Annex 2

DRAFT - Approved baseline methodology AM00XX

"Consolidated baseline methodology for landfill gas project activities"

Sources

This methodology is based on the following approved proposals for baseline 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 landfill gas 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 landfill gas capture projects (approved based on proposal NM0005: Nova Gerar landfill gas 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
- 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);
- NM0021: Cerupt methodology for landfill gas recovery, whose project design document and baseline study, monitoring and verification plans were developed by Onyx (July 2003).

For more information regarding the proposals and its considerations by the Executive Board please refer to the cases 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

This methodology is applicable to landfill gas capture project activities, where the baseline is the partial or total atmospheric release of the gas and the project activities include situations such as:

a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources[1]; or
c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy from other sources.

This methodology must be used in conjunction with the monitoring methodology AM00XX (Consolidated monitoring methodology for landfill gas project activities).

[1] Although in this case no emission reductions are claimed for displacing or avoiding energy from other sources, all possible financial revenues and/or emission leakages shall be taken into account in all the analyses performed.

Emission Reduction[2]

The greenhouse gas emission reduction achieved by the project activity during a given year "y" (ER_y) is the difference between the amount of methane actually destroyed/combusted during the year ($MDproject_y$) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MDreg^3{}_y$), times the approved Global Warming Potential value for methane (GWP_CH4), plus the quantity of electricity displaced during the year (EG_y) multiplied by the CO_2 emissions intensity of the electricity displaced ($CEFelectricity_y$), plus the quantity of thermal energy displaced during the year (ET_y) multiplied by the CO_2 emissions intensity of the thermal energy displaced ($CEFthermal_y$). Electricity and thermal energy emissions reductions apply to case (c) only.

$$ER_y = (MDproject_y – MDreg_y) * GWP\_CH_4 + EG_y * CEFelectricity_y + ET_y * CEFthermal_y$$

ER_y is measured in tonnes of CO_2 equivalents (tCO_2e). $MDproject_y$ and $MDreg_y$ are measured in tones of methane (tCH_4). The approved Global Warming Potential value for methane (GWP_CH_4) for the first commitment period is 21 tCO_2e/tCH_4. EG_y is measured in megawatt hours (MWh). The CO_2 emissions intensity, $CEFelectricity_y$, is measured in tonnes of CO_2 equivalents per megawatt hour (tCO_2e/MWh) and ET_y is measured in TeraJoules (TJ) and $CEFthermal_y$ is measured in terms of tonnes of CO_2 equivalents per TJ (tCO_2e/TJ).

In the case where the $MDreg_y$ is given/defined as a quantity that quantity will be used.

In cases where either no regulatory or contractual requirements exist at the time of inception of the project or regulatory requirements have not specified either the quantity of MDreg an "Adjustment Factor" (AF)) for determining the baseline shall be used, and at least a minimum default of 20% of $MDproject_y$ shall be adopted.

$$MDreg_y = MDproject_y * AF \text{ (where AF=20\%)}$$

The 'Adjustment Factor' shall be revised at the start of each new crediting period taking into account improvements in the amount of GHG flaring that occurs as part of common industry practice and/or legal requirement at that point in the future.

Ex ante emission reduction estimates are made by projecting the future GHG emissions of the landfill, using a publicly available First Order Decay Model. These estimates are for reference purposes only, since emission reductions will be determined (*ex post*) by metering the actual quantity of methane captured and destroyed once the project activity is operational.

[2] The Executive Board, at its twelfth meeting, requested the secretariat to prepare a technical paper, for consideration by the Panel on Methodologies of the Board, on the impact of oxidation of biogas in the calculation of emission reductions of methane (CH_4) for landfill gas project activities. The Board agreed that the Meth Panel shall prepare a recommendation on this issue to be presented to the Board, for its consideration, at its fifteenth meeting. This methodology might be revised in order to incorporate considerations by the Board on this issue. Any revisions shall not affect CDM project activities already registered using this current version of the methodology.

