CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

Title: The Colomba-Guabal Landfill Gas Project
Version: 07
Date: 29/04/2012

A.2. Description of the project activity:

The purpose of this project activity is to efficiently capture the landfill gas (LFG) emitted by the Colomba-Guabal Landfill (hereafter referred as "Landfill") located in the rural area of the Municipality of Yotocó in Cali, Colombia and to destroy methane gas, which is a harmful greenhouse gas (GHG) contained in the LFG with a global warming potential (GWP) of 21, that has an adverse impact on the environment.

Interaseo del Valle S.A. E.S.P. ("Interaseo") is the owner and operator of the site. This landfill started operations in June 25th, 2008 and it is expected to have an operational life of 31.2 years. The Municipal Company EMSIRVA collects the waste and takes it to a "transfer station", from there on Interaseo picks up the waste and deposits it in the Landfill. Interaseo received a concession from the Municipality for the operation of the Landfill for a total period of 20 years starting from June 2008.

Interaseo as being the owner of the LFG opened in October 2009 a public tender for the development of a CDM project in the Yotocó-Guabal Landfill. Green Gas participated and won the tender on December 4th 2009 to develop a CDM project with 3 crediting periods. The contract between Green Gas Yotocó SAS and Interaseo was signed on June 25th 2010.

The landfill site has an active area of 63.7 ha from which 20 ha are expected to receive waste. Per day this landfill receives an average of 1,800 tons and has the capacity to receive up to 2,000 t/d of waste coming from the following Muncipalities: Yotoco, Santiago de Cali, Yumbo, Candelaria, Jamundí, Florida, La Cumbre, Dagua, Caloto, Padilla, Villarica, and Corinto. Approximately 230 trucks arrive to the landfill during its 24 hours of operation; Interaseo estimates to receive a yearly average waste input of 625,000 tons. From the beginning of the landfill operation until the end of July 2010 an accumulated amount of 1,294,743 tons have been deposited.

The areas designated for the disposal of solid waste have a HDPE geomembrane (1.5 mm thickness) bottom layer and have a synthetic daily cover to protect the waste from rain and to avoid the presence of birds, at the bottom of each section a series of pipelines are placed in a way of fish bones with the intention of capturing the generated leachate; these transport the leachate out of the landfill into the Leachate Water Treatment Plant ("LWTP"). The LWTP started its operation in June 2010 and has a flow capacity of 16 (l/s) if necessary, at the moment Interaseo expects to treat a flow of 8 (l/s). The leachate starts its treatment in an anaerobic pool, afterwards goes through a physical-chemical treatment, through anaerobic filters and reactors, aeration tanks, aerobic filters and finally gets in contacts with Chlorine for final disinfection. All the sludge produced is conducted to some anaerobic digesters and then to a press conveyor belt to extract the extra humidity from them, the dry sludge is brought to the landfill. At the moment there are 4 leachate collection pools; once the plant is fully operational, one of these pools (next to Zone A) will be dried out and waste will be deposited in this area too.

Figure A.2.1: View of the Zone A, Colomba-El Guabal Landfill

The final cover of the landfill will be done with 50 centimeters of the natural soil typical from that area, which is clay soil, then the HDPE geomembrane of 1.5 mm, then some soil again, and finally black earth with the purpose of planting grass.

Without the proposed project activity, the LFG would only be collected by the wells and released into the atmosphere. This scenario is consistent with the identified baseline scenario of ACM0001 version 11. Therefore, the business-as-usual scenario would be the continuation of inefficient LFG treatment. As such, the majority of the LFG from the site would still be emitted to the atmosphere and conditions would remain poor in terms of the local environment taking into account the odor and the risk of explosions.

The project activity will be divided into 2 main phases, only flaring will be considered as phase 1 and electricity generation including flaring as phase 2; the high efficiency flares will be kept on site to be operative in occasions where the installed gensets are not operational or are undergoing maintenance. Phase 2 is estimated to start only a year after phase 1 in order to determine the quality and quantity of the gas. If during the first year of operation the quality and quantity of the landfill gas does not satisfy the requirements for operating a power plant, the start date of electricity generation will be postponed until the conditions (gas quality and quantity meets the requirements of the gensets. During total project lifetime, 21 years, Green Gas plans to implement an increasing installed capacity until reaching to approximately 11 MW.

Apart from the collection of LFG required by the environmental license of the landfill, there is no legislation requiring the efficient destruction of LFG from landfill sites in Colombia and the government has no plans to introduce such regulations in the future. According to the national regulations of Colombia, no additional environmental impact has to be carried out for the proposed project activity since these types of projects are already included and addressed properly in the EIA of the landfill itself.

Baseline Scenario

The baseline scenario is arrived at after considering;

- Alternatives for the disposal/treatment of the waste in the absence of the project activity.
- Different technologies prevalent or planned in the region for heat and power generation.

The current situation before the project implementation is the atmospheric release of landfill gas generated at the landfill site with high content of methane without any treatment or control. The situation before project implementation coincides with the baseline scenario, with no active landfill gas capture and destruction. The National Regulation of the Drinking Water Sector and Basic Sanitation (RAS = Reglamento Técnico para el Sector de Agua Potable y Saneamiento Básico) Title F requires simple passive flaring of the landfill gas but it does not define the degree of gas that should be flared nor elaborates on the technology that should be used. On the other hand, the Environmental License for this project mandates for the landfill gas to be flared through the application of a Clean Development Mechanism project implementation.

How the proposed Project Activity reduces GHG emissions

Methane is a strong greenhouse gas, thus the current release of landfill gas contributes to global climate change. It also implies a potential fire and explosion risk as well as bad odors. Moreover, landfill gas contains trace amounts of volatile organic compounds, which are air pollutants. The capture and flaring of landfill gas would greatly reduce all these risks and thereby contribute to reduce GHG emissions by replacing the former system through an active methane collection and flaring system. The project developer anticipates reducing greenhouse gas emission in two different ways. Firstly by destroying the methane contained in landfill gas by flaring in one or more high efficiency flares. Secondly, by producing electricity through the combustion of landfill gas, and the emission reduction being determined by the emission factor of the interconnected power grid where the landfill is located.
In the project scenario most of the LFG released is captured and burnt, thus considerably reducing methane emissions.

Sustainable Development

Besides Climate Change mitigation, the project would have important local environmental benefits. All the landfill gas is currently released into the atmosphere without any treatment. This implies a potential fire and explosion risk as well as bad odors. The capture and combustion of LFG through high efficiency flare and electricity generator would greatly reduce these risks and thereby contribute to sustainable development.

The project will capture the already conducted gas and destroy the gas generated by the landfill improving the quality of the environment, locally and globally. This project will contribute not only with the quality of the environment but will also diminish all the bad odors that are generated by the landfill gas which is, under the current situation, vented.

The project will create employment and develop local technical expertise; local material suppliers will be required throughout the lifetime of the project. All this is consistent with the national sustainable development criteria identified by the Colombian DNA according to the Resolution # 0551 from 19/03/2009 which elaborates on the requirements and criteria for the approval of Clean Development Mechanism projects in Colombia.

To summarize the benefits mentioned above, this CDM project activity would clearly lead to an improvement of economic and social conditions in Cali, Colombia. It would also encourage the development of alternative and sustainable energy sources. Taking these social, economic, environmental and technological benefits into account, the project participants involved in this project are convinced of the positive and long-term contribution of the CDM to sustainable development in Cali and, more widely, in Colombia.

A.3. Project participants:

Please list project participants and Party(ies) involved and provide contact information in Annex I. Information shall be in indicated using the following tabular format.		
Name of Party involved (*) (host) indicates a Host Party)	**Private and or public entity(ies) project participant (*) (as applicable)**	**Kindly indicate if the Party involved wishes to be considered as project participant (yes/no)**
Colombia (host)	Green Gas Yotoco SAS (private entity)	No
United Kingdom of Great Britain and Northern Ireland	Green Gas International B.V. (private entity)	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		
Note: *When the PDD is filled in support of a proposed new methodology (form CDM-NM),* at least the Host Party(ies) and any known project participant (e.g. those proposing a new methodology) shall be identified.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Colombia

A.4.1.2. Region/State/Province etc.:

Valle del Cauca, Cali

A.4.1.3. City/Town/Community etc.:

Yotocó

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

The landfill is located in the rural area of the Municipality of Yotocó, in Cali, at 32.5 km from the round point of Sameco, at 0.5 km after the pay booth of Mediacanoa in the road from Cali to Buga. The geographical coordinates of the landfill site 03°46'12" N and 76°25'05" W (3.77°; -76.4180°). The landfill is located approximately at 950 m. asl.

Figure A.4.1.1: Map of Colombia

Figure A.4.1.2: Map of the Cauca Valley, Colombia

Figure A.4.1.3: Colomba-Guabal Landfill location & close by Municipalities

A.4.2. Category(ies) of project activity:

According to the "Sectoral Scope" Classification, the project category is:
Sectoral Scope 13: Waste handling and disposal

A.4.3. Technology to be employed by the project activity:

The degasification system for this project will start by being built in Zone A of the landfill which is already completed and not operational anymore.

Purpose of the Project activity

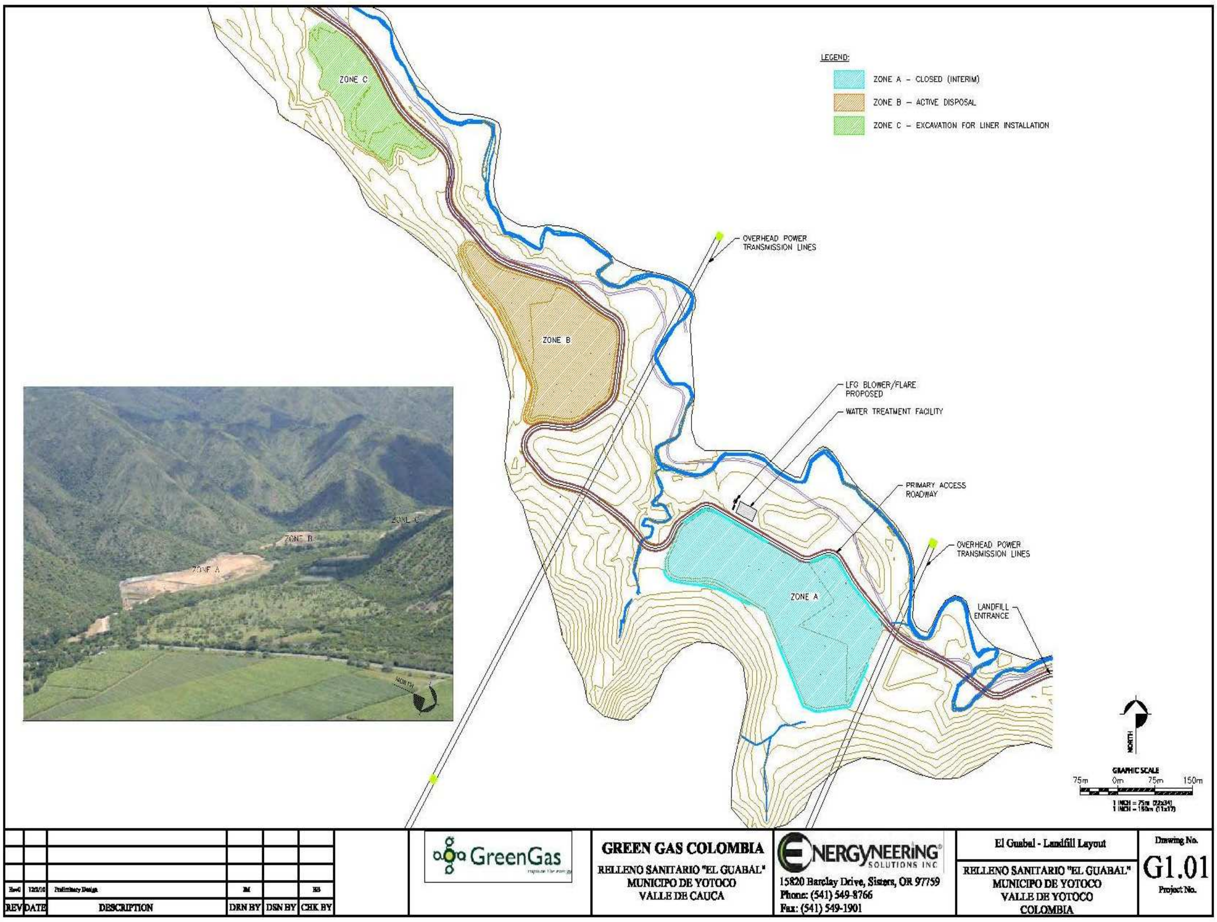
The objective of the project is to effectively capture landfill gas (LFG) and initially used for flaring, phase 1 of the project. Once LFG capture has been established, and the volume of LFG captured is known, phase 2 will start where the collected landfill gas may be used as fuel for electricity generation. The

feasibility of electricity generation will be revisited once the project is fully operational. The principal components of landfill gas are methane (CH_4) and Carbon dioxide (CO_2), both of which are green house gases listed as such in the Kyoto Protocol. Flaring involves methane destruction leading to GHG emission reductions.

Scenario existing prior to the start of the project activity

Current practice in the country is the uncontrolled release of landfill gas. At the Colomba-Guabal Landfill project will have 3 different zones with waste: zone A, B, C. Zone A is the first zone of the landfill that started operation, at the moment it is already closed because it already reached the desired height, 30 meters of waste height; zone A is sub-divided into 4 sections: A1, A2, A3, A4. At the present time, zone B is in operation, once this one has reached its capacity zone C will start functioning. Once the 30 meters height has been reached in all the zones, the waste disposal activities will continue in an area located in front of Zone A in between the slopes of the mountains surrounding the landfill. Interaseo as an operator of the landfill has installed some passive venting wells to conduct the LFG out of the landfill; the wells are constructed with PVC perforated pipeline with a 6’’ diameter surrounded by stones and by a mesh. These are built from the bottom of the landfill and extend until the highest point of the landfill body. In Zone A, the venting wells are placed every 50 meters and in Zone B and the future Zone C, wells will be placed every 25 meters.

Figure A.4.3.1: Map of the Landfill (including zones A, B and C)



Activities/measures implemented within the project activity

In order to maximize LFG recovery rates and thus GHG emission reduction, an active LFG collection system will need to be installed. The capturing system will consist of utilizing the existing passive wells built by Interaseo, cover and seal them in a way that any gas leakage can be avoid, the captured gas will then be conducted to enclosed flares with the help of a blower station which will create the sufficient negative pressure to ensure the gas conduction.

Interaseo as being the landfill operator has built wells, all over Zone A with the intention of venting the generated LFG, these wells are located every 50 meters; Green Gas will utilize these wells for the active collection of the LFG. Each well is constructed from the bottom of the landfill with a perforated PVC pipeline with diameter 6 inches surrounded by gravel and by a metal mesh; the total diameter of each passive well should be approximately 1 meter as per what is described in the *Technical Regulation for Potable Water and Basic Sanitation RAS 2000, Title F.6: Landfill*[1].

During the project activity, the wells will be closed with HDPE well-heads to avoid significant escape of methane. Each one of these well-heads comes with a flexible pipeline, 4 inches of diameter, and with a closing valve to have a better control of the system, by means of a reduction this pipeline will be connected to a secondary HDPE pipeline with a diameter of 6 inches and then through another reduction will be connected to the primary HDPE pipeline with a diameter of 12 inches.

The distribution of both types of pipelines was made in a way that a slope of 5% to avoid the clogging from the condensate will be ensured. The secondary pipelines are considered as collection pipelines, since they will collect the LFG from the wells and transport it into the primary pipelines which will be situated strategically to cover all the perimeter of Zone A. The same planning and engineering will be applied to the other zones.

Figure A.4.3.2: Passive well located at the Zone A, Colomba-Guabal Landfill

[1] http://www.scribd.com/doc/15392960/RAS-2000-titulo-f

The project activity will be first limited to the destruction of the collected LFG through high efficiency flares within phase 1, however as described in Section A.2, the possibility of generating electricity and delivering it to the local grid is considered as a second stage of the project (phase 2). Within the first year of operating phase 1, the gas quality and quantity will be monitored. If the gas quantity and gas quality meets the technical requirements and the generation of electricity is economically viable, the first gensets should be installed in the second year of the project activity. Furthermore since the commissioning of the gensets, the LFG will be fed into the gensets. The high efficiency flares will be retained in operating order for the combustion of the LFG in occasions where the gensets are not operational or in maintenance or in case the LFG flow overcomes the capacity of the gensets.

