Project Design Document

Onyx Landfill Gas Recovery project – Trémembé - Brazil

For the purpose of demonstrating the "**CERUPT Methodology for Landfill Gas Recovery**"

CONTENTS:

A. GENERAL DESCRIPTION OF PROJECT ACTIVITY

A.1 Title of the project activity:

Onyx gas recovery project – Brazil

A.2. Description of the project activity:

Onyx is proposing a Clean Development Mechanism project activity at its SASA landfill facility located in the City of Tremembé – Sao Paulo – Brazil. This landfill is operated by the Brazilian subsidiary SASA. The landfill is divided in two disposal areas. The existing area (Aterro 1) had a capacity of 850,000 m^3 and is no longer used for waste disposal. A new area (Aterro 3) will have a total capacity of 1,700,000 m^3 and will receive approximately 180,000 tonnes/yr of municipal and commercial waste. The new area will be filled in 4 phases until 2012.

The latest European waste management standards are applied to the SASA landfill site. Among others is the installation of landfill gas (LGF) recovery equipment that is not common in Brazil and according to the local regulator not practised at any other landfill site in the state of Sao Paulo. The landfill gas recovery equipment will have a total capacity of 2400 m^3/h, which will be in excess of the projected volume of landfill gas. Onyx will use proven technology, including a piping and well network, blowers and flaring systems. The recovered landfill gas will partly be used onsite for evaporation of waste water from the landfill (leachate). Some electricity will be generated with the LFG, although the generated electricity will be used only for onsite usage. It is envisaged to feed electricity to the grid in a later. This has **not** been taken into account for the proposed CDM project activity.

Greenhouse gas emission reductions will result from the combustion of the recovered methane contained in the landfill gas. It is estimated that this project will generate 700,625 CER's within a 10 year period (2003-2012).

There are several contributions to sustainable development.

Environmental benefits:

The local environment benefits from the highest European waste management standards that are applied to this site including:

- Fully lined disposal areas for leachate containment
- Onsite laboratory for waste analysis and environmental monitoring
- Final cover system including revegetation and reforestation as each disposal area is completed
- In addition, as part of the landfill development plans approximately 25,000 trees will be planted in "green buffer" area around the site.

The project will contribute to the continued environmental improvements by providing the infrastructure to reduce greenhouse gas emissions.

Technology transfer:

The project will support efforts aimed at facilitating the dissemination of design and operational experience gained at SASA landfill for possible use throughout the country. The following activities will be funded by the project and implemented by SASA:

1. Development of information tools (brochures describing the CDM project);
2. Organisation of open house for operators or local authorities interested in LFG management and other potentially interested parties;

A.3. Project participants:

Company name:	ONYX
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Country :	FRANCE
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Date of registration:	23/12/1997

Company name :	SASA (landfill operator, subsidiary of Onyx)
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A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1 Host country Party: Brazil

A.4.1.2 Province: Sao Paolo

A.4.1.3 Town: Tremembé

A.4.1.4 Detail on physical location

The investment is to be made in the city of Tremembé in the state of Sao Paulo, Brazil as shown on the location plan below.

A.4.2. Category(ies) of project activity

Landfill gas recovery (category not yet published on http://unfccc.int/cdm)

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

Construction of the project started in December 2000 and included the installation of a piping network to connect the existing vents at Aterro 1. The construction was finished in March 2001 with the commissioning of the evaporator and flare in March 2001. By November 2003 a landfill gas fuelled generator will be constructed to displace the current emergency diesel generator.

The project will involve proven technology and hardware for the extraction and treatment of landfill gas.

Below is a brief summary of the equipment and technology proposed for this project:
The landfill gas collection system consists of the following components:

- Progressive vertical wells

In order to allow for the possibility to collect landfill gas prior to the completion of a disposal area progressive vertical wells (perforated concrete pipes) are installed. A high density perforated pipe is installed within the centre of the well which is backfilled with gravel.

- Vertical wells

Landfill gas extraction wells will also be drilled into the landfill once areas reach their final elevation and final cover has been applied. The vertical wells consist of a pipe perforated in its lower part, placed in a drilled borehole in the waste, backfilled with gravel and sealed at the surface. Both well types will be equipped with wellheads that enable monitoring of gas flow and quality. Also valves are provided to allow adjustment of the available vacuum at each well.

- Horizontal Drains

In order to maximise the extraction capacity horizontal drains will also be installed in the waste mass. Preliminarily, it is envisioned to install a series of horizontal drains with a horizontal separation distance of 60 meters installed every 5 meters in waste lift height. The horizontal drains will consist of perforated pipes surrounded gravel or equivalent drainage material. The drains will be interconnected to the vertical well system.

- Collection Piping

A high density polyethylene collection piping system will be installed to convey the landfill gas from the well network to the blower/flare/evaporator station.

Leachate evaporator –("EVAP")
The EVAP technology uses landfill gas as a fuel/ heat source to evaporate leachate collected from the lined disposal areas. The evaporator is designed to treat up to 19 m^3 of leachate per day. To treat this maximum amount of leachate approximately 440 m^3/hr of landfill gas (at 50% methane by volume) would be required.
The landfill gas is combusted in a specially designed emerged burner. The hot combustion gas is sparged through the leachate which creates water vapour and strips the volatile organics.

Enclosed Flare
The exhaust gas from the EVAP in passed through an enclosed flare that serves as an after burner to assure the thermal destruction of VOC's and to control odours. The flare operates at 700°C. The flare also treats the excess landfill gas not used in the evaporator.

Controls
The evaporator and flare are equipped with automatic safety and monitoring controls (operator interface, air-fuel ratio, leachate level, chamber temperature, UV scanner, emergency shut down, etc.)

Blower
A centrifugal blower is used to create the required vacuum in the collection network to extract the landfill gas.

Generator
A diesel generator for the production of power in case of disrupt of power from the grid is installed. This generator will be displaced with a landfill gas fuelled generator by the end of 2003.

Possible, in the future, gensets for the production of electricity will be installed which will be interconnected to the local electricity power system. However, in the proposed CDM project activity, emission reductions from feeding electricity to the grid have not been taken into account.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

In Brazil, most of domestic waste goes either to illegal dumps or landfills with minimal environmental controls. The quality of the waste is not properly monitored and poisonous leachate

is leaking into the ground water. Very few installations have developed gas extraction networks, few sites have proper gas wells, and the flaring of landfill gas is rare.

The Brazilian legislation does not require landfill operators to flare landfill gas. The only requirement is to vent the landfill gas in order to avoid the risk of explosion (see Annex 6: Letter from the state environmental regulator CETESB). The flaring of landfill gas, active extraction and generation of electricity are nor compulsory nor common practise in Brazil.

The focus of the national and regional regulatory bodies is tackling the problem of illegal dumping and capturing of leachate. Capturing and flaring of LFG is not a local problem and therefore not a priority. It is unlikely that legislation can be expected in the coming decade (see Annex 7) enforcing flaring.

The envisioned project activity will result in the yearly capturing & combustion of 50% to 80% of the landfill gas (specific amount dependent on the phasing of the project and landfill site filling with waste). The total emission reductions to be realized are 695,880.

A.4.5. Public funding of the project activity:

In this project no public funding is involved.

B. BASELINE METHODOLOGY

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

CERUPT Methodology for Landfill Gas Recovery

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

The chosen methodology is designed specifically for landfill gas recovery projects. The methodology prescribes to develop several alternatives for the particular landfill site in order to determine what would have the most logical course of action to determine the additionality. At this particular project several alternatives have been developed to manage the landfill with respect to the treatment of the leachate. This project does not envisage to feed electricity to the grid. Moreover, the methodology also requires the project developer to look at the regulatory framework.

The methodology is straightforward to apply and is certain to lead to a transparent and conservative estimate of the emission reduction of the project activity.

B.3. Description of how the methodology is applied in the context of the project activity:

The CERUPT methodology makes a difference between a methodology to establish baseline emissions and a methodology to determine whether the proposed project activity is additional. The methodology uses economic and financial criteria to determine whether the proposed project activity is additional. In addition, the regulatory framework should be investigated to see whether any future legal obligation would enforce the project to take place anyway. (see Step 1)

The core business of ONYX at the SASA landfill site is environmental sound disposal and management of municipal and industrial waste. ONYX is applying the latest European standards at their site in Brazil and these standards exceed the current legislation in Brazil. The SASA landfill uses impermeable layers to prevent wastewater (leachate) penetrating in the ground water.

Prior to the installation of a leachate evaporator in 2000, the leachate generated at the SASA landfill was transported via tanker trucks to a local wastewater treatment plant for disposal.

