\left\{1;\ \frac{\eta_{HG,PJ,y}}{\eta_{HG,BL,y}}\right\} \quad \textbf{(14)}$$

Where:

$BE_{TH,y}$	=	Baseline emissions associated with thermal energy production in year y (t CO_2e / yr)
$LFG_{HG,y}$	=	Amount of LFG used for thermal energy generation due to the project activity in year *y* (Nm^3/ yr)
$EF_{CO2,BL,HG,,y}$	=	CO_2 emission factor of the fossil fuel type used for heat generation by the boiler/air heater or kiln in the baseline in year *y* (t CO_2 / TJ)
$\eta_{HG,BL,y}$	=	Efficiency of the heat generation equipment used in the baseline in year y
$\eta_{HG,PJ,y}$	=	Efficiency of the heat generation equipment used in the project activity in year *y*
fd_{CH4}	=	Fraction of methane destroyed when used for thermal energy production
$NCV_{LFG,y}$	=	LFG net calorific value in year y (TJ/Nm^3)

Step C.1: Determination of $\eta_{TH,BL,y}$

To estimate the energy efficiency of a boiler or air heater ($\eta_{TH,BL,y}$) project participants shall apply the "Tool to determine the baseline efficiency of thermal or electric energy generation systems"

Step (D): Baseline emissions associated with natural gas use ($BE_{NG,y}$)

$BE_{NG,y}$ is estimated as follows:

$$BE_{NG,y} = LFG_{NG,y} \cdot NCV_{LFG,y} \cdot EF_{CO2,NG,y} \quad \textbf{(15)}$$

Where:

$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (t CO_2e / yr)
$LFG_{NG,y}$	=	Amount of LFG sent to the natural gas network due to the project activity in year *y* (Nm^3 / yr)
$NCV_{LFG,y}$	=	Average net calorific value of the LFG captured in year y (TJ / Nm^3)
$EF_{CO2,NG,y}$	=	Average CO_2 emission factor of natural gas in the natural gas network in year y (t CO_2 / TJ)

Project emissions

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,j,y} \quad \textbf{(16)}$$

Where:

PE_y = Project emissions in year *y* (t CO_2e / yr)

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year *y* (t CO_2e / yr)

$PE_{FC,j,y}$ = Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (t CO_2e / yr)

The project emissions from consumption of electricity by the project activity ($PE_{EC,y}$) shall be calculated using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". When applying the tool:

- Electricity sources j in the tool corresponds to the sources of electricity consumed due to the project activity. This shall include, where applicable, electricity consumed for the operation of the SWDS, for any processing and upgrading of the LFG, for transportation of the LFG to the flare or other applications (boilers, power generators), for the compression of the LFG into the natural gas network, etc.;
- If in the baseline a proportion of LFG is captured and flared and/or used (FCH4,BL,y> 0), then the electricity consumption in the tool (ECPJ,j,y) should refer to the net quantity of electricity consumption (i.e. the increase due to the project activity). The determination of the amount of electricity consumed in the baseline shall be transparently documented in the CDM-PDD.

The project emissions from fossil fuel combustion for purposes other than electricity generation ($PE_{FC,j,y}$) shall be calculated using the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". When applying the tool:

- Processes j in the tool correspond to the sources of fossil fuel consumption due to the project activity other than for electricity generation or and any on-site transportation by trucks or cars.
- If in the baseline a proportion of LFG is captured and flared and/or used (FCH4,BL,y> 0), then the fossil fuels consumption used in calculation (FCi,j,y) should refer to the net of that consumed in the baseline. A procedure to determine the amount of fossil fuel consumed in the quantity of fossil fuels consumption (i.e. the increase due to the project activity). The determination of the amount of fossil fuels consumed in the baseline shall be transparently documented in the CDM-PDD.

Leakage

No leakage effects need to be accounted under this methodology.

Emission Reduction

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad (17)$$

Where:

ER_y = Emission reductions in year *y* (t CO_2e / yr)

BE_y = Baseline emissions in year *y* (t CO_2e / yr)

PE_y = Project emissions in year *y* (t CO_2 / yr)

Project participants should provide an *ex ante* estimate of emissions reductions in the CDM-PDD. This requires projecting the future GHG emissions of the SWDS for the calculation of baseline emissions.

If the energy component is intended to be implemented after the first year of the project activity, then project participants may exclude the energy component from the ex-ante estimation of baseline emissions. This avoids overestimating ex-ante estimate of emissions if energy generation is not implemented, or a lower capacity is implemented than originally envisaged.