In case the gas has a high content of Sulphur, before entering to the gensets, the gas will be cleaned. The gensets will be containerised units, allowing the addition of further capacity in the event that sufficient methane is available, but also in the removal capacity to another project in the event that insufficient methane is available.

In order to estimate ex-ante the emission reductions resulting from methane destruction (table A.4.3.1 & table A.4.3.2) and energy displacement (table A.4.3.3), following assumptions were taken into consideration:

Table A.4.3.1: Technical Data of the Flaring Systems:

	Flare 1	**Flare 2**
Manufacturer:	John Zink	Hofstetter
Status	Purchased & installed	Not yet purchased
Flare capacity	2700 SCFM[2]	3000 Nm3/h
Flaring efficiency	98% minimum	99%
Methane content	50%	50%
Operation Temperature	760 °C – 871°C (1400°F – 1600°F)	1000°C – 1200°C
Blowers	2 with 2700 SCFM each	2 with a particular range of 1500 - 3000 Nm3/h each
Electricity connection	480 V, 3 phases, 60 Hz	480 V, 3 phases, 60 Hz
Operation hours	7884 h/year	7884 h/year

Table A.4.3.2: Measuring Equipment of the flaring systems

	Flare 1		**Flare 2[1]**	
Flare type	ZTOP	**Details Equipment**	HOFGAS	**Details Equipment**
LFG flow	Thermal Flow Meter Calibrated at	Continuous monitoring, records every 2 minutes	Flow meter + Flow Corrector Differential pressure	Continuous monitoring, records every minute

[2] SCFM = Standard Cubic Feet per minute

[1] The measuring equipment for Flare 2 is based on the quotation from Hofstetter Flare and other projects where Hofstetter Flaring equipment has been used. All the mentioned information for this flare is assumed since no purchase agreement has been signed for buying this flare; therefore some of the above mentioned specifications could vary.

	Normal conditions		measures flow and with the pressure (manometer) and temperature readings (thermometer) the flow corrector calculates the Normalized flow.	
Raw gas analyzer (CH_4, CO_2, O_2)	FAU (Field Analytical Unit) integral system of Landtec AEMS (Automatic Extraction Monitoring System)	Continuous monitoring, records every 2 minutes	NUK Gas Analyzer	Continuous monitoring, records every minute
Flue gas analyzer (CH_4, O2)	FEA (Flare Emissions Analyzer) integral system of Landtec AEMS	Continuous monitoring, records every 2 minutes	NUK gas analyzer	Continuous monitoring, records every minute
Raw gas temperature	Thermometer integral in the FAU, Landtec AEMS	Thermometer after the blowers, continuous monitoring, records every 2 minutes	Thermometer	Temperature measured within the flow corrector, continuously monitored, records every minute
Flue gas temperature	Thermocouple	located above 70 - 80% of the stack height	Thermocouple	located at 70 - 80% of the stack height
Raw gas pressure	Manometer integral to the FAU, Landtec AEMS	Pressure measured after the blowers, continuous monitoring, records every 2 minutes	Manometer	Pressure measured within the flow corrector, continuously monitored, records every minute

Table A.4.3.3: Technical data of the scheduled gensets

Manufacturer:	CATERPILLAR
Generator power	1,600 kW
Engine efficiency	41.3 %
Methane content	50%
Consumption of LFG @ 50% CH_4	775 Nm³/h
Scheduled amount of gensets	7
Genset operation hours per year	7500 h/year
Total installed capacity	11,200 kW

The first high efficiency flare will be commissioned in an area in front of the Zone A, close to the Leachate Water Treatment Plant (LWTP) (please see Figure A.4.3.3 below), crossing the road where the delivery trucks pass in a daily basis; therefore the pipeline which conducts the LFG from the Zones A and B to the high efficiency flare has to be reinforced by a concrete pipeline. The location of the second high efficiency flare will be set at a later stage of the project activity.

Figure A.4.3.3: Leachate Water Treatment Plant at the Colomba-El Guabal Landfill

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

The total emission reductions for this project activity are calculated for the first crediting period, of 7 years.

Table A.4.4.1: Estimation of emission reductions

Year	Annual estimation of emission reductions in
2012 (1st February - 31st December)	217,040
2013	263,331
2014	286,034
2015	307,766
2016	326,383

2017	341,632
2018	349,507
2019 (1st January - 31st January)	29,116
Total estimated reductions in tonnes of CO_2 e	**2,120,809**
Total number of crediting years	**7**
Annual average over the crediting period of estimated reductions in tonnes of CO_2e	**302,973**

A.4.5. Public funding of the project activity:

The project activity will not receive any public funding whatsoever for the development of the project.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

The baseline and monitoring methodology to be applied for the proposed project activity is approved consolidated baseline methodology ACM0001, version 11 from the EB 47 *"Consolidated baseline and monitoring methodology for landfill gas project activities"*.

The methodology also refers to the following tools:

- "Tool for the demonstration and assessment of additionality" - version 05.2, EB39, Annex 10
- "Tool to determine project emissions from flaring gases containing methane" EB28 Annex 13;
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" - version 01 EB39 Annex 7;
- "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion"- version 02 EB41Annex 11;
- "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" - version 05.1.0 EB61 Annex 10;
- "Tool to calculate the emission factor for an electricity system" - version 02.2.0 EB61 Annex 12;

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The selected methodology ACM0001, version 11, specifies to be applicable for landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:

a) The captured gas is flared; and/or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy)
c) The captured gas is used to supply consumers through natural gas distribution network.

The proposed project activity corresponds to alternative a) and b). Captured methane would be flared at its first stage; later on, during a second stage of the project, if it is economically and technically feasible the captured methane will be used to produce energy and any remaining gas would be flared.

a) Gas is captured and flared
b) Gas is used to produce energy

The baseline scenario is the complete atmospheric release of the gas; the gas is collected by means of the passive wells and vented into the atmosphere. No passive or active flaring is conceived without the implementation of the project activity.

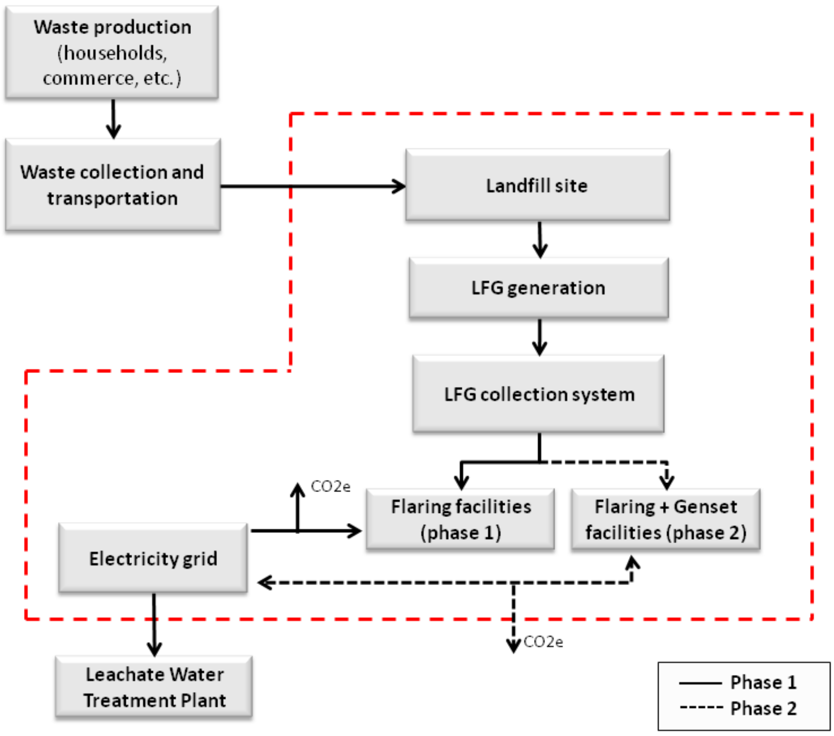
B.3. Description of the sources and gases included in the project boundary:

As per the approved methodology ACM0001, the project boundary is the site of the project activity where the gas is captured and destroyed/used.

ACM0001, Version 11 states: *"If the electricity for the project activity is sourced from the grid or electricity generated by the LFG capture would have been generated by power generation sources connected to the grid, the project boundary shall include all the power generation sources connected to the grid to which the project activity is connected."*

The initial project activity would comprise LFG capture and its flaring. Once the project is operational, Project proponent may decide to generate electricity using LFG, subject to additional authorization. In all cases project boundary includes the landfill site as well as the interconnected power grid.

Figure B.3.1: Project Boundary



The following project activities and emission sources are considered within the project boundaries.

Table B.3.1: Summary of gases and sources included in the project boundary

	Source	Gas	Included	Justification/Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CH_4	Yes	Uncontrolled release of landfill gas
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO_2 emissions from the decomposition of biomass is not counted as a GHG emission

	Emissions from electricity consumption	CO_2	No	Electricity may be consumed from the grid or generated onsite/offsite in the baseline scenario
		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	No	Not applicable
		CH_4	No	Not applicable
		N_2O	No	Not applicable
Project Activity	On-site fossil fuel consumption due to the project activity other than for electricity generations	CO_2	No	Not applicable
		CH_4	No	Not applicable
		N_2O	No	Not applicable
	Emissions from on-site electricity use	CO_2	Yes	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

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

As described in Section A, the project will involve the following project activities:

The capture and combustion of LFG, thereby converting methane into CO2 and reducing the emissions of greenhouse gases;

The generation and supply of electricity from LFG to the regional grid, causing the displacement of fossil fuels used for electricity generation.

The project will replace the existing system of passive LFG venting at Cali Landfill with an active LFG collection and flaring/utilization system. Passive venting of LFG is common practice at most landfills in Colombia, and the proposed project activity is not an obligation under the current and expected future regulatory framework for the operation of landfills in Colombia (see Section B.5 for additional details).

The required procedure for the selection of the most plausible baseline scenario is given by methodology ACM0001 (v. 11), which describes a series of steps to be undertaken using the latest version of the "Tool for the demonstration and assessment of additionality" (Version 5.2 – EB 39). This process was followed as described below in Section B.5 to identify alternative baseline scenarios and eliminate those which are not credible or plausible given current regulations and economic considerations.

The demonstration of additionality in Section B.5 shows that, taking into account national and/or sectoral policies and circumstances, as well as economic considerations, in the absence of the project the RAS regulation will be applicable and passive venting will continue to be in place.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

The following steps describe the approach used to assess the project's additionality, approach given in methodology ACM0001 / Version 11, and in the "Tool for the demonstration and assessment of additionality" (Version 05.2).

STEP 1: Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a: Define alternatives to the project activity:

As stated in the "Tool for demonstration and assessment of additionality "- Version 05.2, the alternatives to both the landfill gas and the electricity components of the proposed project activity are considered. The identified alternatives are listed below.
Alternatives to the landfill gas component of the project activity:

- *LFG 1: The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity;*
- *LFG 2: Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns.*

In principle, Solid waste could be disposed off in other ways besides landfills, e.g incineration, composting, and conversion to Refuse-derived fuel (RDF), thermo chemical gasification. None of these are realistic alternatives for the project proponents, who have the concession to dispose solid waste at the specific landfill, and there is enough space and capacity to use landfill for many years in the future. Moreover, these alternatives all involve advanced processes for treatment of solid waste; they all require very large investments and high operating costs compared to landfilling[3]. There is only limited experiences with these alternative processes in Industrialised countries (Annex 1), and almost none in developing countries, except for handful of projects being submitted through the CDM.

Therefore, options LFG1 and LFG2 are the only realistic alternatives for the disposal/treatment of the waste.
The project activities also includes possible use of LFG for generating power and feeding to local Grid and/or nearby industry or used onsite, realistic and credible alternative should also be separately determine for power generation in the absence of project activity.
For power generation, the realistic and credible alternative(s) may include, *inter alia*:

P1: Power Generated from landfill gas undertaken without being registered as CDM project activity;
P2: Existing or construction of a new on-site or off-site fossil fuel fired cogeneration plant;

[3] http://www.unep.or.jp/ietc/ESTdir/pub/MSW/sp/sp4/sp4_1.asp

P3: Existing or construction of a new on-site or off-site renewable based cogeneration plant;
P4: Existing or construction of a new on-site or off-site fossil fuel fired captive power plant;
P5: Existing or construction of a new on-site or off-site renewable based captive power plant;
P6: Existing and/or new grid-connected power plants.

As the project activity does not aim at producing heat for nearby industry or on-site use, existing or construction of a co-generation plant is not a part of the baseline scenario. Hence, alternative P2 and P3 are not taken into consideration in the present demonstration of additionality.

There is no existing on-site or off-site renewable based or fossil fuel fired captive power plant nearby the site of the project activity. There is no plan to construct a new on-site or off-site renewable based (other than phase 2 of the proposed project activity) or fossil fuel fired captive power plant as renewable energy sources or fossil fuels are not available near the project site. Apart from this, fossil-fuel based captive power plants have high investment and operational costs, would require to purchase and transport the fuels to the site and a great effort to install the equipment for a plant of this magnitude. As grid connection already exists near the project site so the construction of new on site fossil fuel fired captive power plant is not a plausible option as purchasing electricity from the grid. In addition, renewable energy and fossil fuel-based sources are not considered as alternatives in this case as the project participant's core business and expertise is in LFG destruction and power generation from landfills. Hence, alternative P4 and P5 has not taken into consideration.

Sub-step 1b: Consistency with mandatory laws and regulations

In Colombia, there are no national or regional regulatory requirements to burn landfill gas.
The following regulations are related to the construction and operation of Landfills;

- National Regulation of the Drinking Water Sector and Basic Sanitation, Title F (RAS = Reglamento Técnico para el Sector de Agua Potable y Saneamiento Básico)
- Law 142 of 1994:Law on Public Utilities
- Law 99 of 1993:Creation of the ministry of Environment
- Decree 1713 of 2002 amended by decree 838 of 2005: Regulation on the final disposal of solid waste
- Decree 1220 of 2005 amended by decree 500 of 2006

Still none of these rules establishes the obligation to build a system of forced extraction, transport, use of thermal destruction of the biogas.

Consequently, the Colombian regulation does not impose changing the current practice on-site: venting landfill gas to the atmosphere.
All alternatives above are in compliance with mandatory applicable legal and regulatory requirements.

Step 2: "Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable."

For power generation the following two scenarios remain:

Alternative P1 – Power generated from landfill gas undertaken without being registered as CDM project activity;
Alternative P6 – Existing and/or new grid-connected power plants.

ACM0001 states that the PDD must demonstrate that the identified baseline fuel is available in abundance in the host country and there is no supply constraint.

Electricity in Colombia is available at all times. Colombia is a large coal exporter. A good quality coal is extracted in Colombia and consequently it is largely available. There is no sector-based or national policy in regards to the use of fossil fuel.

With respect to the baseline fuel use, no energy shall be used in the LFG2 as it is the continuation of the business as usual scenario. Also, under P6, there is no project power generation and hence there would be a continued use of the grid based electricity by the potential power consumers.

Thus the options listed above (LFG1 and LFG2; P1 and P6) are the only realistic alternatives to be considered as possible alternative baseline.

STEP 2. Investment analysis

The additionality of the project is going to be established by conducting step 2 (investment analysis). The purpose is to determine whether the proposed project activity is economically or financially less attractive than other alternatives without the CDM revenues. To conduct the investment analysis, the following sub-steps are followed:

Sub-step 2a. Determine appropriate analysis method:

As defined in the "Tool for demonstration and assessment of the additionality", if the alternative generates financial or economic benefits other than CDM related income option II or III of sub-step 2b shall be used. Alternative P1 to the project activity involves generating income from the sale of electricity to the grid. Because the project activity would generate non-CDM income, all alternatives must be evaluated using the investment comparison analysis (Option II) or the project alternative without CDM revenues (Alternative P1) must be evaluated using the benchmark analysis (Option III). Because Alternative LFG1 (flaring only project) generates no revenues, it is less financially attractive than Alternative P1, and additionality cannot be demonstrated using Option II. Therefore, for this evaluation the benchmark analysis (Option III) will be applied.

Sub-step 2b. – Option III. Apply benchmark analysis

Alternative P1 (proposed project without CDM revenues) can be evaluated by applying the benchmark analysis. The likelihood that this project would be developed without CDM revenues, as opposed to the continuation of current activities (passive venting of methane), is evaluated by comparing its project internal rate of return (IRR) with the benchmark of Commercial average lending rates available from the National Bank of Colombia[4].

