Draft revision to the approved baseline methodology AM0003

"Simplified financial analysis for landfill gas capture projects"

Source

This methodology is based on the Project Design Document and Baseline Study, Monitoring and Verification Plan developed for the NovaGerar landfill gas to energy project by S.A. Paulista in Nova Iguaçú, Rio de Janeiro, Brazil. These documents were prepared by EcoSecurities Ltd. (version 14, July 2003) for the Carbon Finance Unit of the World Bank. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0005-rev: "Nova Gerar landfill gas to energy project" on http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

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 captured gas is flared; or
- The captured gas is used to generate electricity, but no emission reductions are claimed for displacing or avoiding electricity generation by other sources.

This methodology must be used in conjunction with the monitoring methodology below. It is applicable only where the only plausible outcomes are a business-as-usual scenario (with minor changes and modifications) and the proposed project. In other words, the methodology is inapplicable where a plausible outcome is substantial change in practice or technology different from the proposed technology.

Emission Reduction[1]

The greenhouse gas emission reduction achieved by the project activity (ER_y) during a given year is the difference between the amount of methane actually destroyed ($MDproject_y$) and the amount of methane destroyed in the absence of the project activity ($MDbaseline_y$), times the approved Global Warming Potential value for methane (GWP_CH_4).

$$ER_y = (MDproject_y - MDbaseline_y) \times GWP\_CH_4 \qquad \textbf{(1)}$$

[1] 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 (CH4) 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.

The amount of methane destroyed in the absence of the project activity is the amount of landfill gas that would be flared or otherwise destroyed absent the project activity taking into account the effectiveness of the gas collection systems that would be imposed by regulatory or contractual requirements or similar circumstances at the time of inception of the project[2] (the "Effectiveness Adjustment Factor" (EAF)).

$$MDbaseline_y = MDproject_y \times EAF \quad (2)$$

EAF is defined as the ratio of the destruction efficiency of the collection and destruction system mandated by regulatory or contractual requirement to that of the collection and destruction system in the project activity.
~~The default value for the Effectiveness Adjustment Factor (EAF) is 20%. Deviations from the default value can be proposed and justified based on project-specific considerations such as proposed new laws and regulations or enforcement of existing laws and regulations applicable at the project location.~~
The 'Effectiveness Adjustment Factor' shall be revised at the start of each new crediting period taking into account the amount of GHG flaring that occurs as part of common industry practice at that point in the future.

For the Project Design Document, (*ex ante*) emission reduction estimates are made by projecting the future GHG emissions of the landfill using the US EPA 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.

Based on the above equations, the greenhouse gas emission reduction (ER_y) achieved by the project activity during a given year (y) is equal to the methane destroyed ($MDproject_y$, expressed in tonnes) due to the project activity during that year less the effectiveness adjustment factor (EAF) multiplied by the approved Global Warming Potential value for methane (GWP_CH_4).

$$ER_y = MDproject_y (1 - EAF) \times GWP\_CH_4 \quad (3)$$

ER_y is the greenhouse gas emission reduction measured in tonnes of CO_2 equivalents (tonnes CO_2e). $MDproject_y$ is the methane destroyed by the project activity measured in tonnes of methane. EAF is the effectiveness adjustment factor expressed as a decimal. The default value is 0.20. The approved Global Warming Potential value for methane for the first commitment period is 21 tonnes CO_2e/tonne CH_4. Thus, GWP_CH_4 = 21 until December 31, 2012.

The methane destroyed by the project activity ($MDproject_y$) during a year is determined by monitoring the quantity of methane actually flared and used to generate electricity.

$$MDproject_y = MDflared_y + MDelectricity_y \quad (4)$$

[2] The Executive Board, at its eleventh meeting , requested the Meth Panel to prepare recommendations on the need for ensuring consistency regarding how should changes on regulatory or contractual requirements be considered when establishing baseline scenarios and calculating emission reductions. This methodology maybe be further revised depending on considerations by the Board on this issue. Any revisions shall not affect CDM project activities already registered using this current version of the methodology.

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

$$MDflared_y = LFG_y * w_{CH4,y} * FE * D_{CH4} \quad (5)$$

Where LFG_y is the quantity of landfill gas flared during the year measured in cubic metres (m^3), $w_{CH4,y}$ F_CH4_y is the methane fraction of the landfill gas as measured periodically during the year, FE is the flare efficiency (the fraction of the methane destroyed) expressed as a fraction, D_{CH4} D_CH4 is the methane density expressed in tonnes of methane per cubic metre of methane (tCH_4/m^3CH_4).[3]

$$MDelectricity_y = EG_y * HR / EC\_CH_4 \quad (6)$$

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

Project Boundary

The project boundary is the site of the project activity where the gas is captured and destroyed / used.

Baseline

The baseline 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.

The fraction of the methane captured and destroyed in the baseline is called the 'Effectiveness Adjustment Factor' (EAF). The EAF reflects the effectiveness of the gas collection systems that would be imposed by regulatory or contractual requirements or industry practice at the time of inception of the project and likely changes over the course of the crediting period. The default value for the EAF is 0.20, but the project proponents should demonstrate that there are no regulatory, contractual or other requirements that would require a larger fraction of the methane to be destroyed in the absence of the project. The EAF shall be revised at the start of each new crediting period.