Renewal of the crediting period

Project participants must consider all mandatory applicable legal and regulatory requirements at the beginning of each crediting period and adjust the selection of the most plausible baseline scenario and determination of $F_{CH4,BL,y}$. If relevant, project participants shall explain how changes to regulation were converted to the amount of methane that would have been flared and/or used in the absence of the project activity (determination of $F_{CH4,BL,y}$).

Data and parameters not monitored

In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Data / Parameter:	$OX_{top\ layer}$
Data unit:	Dimensionless
Description:	Fraction of methane that would be oxidized in the top layer of the SWDS in the absence of the project
Source of data:	
Value to be applied:	0.1
Any comment:	In the absence of the project, a fraction of the LFG would oxidize in the top layer of the landfill. Under the project activity, this effect is reduced as the LFG is collected through a system of pipes. This effect is also considered in the methodological tool "Emissions from solid waste disposal sites"

Data / Parameter:	MR_{air}
Data unit:	Dimensionless
Description:	Reduction in methane generation due to additional air suctioned into the SWDS under the project activity
Source of data:	
Value to be applied:	M%
Any comment:	The installation of a LFG collection system under the project activity may have suctioned additional air into the SWDS. This air can decrease the amount of methane that is generated compared to the situation in the baseline.

363

Data/Parameter:	$F_{CH4,BL,R,y}$
Data unit:	--
Description:	Regulatory requirements relating to LFG
Source of data:	Publicly available information of the host country's regulatory requirements relating to LFG
Value to be applied:	
Any comment:	Used to determine $F_{CH4,BL,y}$ and in the procedure to select the most plausible baseline scenario. Must be updated at renewal of the crediting period.

364

Data/Parameter:	$F_{CH4,BL,x-1}$
Data unit:	t CH_4
Description:	Historical amount of LFG captured and destroyed in the year prior to the implementation of the project activity
Source of data:	Information recorded by the SWDS operator
Value to be applied:	
Any comment:	Used to determine $F_{CH4,BL,y}$. Must be updated at renewal of the crediting period.

365

Data/Parameter:	$F_{CH4,x-1}$
Data unit:	t CH_4
Description:	Amount of LFG generated in the SWDS in the year prior to the implementation of the project activity
Source of data:	Estimated using the latest version of the methodological tool "Emissions from solid waste disposal sites"
Value to be applied:	
Any comment:	Used to determine $F_{CH4,BL,y}$. Must be updated at renewal of the crediting period.

366

Date/Parameter:	GWP_{CH4}
Data unit:	t CO_2e / t CH_4
Description:	Global warming potential of CH_4
Source of data:	IPCC
Value to be applied:	21 for the first commitment period. Shall be updated according to any future COP/MOP decisions
Any comment:	

367

Date/Parameter:	η_{reg}
Data unit:	%
Description:	Percentage of LFG that is required to be flared due to contract or regulation requirements

368

Source of data:	Publicly available information of the host country's regulatory requirements relating to LFG
Value to be applied:	
Any comment:	

369

Data/Parameter:	fd_{CH4}
Data unit:	
Description:	Fraction of methane destroyed when used for thermal energy production
Source of data:	
Measurement procedures (if any):	XX for boilers and air heaters YY for brick kilns
Any comment:	

370

Data/Parameter:	η_{PJ}
Data unit:	
Description:	The efficiency of the capturing system that will be installed in the project activity
Source of data:	
Measurement procedures (if any):	
Any comment:	

371

Data/Parameter:	$\eta_{HG,BL,y}$
Data unit:	
Description:	Efficiency of the heat generation equipment used in the baseline in year y
Source of data:	Estimate using the "Tool to determine the baseline efficiency of thermal or electric energy generation systems"
Measurement procedures (if any):	
Any comment:	

372

Data/Parameter:	$\eta_{HG,PJ,y}$
Data unit:	
Description:	Efficiency of the heat generation equipment used in the project activity in year *y*
Source of data:	Manufacturers technical specification
Measurement procedures (if any):	
Any comment:	

373

Data / Parameter:	$EF_{CO2,BL,HG,y}$
Data unit:	t CO_2 / TJ
Description:	CO_2 emission factor of the fossil fuel type used for heat generation by the boiler/air heater or kiln in the baseline in year *y*
Source of data:	
Value to be applied:	For the case of kilns. Lower limit of the 95% confidence interval of the default values provided in table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Any comment:	

III. MONITORING METHODOLOGY

The main variables that are determined based on monitored parameters are:

- Amount of LFG used (FCH4,used,y);
- Amount of LFG flared (FCH4,flared,y);
- Amount of LFG used to generate electricity (FCH4,EL,y);
- Amount of LFG used to produce thermal energy for use in a boiler, air-heater and/or kiln (FCH4,TH,y);
- Amount of LFG sent to the pipeline to the natural gas distribution network ($F_{CH4,NG,y}$).