The analysis is based on the following assumptions:

- The Capital cost (for 21 years): 20,961,029 USD (for 7 power gensets for 11.20 MW of electrical production, civil costs**,** relevant piping, flares, electrical connection costs, etc)
- Total operational and maintenance costs (for 21 years): 107,106,726 USD.
- The electricity generation sale price[5]: 0.083 USD/kWh
- Corporate tax for Colombia: 33%

[4] http://www.banrep.gov.co/series-estadisticas/see_tas_inter5.htm#2010

[5] Please note that this is only an indicative number not an agreement for the purchase of power as such. The applied tariff is stated in the Law 142 from 1994 and from EMCALI Electrical Tariff from July 2010.

The detail economic analysis is shown in the electronic workbook. For the assumptions stated above in the absence of the CDM revenue, the IRR is negative. The break up costs are the following as showed in Table B.5.1.

Table B.5.1: Project Lifetime costs

Project Costs (USD)	Project Lifetime (21 years)
Gas Treatment System	2,791,589
Flaring Facilities	1,320,101
Gensets	12,737,234
Others	4,112,106
Total Capital Expenditures	***20,961,029***
Total Operational Expenditures (O&M, admin, insurance, power costs, etc.)	***107,106,726***
Total investment cost in US $	***128,067,756***

Project IRR (post tax) of the Project, with and without CDM revenues, are shown in Table below. Without CDM revenue, the project IRR (after tax) of the project is negative, which is much lower than the Colombia bank lending rate of 13.25%. Therefore, the project is financially unattractive to the project proponent.

Table B.5.2: Project IRR with and without CDM

	Project IRR benchmark (Colombia Bank Lending Rate = 13.25%)
IRR without CDM	Negative
IRR with CDM	30.1%

The electronic worksheet also includes the sensitivity analysis with respect to the key assumptions, electricity price, O&M cost, and investment requirement. The result of the sensitivity is shown in the table below. For the entire range of assumptions, the IRR remains negative, which means that the project is not profitable without CERs revenue.

Table B.5.3: Project Sensitivities without CERs revenue

After-Tax IRR	Electricity Price $/kWh								
	-20%	-15%	-10%	-5%		+5%	+10%	+15%	+20%
	0.066	0.070	0.074	0.079	0.083	0.087	0.091	0.095	0.099
	Negative returns								

After-Tax IRR	OPEX $/kWh								
	-20%	-15%	-10%	-5%		+5%	+10%	+15%	+20%
	0.024	0.025	0.027	0.028	0.030	0.031	0.033	0.034	0.036
	Negative returns								

After-Tax IRR	Capex $m								
	-20%	-15%	-10%	-5%		+5%	+10%	+15%	+20%
	16.769	17.817	18.865	19.913	20.961	22.009	23.057	24.105	25.153
	Negative returns								

In conclusion the IRR is not substantial enough to warrant investment in this project even with an increase in electricity price or a decrease in investment or operation and management cost. The installation of landfill gas to energy project is therefore not viable without considering carbon finance.

Based on the above information (see Table B.5.2 & B.5.3) the IRR of the project without any carbon revenues is negative and below the benchmark for Colombia 13.25%; therefore the additionality for the project is again proven.

In order to show the chance of IRR reaching the benchmark is little, the analysis of critical assumption is conducted as below.

Table B.5.4 Critical assumption analysis

Parameters	***CAPEX***	***OPEX***	***Electricity price***
Rate to reach the benchmark	***62% reduction would generate an IRR equal to the benchmark***	***44% reduction of the core OPEX would generate an IRR equal to the benchmark***	***26% increase would generate an IRR equal to the benchmark***

1. ***CAPEX:*** The IRR of the project remains below the 13.25% benchmark unless there is more than 62% reduction in total investment. It is highly unlikely that the project will cross the benchmark with such a large reduction in total investment. Therefore, it is impossible to improve the economic attractiveness due to the decrease in total investment.

2. ***OPEX:*** This is very unlikely for the annual O & M costs to have a significant reduction, considering most of the O & M costs are due to gas utilization right, salary and fixation fee. The gas utilisation right is an absolute cost which will be paid to the Landfill owner during the project lifetime, is shown in the OPEX calculation and described by the term “share of gas”. Each year this share of gas is different as defined by contract between the PP and landfill gas owner shown

in the worksheet "Gas Fee" of the Financials. So, the annual O&M cost is unlikely to decrease by as much as 44%.

3. ***Electricity price:*** The electricity tariff will have to increase by 26% to reach the benchmark and make the project financially attractive. However, such an increase in electricity tariff is not likely to happen in Colombia where cheap coal and hydropower is abundant. Historical data for the generation tariffs in Colombia from 2000 until 2010, shown in Table B.5.5. It is very evident from the table displayed below that the electricity generation feed-in tariff has shown minimal variations over the last 10 years, reaching the highest peak price of 31.742 COP/kWh in 2003 and the lowest at 23.567 COP/kWh in 2000. In the year 2010 when the investment decision for this project activity was taken the electricity selling price was even decreased by 12% from 2009. The financial analysis for this project activity has considered an assumption of 0% electricity as a yearly escalation and a feed-in tariff price of 0.083 USD/kWh (155.49 COP/kWh) from EMCali (Municipality Company Cali) for June 2010. Given that at this moment no PPA has been signed, no escalation for the selling price of the electricity can be assumed without having a power purchase agreement in place. The table B.5.5 shows historical values from the Unit of Planning of the Ministry of Energy for all of Colombia. From all the generation companies in the country, the average electricity price variation over the past 10 years is 1.8%.

Table B.5.5. Historical price for generation of electricity:

	Equivalent Real Cost for Energy (CERE)[6] Prices for Generation	
Year	Average COP$/kWh	Yearly variation (%)
2000	23.567	
2001	25.133	6.6
2002	28.192	12.2
2003	31.742	12.6
2004	28.458	-10.3
2005	24.867	-12.6
2006	25.342	1.9
2007	27.750	9.5
2008	28.267	1.9
2009	30.517	8.0
2010	27.050	-11.4
average		1.8

[6] Equivalent Real Cost for Energy (CERE in Spanish as per Costo Equivalente Real Energía) obtained from the Planning Unit of the Ministry of Energy for the price of energy generation http://www.upme.gov.co/generadorconsultas/consulta_ISA.aspx?grupo=G

This further analysis underpins that the proposed project, without CDM revenues, is unlikely to be financially attractive. However, the revenue from the CERs will greatly improve the financial feasibility of the proposed project and reduce the financial risk caused by the economic factors that can influence the IRR.

Furthermore, different Scenarios have been identified and calculated for the financials of the project activity without CDM revenues. Like mentioned above no electricity price escalation has been considered due to the lack of a PPA for selling the generated electricity, nevertheless a yearly cost escalation has been considered as 5%[7] which applies to the core operational costs of the project activity. The following Scenarios have been identified:

Table B.5.6. Scenarios for the Financial Analysis without CDM revenues

	Cost escalation	**Electricity escalation**	**IRR**	**Comments**
Scenario A	0%	0%	11.8% (under the benchmark)	Assuming that 0% cost escalation is not a realistic approach since administration and insurance costs will always have an increase. However, considering this as a project scenario the IRR is still below the benchmark and not financially attractive.
Scenario B	5%	0%	negative	This is the model used for the determination of the additionality and the most likely one considering that no PPA is signed the price of electricity is assumed to remain the same during the project lifetime
Scenario C	5%	1%	negative	Considering that the price of the electricity has a small increase or decrease tendency, including a 1% escalation in the electricity price could be a plausible scenario.
Scenario D	5%	2%	9.5% (under the benchmark)	Taking into consideration an electricity escalation of 2% for every year is not realistic due to the high variability of the electricity prices in Colombia; nevertheless this scenario calculates an IRR lower than the benchmark which makes the project financially not feasible.
Scenario E	5%	3%	16.2%	Referring to the table B.5.5, Considering a 3% of electricity price escalation is not realistic and therefore not feasible.

[7] Based on information from Colombia http://www.tradingeconomics.com/colombia/indicators

Step 4: Common Practice analysis
Step 4 comprises two sub-steps, which are discussed below.

Sub-step 4a: Analyze other activities similar to the proposed project activity:
Provide an analysis of any other activities that are operational and that are similar to the proposed project activity. Projects are considered similar if they are in the same country/region and/or rely on a broadly similar technology, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc. Other CDM project activities (registered project activities and project activities which have been published on the UNFCCC website for global stakeholder consultation as part of the validation process) are not to be included in this analysis. Provide documented evidence and, where relevant, quantitative information. On the basis of that analysis, describe whether and to which extent similar activities have already diffused in the relevant region.

As shown in the table below, there are some other project activities currently operating in Colombia that are similar to the project activity but all are supported through the CDM, which may be disregarded according to the Additionality Tool, version 05.2

Table B.5.7: Landfill gas projects registered or requesting for registration under CDM

Project no.	Project name	LFG energy use	Registration date (until 14/12/2011)
2554	Doña Juana landfill gas-to-energy project	Energy generation	10/09/2009
2794	Bionersis Landfill Project in Pasto, Colombia	Only Flaring	03/11/2009
3332	Bionersis LFG project Colombia 2	Possible energy generation	04/08/2010
3995	El Guacal Landfill Gas Flaring project	Only Flaring	23/02/2010
2183	Curva de Rodas and La Pradera Landfill gas management project	Only Flaring	06/02/2009
3656	Bionersis LFG Projects Colombia 4 (Cucuta and Manizales)	Only Flaring	24/12/2010
3715	Bionersis LFG Projects Colombia 3 (Villavicencio)	Only Flaring	25/12/2010
4424	Pirgua Landfill gas recovery and flaring	Flaring and possible energy generation	27/07/2011
4423	Monteria Landfill gas recovery and flaring	Flaring and possible energy generation	25/08/2011
4324	Montenegro Landfill gas recovery and flaring	Flaring and possible energy generation	02/09/2011

Sub-step 4b: Discuss any similar Options that are occurring: does not apply since no similar project activities exist. There are no other similar projects of gas collection and energy generation neither in the municipality nor in the country, which was implemented without the CDM incentives. Since similar activities cannot be observed, the proposed project activity is additional.

>> **Starting date of the project activity**

After seriously considering the benefits of the CDM in the decision to proceed with the project activity, the company developed continuing and real actions to secure CDM status in parallel to its implementation. In the following table is showed a detailed timeline for the project.

Table B.5.8: Project Key Events Timeline

Date	Key Events	Documents
10/2006	Tender for the Solid Waste Disposal	Base for the Public Tender
	Environmental Impact Assessment (EIA) for the landfill	EIA chapter 1 until 6
09/08/2007	Environmental License	Resolution 0377 from 2007
18/12/2007	Environmental License Amendment	Resolution 0612 from 2007
11/06/2008	Environmental License Amendment	Resolution 0314 from 2008
03/12/2008	Environmental License Amendment	Resolution 0659 from 2008
19/06/2009	Environmental License Amendment	Resolution 0349 from 2009
09/10/2009	Start Tender Process for CDM development	Public Documentation of the tender available[8]
02/11/2009	Preparation of the Landfill gas generation and recovery report for Colomba-Guabal Landfill site by SCS engineers which relates to landfill gas capture and use	Gas prognosis from SCS
04/12/2009	Tender Results: Strategic Partner Selection	Tender Results Communication Letter
25/06/2010	Contract Signature between Green Gas Yotoco & Interaseo for the implementation of CDM	Copy of the contract
13/08/2010	Quotation for flaring system	Price information about the flare
21/09/2010	Notification on prior CDM consideration of the project activity is received by the Colombian DNA	Communication Letter
23/09/2010	Environmental License Amendment	Resolution 0531 from 2010
28/09/2010	Notification on prior CDM consideration of the project activity is received by the CDM Executive Board	Communication Letter
01/12/2010	First PDD draft is prepared	PDD version 01
24/11/2010	Article published on the consideration of the proposed project activity	Copy of the article in the Newspaper “Diario Occidente”
01/12/2010	Local Stakeholders presentation	Minute of the Presentation

[8] http://interaseosaesp.web.officelive.com/default.aspx

03/12/2010	Request for LoA from host country (Colombia)	LoA Letter from May 20th 2011. Registration number 2000 2 42400
07/12/2010	On-site visit by the DOE as part of the Validation procedure	
13/07/2011	Order the John Zink flare	Purchase agreement

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

$$BEy = (MD_{project,,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,BL,y} + ET_{LFG,y} * CEF_{ther,BL,y} \quad (1)$$

Where:

BEy	=	Baseline emissions in year *y* (tCO_2e)
$MD_{project,y}$	=	The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH_4) in project scenario
$MD_{BL,y}$	=	The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tonnes of methane (tCH_4)
GWP_{CH4}	=	Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4
$EL_{LFG,y}$	=	Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year *y*, in Megawatt hours (MWh)
$CEF_{elec,BL,y}$	=	CO2 emissions intensity of the baseline source of electricity displaced, in tCO2e/MWh
$ET_{LFG,y}$	=	The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler/air heater, during the year *y* in TJ
$CEF_{ther,BL,y}$	=	CO2 emissions intensity of the fuel used by boiler/air heater to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO2e/TJ. This is estimated as per equation (10) below

Since the proposed project activity is a landfill gas flaring and electricity generation project, the project activity does not include thermal energy generation. Furthermore within the baseline the electricity was purchased from the grid. Therefore the baseline emissions are calculated with the following simplified formula:

$$BEy = (MD_{project,,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} * EF_{grid,y,} \quad (1')$$

Where:

BEy	=	Baseline emissions in year *y* (tCO_2e)
$MD_{project,y}$	=	The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH_4) in project scenario
$MD_{BL,y}$	=	The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tonnes of methane (tCH_4)
GWP_{CH4}	=	Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4
$EL_{LFG,y}$	=	Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year *y*, in Megawatt hours (MWh)
$EF_{grid,y}$	=	Emission factor for the grid in year *y* (tCO_2/MWh)

1. Methane destroyed by the project activity ($MD_{project,y}$):

$MD_{project,y}$ will be determined ex post by metering the actual quantity of methane captured and destroyed once the project activity is operational. The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring.

a) Ex post:

$$\mathbf{MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} + MD_{PL,y}} \quad \mathbf{(8)}$$

As the proposed project activity does not include thermal energy generation or LFG fed into pipeline, $MD_{project,y}$ can be simplified through following equation:

$$\mathbf{MD_{project,y} = MD_{flared,y} + MD_{electricity,y}} \quad \mathbf{(8')}$$

Where:

$MD_{project,y}$	=	The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH_4) in project scenario
$MD_{flared,y}$	=	Quantity of methane destroyed by flaring during the year (tCH_4)

The quantity of methane destroyed by flaring is calculated using the following equation:

$$\mathbf{MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4})} \quad \mathbf{(9)}$$

Where:

$LFG_{flare,y}$	=	Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m^3) [9]
$w_{CH4,y}$	=	Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3 CH_4/ m^3 LFG)
D_{CH4}	=	Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream during the year in one flare (tCO_2)
GWP_{CH4}	=	Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4

$$\mathbf{MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4}} \quad \mathbf{(10)}$$

Where:

$LFG_{electricity,y}$	=	Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m^3) [10]

[9] $LFG_{flare,y}$ is considered to be equivalent to the variable of $FV_{RG,h}$ (volumetric flow rate of the residual gas) as described in the “Tool to determine project emissions from flaring gases containing methane”.

[10] $LFG_{flare,y}$ is considered to be equivalent to the variable of $FV_{RG,h}$ (volumetric flow rate of the residual gas) as described in the “Tool to determine project emissions from flaring gases containing methane”.

$w_{CH4,y}$ = Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3 CH_4/ m^3 LFG)
D_{CH4} = Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4)

As the sum of quantities fed to the flare and power plant must be compared annually with the total quantity of methane generated in order to adopt the lowest value of $MD_{project,y}$, the following estimation must be carried out:

b) Ex-ante
Ex-ante estimation of the amount of methane which would have been destroyed/combusted during the year is calculated as following:

$$\mathbf{MD_{project,y} = BE_{CH4,\,SWDS,y} / GWP_{CH4}} \quad \textbf{(13)}$$

Where:
$BE_{CH4,\,SWDS,y}$ = Methane generation from the landfill in the absence of the project activity at year y (tCO_2e), calculated as per the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".

The tool estimates methane generation adjusted for, using an adjustment factor (f) to account for any 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. As this is already accounted for in ACM0001 equation 2, "f" in the tool shall be assigned with a value 0.