In 2000, SASA began analysing possible onsite treatment methods. A number of onsite treatment technologies were considered. Although not the least expensive treatment option, SASA selected a leachate evaporation process. This proven technology has a number of environmental benefits such as:

- A portion of the LFG is used as a fuel and is therefore collected and combusted in the evaporator
- No discharge to surface water is required
- The process has guaranteed emission performance

As previously described, the proposed CDM project consists of:

- Installation of a landfill gas recovery network over the future disposal areas of the site
- Optimisation of the landfill gas extraction system
- (Drilling of additional extraction wells, interconnection of horizontal drains)
- Increase in flaring capacity
- Implementation of a landfill gas fueled power generator to supply onsite

- Feasibility study to evaluate the possible extension to export electricity to the electrical grid.

Applying the CERUPT methodology the Project additionality is determined in three steps

Step 1: Assessment of legal requirements
The Brazilian legislation does not require landfill operators to flare landfill gas. The only requirement is to vent the landfill gas in order to avoid the risk of explosion (see Annex 6: Letter from the state environmental regulator CETESB). The flaring of landfill gas, active extraction and generation of electricity are neither compulsory nor common practise in Brazil. The local environmental regulator CETESB confirms this in two letters presented in Annex 6.

Current priorities with the authorities are to prevent illegal dumping and improving the conditions at ‘controlled’ sites, which apply lower standards. It is therefore highly unlikely that the Brazilian or a regional authority would require any flaring as LFG emission do not pose a threat to the local environment. The Brazilian Association of Residue Treatment Facilities (ABERTE) states in Annex 7 that it is unlikely there will be any obligation to flare LFG within the coming 10 years.

Step 2: Assessment of economic attractive courses of action
The following two alternatives could be identified:

1. Reference scenario LFG is vented to reduce the risk of explosions. The LFG is emitted into the atmosphere.
2. Extract and use the LFG as a fuel for a separate leachate evaporation installation and flare excess LFG

Alternative 1
As required by law, LFG is vented to the atmosphere to prevent the risk of explosion. The investment required for this alternative is minor and includes the cost for the vents. This is estimated to be approximately EUR 85,000 over the remaining life of the site.

Alternative 2
Under this alternative ONYX will invest in an LFG extraction system (piping and well network), evaporation system and flare and a LFG engine for onsite electricity needs. The total investment for this infrastructure is estimated to be EUR 2,300,000. The economic lifespan of the equipment is set for 10 years. The investment will not generate any revenue and for the purpose of proving the additionality the potential CER revenues are left out of this calculation. This alternative has a negative Internal Rate of Return.

Clearly Alternative 1 is the least cost option for the SASA landfill site and is chosen as the baseline scenario. Under alternative 1 LFG is emitted to the atmosphere and under the proposed project activity over 80% of the LFG will be captured and flared.

Step 3: Assessment of barriers and common practice
As under step 2 the most likely course of action is no LFG capturing and flaring, this step is not applicable.

It can be concluded that the project is additional and the baseline scenario is not to capture nor flare the LFG.

B.4. 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:
A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would occur in the absence of the registered CDM project activity, i.e. in the baseline scenario.

In the above paragraph it was argued that the baseline scenario for this particular landfill site is to vent the LFG. In the proposed CDM project activity the LFG is captured, flared and the methane is converted into CO_2. Any captured LFG would otherwise be emitted to the atmosphere. Clearly the emissions are reduced below those that would have occurred in the absence of the registered CDM project activity.

As CO_2 emissions from the flaring of methane result from biomass and can therefore be set zero.

The CERUPT methodology advises to use a first order decay model to estimate the production of LFG and consequently to estimate the amount of CERs. ONYX has developed a more advanced model which is based on the first order decay model as described in the CERUPT methodology. Given the project characteristics, the amount of landfill gas that can be recovered is estimated. The recovered LFG will either be combusted in the evaporator, combusted in the generator or simply flared.

The amount of emission reductions is estimated by distracting the amount of emissions in the baseline situation with the amount of emission in the project situation. The final amount of emission reductions is based on the amount of landfill gas combusted. In absence of the project the amount captured would otherwise have been emitted to the air.

B.5. Description of how the definition of the project boundary related to the baseline methodology is applied to the project activity:

The project boundary is defined by the emissions targeted or directly affected by the project activities, construction and operation. Project boundaries are set in a way that they comprise all relevant emissions sources that, can either be controlled or influenced by the project participants and that are reasonably attributable to project activities.

As required by the CERUPT methodology, a flowchart was drawn up of the baseline situation and the project situation. All relevant emissions were identified.

The following emissions were not taken into account:
Emissions from the transport of waste to the site are excluded from the project boundaries, as they are not affected by the implementation of the proposed CDM activity.

In the baseline scenario the *transportation of the leachate* is a source of greenhouse gasses. However for the sake of simplicity and to stay on the conservative site, these emissions have not been taken into account.

In the first three year (2001 -2003) of operation a *diesel generator* will be used for the power supply in case delivery from the grid is interrupted. As the crediting period starts in 2003, only the emissions in that year will be accounted for. By 2004, a generator fuelled with landfill gas will be installed. Emissions from the diesel generator nor from the production of electricity from the grid are not taken into account, as the emissions are non-significant compared to the baseline emissions. The yearly power demand of the

evaporator is 200 MWh. Assuming an efficiency of 30% of the diesel generator and an emission factor of 0.0741 CO2/TJ one can calculate the annual emissions of the diesel generator: 200MWh/30% = 666,67 MWh. 666.67 MWh * 3.6 GJ/MWh=2400 GJ = 2.4 TJ. 2.4 TJ * 0.0741 ktonne CO2/TJ= 0.18 tonne CO_2. The diesel generator is only working when grid supply is interrupted, which is in the worst case would be 2 months. The actual emissions are therefore 2/12* 0.18 tonne = 0.03 tonne CO_2. The electricity supplied from the grid has even lower emissions due to the high share of hydro power.

A schematic overview of the project boundaries of this project is summarized on the next page. As can be seen in the scheme, the LFG will go either to the evaporator or to the flare depending on the demand of the evaporator.