Additionality

The baseline scenario and additionality are determined in a step process.

Step 1. Provide a convincing justification that there is no plausible baseline scenario except the project and the business as usual (BAU) scenarios.[4] If there is another plausible baseline scenario, this methodology can not be used for the proposed project activity.

[3] At STP the density of methane is 0.00064980.000716 tCH_4/m^3CH_4. In the case of the NovaGerar Landfill Project conditions, the density is 0.00067899 tCH_4/m^3CH_4.

[4] BAU is understood to mean the continuation of key present policies and practices. If BAU is conceived of as a set of concentric circles, this implies that no changes are expected to take place at the "core"—the "core" is

Step 2. Calculate a conservative internal rate of return (IRR) for the proposed project activity excluding expected revenue from the sale of CERs. The calculation must include the incremental investment cost, the operations and maintenance costs, and all other costs of upgrading the BAU 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 and cost savings due to avoided electricity purchases, except revenue from the sale of CERs. An IRR is calculated conservatively if the assumptions made tend to raise the IRR of the project scenario instead of lowering it. To ensure this, values that tend to lead to a higher IRR should be used for all assumptions. Conservatism of these assumptions should be ensured by obtaining expert opinions and by the Operational Entity validating the project.

Step 3: Determine whether the project IRR is significantly lower than a conservatively (i.e. rather low) expected and acceptable IRR for an alternative to this project or a comparable project type in the relevant country. The conservatively acceptable IRR can be based on:

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

The choice of conservatively acceptable IRR should be justified.

If the project IRR is clearly and significantly lower than the conservatively acceptable IRR, the project is not an economically attractive course of action. Therefore it can be assumed that the BAU alternative is the most economically attractive course of action and the most likely baseline scenario, and that the project is additional.

Step 4: Analyze the anticipated development of the most likely baseline scenario during the crediting period and provide a summary description.

Leakage

The only source of leakage is the emissions resulting from generating the electricity used to pump the landfill gas in the additional collection equipment.

If sufficient electricity is generated from recovered landfill gas to operate the collection system, there is no leakage. If purchased electricity is used to operate the collection system exceeds the total amount of electricity sold back to the grid, the associated emissions should be calculated in the manner specified for leakage in the approved baseline methodology AM0002 ("Greenhouse Gas Emission Reductions through Landfill Gas Capture and Flaring where the Baseline is established by a Public Concession Contract") with the resulting emissions being deducted from the estimated emission reduction during the year.

constituted by the key present practices and policies. Changes at the "periphery", however, may likely happen over time, as for instance minor regulations and policy adjustments. But such minor changes will not have any impact on the "core" which therefore will remain intact and unchanged.

Draft revision to the approved monitoring methodology AM0003

"Simplified financial analysis for landfill gas capture projects"

Source

This methodology is based on the NovaGerar Landfill gas to energy project by S.A. Paulista in Nova Iguaçú, Rio de Janeiro, Brazil whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by EcoSecurities Ltd. (version 14, July 2003) for the Carbon Finance Unit of the World Bank. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0005-rev: "Nova Gerar landfill gas to energy project" on http://cdm.unfccc.int/methodologies/approved.

Applicability

This monitoring methodology can be used for project activities that reduce greenhouse gas emissions through landfill gas capture and destruction of the methane by flaring and/or generation of electricity. This methodology must be used in conjunction with the baseline methodology above.

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 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 generated. The main variables that need to be determined are the quantity of methane actually flared ($MDflared_y$) and the quantity of methane used to generate electricity ($MDelectricity_y$). They are determined as follows:

Methane collected and flared: As shown in Figure 1, the amount of methane actually flared will be determined by monitoring the:

- amount of landfill gas collected (LFG_y) [m^3 - using a continuous flow meter]
- percentage of landfill gas that is methane ($w_{CH4,y}$ ~~F_CH_{4y}~~) [% - using a continuous analyser **or, alternatively, with periodical measurements, at a 95% confidence level , using calibrated portable gas meters and taking a statistically valid number of samples**]
- flare working hours [hours - using a run time meter]