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j (y-x)} \cdot (1-e^{-k_j})$$

Where:

Table B.6.1: Parameters for the calculation

Parameter	Value	Unit	Description
φ	0.9	-	Model correction factor to account for model uncertainties
f	0	-	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
GWP_{CH4}	21	tCO_2/tCH_4	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
OX	0.1	-	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)

F	0.5	-	Fraction of methane in the SWDS gas
DOC_f	0.5	-	Fraction of degradable organic carbon (DOC) that can decompose
MCF	1	-	Methane correction factor
$W_{j,x}$		t	Total amount of organic waste type *j* prevented from disposal in the SWDS in the year *x*
DOC_j		-	Fraction of degradable organic carbon (by weight) in the waste type *j*
k_j		-	Decay rate for the waste type *j*
j		-	Waste type category (index)
x	1	years	Year during the crediting period: x runs from the first year of the first crediting period (x = 1) to the year y for which avoided emissions are calculated (x = y)
y	1	years	Year for which methane emissions are calculated

The above specified default values were taken from the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” (Version 05) where the tool provides different values to choose from, the chosen values are summarised below:

- OX: 0.1 as set for managed solid waste disposal sites that are covered with oxidising material such as soil or compost. At the Colomba-Guabal landfill site, when an area or section closes permanently, it is covered by clayed soil.
- MCF: 1.0 the landfill site belongs to the category of anaerobic managed solid waste disposal site. This factor is only applicable if the site has got controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste. At the landfill site Colomba-Guabal, the waste is directed to the specific section of the deposition area, there is no scavenging on the site and through the wells reaching from the bottom to the top of the landfill, there is good control of fires. The landfill area where the daily disposal work is taking place is covered with synthetic tarp on a daily basis. After an area closes permanently and reaches its capacity, it is covered by clayed soil.
- DOC_j: Values are chosen considering that the waste is wet as per the information stated in the Environmental Impact Assessment prepared by EMAPA.
- k_j: The tropical, wet default values are applicable as per the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” (Version 05). In the Cali area, the mean annual temperature is 23 °C and the average annual precipitation is 1473 mm.

The GWP_{CH4} is the global warming potential of methane, which is set at the default value 21 tCO_2e/tCH_4. This value is valid for the relevant commitment period and shall be updated according to future COP/MOP decisions.

2. Methane that would have been destroyed/combusted in the absence of the project activity due to regulatory and/or contractual requirements ($MD_{BL,y}$):

For the amount of methane destroyed in the baseline scenario, the following equation is used:

$$MD_{BL,y} = MD_{project,y} * AF \qquad (2)$$

Where:

$MD_{BL,y}$	=	The amount of methane that would have been destroyed/combusted during the year *y* in the absence of the project due to regulatory and/or contractual requirements, in tonnes of methane (tCH_4)
$MD_{project,y}$	=	The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH_4) in project scenario
AF	=	Adjustment factor expressed as a percentage (%)

The CVC (Corporación Autónoma Regional del Valle del Cauca, Environmental Authority for the region of Valle del Cauca) Resolution 0100 No. 0740 – 0612 from 18/12/2007 states that the obligation for passive flaring the landfill gas has been removed from the requirements of the Environmental License in order to more effectively mitigate the reduction of gas emissions and comply with countrywide regulations already in place. Furthermore the most recent CVC Resolution 0100 No. 0740 – 0531 from 23/09/2010 also confirms that no flaring is required, unless it is done by means of the implementation of a CDM project.

Therefore, no passive flaring has occurred since the landfill. After several studies, the landfill operator opened a public tender in October 2009 for the development of a CDM project. This was completed and Green Gas Yotoco S.A.S. was selected to develop the project.

Given that passive flaring was not required by the local region authority or the Environmental Minister, no destruction of methane has occurred since landfill operations began in 2008. The adjustment factor (AF) for proposed project activity was set at 0% (fixed ex-ante value) project implementation.

As the the adjustment factor (AF) was set to 0, $MD_{BL,y}$ can be simplified as below:

$$MD_{BL,y} = 0 \qquad (2')$$

This value will be considered for all calculation methods as ex-ante estimation, ex-post estimation and the ex-post calculation during the whole crediting period.

STEP 1. Determination of the mass flow rate of the residual gas that is flared

This step calculates the residual gas mass flow rate in each hour h, based on the volumetric flow rate and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

$$FM_{RG,h} = \rho_{RG,n,h} \times FV_{RG,h} \qquad (1)$$

Where:

Variable	SI Unit	Description
$FM_{RG,h}$	kg/h	Mass flow rate of the residual gas in hour h
$\rho_{RG,n,h}$	kg/m^3	Density of the residual gas at normal conditions in hour h
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h

and:

$$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \times T_n} \qquad (2)$$

Where:

Variable	SI Unit	Description
$\rho_{RG,n,h}$	kg/m^3	Density of the residual gas at normal conditions in hour h
P_n	Pa	Atmospheric pressure at normal conditions (101 325)
R_u	$Pa.m^3/kmol.K$	Universal ideal gas constant (8 314)
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
T_n	K	Temperature at normal conditions (273.15)

and:

$$MM_{RG,h} = \sum_i (fv_{i,h} * MM_i) \qquad (3)$$

Where:

Variable	SI Unit	Description
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
$fv_{i,h}$	-	Volumetric fraction of component i in the residual gas in the hour h
MM_i	kg/kmol	Molecular mass of residual gas component i
I		The components CH_4, CO, CO_2, O_2,H_2, N_2

As simplified approach, project participants may only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2)
The above simplification was only used for the estimation of emission reductions, but in the proposed project activity the volumetric fraction of methane, carbon-dioxide and oxygen will be continuously monitored.

STEP 2. Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas

Determine the mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas, calculated from the volumetric fraction of each component *i* in the residual gas, as follows:

$$fm_{j,h} = \frac{\sum_i fv_{i,h} \cdot AM_j \cdot NA_{j,i}}{MM_{RG,h}} \qquad \textbf{(4)}$$

Where:

Variable	**SI Unit**	**Description**
$fm_{j,h}$	-	Mass fraction of element j in the residual gas in hour h
$fv_{i,h}$	-	Volumetric fraction of component i in the residual gas in the hour h
AM_j	kg/kmol	Atomic mass of element j
$NA_{j,i}$	-	Number of atoms of element j in component i
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
j		The elements carbon, hydrogen, oxygen and nitrogen
i		The components CH_4, CO, CO_2, O_2,H_2, N_2

STEP 3. Determination of the volumetric flow rate of the exhaust gas on a dry basis
This step is applicable since the methane combustion efficiency of the flare will be continuously monitored.
Determine the average volumetric flow rate of the exhaust gas in each hour *h* based on a stoichiometric calculation of the combustion process, which depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

$$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h} \qquad \textbf{(5)}$$

Where:

Variable	**SI Unit**	**Description**
$TV_{n,FG,h}$	m^3/h	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour h
$V_{n,FG,h}$	m^3/kg residual gas	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in hour h
$FM_{RG,h}$	kg residual gas/h	Mass flow rate of the residual gas in the hour h

$$V_{n,FG,h} = V_{n,CO2,h} + V_{n,O2,h} + V_{n,N2,h} \qquad \textbf{(6)}$$

Where:

Variable	SI Unit	Description
$V_{n,FG,h}$	m^3/kg residual gas	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in the hour h
$V_{n,CO2,h}$	m^3/kg residual gas	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h
$V_{n,N2,h}$	m^3/kg residual gas	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h
$V_{n,O2,h}$	m^3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h

$$V_{n,O2,h} = n_{O2,h} \; x \; MV_n \qquad \textbf{(7)}$$

Where:

Variable	SI Unit	Description
$V_{n,O2,h}$	m^3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour h
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol)

$$V_{n,N_2,h} = MV_n * \left\{ \frac{fm_{N,h}}{200 AM_N} + \left(\frac{1 - MF_{O_2}}{MF_{O_2}} \right) * \left[F_h + n_{O_2,h} \right] \right\} \qquad \textbf{(8)}$$

Where:

Variable	SI Unit	Description
$V_{n,N2,h}$	m^3/kg residual gas	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol)
$fm_{N,h}$	-	Mass fraction of nitrogen in the residual gas in the hour h
AM_n	kg/kmol	Atomic mass of nitrogen
MF_{O2}	-	O_2 volumetric fraction of air
F_h	kmol/kg residual gas	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour h
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour h

$$V_{n,CO_2,h} = \frac{fm_{C,h}}{AM_C} * MV_n \quad (9)$$

Where:

Variable	**SI Unit**	**Description**
$V_{n,CO2,h}$	m^3/kg residual gas	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h
$fm_{C,h}$	-	Mass fraction of carbon in the residual gas in the hour h
AM_C	kg/kmol	Atomic mass of carbon
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol)

$$n_{O_2,h} = \frac{t_{O_2,h}}{\left(1-(t_{O_2,h}/MF_{O_2})\right)} \times \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1-MF_{O_2}}{MF_{O_2}}\right) \times F_h\right] \quad (10)$$

Where:

Variable	**SI Unit**	**Description**
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour h
$t_{O2,h}$	-	Volumetric fraction of O_2 in the exhaust gas in the hour h
MF_{O2}	-	Volumetric fraction of O_2 in the air (0.21)
F_h	kmol/kg residual gas	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour h
$fm_{j,h}$	-	Mass fraction of element j in the residual gas in hour h (from equation 4)
AM_j	kg/kmol	Atomic mass of element j
j		The elements carbon (index C) and nitrogen (index N)

$$F_h = \frac{fm_{C,h}}{AM_C} + \frac{fm_{H,h}}{4AM_H} - \frac{fm_{O,h}}{2AM_O} \quad (11)$$

Where:

Variable	SI Unit	Description
F_h	kmol O_2/kg residual gas	Stoichiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour h
$fm_{j,h}$	-	Mass fraction of element j in the residual gas in hour h (from equation 4)
AM_j	kg/kmol	Atomic mass of element j
j		The elements carbon (index C), hydrogen (index H) and oxygen (index O)

STEP 4. Determination of methane mass flow rate in the exhaust gas on a dry basis

This step is applicable since the methane combustion efficiency of the flare will be continuously monitored.

The mass flow of methane in the exhaust gas is based on the volumetric flow of the exhaust gas and the measured concentration of methane in the exhaust gas, as follows:

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH4,FG,h}}{1000000} \quad \textbf{(12)}$$

Where:

Variable	SI Unit	Description
$TM_{FG,h}$	kg/h	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h
$TV_{n,FG,h}$	m^3/h exhaust gas	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour h
$fv_{CH4,FG,h}$	mg/m^3	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour h

STEP 5. Determination of methane mass flow rate in the residual gas on a dry basis

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

It is necessary to refer both measurements (flow rate of the residual gas and volumetric fraction of methane in the residual gas) to the same reference condition that may be dry or wet basis. If the residual gas moisture is significant (temperature greater than 60ºC), the measured flow rate of the residual gas that is usually referred to wet basis should be corrected to dry basis due to the fact that the measurement of methane is usually undertaken on a dry basis (i.e. water is removed before sample analysis).

$$TM_{RG,h} = FV_{RG,h} \ x \ fv_{CH4,RG,h} \ x \ \rho_{CH4,n} \quad \textbf{(13)}$$

Where:

Variable	SI Unit	Description
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour h
$FV_{RG,h}$	m^3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to $fv_{i,RG,h}$ where i refers to methane).
$\rho_{CH4,n}$	kg/m^3	Density of methane at normal conditions (0.716)

STEP 6. Determination of the hourly flare efficiency

The determination of the hourly flare efficiency depends on the operation of flare (e.g. temperature), the type of flare used (open or enclosed) and, in case of enclosed flares, the approach selected by project participants to determine the flare efficiency (default value or continuous monitoring).

In case of **enclosed flares and continuous monitoring** of the flare efficiency, the flare efficiency will be calculated as follows:

$$\eta_{flare,h} = 1 - \frac{|TM_{FG,h}}{TM_{RG,h}} \quad \textbf{(14)}$$

Where:

$\eta_{flare,h}$	-	Flare efficiency in the hour h
$TM_{FG,h}$	kg/h	Methane mass flow rate in exhaust gas averaged in a period of time t (hour, two months or year)
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour h

However, for the estimations of emission reductions and if no records for monitoring exist, the default value for enclosed flare is selected and the flare efficiency in the hour *h* is:

- 0% if the temperature in the exhaust gas of the flare (T_{flare}) is below 500 °C for more than 20 minutes during the hour *h*.
- 50% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour *h* but the manufacturer`s specifications on proper operation of the flare are not met at any point in time during the hour *h*. See Table A.4.3.1. Technical Data of the flaring system
- 90% if the temperature in the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour *h* and the manufacturer`s specifications on proper operation of the flare are met continuously during the hour *h*. See Table A.4.3.1. Technical Data of the flaring system

STEP 7. Calculation of annual project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions from each hour *h*, based on the methane flow rate in the residual gas ($TM_{RG,h}$) and the flare efficiency during each hour *h* ($\eta_{flare,h}$), as follows:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH4}}{1000} \quad \textbf{(15)}$$

Where:

Variable	**SI Unit**	**Description**
$PE_{flare,y}$	tCO_2e	Project emissions from flaring of the residual gas stream in year y
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour h
$\eta_{flare,h}$	-	Flare efficiency in hour h
GWP_{CH4}	tCO_2e/tCH_4	Global Warming Potential of methane valid for the commitment period

1) Determination of project emissions from electricity consumption

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

Where:

PE_y = Project emissions in year *y* (tCO_2/y)
$PE_{EC,y}$ = Emissions from consumption of electricity in the project case (tCO2/y)
$PE_{FC,y}$ = Emissions from consumption of heat in the project case (tCO2/y)

Since the proposed project activity is a simple landfill gas flaring project and does not include heat consumption, the project emissions are calculated with the following simplified formula:

$$\mathbf{PEy = PE_{EC,y}} \quad \textbf{(16')}$$

Where:
PE_y = Project emissions in year *y* (tCO_2/y)
$PE_{EC,y}$ = Emissions from consumption of electricity in the project case (tCO2/y)

For this project there will be no use of thermal energy. Furthermore, no back-up fossil fuel generator will be associated with this project. Therefore the project emissions will be equal to the project emissions from electricity consumption which will be calculated according to equation (1) of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”, justified by Scenario A: electricity consumption from the grid:

$$\mathbf{PE_{EC,y} = (EC_{PJ,flare,y} + EC_{PJ,elec.y}) * EF_{grid,y} * (1+TDLy)}$$

Where:

$PE_{EC,y}$	=	Project emissions from electricity consumption by the project activity during the year, (tCO_2/y)
$EC_{PJ,flare,y}$	=	Quantity of electricity consumed by the flare during the year *y* (MWh)
$EC_{PJ,elec,y}$	=	Quantitiy of electricity consumed by the gensets during the year *y* (MWh)
$EF_{grid,y}$	=	Emission factor for the grid in year *y* (tCO_2/MWh)
TDLy	=	Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site

According to a published document from 2009, the Ministry of Energy and Mining calculated the emission factor for the Colombian grid[11]. From the study resulted an emission factor for combined margin of 0.2849 tCO2/MWh. Furthermore this value was published in the Resolution 18-0947 from 04/06/2010[12]).

According to the webpage www.nationmaster.com (a database for statistics done by the Australian company Rapid Intelligence), the electric power transmission and distribution losses for Colombia (position 23 in the list) were calculated in 2004 with 19.32%[13] grid losses. However, since the data is not recent and its accuracy and reliability cannot be confirmed, in order to be conservative, the default value for TDL_y was applied (20%) about grid-related transmission and distribution losses for Colombia. At the time of PDD submission no up-to-date data was available.

Leakage

No leakage effects need to be accounted for under this methodology.

Emission Reductions

$$\mathbf{ER_y = BE_y - PE_y} \qquad \textbf{(17)}$$

Where:

ER_y	=	Emission reduction in year *y* (tCO_2e/y)
BE_y	=	Baseline emissions in year *y* (tCO_2e/y)
PE_y	=	Project emissions in year *y* (tCO_2/y)

The above formula shall be modified in order to clearly differentiate between project emissions from flaring ($PE_{flare,y}$) and electricity consumption ($PE_{EC,y}$). Project emissions from flaring are already included in the calculation of $MD_{flared,y}$ (equation (9) of ACM0001 version 11) and therefore in $MD_{project}$ and BE_y.