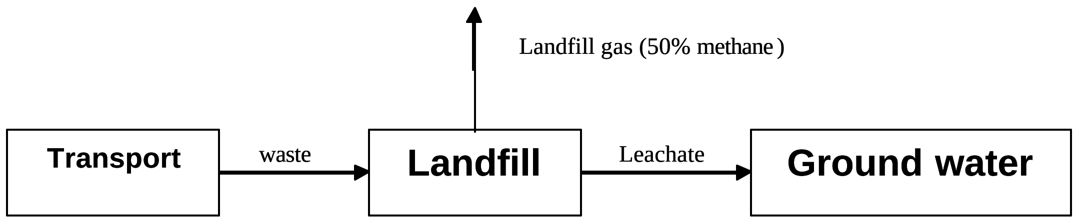
B.6. Details of baseline development

B.6.1 Date of completing the final draft of this baseline section

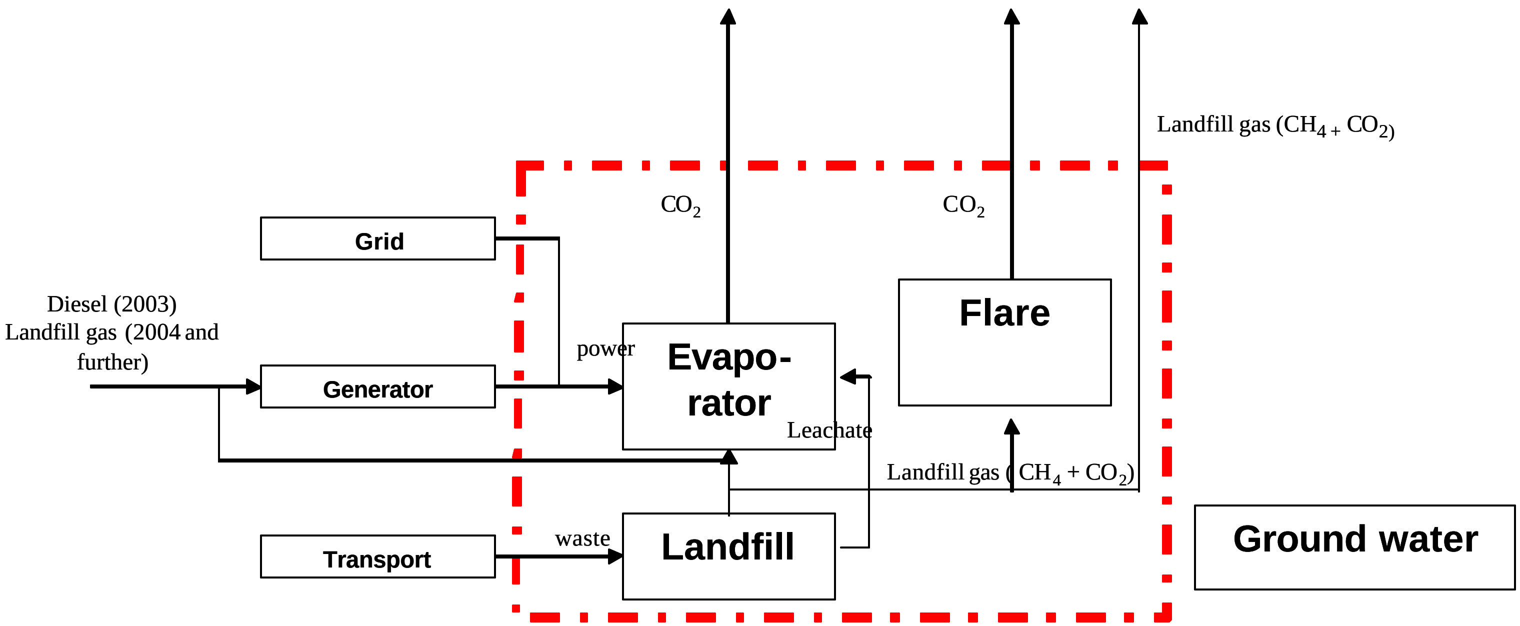
15/07/2003

B.6.2 Name of person/entity determining the baseline:

Company name:	ONYX
Address :	169 avenue Georges Clémenceau
Zip code + city address :	92735 NANTERRE -
Country :	FRANCE
Contact person:	Mr Gary CRAWFORD
Job title :	Vice President Environment / Quality
Telephone number :	33 1 46 69 36 16
Fax number :	33 1 46 69 34 67
E-mail :	gcrawford@cgea.fr
Date of registration :	23/12/1997



Baseline situation



Project situation

C. DURATION OF THE PROJECT ACTIVITY / CREDITING PERIOD

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

December 2000 (construction starting date)

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

10 years (landfill gas will be produced at the site for over 20 years, the extraction system and LFG combustion will remain in use until no longer required)

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

C.2.1. Renewable crediting period *(at most seven (7) years per period)*

C.2.1.1. Starting date of the first crediting period:
C.2.1.2. Length of the first crediting period

C.2.2. Fixed crediting period *(at most ten (10) years)*:

C.2.2.1. Starting date : 01/01/2003
C.2.2.2. Length: 10 years

D. MONITORING METHODOLOGY AND PLAN

D.1. Name and reference of approved methodology applied to the project activity:

CERUPT monitoring methodology for landfill gas recovery

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

The chosen methodology is designed specifically for landfill gas recovery projects. According to the methodology, the basis for the monitoring of the emission reduction is the measuring of landfill gas amount and composition recovered for combustion. The chosen methodology does not include generation of electricity. In the current project generation of electricity is foreseen in the future, but has been not been included in this project activity.

D.3. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived

The emission reductions are defined as the difference of emissions in the baseline situation and in the project situation. For this project, this means that all landfill gas emissions that are recovered and combusted in the flare and evaporator lead to emission reductions.

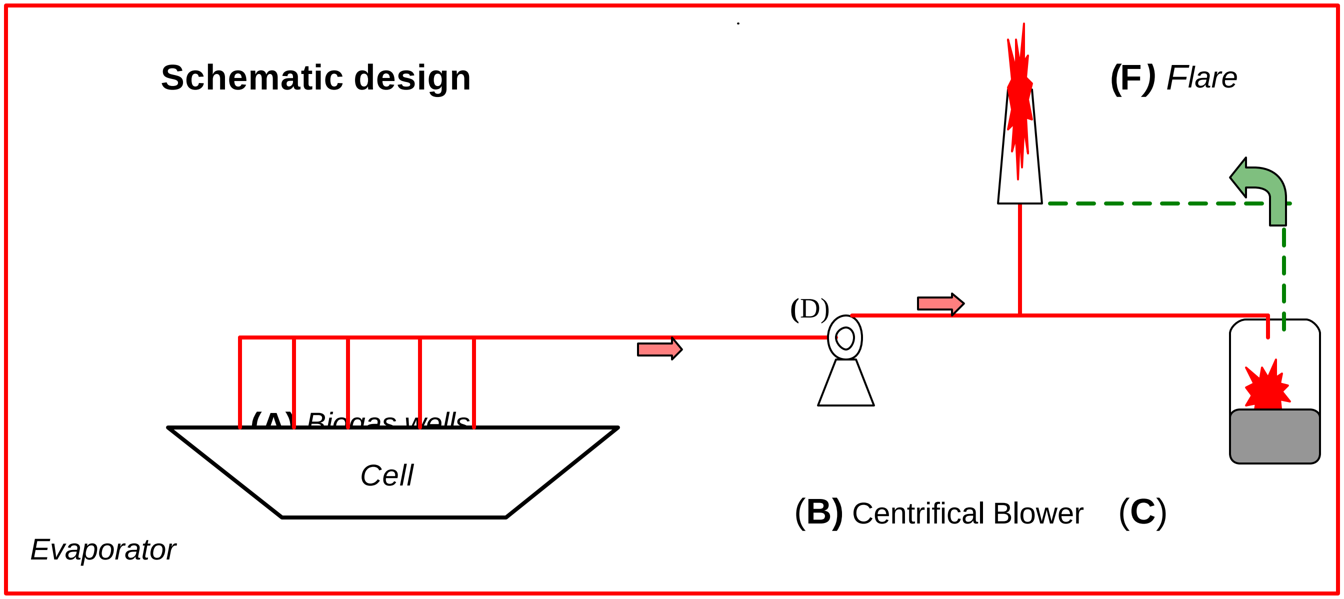
$$Q_c = \sum_{t=1}^{t=8760} (Q_f + Q_e)$$

Q_c = total landfill gas recovered in year x (m^3/yr)
Q_f = total landfill gas to flare (m^3/hr) (measured)
Q_e = total landfill gas to evaporator (m^3/yr) (measured)

Furthermore, the formulae A4.2 and A4.3 (Annex 4) will be applied to calculate the emission reduction.

SASA conducts routine monitoring of the active LFG extraction system and associated equipment. This monitoring is done to ensure optimal performance of the system.

Below is a schematic representation of table representing the primary components of the routine monitoring activities performed by SASA's technicians.



- **In refuse Biogas wells (A)** – The gas extraction wells are monitored daily in order to assess the gas flow and the concentration of the landfill gas (CH_4, CO_2, O_2). The optimum operational parameter being a minimum of 45% methane and a maximum of 3% oxygen).

  The measurements are made with a portable gas meter. Adjustments to the individual well vaccums are made based on this monitoring.

- **Evaporator (C) -** A totalising meter installed prior to the evaporator flow provides the actual gas.

  In addition the landfill gas concentration is also measured prior to the evaporator unit. To measure the performance of the unit there is a steam temperature control device with a maximum set point of 200° F and a device to control the maximum and minimum leachate level.

- **Flare (F) -** The gas flow is also measured prior to the flare. There is an in-line temperature gauge to measure the combustion temperature of the flare. (The minimum operating valve is 1300 ° F ; the set point of 1650° F being considered optimal).

- **Well and pipe integrity (D) -** A visual inspection is conducted of above ground piping and wells heads to ensure its integrity.

This operational data will serve as the basis for verification of emission reductions. All data collected is kept on-site in the monitoring database.

The total flow measurements taken before the flare and evaporator allow for accurate calculation of actual emission reductions.

In addition to the gas monitoring described above, the following items will also be monitored as part of the operation procedures :

- Landfill volume consumed :

  Annual topographic surveys are conducted to determine the consumed and remaining landfill volume. This data will be compared with the landfill phasing assumptions used in the LFG production model.

- Waste input :

  All waste entering the site is weighed on calibrated scales. The annual waste input will be compared with the assumed input used in the model.

- Waste composition

  Waste accepted at the SASA landfill must be classified according to its composition. This will enable review of the model assumptions. This information is maintained onsite. This will enable review of the model assumptions concerning waste types and associated carbon content.