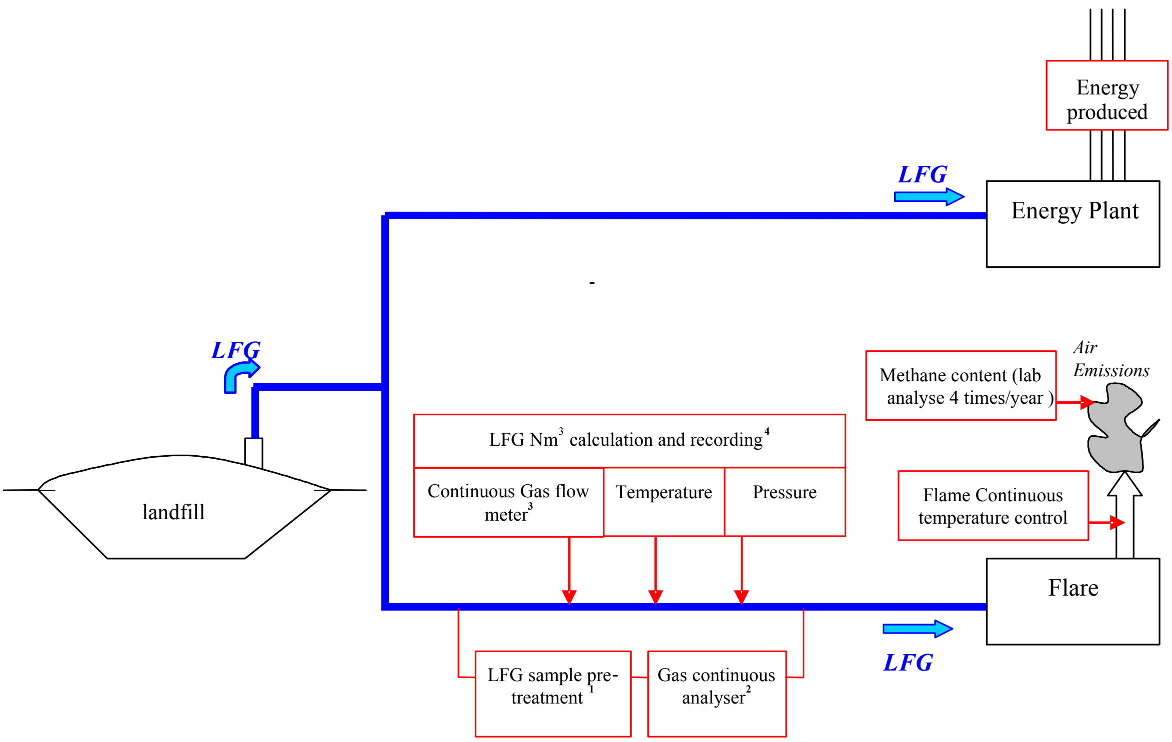
In addition, the methane content of the flare emissions will be analysed quarterly to determine the flare efficiency (FE), **measured as the fraction of time in which the gas is combusted in the flare multiplied by the efficiency of the flaring process,** ~~the fraction of the methane destroyed.~~

- **Temperature (*T*) and pressure (*p*) of the landfill gas are required to determine the density of methane in the landfill gas.**

Methane collected and used to generate electricity[5]: The amount of methane used to generate electricity can be determined 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].

Figure 1
Monitoring Plan



To estimate leakage the electricity used by the pumping equipment for the collection system needs to be metered. Electricity sold to the grid should be deducted from the electricity purchased prior to calculating any leakage.

This monitoring methodology provides for direct and continuous measurement of the actual quantity of landfill gas flared and of the methane content of the landfill gas flared using a continuous flow meter and a continuous methane analyser. The continuous methane analyser is important 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.).

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[5] The Executive Board may revise this methodology based on further recommendations of the Meth Panel to reflect more accuracy in metering the methane destruction by electricity generation. Any revisions shall not affect CDM project activities already registered using this current version of the methodology.

The monitoring methodology is commonly used on landfills with gas to energy plant where it is necessary to have a strict control of the fuel for the energy plant. 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.

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

ID	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_y	Amount of landfill gas to flares	m^3	m	Continuous	100%	electronic	Duration of crediting period	Measured by a flow meter. Data will be aggregated monthly and yearly.
2. 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
3. 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
4. FE	Flare efficiency	%	m and c	Semi-annual, monthly if unstable	n/a	electronic	Duration of crediting period	Methane content of flare exhaust gas
5. $w_{CH4,y}$	Methane fraction in the landfill gas	%	m and c	Continuous	100%	electronic	Duration of crediting period	Measured by continuous gas quality analyzer
6.	Annual Carbon Dioxide Equivalent Avoided	%	e	Every 7 years	A minimum of 10 control sites	electronic	Duration of crediting period	
7. T	Temperature of the landfill gas	°C	m	continuously / periodically	100%	electronic	During the crediting period and two years after	Measured to determine the density of methane DCH4.
8. p	Pressure of the landfill gas	Pa	m	continuously / periodically	100%	electronic	During the crediting period and two years after	Measured to determine the density of methane DCH4.

ID	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
10.*	CO2 emission intensity of the electricity	t CO2 / MWh	c	annually	100%	electronic	During the crediting period and two years after	Required to determine CO2 emissions from use of electricity or other energy carriers to operate the project activity
11.	Regulatory requirements relating to landfill gas projects	Test	n/a	annually	100%	electronic	During the crediting period and two years after	Required for any changes to the adjustment factor (AF) or directly MDreg,y

The approved monitoring methodology AM0002 (Greenhouse Gas Emission Reductions through Landfill Gas Capture and Flaring where the Baseline is established by a Public Concession Contract) also required monitoring of: the 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	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 electricity used for gas pumping	[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. Their readings will be checked by the electricity distribution company.
3. 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.
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. $w_{CH4,y}$ ~~F_CH4y~~	Low	Yes	The gas analyzer 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	At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 tCH_4/m^3CH_4	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