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[11] República de Colombia – Ministerio de Minas y Energía, Cálculo del factor de emisión de CO2 del sistema eléctrico interconectado colombiano, issued by Haider Amaranto Sanjuán, Versión 2009.3; Value on page 19 http://www.siame.gov.co/Portals/0/Factor_CO2/Calculo%20del%20Factor%20de%20Emision_2008_3.pdf

[12] Resolution 180947 Emission Factor Grid in Colombia http://www.minminas.gov.co/minminas/kernel/usuario_externo_normatividad/form_consultar_normas.jsp?parametro=2266&site=18

[13] Electric Power transmission and distribution losses in Colombia http://www.nationmaster.com/red/graph/ene_ele_pow_tra_and_dis_los_of_out-power-transmission-distribution-losses-output&b_map=1,

Hence, they shall not be deducted once more in the overall emission reduction calculation in equation (17) above.
The modified equation is as follows:

$$\mathbf{ER_y = BE_y - PE_{EC,y}} \quad \textbf{(17')}$$

All ex-ante calculations for obtaining the emission reductions from the project activity are listed in Section B.6.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**Regulatory requirements relating to landfill gas**
Data unit:	--
Description:	Regulatory requirements relating to landfill gas
Source of data used:	Publicly available information of the host country´s regulatory requirements relating to landfill gas
Value applied:	
Justification of the choice of data or description of measurement methods and procedures actually applied :	
Any comment:	The information though recorded annually, is used for changes to the adjustment factor (AF) or directly $MD_{BL,y}$ at renewal of the credit period. Relevant regulations for LFG project activities shall be updated at renewal of each crediting period. Changes to regulation should be converted to the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity ($MD_{BL,y}$). Project participants should explain how regulations are translated into that amount of gas.

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2/tCH_4
Description:	Global Warming Potential of CH_4
Source of data used:	IPCC
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value of 21 is set for the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	The applied value is valid for the first commitment period. It shall be updated according to any COP/MOP decisions.

Data / Parameter:	**D_{CH4}**
Data unit:	tCH_4/m^3CH_4
Description:	Methane density
Source of data used:	Methodology ACM0001 version 11, adopted by EB 47, page 14
Value applied:	0.0007168
Justification of the choice of data or description of measurement methods and procedures actually applied :	At Standard temperature and pressure (0 degree Celsius and 1,013 bar), the density of methane is 0.0007168 tCH_4/m^3CH_4
Any comment:	

Data / Parameter:	**$BE_{CH4,SWDS,y}$**
Data unit:	tCO_2e
Description:	Methane generation from the landfill in the absence of the project activity at year y
Source of data used:	Calculated as per the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"
Value applied:	Applied values are listed in table B.6.3.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"
Any comment:	Used for ex ante estimation of the amount of methane that would have been destroyed/combusted during the year.

Data / Parameter:	**φ**
Data unit:	
Description:	Model correction factor to account for model uncertainties
Value to be applied:	0.9
Any comment:	Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results.

Data / Parameter:	**OX**
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data:	Conduct a site visit at the solid waste disposal site in order to assess the type of cover of the solid waste disposal site. Use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories for the choice of the value to be applied.
Value to be applied:	Use 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost.
Any comment:	

Data / parameter:	**F**
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	0.5
Any comment:	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.

Data / parameter:	**DOC_f**
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	0.5
Any comments:	

Data / parameter:	**MCF**
Data unit:	-
Description:	Methane correction factor
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	Use the following values for MCF: • 1.0 for **anaerobic managed solid waste disposal sites**. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste;
Any comment:	The methane correction factor (MCF) accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS.

<table>
<tr><td>Data / Parameter:</td><td>DOC_j</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Fraction of degradable organic carbon (by weight) in the waste type j</td></tr>
<tr><td>Source of data used:</td><td>IPCC 2006, Guidelines for National Greenhouse Gas Inventories. Volume 5: Waste. Page 2.14</td></tr>
<tr><td>Value applied:</td><td>The following values for the different waste types j are applied:
<table>
<tr><td>Waste type j</td><td>DOC_j (% wet waste)</td></tr>
<tr><td>Pulp, paper and cardboard</td><td>40</td></tr>
<tr><td>Food, food waste, beverages and tobacco</td><td>15</td></tr>
<tr><td>Textiles</td><td>24</td></tr>
<tr><td>Wood and wood products</td><td>43</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr>
</table></td></tr>
<tr><td>Justification of the choice of data of descriptions of measurement methods and procedures actually applied:</td><td>In accordance with the “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site” (version 05, EB55, Annex 18)</td></tr>
<tr><td>Any comment:</td><td>According to the “Tool”: “If a waste type, prevented from disposal by the proposed CDM project activity, cannot clearly be attributed to one of the waste</td></tr>
</table>

	types in the table above, project participants should choose among the waste types that have similar characteristics that waste type where the values of DOC_j and k_j result in a conservative estimate (lowest emissions), or request a revision of / deviation from this methodology." In this case, the classification provided in the tool is used, and no deviation from the methodology is needed.

Data / Parameter:	**k_j**
Data unit:	-
Description:	Decay rate for the waste type j
Source of data used:	"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (Version 05) which applies IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value applied:	The following values are applied for the different waste types: (see table below)
Justification of the choice of data of descriptions of measurement methods and procedures actually applied:	The above mentioned "Tool" provides default values for different waste types as a function of climate, specifically mean annual temperature (MAT, ºC) and mean annual precipitation (MAP, mm per year). According to the information from the Environmental Impact Assessment prepared by EMAPA, the mean temperature is 23°C, and an annual precipitation of 1,473 mm per year. The values that were selected and applied to the estimation correspond to the conditions of wet climate (MAP>1000 mm) with tropical temperatures (MAT>20 ºC).
Any comment:	According to the "Tool": "If a waste type, prevented from disposal by the proposed CDM project activity, cannot clearly be attributed to one of the waste types in the table above, project participants should choose among the waste types that have similar characteristics that waste type where the values of DOC_j and k_j result in a conservative estimate (lowest emissions), or request a revision of / deviation from this methodology."

Waste type j		**k**
Slowly degrading	Wood, wood products and straw	0.035
	Pulp, paper, cardboard	0.07
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.17
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.40

Data / Parameter:	***$EF_{grid,y}$***
Data unit:	tCO_2e/MWh
Description:	Emission factor for the electricity consumed from the grid during the project activity
Source of data used:	Resolución 180947 del 04/06/2010 Ministerio de Minas y Energía and calculation of emission factor from the Colombian grid, Version 2009.3

Value applied:	0.2849 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	There is no captive power plant installed at the site and no on-site captive power plant exists. Therefore the electricity is purchased from the grid only.
Any comment:	The electricity consumption of the project is greater than the electricity consumption of the baseline (no electricity consumption in baseline).

Data / Parameter:	**Wtotal**
Data unit:	Tons
Description:	The amount of waste disposed in the landfill sites in year x
Source of data used:	Historical and predicted waste data from Interaseo as being the operator of the landfill
Value applied:	(see table below)
Justification of the choice of data or description of measurement methods and procedures actually applied :	For the years 2008 and 2009 historical data from the landfill operator was received. Since 2009 (last full set of data), an estimation for the following years was taken into consideration. The yearly increase of 2.107% is based on the Environmental Impact Assessment Study. In the Resolution 0100 No. 0740-0659 from 2008, in Article Fourth it is stated “Maximum Capacity: The maximum capacity of operation, this is determined by the logistical and operational capacity, which must be proven; therefore EMAPA S.A. E.S.P. can receive a larger volume of solid waste than the initially authorized in the Resolution which granted the Environmental License, as long as technical, logistical and operational capacity exists”. The document which granted the Environmental License to the Landfill is the Resolution 0100 No. 0740-0377 from 2007, which in section 4.2 Technical Evaluation, Capacity for Final disposal states the following “The landfill El Colomba-Guabal has the approval for the disposal of domestic solid waste with a maximum capacity of 1,654 tons per day according to the Decree 838 from 2005

Value applied:

Section North	
Year	**W_{total} (Mg/y)**
2008	318,619
2009	608,672
2010	621,497
2011	634,592
2012	647,963
2013	661,615
2014	675,555
2015	689,789
2016	704,323
2017	719,163
2018	734,316
2019	749,788

	issued by the Ministry of Environment, Housing and Land".
Any comment:	

Data / Parameter:	**CE**
Data unit:	%
Description:	LFG collection efficiency
Source of data used:	As per project setup
Value applied:	see table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	In 2010, experts from the US based company SCS Engineers were contracted to elaborate a gas prognosis of the landfill site. The expert used the collection efficiency as shown above. The average collection efficiency is calculated as 67%.
Any comment:	Factor needed to quantify the amount of landfill gas flared (MD_{flared})

Year	**Collection System Efficiency %**
February 2012	65%
2013	66%
2014	66%
2015	67%
2016	67%
2017	67%
2018	68%
January 2019	68%

Parameter	**SI Unit**	**Description**	**Value**
MM_{CH4}	Kg/kmol	Molecular mass of methane	16.04
MM_{CO}	Kg/kmol	Molecular mass of carbon monoxide	28.01
MM_{CO2}	Kg/kmol	Molecular mass of carbon dioxide	44.01
MM_{O2}	Kg/kmol	Molecular mass of oxygen	32.00
MM_{H2}	Kg/kmol	Molecular mass of hydrogen	2.02
MM_{N2}	Kg/kmol	Molecular mass of nitrogen	28.02
AM_{C}	Kg/kmol (g/mol)	Atomic mass of carbon	12.00
AM_{H}	Kg/kmol (g/mol)	Atomic mass of hydrogen	1.01
AM_{O}	Kg/kmol (g/mol)	Atomic mass of oxygen	16.00
AM_{N}	Kg/kmol (g/mol)	Atomic mass of nitrogen	14.01
Pn	Pa	Atmospheric pressure at normal conditions	101,325
Ru	Pa m^3/kmol K	Universal ideal gas constant	8,314.472
Tn	K	Temperature at normal conditions	273.15
MF_{O2}	Dimensionless	O2 volumetric fraction of air	0.21
MVn	m^3/kmol	Volume of one mole of any ideal gas at	22.414

		the normal temperature and pressure	
$\rho_{CH4,n}$	kg/m^3	Density of methane gas at normal conditions	0.7168
$N_{Ai,j}$	Dimensionless	Number of atoms of element j in component I, depending on molecular structure	

Source of data: "Tool to determine project emissions from flaring gases containing methane"

B.6.3. Ex-ante calculation of emission reductions:

The ex-ante emission reduction calculation requires the estimation of several values. Most of the estimated parameters can be found under Section B.6.2. including inter alia the estimation of landfill gas production from the waste at the site, the prognosis of the waste deposit for the crediting period, the LFG collection efficiency and the adjustment factor.

According to the proposed project activity, the collected LFG would be destroyed in high efficient flaring facilities.

For conservativeness, the estimations assume a default flare efficiency of 90% as recommended in the "Tool to determine project emissions from flaring gases containing methane" (EB28, Annex 13). However, as from the moment when the entire measurement equipment for continuous measurement of the fraction of methane in the exhaust gas is installed and is operational, the flare efficiency will be monitored continuously ex-post and the default value only applies according to Step 6 of the Tool to determine project emissions from flaring gases containing methane (EB 28, Annex 13).
For the estimation of emission reductions, in order to be conservative, it was assumed that the flaring facility will operate 7,884 h/year leaving 10% of non-operational time on a yearly basis for necessary maintenances or unscheduled events.

Based on the formulae given in section B.6.1., and the parameters presented in section B.6.2., the estimated emission reductions due to the project activity are calculated as below, giving the following results:

Baseline emissions:

$$BEy = (MD_{project,,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} * EF_{grid,y}, \quad (1')$$

1. $MD_{project,y}$

a) Estimated amount of methane destroyed by the project activity – Sum of quantities fed to the flare:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} \quad (8)$$

Table B.6.3.1: $MD_{project,y}$ (ex-post estimation)

Year	$MD_{flared,y}$ (tCH_4)	$MD_{electricity,y}$ (tCH_4)	MDproject,y (tCH_4)
Feb 2012	7,764	2,275	10,039
2013	8,125	3,930	12,055
2014	9,012	4,124	13,136
2015	8,625	5,384	14,009
2016	9,314	5,582	14,896
2017	8,761	6,861	15,622
2018	14,704	1,131	15,835
Jan 2019	1,270	49	1,319
Total	**67,575**	**29,335**	**96,910**

Where the quantity of methane destroyed by flaring was calculated using the following equation:

$$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4}) \quad (9)$$

Table B.6.3.2: $MD_{flared,y}$

Year	$LFG_{flare,y}$ (Nm^3)	$PE_{flare,y}$ (tCO2e)	$MD_{flared,y}$ (tCH4)
Feb 2012	24,070,960	18,117	7,764
2013	25,188,052	18,958	8,125
2014	27,940,469	21,029	9,012
2015	26,738,218	20,124	8,625
2016	28,874,212	21,732	9,314
2017	27,160,987	20,442	8,761
2018	45,585,200	34,309	14,704
Jan 2019	3,936,589	2,963	1,270
Total	**209,494,687**	**157,674**	**67,575**

(Default values: w_{CH4} = 50%; D_{CH4} = 0.0007168 tCH4/m^3CH4; GWP_{CH4} = 21)

$$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4} \quad (10)$$

Table B.6.3.3: $MD_{electricity,y}$

Year	$LFG_{electricity,y}$ (Nm^3)	$MD_{electricity,y}$ (tCH4)
Feb 2012	6,347,861	2,275
2013	10,964,487	3,930
2014	11,506,053	4,124

2015	15,021,792	5,384
2016	15,573,850	5,582
2017	19,142,857	6,861
2018	3,155,771	1,131
Jan 2019	137,207	49
Total	**81,849,879**	**29,335**

(Default values: w_{CH4} = 50%; D_{CH4} = 0.0007168 tCH4/m^3CH4)

b) Ex-ante estimation of the amount of methane that will be destroyed/combusted during the year ($MD_{project,y}$)

$$\mathbf{MD_{project,y} = BE_{CH4,\ SWDS,y} / GWP_{CH4}} \quad (13)$$

Table B.6.3.4: $MD_{project,y}$ (ex-ante estimation)

Year	$BE_{CH4, SWDS,y}$ (tCO2e)	GWP_{CH4} (tCO_2e/tCH_4)	$MD_{project,y}$ (tCH_4)
Feb 2012	352,222	21	10,902
2013	418,613	21	12,957
2014	449,834	21	14,138
2015	476,216	21	14,967
2016	499,304	21	15,930
2017	520,151	21	16,595
2018	539,477	21	17,469
Jan 2019	45,090	21	1,460
Total	**3,300,906**		**104,418**

The comparison of $MD_{project,y}$ from Table B.6.3.1 and Table B.6.3.4 shows, that $MD_{project,y}$ from Table B.6.3.1 gives lower values, as it includes the project emissions from flaring. Therefore, the lower $MD_{project,y}$ values from Table B.6.3.1 will be adopted for the ex-ante estimation of the emission reductions. The methane actually destroyed by the project activity is determined ex-post by monitoring the quantity of methane flared.

2. $MD_{BL,y}$

For the amount of methane destroyed in the baseline scenario, the following equation is applied:

$$\mathbf{MD_{BL,y} = MD_{project,y} * AF} \quad (2)$$

Table B.6.3.5: $MD_{BL,y}$

Year	$MD_{project,y}$ (tCH4)	AF (%)	$MD_{BL,y}$ (tCH4)
Feb 2012	10,039	0.000	0
2013	12,055	0.000	0
2014	13,136	0.000	0
2015	14,009	0.000	0
2016	14,896	0.000	0
2017	15,622	0.000	0
2018	15,835	0.000	0
Jan 2019	1,319	0.000	0
Total	**96,910**		**0**

$$BEy= (MD_{project,,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,BL,y} , \quad (1')$$

Table B.6.3.6: BE_y

Year	$MD_{project,y}$ (tCH4)	$MD_{BL,y}$ (tCH4)	GWP_{CH4} (tCO_2e/tCH_4)	$EL_{LFG,y}$ (MWh)	$EF_{grid,y}$ tCO2/MWh	BEy (tCO2e)
Feb 2012	10,039	0	21	21,999	0.2849	217,088
2013	12,055	0	21	35,999	0.2849	263,404
2014	13,136	0	21	35,999	0.2849	286,107
2015	14,009	0	21	47,999	0.2849	307,860
2016	14,896	0	21	47,999	0.2849	326,484
2017	15,622	0	21	47,999	0.2849	341,733
2018	15,835	0	21	59,998	0.2849	349,629
Jan 2019	1,319	0	21	5,000	0.2849	29,127
Total	**96,910**	**0**		**302,992**		**2,121,432**

Project emissions

To calculate the emission reductions achieved due to the project activity, the emissions caused by electricity consumption during the project activity has to be taken into account. The project activity requires electricity for operating the flare booster station, inter alia for the blowers to extract the gas from the landfill and boost it further to the flare, the control units, some of the monitoring equipments and the data logging system.