ID number *(Please use numbers to ease cross-referencing to table D.6)*	Data type	Data variable	Data unit	Will data be collected on this item? (If no, explain).	How is data archived? (electronic/paper)	For how long is data archived to be kept?	Comment
In-refuse wells							
1	Numbers	Well pressure	Pa	Yes	Electronic		Daily monitoring
2	Numbers	Well flow	m^3/hr	Yes	Electronic		Daily monitoring
3	Numbers	LFG concen-tration CH_4, CO_2	%	Yes	Electronic		Daily monitoring

		and O_2					
EVAP (leachate evaporator)							
4	Numbers	Gas flow	m^3/hr	Yes	Electronic		Continuous monitoring
5	Numbers	Steam temperature	°F	Yes	Electronic		Continuous monitoring
6	Numbers	Leachate volume	m^3/hr	Yes	Electronic		Continuous monitoring
Flare							
7	Numbers	Gas flow	m^3/hr	Yes	Electronic		Daily monitoring
8	Numbers	Combustion temperature	°F	Yes	Electronic		Continuous monitoring
Inspect collection system							
9		well and pipe integrity		Yes	Electronic		daily visual inspections

D.4. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources.

As shown in the baseline study, the occurrence of leakage is not likely. Data on this will therefore not be collected.

D.5. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHG within the project boundary and identification if and how such data will be collected and archived

Data on this item will not be collected. As previously described this date is not required as all combusted landfill gas in considered emission reductions.

D.6. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored.

Monitoring procedures have been formalised as part of documentation for planned ISO 14001 certification.

Data	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
In-refuse wells			
1 Well pressure	low	Yes	Monitoring data used immediately by technician to adjust well vacuum
2 Well flow	low	*Yes*	Monitoring data used immediately by technician to adjust well vacuum
3 Concentration	low	*Yes*	Monitoring data used immediately by technician to adjust well vacuum
EVAP			

4 Gas Flow	low	*Yes*	*Data reviewed as part of daily monitoring*
5 Steam Temperature	low	*Yes*	*Data reviewed as part of daily monitoring*
6 Leachate Volume	low	*Yes*	*Data reviewed as part of daily monitoring*
Flare			
7 Gas Flow	low	*Yes*	*Data reviewed as part of daily monitoring*
8 Concentration	low	*Yes*	*Data reviewed as part of daily monitoring*
9 Comb. Temperature	low	*Yes*	*Data reviewed as part of daily monitoring*
Inspect collection system			
10 Well & pipe	*Medium*	*yes*	*Ensure integrity of collection system*

D.7 Name of person/entity determining the monitoring methodology:

Company name: ONYX
Address : 169 avenue Georges Clémenceau
Zip code + city address : 92735 NANTERRE -
Country : FRANCE
Contact person: Mr Gary CRAWFORD
Job title : Vice President Environment / Quality
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E-mail : gcrawford@cgea.fr
Date of registration : 23/12/1997

E. CALCULATION OF GHG EMISSIONS BY SOURCES

E.1 Description of formulae used to estimate anthropogenic emissions by sources of greenhouse gases of the project activity within the project boundary:

The potential landfill gas production has been estimated in order to quantify possible gas volumes that may be generated by the SASA landfill site.

Geolia, Onyx 's in-house landfill technical division, has developed a model to calculate landfill gas production entitled "Biogeolia". This model estimates the evolution of landfill gas production using a *first-order degradation model* (kinetic model) with multiple waste types inputs. This model describes both the growth and descending phases.

The formulae used in this model are described below. The general formula of degradation used in this model depends on several parameters including age of waste, mass, waste composition (concentration in organic carbon) and waste temperature.

Formula 1: BIOGEOLIA – Derivative model – first stage

for $t_p \geq t \geq 0$ $$Q(t) = (L_0)_x \, k \, R_x \sqrt{t}$$

with

$Q(t)$ = methane generated in current year (t) by a quantity of waste R_x
$(L_0)_x$ = methane generation potential for waste R_x (Nm^3/Mg of wet waste)
R_x = quantity of waste placed during year x (Mg)
x = year the quantity R_x of waste was placed
k = methane generation rate constant (l/yr)
t = time of peak production rate (yr)

Formula 2: BIOGEOLIA – Derivative model – second stage

for $t \geq t_p$ $$Q(t) = (Q_p)_x \, e^{-(\eta t - 2k)t}$$

with:

$Q(t)$ = methane generated in current year (t) by a quantity of waste R_x
$(Q_p)_x$ = peak production rate for R_x waste (Nm^3/kg)
k = methane generation rate constant (l/yr)
η = factor

In order to estimate the current emissions from waste placed in all years, Formula 1 and 2 can be solved for all values of R_x and the results summed (see formula 3).

Formula 3: BIOGEOLIA model – Sum of the derivative model

$$Q(t) = \sum_x Q_x(t)$$

The figure below presents how waste placed during year N contributes to the global generation of methane in the landfill. This graph also shows that the generation of methane continues after the closure of the site.

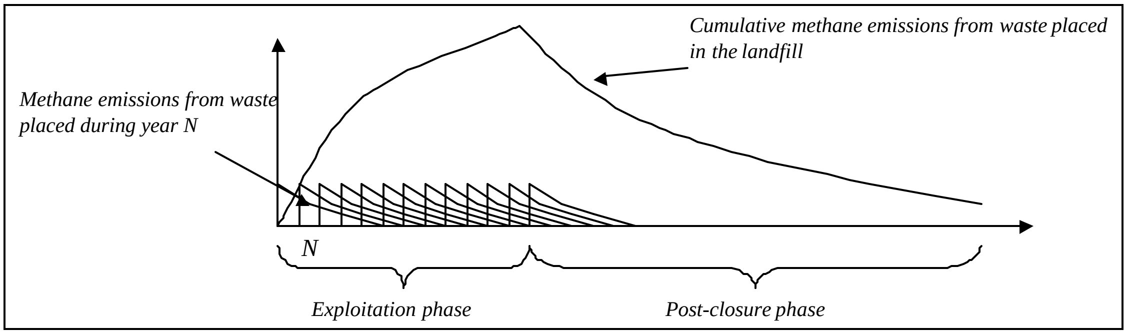


Figure 1: Methane production for waste placed during one year and for the total landfill

Geolia developed this in-house tool to enable Onyx to predict and closely approximate the gas flow from its landfills. The model has been calibrated with data from Onyx's extensive portfolio of landfills. This model is driven by the input of four key parameters as follows :

- *The annual tonnage of waste* (ton / year)

- *The organic carbon content* is the total quantity of organic carbon, contained in waste, and measured in kg/ton. The organic carbon content depends on the composition of waste and is calculated for each type of waste. By using bibliographical data and measurements in laboratory column tests or in instrumented cells, the following values of organic carbon can be evaluated for different type of waste:
  - Municipal solid waste: 160 to 240 kg / Mg wet component.
  - Commercial waste: 20 to 120 kg / Mg wet component.
  - Cardboard, paper: 20 to 40 kg / Mg wet component.

- *The methane generation decay rate* is specified as the exponential rate of decomposition of the landfill refuse. The value, specified in 1/yr, determines the amount of methane a given disposal area will release in a specified time. Several methods can be used to set the value of this parameter. Experimental measurements in column or in instrumented cells are being used to develop a methane generation rate constant database for each waste fraction. For example, the research project "BIOSAR" conducted by Geolia and CREED, Onyx's Research and Development Division, is focused on this parameter.

- *The temperature* in the refuse expressed in °C. Temperature has an impact on the biodegradable carbon converted to landfill gas. Temperatures generally observed in landfills ranged from 25 to 60 ° C.

- *The extraction efficiency or recovery rate* is an additional parameter, which should be introduced to determine the quantity of recovered gas. It ranges between 0% and 100% and represents the effectiveness of the extraction system.

The following assumptions have been used in the SASA landfill model run.

- *Waste volume*

The modelling for the existing filled areas is based on the actual in-place waste volumes and past waste inputs.

The recently approved extension (Aterro 3) will extend the site life to 2012. This extension is divided into four phases and the production of each phase is detailed in the calculation.
The model considers only permitted areas and does not consider the potential expansions that may extend the site life beyond 2012.

- *Annual tonnage*

The municipal and commercial waste input assumed is 180,000 tons per year. This was based on the actual waste being received in 2000 (see table 3)

- *Extraction efficiency*

The recoverable landfill gas depends on the effectiveness of the extraction system. The rate of landfill gas recoverable generally ranges between 50 and 90% of the total production.

It was considered for this calculation that the extraction efficiency is 0 % during the filling period and 80 % one year after the area is covered and equipped with an extraction system.

For the existing site "Aterro 1" the actual extraction efficiency is evaluated to be 70 %, and will increase to 80 % following the cover placement and extraction equipment installation.

For "Aterro 3 - phase 3", the extraction efficiency is evaluated to 50 % for the last part of the filling period and will increase to 80 % one year after the closure of this area.

- *Waste Composition*

The waste composition for the year 2000, as shown on table, was used as the expected waste type breakdown for the remaining site life.