To determine these variables, the following parameters shall be monitored (as shown in Figure 1):

- Energy consumed by the project activity that is produced using fossil fuels;
- Operating hours of the energy plant(s) boiler(s), air heater(s) or kilns(s) (as relevant).

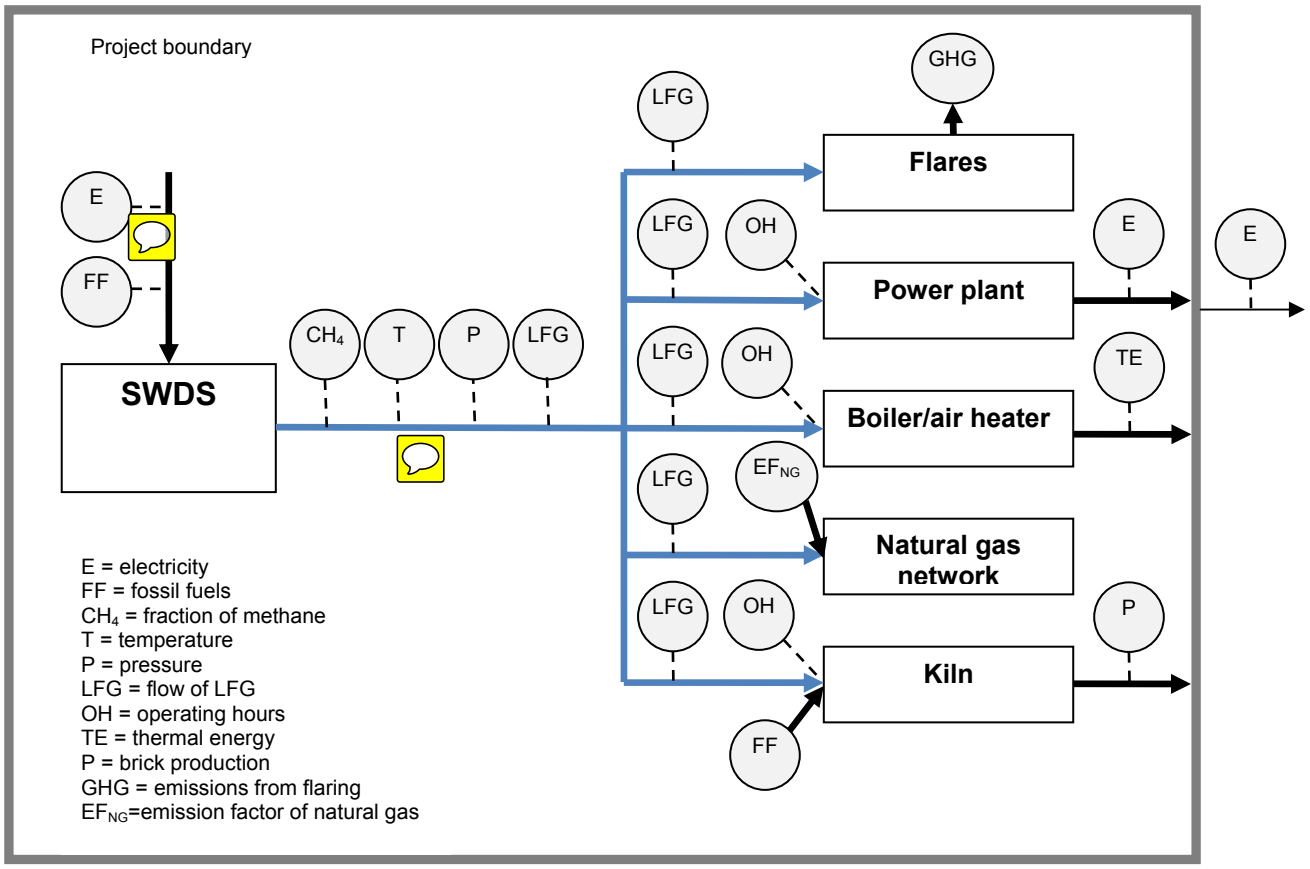

Figure 1: Monitoring Plan

Parameters required in tools referenced in this methodology include.