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1-\eta_{flare,h}) \times \frac{GWP_{CH4}}{1000} \quad (15)$$

$TM_{RG,h}$ is calculated with the following equation:

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n} \quad (13)$$

Table B.6.3.7: $PE_{flare,y}$

Year	$FV_{RG,y}$ (Nm^3)	$TM_{RG,y}$ (kg)	$PE_{flare,y}$ (tCO2e)
Feb 2012	24,070,960	8,627,032	18,117
2013	25,188,052	9,027,398	18,958
2014	27,940,469	10,013,864	21,029
2015	26,738,218	9,582,977	20,124
2016	28,874,212	10,348,518	21,732
2017	27,160,987	9,734,498	20,442
2018	45,585,200	16,337,736	34,309
Jan 2019	3,936,589	1,410,873	2,963
Total	**209,494,687**	**75,082,896**	**157,674**

These project emissions are already included in the calculation of equation (8). Therefore, they shall not be deducted again in the overall emission reduction calculation.

$$PEy = PE_{EC,y} \quad (16)$$

$$PE_{EC,y} = EC_{PJ,y} * EF_{grid,y} * (1+TDL_y)$$

The 20% default value is applied for the technical transmission and distribution losses. The grid factor ($EF_{grid,y}$) used for the calculation is 0.2849 tCO_2/kWh.

Table B.6.3.8: $PE_{EC,y}$

Year	$EC_{PJ,flare,y}$ (MWh)	$EC_{PJ,elec,y}$ (MWh)	$PE_{EC,y}$ (tCO_2)
Feb 2012	29	111	48
2013	31	181	73
2014	31	181	73
2015	31	242	94
2016	52	242	101
2017	52	242	101
2018	52	302	122
Jan 2019	5	25	11
Total	**283**	**1,526**	**623**

(Default values: EFgrid,y = 0.2849; TDLy= 0.2)

Leakage:

No leakage effects need to be accounted under the selected methodology, ACM0001 version 11.

B.6.4 Summary of the ex-ante estimation of emission reductions:

$$ER_y = BE_y - PE_y \quad (13)$$

Table B.6.4.1: Estimation of emission reductions resulting from methane destruction

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
Feb 2012	10	210,821	0	210,811
2013	11	253,148	0	253,137
2014	11	275,851	0	275,840
2015	11	294,185	0	294,174
2016	18	312,809	0	312,791
2017	18	328,058	0	328,040
2018	18	332,536	0	332,518
Jan 2019	2	27,703	0	27,701
Total	**99**	**2,035,111**	**0**	**2,035,012**

Table B.6.4.2: Estimation of emission reductions resulting from energy displacement

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
Feb 2012	38	6,268	0	6,230
2013	62	10,256	0	10,194
2014	62	10,256	0	10,194
2015	83	13,675	0	13,592
2016	83	13,675	0	13,592
2017	83	13,675	0	13,592
2018	104	17,093	0	16,989
Jan 2019	9	1,425	0	1,416
Total	**524**	**86,323**	**0**	**85,799**

Hence, estimation of total emission reductions of the project activity over the period (comprising methane destruction and energy displacement) is 2,120,809 tonnes of CO_2e.

B.7. Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	**$LFG_{total,y}$**
Data unit:	m^3
Description:	Total amount of gas captured at Normal Temperature and Pressure
Source of data to be used:	Measured by the flow meters placed directly on the installation.
Value of data applied for the purpose of calculation expected emission reductions in section B.5	Average value of 41,620,652Nm³ over the crediting period.
Description of measurement methods and procedures to be applied:	The flow meter will express gas flow in cubic meters (m³). The proportion of the data to be monitored is 100% and the data are aggregated monthly and yearly. There will be continuous monitoring frequency.
QA/QC procedures to be applied:	The flow meter will be subject to a regular maintenance and testing regime to ensure accuracy. The flow meter will be calibrated according to manufacturer`s specifications.
Any comment:	

Data / Parameter:	**$LFG_{flare,y}$**
Data unit:	m^3
Description:	Amount of landfill gas flared at Normal Temperature and Pressure
Source of data to be used:	Measured by the flow meter placed directly on the installation.
Value of data applied for the purpose of calculation expected emission reductions in section B.5	Average value of 29,927,812 Nm³ over the first crediting period.
Description of measurement methods and procedures to be applied:	The flow meter will express gas flow in cubic meters (m³). The proportion of the data to be monitored is 100% and the data are aggregated monthly and yearly. There will be continuous monitoring frequency.
QA/QC procedures to be applied:	The flow meter will be subject to a regular maintenance and testing regime to ensure accuracy. The flow meter will be calibrated according to manufacturer`s specifications.
Any comment:	The amount of landfill gas flared equals to the amount of landfill gas sent to the flares as the project activity will contain two high efficiency flares. Methane fraction of the landfill gas and LFG flow has to be measured on the same basis (either wet or dry).

Data / Parameter:	$LFG_{electricity,y}$
Data unit:	m^3
Description:	Amount of landfill gas combusted in power plant at Normal Temperature and Pressure
Source of data to be used:	Measured by the flow meter placed directly on the installation.
Value of data applied for the purpose of calculation expected emission reductions in section B.5	Average value of 11,692,840 Nm^3 over the first crediting period.
Description of measurement methods and procedures to be applied:	The flow meter will express gas flow in cubic meters (m^3). The proportion of the data to be monitored is 100% and the data are aggregated monthly and yearly. There will be continuous monitoring frequency.
QA/QC procedures to be applied:	The flow meter will be subject to a regular maintenance and testing regime to ensure accuracy. The flow meter will be calibrated according to manufacturer`s specifications.
Any comment:	Methane fraction of the landfill gas and LFG flow has to be measured on the same basis (either wet or dry).

Data / Parameter:	$PE_{flare,y}$
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year y
Source of data to be used:	Calculated as per the “Tool to determine project emissions from flaring gases containing methane”
Value of data applied for the purpose of calculation expected emission reductions in section B.5	Annual average of the first crediting period is 22,525 tCO_2e
Description of measurement methods and procedures to be applied:	The parameters used for determining the project emissions from flaring of the residual gas stream in year *y* will be monitored as per the “Tool to determine project emissions from flaring gases containing methane”. The parameters used for the determination of PE_{flare} are $FV_{RG,h}$, w_{CH4}, $fv_{i,h}$, $fv_{CH4,FG,h}$, tO_2 and T_{flare}.
QA/QC procedures to be applied:	As per the “Tool to determine project emissions from flaring gases containing methane” and regular maintenance and testing regime in line with the manufacturer`s recommendations will ensure optimal operation of the flare.
Any comment:	

Data / Parameter:	w_{CH4}
Data unit:	m^3CH_4/ m^3LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	Gas quality analyser
Value of data applied	An estimation of 0.50 was taken into account according to IPCC 2006

for the purpose of calculation expected emission reductions in section B.5	Guidelines for National Greenhouse Gas Inventories.
Description of measurement methods and procedures to be applied:	The gas analysing system is a modular construction and designed for stationary operation for measuring directly the fraction of methane in the landfill gas. The gas analyser provides three analogue signals, CH_4, CO_2 and O_2. The values are measured continuously. The proportion of the data to be monitored is 100%.
QA/QC procedures to be applied:	The gas analyser will be subject to a regular maintenance and testing regime to ensure accuracy. The gas analyser will be calibrated according to manufacturer's specifications.
Any comment:	Methane fraction of the landfill gas and LFG flow has to be measured on the same basis (either wet or dry).

Data / Parameter:	**T**
Data unit:	°C
Description:	Temperature of the landfill gas
Source of data to be used:	Thermometer
Value of data applied for the purpose of calculation expected emission reductions in section B.5	No value was estimated.
Description of measurement methods and procedures to be applied:	Measured to determine the density of methane D_{CH4}. The monitoring frequency will be continuous.
QA/QC procedures to be applied:	The thermometer will be subject to a regular maintenance and testing regime to ensure accuracy.
Any comment:	

Data / Parameter:	**P**
Data unit:	Pa
Description:	Pressure of the landfill gas
Source of data to be used:	Manometer
Value of data applied for the purpose of calculation expected emission reductions in section B.5	No value was estimated.
Description of measurement methods and procedures to be applied:	Measured to determine the density of methane $D_{CH4.}$ The monitoring frequency will be continuous.
QA/QC procedures to be applied:	The manometer will be subject to a regular maintenance and testing regime to ensure accuracy.

Any comment:	Measurement instruments may read Pa or mbar values. To convert from Pa (N/m^2) to mbar simply multiply by 0.01 mbar.

Data / Parameter:	$\mathbf{PE_{EC,y}}$
Data unit:	tCO_2e
Description:	Project emissions from electricity consumption by the project activity during the year *y*
Source of data:	Calculated as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Value of data applied for the purpose of calculation expected emission reductions in section B.5	An average of 89 tCO_2e (approximately 258 MWh) was estimated for the first crediting period due to the scheduled implementation of the gensets within phase 2 as from the second year of the project activity.
Measurement procedure (if any):	Calculated as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Monitoring frequency:	Calculated as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
QA/QC procedures:	Calculated as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Any comment:	The required electricity will be consumed from the interconnected grid until the implementation of phase 2. The consumed electricity invoiced by the local utility provider will be taken into consideration as the electricity consumed by the project activity.

Data / Parameter:	$\mathbf{EL_{LFG,y}}$
Data unit:	MWh
Description:	Net amount of electricity generated using LFG
Source of data:	Power meter installed at the facility
Value of data applied for the purpose of calculation expected emission reductions in section B.5	An average of 37,874 MWh was estimated for the first crediting period.
Description of measurement methods and procedures to be applied:	The power meter will express total net amount of electricity which was fed into the interconnected grid. The values are aggregated monthly and yearly. There will be continuous monitoring frequency.
QA/QC procedures to be applied:	Power meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy
Any comment:	Required to estimate the emission reductions from electricity generation from LFG, if credits are claimed.

Data / Parameter:	Operation of the electricity generating equipment
Data unit:	Hours
Description:	Operation of the electricity generating equipment
Source of data:	Project participants
Measurement procedures (if any):	
Monitoring frequency:	Annually
QA/QC procedures:	
Any comment:	This is monitored to ensure methane destruction is claimed for methane used in electricity generating equipment when it is operational

Data / Parameter:	TDLy
Data unit:	%
Description:	Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.
Source of data:	One of the following options will be used: a) Recent, accurate and reliable data available within the host country. b) A default value of 20%.
Value of data applied for the purpose of calculation expected emission reductions in section B.5	The default value is chosen, i.e., 20%.
Description of measurement methods and procedures to be applied:	For a): TDLy should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical distribution losses should not take into account other types of grid losses (e.g. commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation
QA/QC procedures:	In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
Any comment:	Technical distribution losses do not take into account other types of grid losses (e.g. commercial losses/theft).

The following parameters will be monitored to determine the flare efficiency using the “Tool to determine project emissions from flaring gases containing methane.”

The project activity applies a high temperature enclosed flare. For the estimations of emission reductions the conservative 90% default value is applied taken from the above mentioned Tool.
However, continuous monitoring of the flare destruction efficiency will be employed for the ex post calculations of emission reductions.

Data / Parameter:	$FV_{RG,h}$
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas at normal conditions in the hour *h*
Source of data to be used:	Measured by the flow meter placed directly on the installation.
Value of data applied for the purpose of calculation expected emission reductions in section B.5	Average value of 29,927,812 Nm^3 over the first crediting period. (See parameter $LFG_{flare,y}$)
Description of measurement methods and procedures to be applied:	The flow meter will express gas flow in cubic meters (m^3). The proportion of the data to be monitored is 100% and the data are aggregated monthly and yearly. There will be continuous monitoring frequency. The same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas (**$fv_{i,h}$**) when the residual gas temperature exceeds 60 °C.
QA/QC procedures to be applied:	The flow meter will be subject to a regular maintenance and testing regime to ensure accuracy. The flow meter will be calibrated according to manufacturer`s specifications.
Any comment:	Please note: the volumetric flow rate and the amount of landfill gas sent to flare ($LFG_{flare,y}$) is measured by one flow meter for each flare.

Data / Parameter:	$fv_{i,h}$
Data unit:	-
Description:	Volumetric fraction of component *i* in the residual gas in the hour h where *i* = CH_4, CO, CO_2, O_2, H_2, N_2
Source of data to be used:	Gas quality analyser
Value of data applied for the purpose of calculation expected emission reductions in section B.5	An estimation of 0.50 was taken into account for the volumetric fraction of CH_4 according to IPCC 2006 Guidelines for National Greenhouse Gas Inventories. (See parameter w_{CH4})
Description of measurement methods and procedures to be applied:	The gas analysing system is a modular construction and designed for stationary operation for measuring directly the fraction of methane in the landfill gas. The gas analyser provides three signals, CH_4, CO_2 and O_2. The values are measured continuously. The proportion of the data to be monitored is 100%. The same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas (**$FV_{RG,h}$**) when the residual gas temperature exceeds 60 °C.
QA/QC procedures to be applied:	The gas analyser will be subject to a regular maintenance and testing regime to ensure accuracy and will be calibrated according to manufacturer's specifications. A zero check and a typical value check should be performed by comparison with a standard certified gas.
Any comment:	Please note: A separate gas analyser will be used for each flare to measured the volumetric fraction of CH_4, CO_2 and O_2 in the residual gas (**$fv_{i,h}$**)

Data / Parameter:	**tO_2,h**
Data unit:	**-**
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in *hour*
Source of data to be used:	Gas analyser
Value of data applied for the purpose of calculation expected emission reductions in section B.5	No value was estimated.
Description of measurement methods and procedures to be applied:	The gas analysing system is a modular construction and designed for stationary operation for measuring directly the fraction of methane in the landfill gas. The gas analyser provides two signals, CH_4 and O_2. The point of measurement (sampling point) will be in the upper section of the flare (80% of total flare height). The values are measured continuously. The proportion of the data to be monitored is 100%.
QA/QC procedures to be applied:	The gas analyser will be subject to a regular maintenance and testing regime to ensure accuracy. This device will be calibrated according to manufacturer`s specifications. A zero check and a typical value check should be performed by comparison with a standard certified gas.
Any comment:	The used high efficiency flare is enclosed flare and the flare efficiency will be monitored continuously. A separate gas analyser will be implemented for monitoring of the exhaust gas at each flare

Data / Parameter:	**$fv_{CH4,FG,h}$**
Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in *hour*
Source of data to be used:	Gas analyser
Value of data applied for the purpose of calculation expected emission reductions in section B.5	No value was estimated.
Description of measurement methods and procedures to be applied:	The gas analysing system is a modular construction and designed for stationary operation for measuring directly the fraction of methane in the landfill gas. The gas analyser provides two signals, CH_4 and O_2. The point of measurement (sampling point) will be in the upper section of the flare (80% of total flare height). The values are measured continuously. The proportion of the data to be monitored is 100%.
QA/QC procedures to be applied:	The gas analyser will be subject to a regular maintenance and testing regime to ensure accuracy. This device will be calibrated according to manufacturer`s specifications. A zero check and a typical value check should be performed by comparison with a standard certified gas.

Any comment:	A separate gas analyser will be implemented for monitoring of the exhaust gas at each flare The monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. Measurement instruments may read ppmv or % values. To convert from ppmv to mg/m^3 simply multiply by 0.716. 1% equals 10 000 ppmv.

Data / Parameter:	**T_{flare}**
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	Thermocouple
Value of data applied for the purpose of calculation expected emission reductions in section B.5	1,000 °C is set as estimated value.
Description of measurement methods and procedures to be applied:	Measures the temperature of the exhaust gas stream in the flare. A temperature above 500 °C indicates that significant amount of gases are still being burnt and that the flare is operating.
Monitoring frequency	Continuously
QA/QC procedures to be applied:	The thermocouple will be replaced yearly or calibrated according to manufacturer specification.
Any comment:	The temperature in the exhaust gas is measured by a thermocouple located at each flare.

B.7.2. Description of the monitoring plan:

The monitoring parameters proposed in section B of this PDD are consistent with the consolidated baseline and monitoring methodology ACM0001 version 11 and its applicable tools (please refer to Section B.6.1).
The monitoring plan is set to give opportunity for real measurements of achieved emission reductions. These emission reductions, achieved by the project activity in each year, will be assessed ex-post through direct measurements; therefore, the amount of landfill gas captured and flared will be measured directly.