[3] Reg= regulatory and contractual requirements

The methane destroyed by the project activity ($MDproject_y$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and/or produce thermal energy, if applicable.

$$MDproject_y = MDflared_y + MDelectricity_y + MDthermal_y$$

$$MDflared_y = LFG_y * F\_CH_{4y} * FE * D\_CH_4$$

Where LFG_y is the quantity of landfill gas flared during the year measured in cubic meters (m^3), F_CH_{4y} is the methane fraction of the landfill gas as measured continuously during the year, FE is the flare efficiency (the fraction of the methane destroyed) expressed as a fraction, D_CH_4 is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4).[4]

$$MDelectricity_y = EG_y * HR / EC\_CH_4$$

The quantity of methane destroyed by electricity generation is monitored ($MDelectricity_y$) and confirmed by the amount of electricity generated, EG_y during the year measured in MWh, HR, the heat rate measured in GJ/MWh, and EC_CH_4, the energy content of methane measured in GJ/tCH_4.

$$MDthermal_y = ET_y / HE / EC\_CH_4$$

The quantity of methane destroyed for thermal energy, $MDthermal_y$ is monitored and confirmed by displaced amount of thermal energy, ET_y during the year measured in GJ, HE, heat conversion efficiency and $EC\_CH_{4,}$ the energy content of methane measured in GJ/tCH_4.

Baseline

The baseline is the atmospheric release of the gas and the baseline methodology considers that some of the methane generated by the landfill may be captured and destroyed to comply with regulations or contractual requirements, or to address safety and odour concerns.

In applicability case (c) a baseline methodology for electricity and/or thermal energy displaced shall be provided or an approved one used. If capacity of electricity generated is less than 15MW, and/or thermal energy displaced is less 54 TJ (15GWh) small scale methodologies can be used.

Additionality

Additionality analysis shall involve:

Providing a convincing justification that there is no plausible baseline scenario except the project and the continuation of key present policies and practices. If there is another plausible baseline scenario, this methodology cannot be used for the proposed project activity.

Performing an investment analysis[5] to prove that the project activity would not have been carried out without CDM anywhere. Internal Rate of Return-IRR and Net Present Value-NPV, may be used to

[4] At STP the density of methane is 0.0006498 tCH_4/m^3CH_4.

[5] The analysis must include the incremental investment cost, the operations and maintenance costs, and all other costs of upgrading the baseline scenario to the proposed project activity. The calculation must also include all revenues generated by the project activity, including revenue from the sale of electricity/energy and cost savings

demonstrate that project activities would not be profitable without CERs. Results of investment analysis were also compared with:

- Government bond rates or other appropriate estimates of the cost-of-capital (e.g. commercial lending rates);
- Values for alternative baseline project types;
- Expert views on expected return on investments on comparable project types;
- Other hurdle rates that can be applied for the country or sector, company.

Long Run Marginal Costing- LRMC may be used to compare cost of producing electricity in the baseline and in the project case.

Barrier analysis should demonstrate that barriers/risks considered can be mitigated by the CDM project activity. Some of the possible barriers that may be considered are:

- Investment barrier: The absence of access to capital in undeveloped markets for incremental financing of the proposed project activity means the project would not go ahead without CER revenue;
- Technological barrier: Where technology proposed for the project activity has low market share and involves risks due to the performance and management uncertainty;
- Barrier due to prevailing practice: Prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;
- Other barriers: Without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies.

The additionality analysis should also demonstrate that the project type is not common practice (e.g. occurs in less than 5 percent of similar cases) in the proposed area of implementation, and is not required by recent/pending legislation/regulations.

Leakage

Possible sources of leakage are the emissions resulting from energy other than the methane recovered that is used to pump the landfill gas in the additional collection equipment and to transport heat for the processes where this heat is to be used.

due to avoided electricity/energy purchases, except revenue from the sale of CERs, with a clear choice of project life spans, discount rates, etc.