The total quantity of waste material deposited at the SASA landfill from 1996 to 2000 is as follows :

Waste quantities co-disposal (tons)	**1996**	**1997**	**1998**	**1999**	**2000**
Municipal Solid Waste	1 387	9 523	18 845	22 287	39 381
Industrial and Commercial Waste	0	11 198	27 331	62 592	110 099
Biological Sludge	518	3 569	5 395	3 695	2 143
Foundry Sand	38 405	13 030	16 268	14 468	27 136
Inert Waste	1 547	2 319	22 847	6 411	0

Total	41 856	39 639	90 686	109 453	178 759

Table 1: "Waste inputs in SASA landfill site"

The composition of waste used for calculations is as follows:

Waste quantities co-disposal	1996	1997	1998	1999	2000
Municipal Solid Waste	3,3%	24,0%	20,8%	20,4%	22,0%
Industrial and Commercial Waste	0,0%	28,3%	30,1%	57,2%	61,6%
Biological Sludge	1,2%	9,0%	5,9%	3,4%	1,2%
Foundry Sand	91,8%	32,9%	17,9%	13,2%	15,2%
Inert Waste	3,7%	5,9%	25,2%	5,9%	0,0%
Total	100,0%	100,0%	100,0%	100,0%	100,0%

Table 2: Waste composition at SASA landfill site"

Results

The results of the landfill gas production estimation are shown graphically on the figure below. This graph presents the theoretical production curve for each of the designated disposal areas, as well as a consolidated total production curve. The maximum theoretical production rate is 2,279 Nm^3 / hr occurring in year 2012.

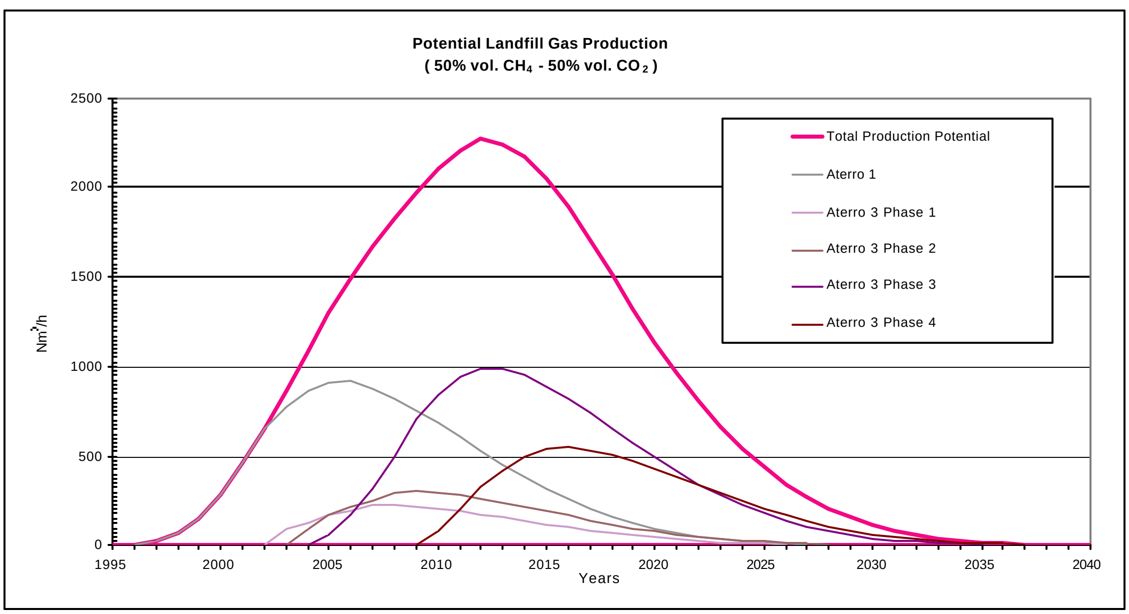


Figure 2: Potential LFG production

However not all LFG will be recovered. The actual emissions by the project activity are the difference between the production of LFG and the amount of LFG that has been recovered.

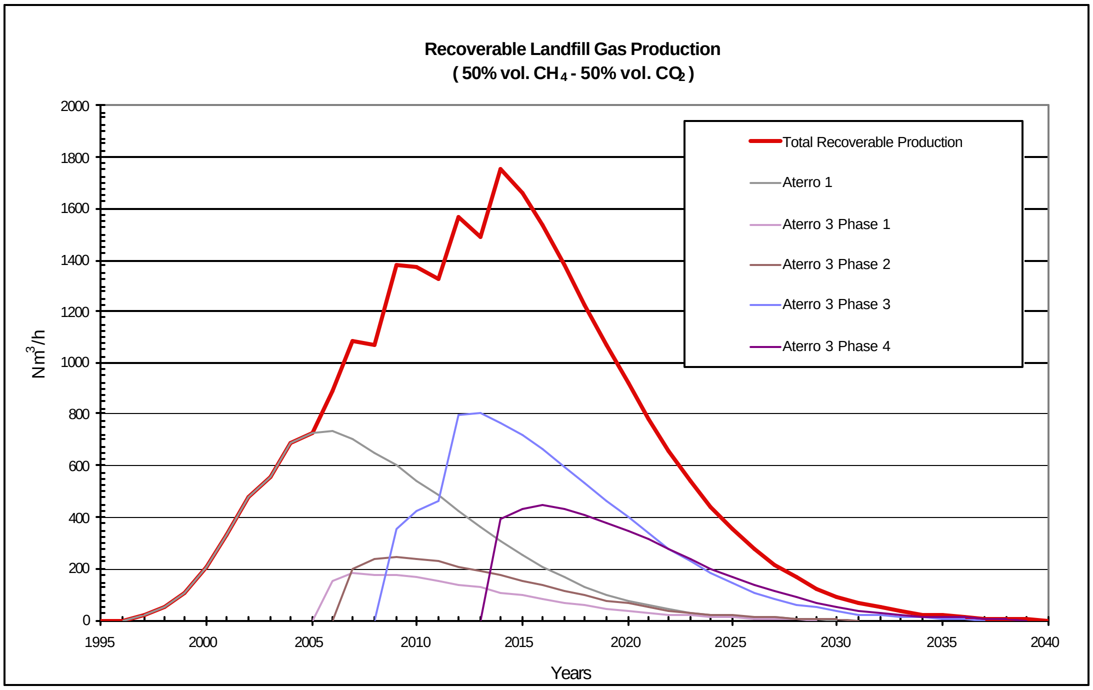


Figure 3: Recoverable LFG

The result in the follow table showing the emissions by the project activity within the project boundary.

Project emissions	landfill gas production (m^3/hr)	landfill gas recovered (m^3/hr)	landfill gas emitted to air m^3/hr	landfill gas emitted to air m^3/yr	methane gas emitted to air m^3/yr	CO_2e/yr (Ton CO_2e/yr)
2003	869	558	311	2.724.360	1.362.180	20.433
2004	1.086	689	397	3.477.720	1.738.860	26.083
2005	1.296	727	569	4.984.440	2.492.220	37.383
2006	1.492	889	603	5.282.280	2.641.140	39.617
2007	1.670	1.083	587	5.142.120	2.571.060	38.566
2008	1.832	1.072	760	6.657.600	3.328.800	49.932
2009	1.977	1.375	602	5.273.520	2.636.760	39.551
2010	2.104	1.371	733	6.421.080	3.210.540	48.158
2011	2.213	1.331	882	7.726.320	3.863.160	57.947
2012	2.279	1.569	710	6.219.600	3.109.800	46.647
Total				53.909.040	26.954.520	404.318

Table 3: CO_2e emission of the project activity

E.2 Description of formulae used to estimate leakage, defined as: the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and that is measurable and attributable to the project activity:

Changes in emissions which occur outside the project boundary can occur from:
- the transport of waste to the landfill site. However, as it is not likely that these emissions will change compared to the baseline scenario, they are not estimated.
- use of power (either taken form the grid or produced with a generator using landfill gas or diesel). The emissions from diesel or from the grid are fro certain non-significant and need not to be estimated.

E.3 The sum of E.1 and E.2 representing the project activity emissions:

See table 3 in E.1

E.4 Description of formulae used to estimate the anthropogenic emissions by sources of greenhouse gases of the baseline:

Formula 1, 2 and 3(See E.1) are used for estimation of landfill gas to be released through time from the landfill .

In the baseline situation, all the landfill gas is emitted to the air.

To calculate the greenhouse gas emissions formulae A3.2 and A3.3 are (Annex 3) is used.