- The parameters used for determining the project emissions from flaring of the residual gas stream in year *y* should be monitored as per the "Tool to determine project emissions from flaring gases containing methane";
- The quantities of fossil fuels required to operate the LFG project, including the pumping equipment for the collection system and energy required to transport heat, should be monitored as per the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion". In projects where LFG is captured in the baseline to either meet the regulation or for safety reason, then fossil fuel used in the baseline too shall also be recorded;
- The quantity of electricity imported, in the baseline and the project situation, to meet the requirements of the project activity, if any, as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

405 **Data and parameters monitored**

406

Data / Parameter:	$F_{CH4,EL,y}$
Data unit:	(t CH_4 / yr)
Description:	Amount of methane in the LFG which is used for generation of electricity in year *y*
Source of data:	Project participants
Measurement procedures (if any):	Determined directly using the latest version of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream "
Monitoring frequency:	
QA/QC procedures:	Project participants should ensure that the point where the LFG shall ensure the appropriate location of the measurement equipment to ensure they only measure the LFG coming from the project activity
Any comment:	The working hours of the power plant(s) should be monitored and no emission reduction should be claimed for methane destruction during non-working hours

407

Data / Parameter:	$F_{CH4,TH,y}$
Data unit:	(t CH_4 / yr)
Description:	Amount of methane in the LFG which is used for generation of thermal energy in year *y*
Source of data:	Project participants
Measurement procedures (if any):	Determined directly using the latest version of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream "
Monitoring frequency:	
QA/QC procedures:	Project participants should ensure that the point where the LFG shall ensure the appropriate m location of the measurement equipment to ensure they only measure the LFG coming from the project activity
Any comment:	The working hours of the boiler(s), air heater(s) and kiln(s) should be monitored and no emission reduction should be claimed for methane destruction during non-working hours

408

Data / Parameter:	$F_{CH4,NG,y}$
Data unit:	(t CH_4 / yr)
Description:	Amount of methane in the LFG which is sent to the natural gas distribution network in year *y*
Source of data:	Project participants
Measurement procedures (if any):	Determined directly using the latest version of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream "
Monitoring frequency:	
QA/QC procedures:	Project participants should ensure that the point where the LFG shall ensure the appropriate m location of the measurement equipment to ensure they only measure the LFG coming from the project activity
Any comment:	

409

410

Data / Parameter:	$F_{CH4,send\ flare,y}$
Data unit:	(t CH_4 / yr)
Description:	Amount of methane in the LFG which is sent to the flare in year *y*
Source of data:	Project participants
Measurement procedures (if any):	Determined directly using the latest version of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream "
Monitoring frequency:	
QA/QC procedures:	Project participants should ensure that the point where the LFG shall ensure the appropriate m location of the measurement equipment to ensure they only measure the LFG coming from the project activity
Any comment:	

411

Data / Parameter:	$PE_{flare,y}$
Data unit:	(t CO_2e / yr)
Description:	Amount of LFG to be flared in year *y*
Source of data:	Project participants
Measurement procedures (if any):	Determined using the "Tool to determine project emissions from flaring gases containing methane". If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

412

Data / Parameter:	$BE_{CH4,SWDS,y}$
Data unit:	(t CO_2e / yr)
Description:	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y*
Source of data:	Project participants
Measurement procedures (if any):	Determined using the latest version of the methodological tool "Emissions from solid waste disposal sites"
Monitoring frequency:	
QA/QC procedures:	
Any comment:	

413

Data / Parameter:	$NCV_{LFG,y}$
Data unit:	TJ/Nm^3
Description:	LFG net calorific value in year y
Source of data:	The source of data shall be the following, in order of preference: 1. project specific data; 2. country specific data; or
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	NCV for the fossil fuel that would have been used in the baseline thermal energy generation. As per guidance from the Board, IPCC default values shall be used only when country or project specific data are not available or difficult to obtain

414

Data / Parameter:	$LFG_{HG,y}$
Data unit:	Nm^3 / yr
Description:	Amount of LFG used for thermal energy generation due to the project activity in year *y*
Source of data:	Project participants
Measurement procedures (if any):	Measured by a flow meter at NTP for each flare. Data to be aggregated monthly and yearly for each flare.
Monitoring frequency:	Continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions)
QA/QC procedures:	Flow meters shall be subject to a regular maintenance and testing regime to ensure accuracy. Calibration shall be according to manufacturers specifications
Any comment:	

415

Data / Parameter:	$LFG_{NG,y}$
Data unit:	Nm^3 / yr
Description:	Amount of LFG sent to the natural gas network due to the project activity in year *y*
Source of data:	Project participants
Measurement procedures (if any):	Measured by a flow meter at NTP. Data to be aggregated monthly and yearly
Monitoring frequency:	Continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions)
QA/QC procedures:	Flow meters shall be subject to a regular maintenance and testing regime to ensure accuracy. Calibration shall be according to manufacturers specifications
Any comment:	

416

Data / Parameter:	$EF_{CO2,NG,y}$
Data unit:	t CO_2 / TJ
Description:	Average CO_2 emission factor of natural gas in the natural gas network in year y
Source of data:	The source of data shall be the following, in order of preference: 1. project specific data; 2. country specific data; or 3. IPCC default values.
Measurement procedures (if any):	Project participants shall use the latest version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" to calculate the emission factor using project specific data
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	

IV. REFERENCES AND ANY OTHER INFORMATION

Not applicable.