Approved monitoring methodology AM00XX

"Consolidated monitoring methodology for landfill gas project activities"

Sources

This methodology is based on the following approved proposals for 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 landfill gas project, whose project design document and baseline study, monitoring and verification plans were developed by ICF Consulting (version 03, June 2003);
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For more information regarding the proposals and its considerations by the Executive Board please refer to the cases on http://cdm.unfccc.int/methodologies/approved.

Applicability

This methodology is applicable to landfill gas capture project activities where the baseline is the partial or total atmospheric release of the gas and the project activities include situations such as:
a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources[6]; or
c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy from other sources.

Monitoring Methodology

The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform and the electricity generating/thermal energy unit(s) as shown in Figure 1. The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared and the electricity/thermal energy generated. The main variables that need to be determined are the quantity of methane actually captured $MDproject_y$, quantity of methane flared ($MDflared_y$) and the quantity of methane used to generate electricity ($MDelectricity_y$)/thermal energy ($MDthermal_y$)-determined as follows:

[6] Although in this case no emission reductions are claimed for displacing or avoiding energy from other sources, all possible financial revenues and/or emission leakages shall be taken into account in all the analyses performed.

Methane collected and flared

As shown in Figure 1, the amount of methane actually flared ($MDflared_y$[7]) will be determined by monitoring.

- Amount of landfill gas collected (LFG_y) [m^3 - using a continuous flow meter];
- Percentage of landfill gas that is methane (F_CH_{4y}) [% - using a continuous analyser];
- Flare working hours [hours - using a run time meter].

In addition, the methane content of the flare emissions will be analysed quarterly to determine the flare efficiency (FE), the fraction of the methane destroyed.

Methane collected and used to generate electricity

The amount of methane used to generate electricity shall be monitored ($MDelectricity_y$).

The amount of methane used to generate electricity shall also be confirmed from the amount of electricity generated with the following monitored information:

- The amount of electricity generated (EG_y) [MWh metered];
- The heat rate of the electricity generator (HR) [GJ/MWh, determined through periodic testing];
- The energy content of methane (EC_CH4) [GJ/tCH_4, determined through periodic testing].

Methane collected and used to produce thermal energy

The amount of methane used to produce thermal energy ($MDthermal_y$) shall be monitored.

The amount of methane used to produce thermal energy shall be confirmed from the amount of thermal energy produced with the following monitored information:

- The amount of thermal energy produced (ET_y) [TJ metered];
- The heat conversion efficiency, HE (Fraction or %);
- The energy content of methane (EC_CH4) [GJ/tCH_4].

The monitoring methodology shall provide for changes in regulations and converting those changes to the amount of methane to be destroyed[8] or adopt AF of 20% which ever is greater.

The continuous methane analyser is requested because the methane content of landfill gas captured can vary by more than 20% during a single day due to gas capture network conditions (dilution with air at wellheads, leakage on pipes, etc.).

[7] $MDflared_y$; $MDelectricity_y$; $MDthermal_y$ will be determined using amount of landfill gas delivered [m^3 - using a continuous flow meter]; percentage of landfill gas that is methane (F_CH_{4y}) [% - using a CH_4 analyser] and monitoring running hours [hours - using a run time meter]

[8] PPs have to explain how regulations are translated into amount of gas.

The measurement equipment for gas quality (humidity, particulate, etc.) is sensitive, so a strong QA/QC procedure for the calibration of this equipment is needed.

To estimate leakage, the energy used by the pumping equipment for the collection system needs to be monitored.