Applying these formulae leads to the following baseline emissions:

Baseline emissions	landfill gas produced (m^3/hr)	landfill gas recovered (m^3/hr)	landfill gas emitted to air m^3/hr	landfill gas emitted to air m^3/yr	methane gas emitted to air m^3/yr	CO_2e/yr (Ton CO_2e/yr)
2003	869	-	869	7.612.440	3.806.220	57.093
2004	1.086	-	1.086	9.513.360	4.756.680	71.350
2005	1.296	-	1.296	11.352.960	5.676.480	85.147
2006	1.492	-	1.492	13.069.920	6.534.960	98.024
2007	1.670	-	1.670	14.629.200	7.314.600	109.719
2008	1.832	-	1.832	16.048.320	8.024.160	120.362
2009	1.977	-	1.977	17.318.520	8.659.260	129.889
2010	2.104	-	2.104	18.431.040	9.215.520	138.233
2011	2.213	-	2.213	19.385.880	9.692.940	145.394
2012	2.279	-	2.279	19.964.040	9.982.020	149.730
Total				147.325.680	73.662.840	1.104.943

Table 4: CO_2e emissions of the baseline scenario

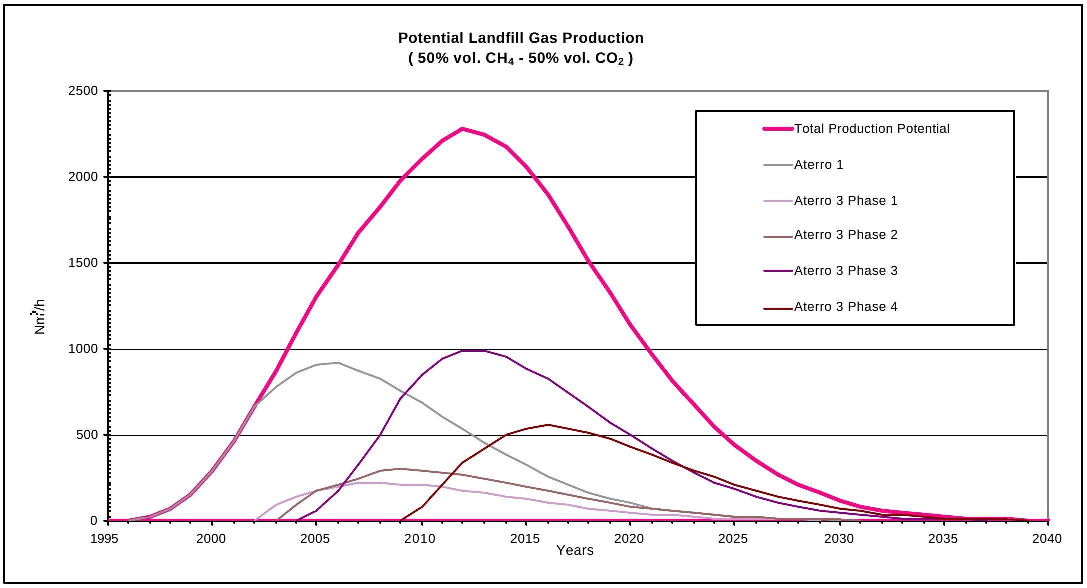


Figure 4: Potential LFG production in the baseline scenario

E.5 Difference between E.4 and E.3 representing the emission reductions of the project activity:

See. E.6. The emission reductions are equal to the amount recovered and combusted.

E.6 Table providing values obtained when applying formulae above:

The following table represents the avoided (reduced) emissions of GHG by the CDM project activity resulting from the recovery and combustion of landfill gas. It should however be noted that the amount of CER will be determined by monitoring the amount of captured LFG and its methane content.

Emission reductions	landfill gas produced (m^3/hr)	difference in landfill gas emitted to air m^3/hr	difference in landfill gas emitted to air m^3/yr	difference methane gas emitted to air m^3/yr	CO_2e/yr (Ton CO_2e/yr)
2003	869	558	4.888.080	2.444.040	36.661
2004	1.086	689	6.035.640	3.017.820	45.267
2005	1.296	727	6.368.520	3.184.260	47.764
2006	1.492	889	7.787.640	3.893.820	58.407
2007	1.670	1.083	9.487.080	4.743.540	71.153
2008	1.832	1.072	9.390.720	4.695.360	70.430
2009	1.977	1.375	12.045.000	6.022.500	90.338
2010	2.104	1.371	12.009.960	6.004.980	90.075
2011	2.213	1.331	11.659.560	5.829.780	87.447
2012	2.279	1.569	13.744.440	6.872.220	103.083
Total			93.416.640	46.708.320	700.625

Table 5: Avoided (reduced) emissions as a result of the CDM project activity.

F. ENVIRONMENTAL IMPACTS

F.1. Documentation on the analysis of the environmental impacts, including trans-boundary impacts

The project does not require an Environmental Impact Assessment as the project will be within the permit of the approved landfilling activities. SASA submitted an EIA as part of the permitting process. This EIA was reviewed and the permit for the landfill has been issued by CETESB, the local environmental agency.

This project will have no detrimental effects on the environment. In fact the project is planned in order to enhance the environmental performance of this landfill. The project will allow for optimum landfill gas extraction. This project will prevent the following risks associated with landfill gas at uncontrolled landfills :

- risk of explosion
- risk of fire
- unpleasant odours nuisances
- GHG emissions effects
- Potential atmospheric pollution
- damage to vegetation by asphyxia

The impacts are and will continue to be mitigated by the installations proposed in this project.

Final cover is placed on the landfill as areas reach their final elevation. The final cover includes a semi-impermeable clay layer overlain by top soil. The surface is re-vegetated as part of the reforestation plan.

F.2. If impacts are considered significant by the project participants or the host Party:.

The environmental aspects of the project are only positive.

G. STAKEHOLDERS COMMENTS

G.1. Brief description of the process on how comments by local stakeholders have been invited and compiled:

SASA invited the most important local stakeholders for a meeting that was held on 17th of August 2002 in Continental Inn Hotel in Taubaté, state of Sao Paulo. A stakeholder's list is available(Annex 8 Stakeholder meeting). Discussed were Kyoto Protocol Concepts & SASA's Landfill Gas Recovery Project. No comments were received.

Since 1999 the "Open House" program has been developed. It is a 2 hours site tour, to show the facility and explain all the activities developed by SASA. Most of the stakeholders invited for this meeting, have participated SASA's "Open House" program.

G.2. Summary of the comments received:

There were no comments received.

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

No action was taken, as there were no comments received.

ANNEX 1 CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

See A.3

ANNEX 2 INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved.

ANNEX 3 NEW CERUPT BASELINE METHODOLOGY

1. Title of the proposed methodology:

CERUPT methodology for landfill gas recovery

2. Description of the methodology:

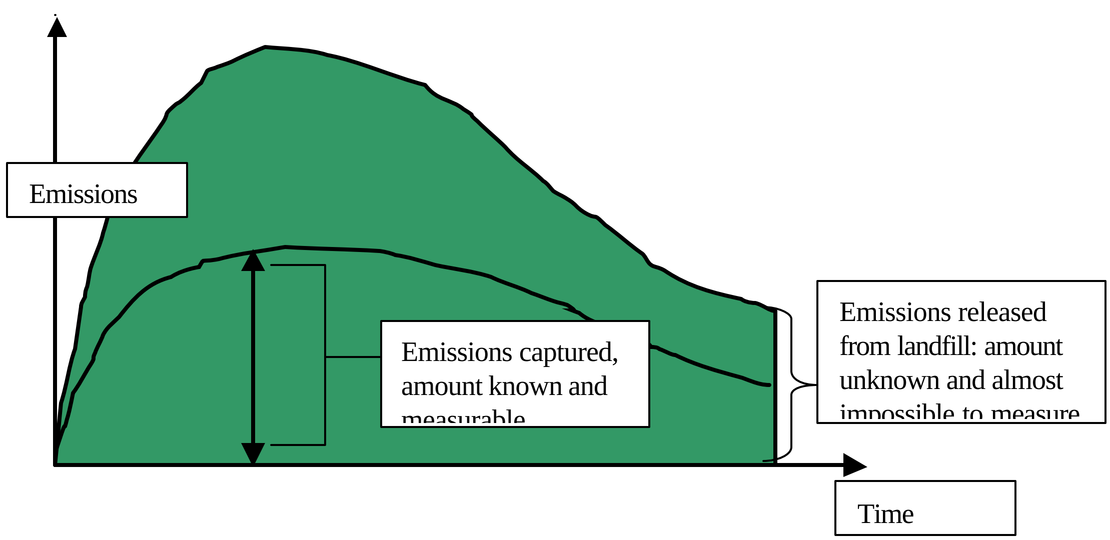
2.1. General approach *(Please check the appropriate option(s))*

? Existing actual or historical emissions, as applicable;

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

? The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.