The following parameters shall be collected and recorded for calculation of emission reductions:

Figure B.7.2.1: Monitoring plan for phase 1

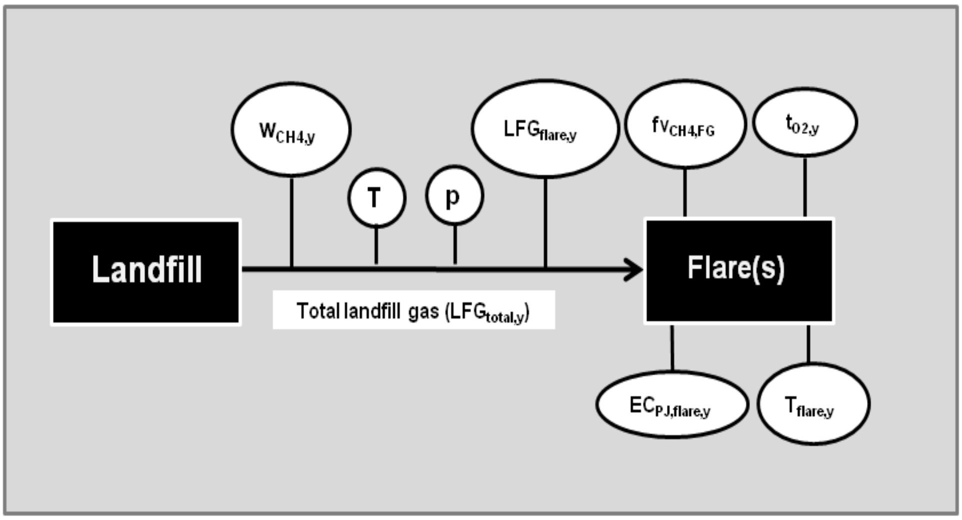


Figure B.7.2.2: Monitoring plan for phase 2

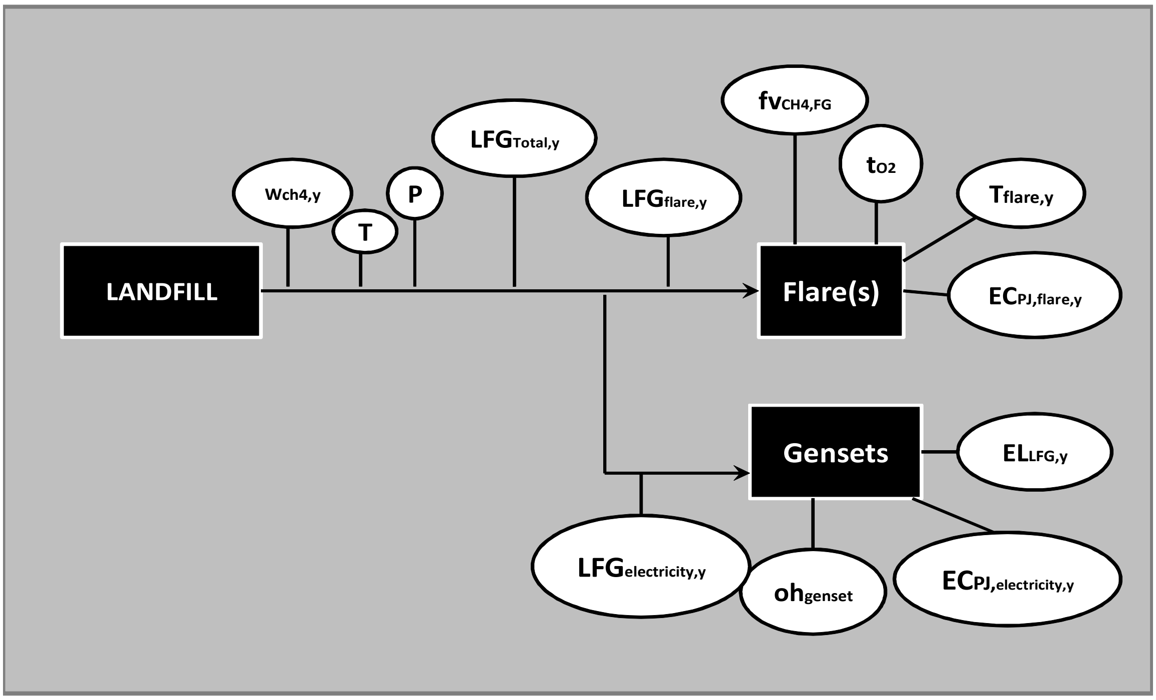


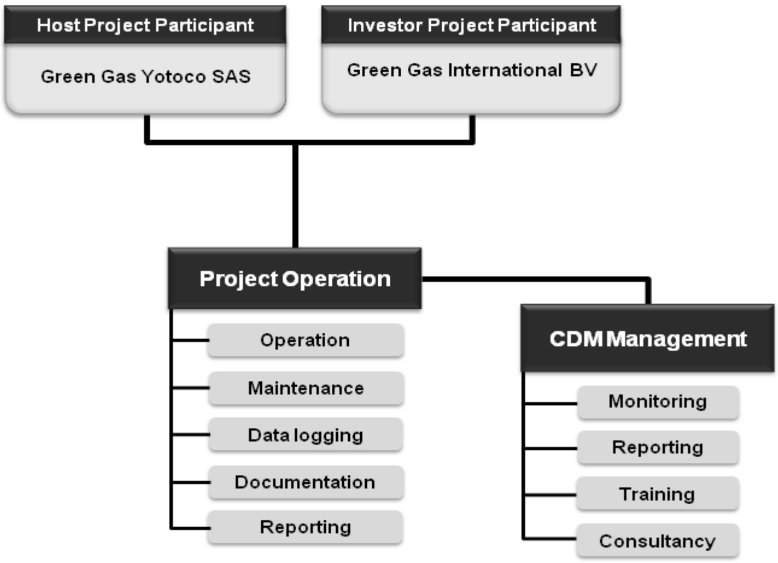
Table B.7.2.1: Parameters monitored in the project activity

Parameter	Description	Measurement equipment
$LFG_{total,y}$	Total amount of landfill captured at Normal Temperature and Pressure	Flow meter is installed so that the total gas is measured before the gas is diverted and sent to the flare measuring $LFG_{flare,y}$ or to the gensets measuring $LFG_{electricity,y}$
$LFG_{flare,y}$	Quantity of landfill gas fed to flare(s) during the year measured in cubic meters (m^3)	Flow meter at the flare measuring only the gas that is going to be flared
$LFG_{electricity,y}$	Amount of landfill gas combusted in power plant at Normal Temperature and Pressure	Flow meter at the gensets measuring only the gas that is going to the gensets
w_{CH4}	Average methane fraction of the landfill gas measured during the year and expressed as a fraction (in m^3 CH4/m^3 LFG	Gas quality analyser
T	Temperature of the landfill gas	Thermometer
p	Pressure of the landfill gas	Manometer
T_{flare}	Temperature in the exhaust gas of the flare	Thermocouple
t_{O2}	Volumetric fraction of O2 in the exhaust gas of the flare	Gas analyser
$fv_{CH4,FG}$	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions	Gas analyser
Oh_{genset}	Operation hours of each electricity generator (genset)	Operation hours counter at the facility
$EL_{LFG,y}$	Net amount of electricity generated using LFG	Power meter installed at the facility
$EC_{PJ, y}$	Electricity consumed by the project activity in MWh	Power meter

To achieve a constant monitoring of the measured values by the relevant measurement equipment listed under B.7.1, the operating personnel is required to proceed with the maintenances and inspections of the accordant measurement equipments in order to have a high functionality and reliability.
Furthermore the operating personnel proceed with the analysis of the measured values in order to ensure the quality of the measured data.

The operational and management structure responsible for project monitoring is as follows.

Figure B.7.2.3: Organisation chart



The project operator will be responsible for the day-to-day operation of the landfill gas collection system and the flaring facility. This team will also be responsible for the calibration and maintenance of the monitoring equipments required for meeting the CDM monitoring requirements.

All units installed in the project are designed to run fully automatic, so that the operating personnel have only to supervise the correct operation of the plant and the plausibility of the collected and monitored data through the data logging system. However, in order to assure accuracy of received data, physical inspections are periodically required from the operating personnel which shall be documented.

Calibration, inspection and maintenance reports will be stored both in paper copies and in scanned electronic format. The collected data should be stored and archived together with the scanned reports in the central data base for quality control.

The team of the project operator include the Plant Manager and Field Engineer who will be responsible for the day-do-day operation on site.

The key responsibilities of the Plant Manager are, inter alia:

- Supervision of all required internal calibration procedures as well as reference measurements;
- Interface between the Field Engineer and the CDM Monitoring personnel
- Identification of sufficient and efficient procedure for troubleshooting in case of failure of equipment with the support of the CDM Monitoring personnel;
- Arrangements of the accordant maintenance of the gensets (periodical interventions)
- Ensuring accurate documentation of the Field Engineer’s interventions according to the requirements of the CDM Monitoring personnel;
- Preparation of site related reports according to any special events;
- Monthly and yearly reports for the Project Participants;
- Coordinating the yearly audit and training; respectively additional trainings (if required);

- Collecting and integrating utility (e.g. electricity consumption) data from external service providers.

The key responsibilities of the Field Engineer are, inter alia:

- Proceeding with scheduled and unscheduled interventions (e.g. inspection and maintenance reports according to weekly, monthly, half-yearly or yearly routine) according to the Operation, Monitoring and & Maintenance Schedule (OM&M);
- Documentation of all interventions (scheduled or unscheduled);
- Proceeding with all required internal calibrations and document the intervention in a calibration report;
- Preparation of visit reports at each site visit;
- Proceeding with reference measurements to check the accuracy of the measurement equipment;
- Storing all reference measurement certifications;
- Downloading and archiving the raw data electronically and also entering it into a database that is set for the analysis of the collected data;
- In case of malfunction or failure of any equipment to proceed as per the troubleshooting procedures and documenting all activities.

The CDM Monitoring personnel will supervise the monitoring activities and is responsible for the correctness of logged data. Regular quality assurances of the electronically recorded data with the handwritten samples are conducted through checking the stored data on plausibility, errors, deviations and non-conformity. All inconsistencies will be dealt with as necessary, so the plant operation can be optimised which will result in a more accurate monitoring.

The preparation of the periodical Monitoring Reports and the analysis of the data received and stored on the central data base together with the calculations of the emission reductions are also amongst the key responsibilities of the CDM Monitoring personnel. The emission reductions will be calculated according to the selected methodology and its applicable tools.
For quality control, all data should be continuously checked for consistency, completeness and integrity. Therefore, the calculations of emission reductions and the Monitoring Reports will be revised and cross-checked during the internal audits by the responsible reviser.
The training of the operating personnel will occur according to a set training programme taking into consideration the requirements of the facility and CDM requirements. The first training will occur after the commissioning of the flare-booster-station. Additional trainings will take place during operation.

The key responsibilities of the CDM Monitoring personnel are, inter alia:

- Ensuring that the calibration and/or reference measurements of measurement equipments are dealt with according to QA/QC procedures (listed in section B.7.1) and to manufacturers` recommendations, if necessary, respectively whenever it is required;
- Crosschecking the reference measurements and the accordant accuracy levels;
- Crosschecking the scheduled and unscheduled inspection and maintenance reports with the raw data (if applicable);
- Collecting all relevant documentations during the monitoring period (special events) and attaching all external calibration certificates to the monitoring report;
- Ensuring that the internal calibration reports are available;

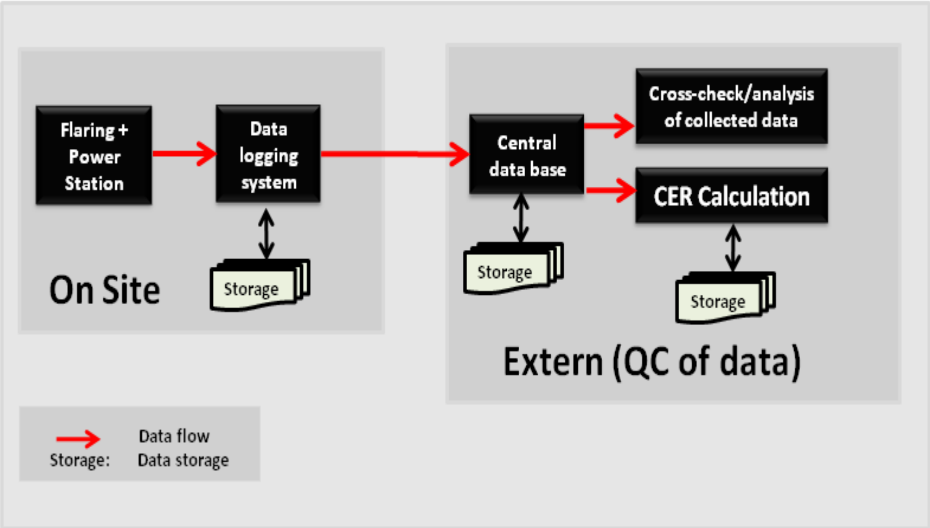
- Crosschecking internal calibration reports with the visit reports and the stored monitored raw data;
- Preparing the periodical Monitoring Reports;
- Ensuring that the yearly training and audit occur on site; respectively collecting the certificates of training and audit;
- Calculating the achieved emission reductions.

The above mentioned responsibilities and procedures will be part of the standard operating procedure of the project activity and documented as part of the monitoring supporting materials.

Data collection and archiving

The following procedures apply for the data collection, archive and data analysis to ensure quality assurance and quality control.

Figure B.7.2.3: Data logging and data usage (for both phases similar)



All measurement equipment is connected to a data logging system. All data are sent permanently in binary codes to this specific data logging system which is installed on site. The data are stored on a storage device within the data logging system.
The data logging system visualizes the logged values where the operating personnel can assure the quality of logged data. Through a defined procedure as per the OM&M Schedule, the logged data will be transmitted electronically the central data base. Both, the project operator and the personnel responsible for the CDM Monitoring have access to the stored data on the central data base. Through the restricted access to the data, any unauthorized access from non responsible personnel can be avoided.

The CDM Monitoring personnel will afterwards analyse and cross-check all collected data with the collected reports which are stored by the project operator on the central data base. The collected raw data will be furthermore used to proceed with the calculation of achieved emission reductions. The calculations and the accordant raw data will be separately stored.

Data that are recorded will be archived in electronic form and kept in digital format. All data are kept for at least two (2) years after the end of crediting period or until the last issuance of CERs happens for this project activity (if that occurs later).

Troubleshooting procedures

In case of any power outages the complete landfill gas extraction system, including booster and flare, is out of operation as there is no emergency power supply installed.
Therefore, all measurement devices would be out of operation. The project operator will analyse the situation as soon as possible and solve the failure if the problem is located internally.
In the unlikely event of any malfunction of the gas flow meter, the gas quality analyser, the gas analyser and the data logger, these measurement devices and/or any other related equipment will be taken care of according to the defined procedures listed in the OM&M Schedule.

As from the moment where gensets are implemented and commissioned on site, the Operator will sub-contract or use own personnel to intervene in case of malfunction of the gensets or the wiring and electricity part.

In the unlikely event of emergency cases that can cause unintended emissions the following procedures will apply:

If fire, gas leak or explosion at the landfill site has occurred the affected area should be identified and isolated. Personnel are to abandon the affected area immediately and be evacuated. If actions taken to control the emergency are insufficient, the fire department should be notified and further actions coordinated with the fire department.

If LFG leaks are detected from collection system, piping or wells during system inspections and monitoring tours the affected system should be determined, and the leak repaired. If it is required that the entire system is shut, the project operator will be notified and the system will be shut off until repairs are completed.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

Date of completing the final draft of the baseline: 05/11/2010

Name of person/entity determining the baseline

Organization	Green Gas Yotoco Services SAS
Address	Avenida 82 # 10 -62, Piso 6
Postal ZIP/city	Bogota
Country	Colombia

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

The start of the project activity is set for the 25/06/2010, which represents the date of the signature of the contract between Green Gas and Interaseo for the development of a CDM project in the Colomba-Guabal Landfill.

C.1.2. Expected operational lifetime of the project activity:

The operational lifetime of the project is 21 years starting on September 2011.

C.2. Choice of the crediting period and related information:

Renewable Crediting Periods

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the first crediting period:

The start of the first crediting period is assumed to be the 01/02/2012 or the date when the project is registered under the Clean Development Mechanism.

C.2.1.2. Length of the first crediting period:

7 years

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

Not applicable

C.2.2.2. Length:

Not applicable

SECTION D. Environmental impacts

The active collection and destruction of uncontrolled methane emission from solid waste has a positive effect on the local and global air quality.

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The project activity that will be developed in the Colomba-Guabal landfill will increase in a significant manner the efficiency of the existing landfill gas collection system by installing an active collection system and a LFG combustion system.

It is expected that the project, will not have any negative impacts, the high quantity of methane, which is considered to be a very harmful Greenhouse gas, will be flared in a high temperature flare which will efficiently destroy the methane.