Data to be collected or used to monitor emissions from the project activity, and how this data will be archived

ID number	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic : e / paper : p)	For how long is archived data kept?	Comment
1. LFG for $MDproject_y$	Total amount of landfill gas captured	m^3	m and c	continuous	100%	electronic	Duration of crediting period	Measured by a flow meter. Data will be aggregated monthly and yearly.
2. LFG_y for $MDflared_y$	Amount of landfill gas flared	m^3	m and c	continuous	100%	electronic	Duration of crediting period	Measured by a flow meter. Data will be aggregated monthly and yearly.
3. LFG for $MDelectricity_y$	Amount of landfill gas going into electricity generator	m^3	m and c	continuous	100%	electronic	Duration of crediting period	Measured by a flow meter. Data will be aggregated monthly and yearly.
4. EG_y	Amount of electricity generated	MWh	m	continuous	100%	electronic	Duration of crediting period	Measured by a kWh meter. Data will be aggregated monthly and yearly.
5. LFG for $MDthermal_y$	Amount of methane going into thermal generator	m^3	m	continuous	100%	electronic	Duration of crediting period	Measured by a flow meter. Data will be aggregated monthly and yearly.
6. ETy	Amount of thermal energy produced	TJ	m/e	regularly	100%c	electronic	Duration of Crediting Period	Small scale methodologies can apply where relevant.
7. FE	Flare efficiency	%	m and c	Semi-annual, monthly if unstable	n/a	electronic	Duration of crediting period	Methane content of flare exhaust gas.

ID number	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic : e / paper : p)	For how long is archived data kept?	Comment
8. HR	Heat rate of the generator	GJ/MWh	m and c	Semi-annual, monthly if unstable	n/a	electronic	Duration of crediting period	Data will be used to test and, if necessary, correct the generator's name plate heat rate.
9. HE	Heat conversion efficiency	%	m and c	Semi-annual, monthly if unstable	n/a	electronic	Duration of crediting period	Data will be used to test and, if necessary, correct the generator's name plate heat rate.
10. F_CH4y	Methane fraction in the landfill gas	%	m	continuous	100%	electronic	Duration of crediting period	Measured by continuous gas quality analyser.

LFG temperature and pressure, flare temperature, and flare working hours. These variables shall also be monitored here unless the project developer can justify that this information is not needed in order to adequately estimate LFG_y.

Data to be collected or used to monitor leakage, and how this data will be archived

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic: e / paper: p)	For how long is archived data kept?	Comment
3.1	Electricity	Total amount energy used in the project for gas pumping and steam transport (not derived from the gas)	[kWh]	m	continuously	100%	Daily: e Monthly: p	Project lifetime	

Quality control (QC) and quality assurance (QA) procedures to be undertaken for the items monitored. *(see tables above)*

Appropriate quality control and quality assurance procedures are needed for the monitoring equipment and the data collected.

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. LFG_y	Low	yes	Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.
2. EG_y	Low	yes	Electricity meters will be subject to a regular maintenance and testing regime to ensure accuracy. The electricity distribution company will check their readings.
3. ET_y	Low	yes	Thermometers will be subject to a regular maintenance and testing regime to ensure accuracy. The heat distribution company will check their readings.
4. FE	Low	yes	Regular maintenance will ensure optimal operation of flares. Flare efficiency will be checked semi-annually, with monthly checks if the efficiency shows significant deviations from previous values.
5. HR	Low	yes	Regular maintenance will ensure optimal operation of engines and generators. The heat rate will be checked semi-annually, with monthly checks if the heat rate shows significant deviations from previous values.
6. HE	Low	yes	Regular maintenance will ensure optimal operation of engines and generators. The heat rate will be checked semi-annually, with monthly checks if the heat rate shows significant deviations from previous values.
7. F_CH_4y	Low	yes	The gas analyser will be subject to a regular maintenance and testing regime to ensure accuracy.

Miscellaneous Parameters

Factor Used for Converting Methane to Carbon Dioxide Equivalents[1]

Factor used (CO_2e/CH_4)	Period Applicable	Source
21	1996-present	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

[1] This table is updated as reporting guidelines are modified.

Conversion Factors[1]

	Factor	Unit	Period Applicable	Description/Source
Methane Energy Content		GJ/tCH_4		
Methane Density	0.0006498	tonnes CH_4/m^3CH_4 (STP)	default	Density should be corrected for local climate and altitude.

[1] This table is updated as more scientific information becomes available or reporting guidelines are modified.