2.2. Overall description (other characteristics of the approach):
Recovery of LFG, a mixture of mostly methane (CH_4) and CO_2, is an effective way to reduce the emissions released by a landfill. For landfill projects it is almost impossible to assess what emissions would have taken place without the project. This is illustrated in the picture below. The many uncertainties and unknown parameters explain why determining the size of such emissions is difficult, even if a measuring system exists. Therefore, as a starting point it is accepted for LFG CDM projects to use the volume of the LFG actually captured as a conservative indication of the volume of gas(es) that would have been emitted without the project.



The main GHG gas from landfills is CH_4. Following the IPCC approach in their Inventory Guidelines, the CH_4 originates from organic material that can be classified as biomass. The CO2 emissions resulting from the burning of this CH_4 therefore do not have to be accounted for in the national GHG Emission Inventory of the host country, but only have to be reported. However, emissions from fuels used to initiate or sustain the combustion process of the LFG have to be included in the inventories.

The project developer has to make an estimate on the amount of GHG emissions from the landfill to be released and captured during the crediting period. This includes factors such as the history of the landfill, surface, depth, age, composition of the waste material, the layer structure of the landfill, etc.

This methodology foresees in the determination of a baseline in those cases where no capture of LFG is foreseen. It calculates avoided GHG emissions ex post by measuring the captured methane. In section 6 an financial economic test is used to determine whether this baseline may be applied. This methodology does not provide guidance for projects where methane is partially captured in the baseline scenario.

3. Key parameters/assumptions (including emission factors and activity levels), and data sources considered and used:

In theory, the baseline scenario for a LFG recovery project would be the actual emissions of CH_4 from the landfill if the project were not implemented. The CH_4 emission reduction would then have to be calculated by taking the difference between these baseline emissions and the CH_4 emissions that still remain when the project is operational.

Since there are too many uncertainties connected to an estimation of the (future) CH_4 emissions from a landfill, constructing a realistic baseline can be considered an impossibility. Therefore, another way of working has been chosen:

- The amount of captured CH_4 during the operating of the LFG project is considered to be the best estimate of CH_4 released in absence of the project;
- this amount is determined ex post by measuring and monitoring the project's performance. Key parameters to be monitored are:
    - LFG extracted;
    - amount of CH_4 in extracted LFG;
    - amount of combusted LFG;
    - amount of flared LFG;
    - amount of vented LFG;
    - amount of other fuel used;
    - emission factors from other fuel used;
    - heat produced;
    - electricity produced;
    - heat replaced;
    - electricity replaced;
    - natural gas replaced;
    - grid factors (heat/electricity).
- baseline setting consequently is focussed substantiating that in absence of the project there will be full atmospheric release of CH_4;
- as an estimation tool ex ante, a first order decay model is used to quantify LFG generation. Input parameters in this model are *inter alia*:

- waste disposal rate (ton/yr);
- methane generation potential (m^3/ton), depending on organic carbon content'
- methane generation rate (yr^{-1}), depending on moisture content, current methane rates;
- temperature, waste distribution, waste volume, landfill depth.

Of course, the composition and the amount of waste delivered to the landfill will determine the obtainable amount of LFG. The Dutch Handbook on LFG recovery and the IPCC 1996 Revised Guidelines on Emission Inventory contain useful information for this. These publications provide a number of formulas that can be used to estimate the LFG production over time. Data should further be obtained from the landfill site's management, national or regional policy papers and on site measurements. The user of this methodology should include data sources and references to other documents in a traceable manner. Sources of all data should be public and explicitly mentioned in the PDD so that they can be verified. If non-public data are used, it should be motivated why; such data can only be accepted if verifiable by the validation/verification body

4. Definition of the project boundary related to the baseline methodology:

(Please describe and justify the project boundary bearing in mind that it shall encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the project activity. Please describe and justify which gases and sources included in Annex A of the Kyoto Protocol are included in the boundary and outside the boundary.)

The project boundary shall encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the project.

Step 4.1 Make Flowchart
Make a flowchart describing which components of the current system are influenced by the project.

A flowchart of an LFG capture project should look like the next figure distinguishing three major phases, upstream, utilisation, and downstream.

The upstream phase consists of the waste collecting, sorting or treatment and transportation to the landfill. Do not include emissions from this part even if the situation after the project implementation differs from the current situation. GHG emissions from transportation should not be included if for instance more organic material is collected at the waste producers, i.e. by enforced sorting of waste or by adding additional waste sources. Transport emissions are to be excluded because they lay beyond the control of the project developer, even if the project activity (amount of gas recovered) depends on it.

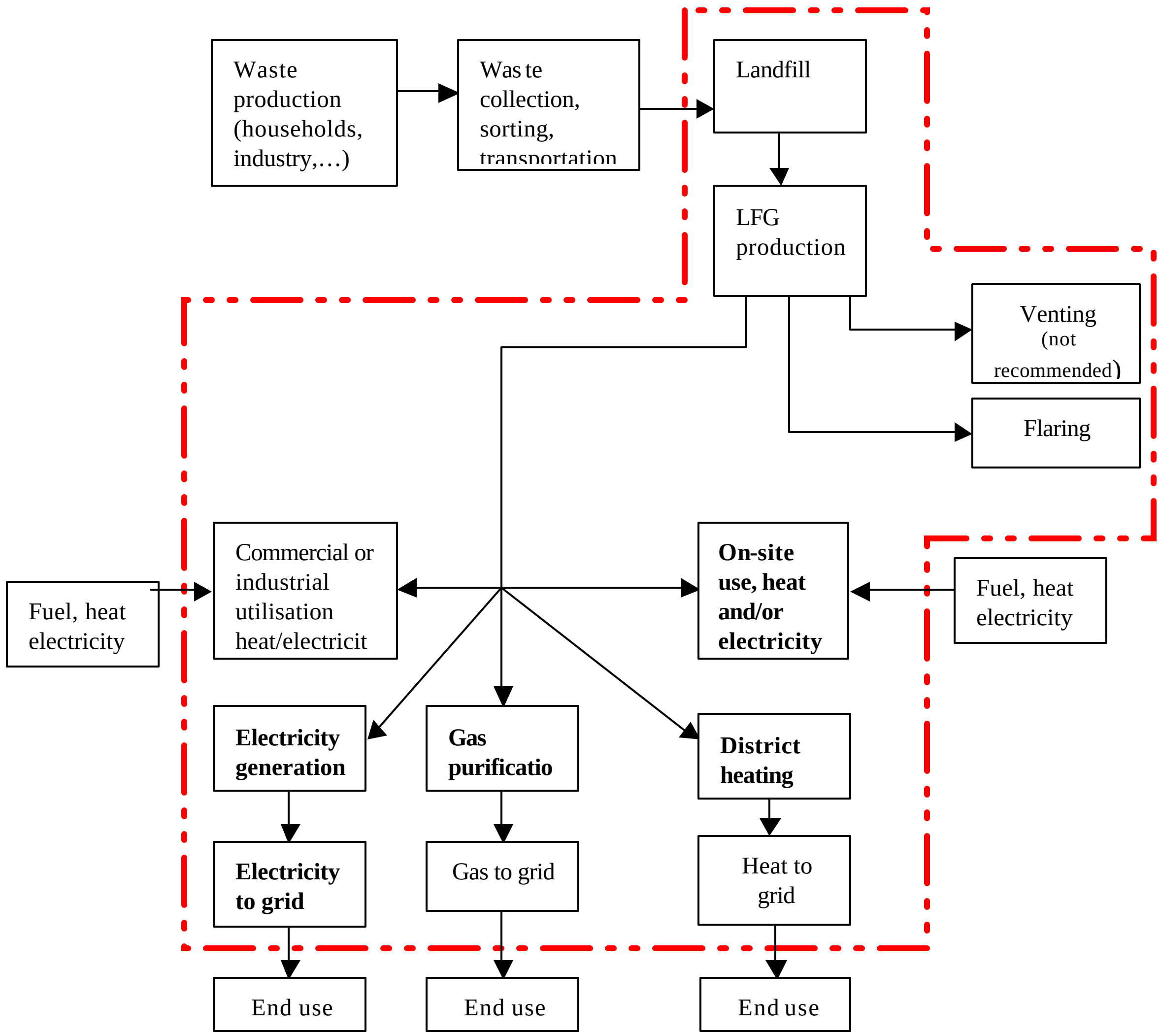


Figure 2: Flowchart of a LFG recovery project; the dashed line indicates the project boundary

The LFG captured (mostly CH_4) can be used in different ways to recover its energy.

On-site use of LFG may include:

- a flaring device where the gas is burned;
- direct utilisation for heating or other purposes (e.g. evaporation of leachate);
- combustion processes (engines, heaters, boilers) for electricity and heat production;
- the upgrading to natural gas quality for grid feeding.