All the bad odours and nuisances will decrease, causing a positive impact to the population surrounding the landfill site. The general sanitary conditions will improve.

The project has few noise impacts on the local environment coming from the flare and the blowers. However, the strategic location of the site provides a perfect isolation of the project; the most important generation of noise will come from the daily operational activities of the landfill done by Interaseo.

In December 2006, the Empresa de Aguas y Aseo del Pacífico S.A. E.S.P. (“EMAPA”) developed the Environmental Impact Assessment (“EIA”) and the Environmental Management Plan (“PMA” as per the name in Spanish) for the construction and operation of the landfill site Colomba-Guabal.

Based on EIA and PMA documentation, the Corporación Autónoma Regional del Valle del Cauca (“CVC”), entity responsible of the activities taking place in the Cauca Valley, granted the Environmental License on the 09/08/2007 by means of the Resolution 0100 No. 0740 -0377 de 2007.

The Environmental License will be valid during the project lifetime and has been modified 5 times:

- Resolution 0100 – No. 0740-0612 from 18/12/2007
- Resolution 0100 – No. 0740-0314 from 11/06/2008
- Resolution 0100 – No. 0740-0659 from 03/12/2008
- Resolution 0100 – No. 0740-0349 from 19/06/2009
- Resolution 0100 – No. 0740-0531 from 23/09/2010

As per the Environmental License and its amendments, the landfill must fulfil the following conditions:

- The use of forestry and vegetal cover is allowed; all the used and cut trees will have to be replaced by Interaseo in a rate of 1:1.
- Leachate must be treated and continuously monitored
- Landfill activities and operation must be done accordingly to the RAS 2000
- The area for depositing the waste must be covered with geomembrane and filters for the leachate capture must be placed at the bottom of the landfill.
- The utilized material for the leachate collection at the bottom of the landfill and for the biogas collection will be PVC Novafort.
- The installed passive wells can be installed every 50 meters.

- There is no obligation to flare the gas, the landfill El Guabal will have to implement a CDM project in order to control the environmental impact caused by the LFG. The gas shall be flared only through the implementation of a CDM project.

No additional environment impact study has to be carried out for the specific proposed project activity; according to the national regulations of Colombia the granted Environmental License applies for the El Colomba-Guabal Landfill lifetime operations, which include the closure and post-closure period. A letter from the Ministry of Environment (Ministerio de Ambiente, Vivienda y Desarrollo Territorial) was received on the 05/11/2010 confirming that no additional permits and licenses are required.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

There are no significant impacts expected for the project activity.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

An information flyer with important information about the Global Warming Greenhouse Gases and the project was distributed during the local Stakeholder presentation which took place in the Municipality of Yotoco on the 01/12/2010. During the meeting Interaseo del Valle S.A. E.S.P. and Green Gas informed to all the stakeholders who are more directly affected by the project about its main characteristics of the development and operation.

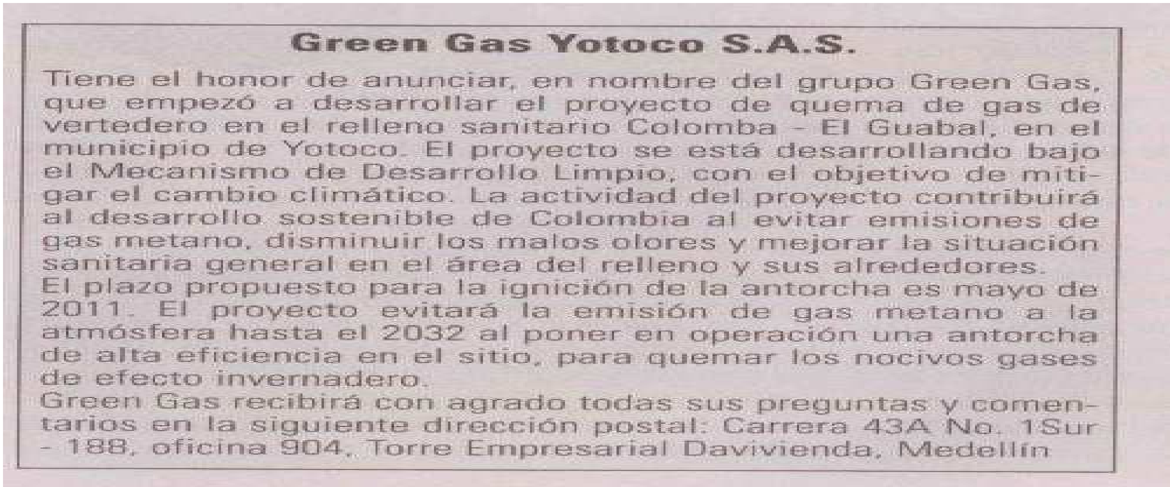
The public was informed about the project activity through a newspaper article published on the 24/11/2010 in the newspaper "Diario Occidente" for the Valle del Cauca. The article announced to the general public the objective of the project and provided with the necessary contact data to raise questions, express ideas and receive more information if requested.

Figure E.1.1: Published article in Diario Occidente on the project activity

EJEMPLAR GRATUITO www.diariooccidente.com.co

DIARIO OCCIDENTE

Cali, miércoles, 24 de noviembre de 2010 - 12 págs. LA INFORMACIÓN NO TIENE PRECIO N.° 3.820 - ISSN 0124-5171



Green Gas Yotoco S.A.S.

Tiene el honor de anunciar, en nombre del grupo Green Gas, que empezó a desarrollar el proyecto de quema de gas de vertedero en el relleno sanitario Colomba – El Guabal, en el municipio de Yotoco. El proyecto se está desarrollando bajo el Mecanismo de Desarrollo Limpio, con el objetivo de mitigar el cambio climático. La actividad del proyecto contribuirá al desarrollo sostenible de Colombia al evitar emisiones de gas metano, disminuir los malos olores y mejorar la situación sanitaria general en el área del relleno y sus alrededores.
El plazo propuesto para la ignición de la antorcha es mayo de 2011. El proyecto evitará la emisión de gas metano a la atmósfera hasta el 2032 al poner en operación una antorcha de alta eficiencia en el sitio, para quemar los nocivos gases de efecto invernadero.
Green Gas recibirá con agrado todas sus preguntas y comentarios en la siguiente dirección postal: Carrera 43A No. 1Sur - 188, oficina 904, Torre Empresarial Davivienda, Medellín

The translated text in English reads as below:

"Green Gas Yotoco S.A.S is proud to announce that under the Green Gas group name it has started to develop the project for flaring the landfill gas in the landfill Colomba – El Guabal in the municipality of Yotoco. The project is being developed under the Clean Development Mechanism, with the aim of mitigating against the climate change. The project activity will contribute to the sustainable development of Colombia by reducing methane gas emissions, as well as reducing bad odours and improve the general

hygiene in and around the landfill area. The time proposed for the beginning of combustion is May 2011. The project will avoid the emission of methane gas into the atmosphere until 2032 as two high efficiency flares will be installed to burn the harmful greenhouse gas.
Green Gas will be happy to answer any questions, comments or advises at the following address: Carrera 43A No. 1 Sur – 188, office 904, Torre Empresarial DaVivienda, Medellín"

The meeting that took place in the offices of the Municipality of Yotoco was conducted by Interaseo del Valle SA ESP and Green Gas from 9h00 until 10h30 where the following key aspects where discussed:

- Kyoto Protocol (scope of the CDM mechanism)
- Green house gas effect on the environment
- Presentation of the project activity (including environmental and social benefits)
- Green Gas and the experience in Colombia
- Q&A session
- Closing of the meeting

The following stakeholders to this project were identified and invited to take part in the Project presentation:

- The government of Colombia at municipal, sub-regional, departmental and national levels
- The private sector
- The general public

A detailed list of the members and the entity which they represented is presented as an attachment to this document.

E.2. Summary of the comments received:

Prior to the end of the meeting the stakeholders were invited to raise their questions, concerns and feedback referring to the discussed parts of within the stakeholder meeting. Only non-project specific questions were raised concerning the CDM mechanism and the experiences of Green Gas with projects in Colombia.

E.3. Report on how due account was taken of any comments received:

No negative comment has been received during the local stakeholders' consultation. People showed interest in the project and its environmental and social benefits.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Host country Project Participant

Organization:	Green Gas Yotoco SAS
Street/P.O.Box:	Avenida 82 #10-62, piso 6
Building:	
City:	Bogotá
State/Region:	
Postcode/ZIP:	
Country:	Colombia
Telephone:	Phone: + 57 317 657 9381
FAX:	
E-Mail:	duncan.cox@greengas.net
URL:	www.greengas.net
Represented by:	
Title:	
Salutation:	Mr.
Last name:	Cox
Middle name:	
First name:	Duncan
Department:	
Mobile:	+1 561 322 8011
Direct FAX:	
Direct tel:	
Personal e-mail:	duncan.cox@greengas.net

Investor (Foreign) Project Participant

Organization:	Green Gas International B.V.
Street/P.O.Box:	Jachthavenweg 109h
Building:	
City:	Amsterdam
State/Region:	
Postcode/ZIP:	1081 KM
Country:	The Netherlands
Telephone:	+31 20 570 2251
FAX:	+31 20 570 2222
E-Mail:	chris.norval@greengas.net
URL:	www.greengas.net
Represented by:	
Title:	
Salutation:	Mr.

Last name:	Norval
Middle name:	Michiel
First name:	Christiaan
Department:	
Mobile:	
Direct FAX:	
Direct tel:	+44 20 8614 7310
Personal e-mail:	chris.norval@greengas.net

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

This Project will not receive any public funding.

Annex 3

BASELINE INFORMATION

TableB.7.2.3.. Calculation of $BE_{CH4,SWDS}$

WASTE 2006 – 2017									
Years	**j**		**$W_{j,x}$**						
	Fraction		**Food**	**Wood**	**Paper**	**Green Waste**	**Textile**	**Plastics**	**Inert**
	W_total (t/y)	**Refuse-in**	0.729	0.015	0.069	0.067	0.007	0.032	0.081
2008	318,619	318,619	232,273	4,779	21,985	21,347	2,230	10,196	25,808
2009	608,672	927,291	443,722	9,130	41,998	40,781	4,261	19,478	49,302
2010	621,497	1,548,788	453,071	9,322	42,883	41,640	4,350	19,888	50,341
2011	634,592	2,183,379	462,617	9,519	43,787	42,518	4,442	20,307	51,402
2012	647,963	2,831,342	472,365	9,719	44,709	43,413	4,536	20,735	52,485
2013	661,615	3,492,957	482,317	9,924	45,651	44,328	4,631	21,172	53,591
2014	675,555	4,168,512	492,480	10,133	46,613	45,262	4,729	21,618	54,720
2015	689,789	4,858,301	502,856	10,347	47,595	46,216	4,829	22,073	55,873
2016	704,323	5,562,625	513,452	10,565	48,598	47,190	4,930	22,538	57,050
2017	719,163	6,281,788	524,270	10,787	49,622	48,184	5,034	23,013	58,252
2018	734,316	7,016,104	535,316	11,015	50,668	49,199	5,140	23,498	59,480
2019	749,788	7,765,892	546,595	11,247	51,735	50,236	5,249	23,993	60,733

			Food	**Wood**	**Paper**	**Green Waste**	**Textile**	**Plastics**	**Inert**
	DOCj		0.15	0.43	0.40	0.20	0.24	0.00	0.00
	kj		0.400	0.035	0.070	0.170	0.070	0.000	0.000

Without Collection Efficiency

Years	**$BE_{CH4,SWDS}$ (tCO2e)**	**$MD_{project,y}$ (tCH_4)**
Feb 2012	352,222	16,772
2013	418,613	19,934
2014	449,834	21,421
2015	476,216	22,677
2016	499,304	23,776
2017	520,151	24,769
2018	539,477	25,689
Jan 2019	45,090	2,147
Total	**3,300,906**	**157,186**

With Collection Efficiency

Years	**Collection efficiciency**	**$BE_{CH4,SWDS}$ (tCO2e)**	**$MD_{project,y}$ (tCH_4)**
Feb 2012	65%	228,944	10,902
2013	65%	272,098	12,957
2014	66%	296,890	14,138
2015	66%	314,303	14,967
2016	67%	334,534	15,930
2017	67%	348,501	16,595
2018	68%	366,844	17,469
Jan 2019	68%	30,661	1,460
Total		**2,192,776**	**104,418**

Annex 4

MONITORING INFORMATION

Table B.7.2.4: Table of the monitoring equipment

Ref-ID	Variable	Unit	Measured (m) Calculated (c) Estimated (e)	Frequency of registration	Responsible	Internal QC procedure	Comments
1	Total amount of landfill gas captured ($LFG_{total,y}$)	m³	m	Continuously (values to be averaged hourly or at shorter time intervals)	Plant Management	yes	Total amount of landfill gas captured has to be measured on the same basis (either wet or dry)
2	Total amount of landfill gas flared ($LFG_{flare,y}$)	m³	m	Continuously (values to be averaged hourly or at shorter time intervals)	Plant Management	yes	Methane fraction of the landfill gas and LFG flow has to be measured on the same basis (either wet or dry).
3	Total amount of landfill gas sent to power plant ($LFG_{electricity,y}$)	m³	m	Continuously (values to be averaged hourly or at shorter time intervals)	Plant Management	yes	Methane fraction of the landfill gas and LFG flow has to be measured on the same basis (either wet or dry).
4	Methane fraction contained in the landfill gas ($w_{CH4,y}$)	m³ CH4/ m³ LFG	m	Continuously (values to be averaged hourly or at shorter time intervals)	Plant Management	yes	Methane fraction of the landfill gas and LFG flow has to be measured on the same basis (either wet or dry).
5	Temperature of landfill gas (T)	°C	m	Continuously (at least each hour)	Plant Management	yes	The thermometer will be subject to a regular maintenance and testing regime to ensure accuracy.
6	Pressure of landfill gas (p)	Pa	m	Continuously (at least each hour)	Plant Management	yes	The manometer will be subject to a regular maintenance and testing regime to ensure accuracy.
7	Hours of operation of the gensets	h	m	Daily	Plant Management	no	The real hours of the operation of the gensets will be registered.
8	Net production of electricity	MWh	m	Continuously	Plant Management	no	The power meter will be subject to a regular maintenance and testing regime to ensure accuracy.

The following variables corresponds for the Project Emissions from flaring gases containing methane **($PE_{flare,y}$)** in the enclosed flare:

Ref-ID	Variable	Unit	Measured (m) Calculated (c) Estimated (e)	Frequency of registration	Responsible	Internal QC procedure	Comments
9	Volumetric flow rate of the residual gas I dry basis at normal conditions ($FV_{RG,h}$)	m³/h	m	Continuously (values to be averaged hourly or at shorter time intervals)	Plant Management	yes	Please note: the volumetric flow rate and the amount of landfill gas sent to flare ($LFG_{flare,y}$ respectively $LFG_{total,y}$) is measured by a flow meter located at each flare The same basis (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas (**$fv_{i,h}$**) when the residual gas temperature exceeds 60 °C.
10	Volumetric fraction of component *i* in the residual gas in the hour h (**$fv_{i,h}$**) where *i* = CH_4, CO, CO_2, O_2, H_2, N_2	Vol.-%	m	Continuously (values to be averaged hourly or at shorter time intervals)	Plant Management	yes	The gas analyser will be calibrated according to manufacturer's specifications. The same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas (**$FV_{RG,h}$**) when the residual gas temperature exceeds 60 °C.
11	Volumetric fraction of O_2 in the exhaust gas of the flare in *hour* ($t_{O2,h}$)	Vol.-%	m	Continuously (values to be averaged hourly or at shorter time intervals)	Plant Management	yes	The used high efficiency flares are enclosed flares and their efficiency is continuously monitored. One gas analyser will be implemented for monitoring the exhaust gas. The gas analyser will be subject to a regular maintenance and testing regime to ensure accuracy and will be calibrated according to manufacturer's specifications.
12	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in *hour* ($fv_{CH4,FG,h}$)	mg/m³	m	Continuously (values to be averaged hourly or at shorter time intervals)	Plant Management	yes	The used high efficiency flares are enclosed flares and their efficiency is continuously monitored. One gas analyser will be implemented for monitoring the exhaust gas at each flare. The gas analyser will be subject to a regular maintenance and testing

							regime to ensure accuracy and will be calibrated according to manufacturer's specifications.
13	Temperature in the exhaust gas of the flare (T_{flare})	°C	m	Continuously (values to be averaged hourly or at shorter time intervals)	Plant Management	yes	The thermocouple will be replaced yearly or calibrated according to manufacturer specification.