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History of the document

Version	Date	Nature of revision
12.0.0	EB XX, Annex #	• Clarifies that the methodology is applicable to new and existing landfills; • Broadens the applicability by allowing the use of landfill gas in brick kilns and by allowing the claim of certified emission reductions associated with fossil fuel displaced by landfill gas fed into a natural gas network; • Revises the applicability conditions, requiring that: o If an existing landfill gas collection system was in place prior to the implementation of the project activity, then historical information on the amount of landfill gas collected is required and the collected gas should only have been vented or flared but not used; and o The implementation of the project activity does not reduce the amount of organic waste that would be recycled in the absence of the project activity; • Incorporates: o The effect of methane oxidation in the top layer of the solid waste disposal site in the baseline scenario; and o The effect of additional air suctioned into the solid waste disposal site after the implementation of the project activity. • Refers to relevant tools. Due to the overall modification of the document, no highlights of the changes are provided.

11	EB 47, Annex 6 28 May 2009	• Allow only the option of continuous measurement of methane content of the LFG; • Include definition of continuous monitoring system.
10	EB 45, Annex 9 13 February 2009	• Include guidance for air heater efficiency; • Include a clarification that emission reductions can be claimed for generation of thermal energy provided that the LFG displaces use of fossil fuel either in a boiler or in an air heater.
09.1	EB 43, Annex 2 24 October 2008	Editorial changes to reflect that the source of data for the "Regulatory requirements relating to LFG" has been changed. Publicly available information should be used instead of contacting the DNA for collecting the information.
09	EB 41, Annex 4 02 August 2008	Following clarifications have been added: • The measurement of both LFG flow and methane fraction in LFG have to be conducted on the same basis (wet or dry); • Inclusion of cases where periodical measurements are allowed and guidance on performing periodical measurements for monitoring the fraction of methane in the LFG; • The title of the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site" changes to "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".
08.1	EB 39, Paragraph 22 16 May 2008	"Tool to calculate baseline, project and/or leakage emissions from electricity consumption" replaces the withdrawn "Tool to calculate project emissions from electricity consumption".
08	EB 36, Annex 10 30 November 2007	• Clarify the procedure to calculate the Adjustment Factor, where in the baseline the LFG was captured and destroyed/used; • Clarify how to apply the "Tool to determine methane emissions avoided from the dumping waste at a solid waste disposal site" for estimating ex-ante LFG emissions over the crediting period.
07	EB 35, Annex 11 19 October 2007	• To include AM0002, AM0003, AM0010, and AM0011; • Reference to the following tools was added: "Tool to calculate project emissions from electricity consumption", "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion", and "Combined tool to identify the baseline scenario and demonstrate additionality".
06	EB 32, Annex 6 22 June 2007	• Include procedures for estimating emissions reductions from use of captured LFG for energy generation; • Expand the applicability to project activities where the captured LFG is used to supply consumers through a natural gas distribution network.
05	EB 28, Annex 9 15 December 2006	Replace the procedure for estimating flare efficiency with a reference to the Methodological "Tool to determine project emissions from flaring gases containing methane".
04	EB 25, Annex 6 21 July 2006	• Allow the use of one measurement point for LFG captured, if the captured LFG is flared only and not used for energy and/or electricity generation; • Provide a default value for methane destruction flare efficiency (50%) should the methane destruction efficiency not be measured.

430

03	EB 24, Annex 6 12 May 2006	• Reflect that separate monitoring of LFG temperature and pressure is not required if the monitoring equipment used automatically adjusts the volume for these two parameters; • Incorporate the procedures of estimating emissions reductions to take into account situations where project activities may not utilize the captured LFG but require use of fossil fuel or purchased electricity in operating the project activity.
02	EB 21, Annex 9 30 September 2005	Guidance on how to estimate the Adjustment Factor (AF) was provided.
01	EB 15, Annex 1 03 September 2004	Initial adoption.

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