Off-site options for the use of gas are:

- pipeline gas transportation to a nearby commercial or industrial application;
- pipeline gas transportation to a nearby combustion unit where heat and/or electricity for grid feeding is produced.

Step 4.2. Calculate Direct and Indirect Emissions
List all the on-site emissions or absorption in the project and in the current situation. This includes e.g.:

- Emissions from fuel combustion and process emissions on the site of the project;
- LFG vented.

List all the relevant off-site emissions in the project and in the current situation. This includes at least emissions from the power produced in the current situation, which is displaced by the project (if the project aims to generate electricity from the captured methane).

All Kyoto Protocol greenhouse gases (CO_2, CH_4, N_2O, SF_6, HFCs and PFCs) should be separately listed. Emissions that contribute less than 1 percent to the total baseline emission should not be discounted for. In practice, often only CH_4 and CO_2 apply at landfills.

Determine if the emissions are direct or indirect. Direct emissions are under direct influence and control of the project developer, indirect emissions are not. Indirect effects are usually referred to as leakages, because they are considered to occur outside the project boundary (see also Section 7).

Step 4.3. Determine Project boundaries
Make a selection which emissions are included in the project boundary. If the extracted gas is used in a combustion process (engine, turbines or boiler), the emissions of the co-fired fuel (for ignition (engines) or for sustaining the combustion process (turbines and boilers)) have to be subtracted from the emission reduction. Attention should be given to emissions from back-up units that will be installed to secure the delivered service by the LFG recovery project. Energy used for transport or process of the LFG on site (fans, compressors, heaters and coolers) will also need to be taken into account.

Some other effects have to be added to (reductions) or subtracted (emissions) from this amount:

- leakage emissions from the on-site utilisation application
- emissions linked to the energy used for preparing the gas for final use
- emissions of auxiliary and back-up fuels for combustion of the recovered gas
- emission reductions through replaced heat or electricity production.

Determine the project boundary and draw those in the project flowchart. The boundary should include all emissions selected in the previous step. Equivalent boundaries should be used for both the calculations of the baseline emissions and of the project emissions.

5. Assessment of uncertainties:

(Please indicate uncertainty factors and how those uncertainties are to be addressed)

The main uncertainty in LFG projects is the (im-)possibility to predict future emission levels, LFG production levels and LFG extraction efficiency, which are depending on a large number of practical and operational factors.

As the baseline emissions are determined by measuring the real amount of extracted LFG, this uncertainty does not affect the choice of the baseline scenario.

6. Description of how the baseline methodology addresses the calculation of baseline emissions and the determination of project additionality:

(Formulae and algorithms used in section E)

Conceptually, a difference may exist between establishing baseline emissions and determining whether the proposed project activity is additional. This methodology emphasises the use of economic and financial criteria to determine whether the proposed project activity is additional and next a key factor analysis to establish the baseline scenario and calculate baseline emissions. Sequence in the analysis is:
- determine project additionality;
- determine baseline scenario.

The estimation of baseline emissions as such is not so relevant for LFG CDM projects. Emissions reductions here are defined as avoided methane emissions that are per definition determined ex post by monitoring the amount of LFG extracted. This methodology however chooses to give some guidance to the estimation of baseline emissions as it plays a crucial role in the trade ex ante of CERs from these projects. Steps to be followed after determining project additionality are hence:
- estimate baseline emissions;
- estimate project emissions;
- estimate emission reductions.

Determine Project Additionality
Paragraph 43 of the Marrakech accords describes how to determine project additionality: A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity.

Additionality testing for LFG projects entails three steps:
1. Assessment of legal requirements
2. Assessment of economic attractive courses of action
3. Assessment of barriers and common practice.

Ad 1 – Assessment of legal requirements
An LFG recovery project is not additional if it complies with any existing or foreseeable – at least for the duration of the crediting time – legislation. The project developer must state whether capturing CH_4 from landfills in any way is prescribed by any legislation or will/may be prescribed in the future. Thorough research on the likely future legislation needs to be carried out, preferably by a legal consultant in the host country. If, e.g. such research shows that in 2010 legislation comes into force that makes LFG extraction obligatory, the project is no longer additional from that date, and thus only generate credits until 2010. This can be substantiated by a statement by the local regulator and/or a statement by a relevant professional body.

Ad 2 – Assessment of economic attractive course of action
CH_4 is transformed partially into CO_2 when it makes its way through the landfill to the surface. Covering a landfill with a layer of topsoil creates an extra oxidation layer in which the CH_4 is transformed to CO_2, thus reducing the amount of CH_4 actually released. An extraction system that operates under less than atmospheric pressure will extract more CH_4 than the natural undisturbed release. The project developer should examine such effects, and provide evidence about what the likely amount of released CH_4 would have been without the project.

The project developer must show that the situation without the project would have implied full atmospheric release. Scenarios to be considered include, but are not limited to:

- a scenario without recovery;
- a scenario where a modified amount of LFG is extracted;
- a scenario with air or O_2 injection in the landfill;
- a scenario with a changed/changing waste composition;
- a scenario with an other on-site LFG use;
- a scenario with an other off-site LFG use;
- a scenario in which the project is deferred with five years;
- a scenario with combinations of the above;
- the project scenario.

These scenarios must then be compared by making a long term cost calculation, assuming no or little income from electricity generation. In case income from electricity generation is considerable, IRR calculation should be used.
If the economic or financial analysis shows that the proposed CDM project activity has higher cost c.q. lower IRR than one of the other scenarios, it is considered to be additional

Ad 3 - Assessment of barriers and common practice
In cases that the CDM project activity raises income from electricity generation, financial analysis might point out that the project scenario has higher IRR than one of the other scenarios.
However, situations exist that justify that "the proposed CDM project activity" is additional even if it is the most attractive course of action based on the economic or financial analysis. This methodology identifies two procedures to determine that without the ability to register under the CDM, the proposed project activity would be, or would have been, unlikely to occur.

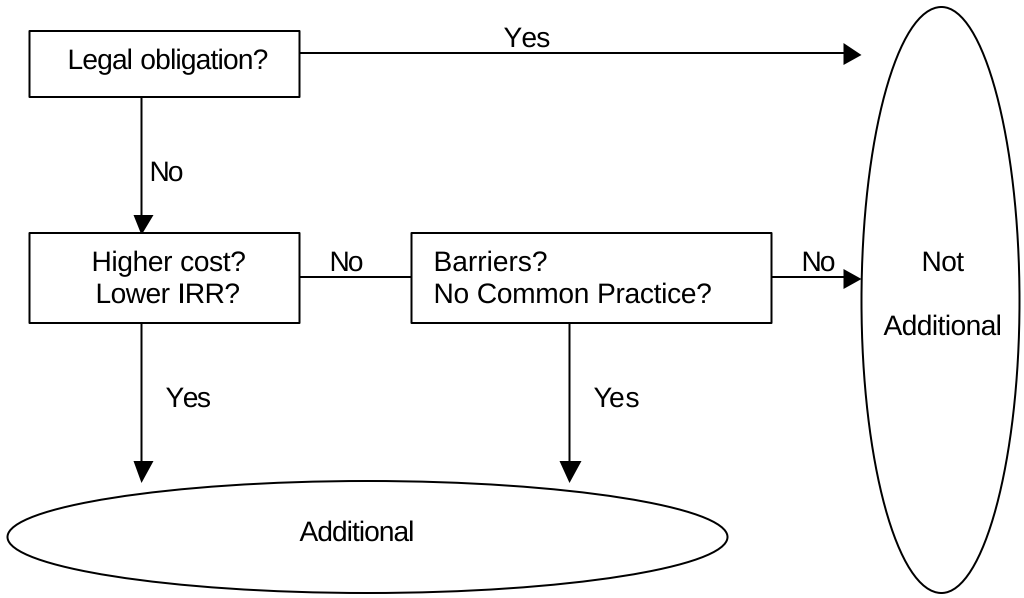
Barriers
Barriers to investment can require that the risks of the proposed project be mitigated by relying on benefits related to registration of the proposed project activity under the CDM. Such barriers can be identified in countries where no developed markets exist. Barriers must be clearly identified, justified, and documented.

Possible barriers are:

(a) Investment barrier: the absence of access to capital in undeveloped markets to finance the proposed project activity would have led to higher emissions;
(b) Technological barrier: a less technologically advanced alternative to the project activity involves lower risks due to the performance uncertainty or low market share of the new technology adopted for the project activity and so would have led to higher emissions;
(c) Barrier due to prevailing practice: prevailing practice or existing regulatory or policy requirements would have led to implementation of a technology with higher emissions;
(d) Other barriers: without the project activity, for another specific reason identified by the project participant, such as institutional barriers or limited information, managerial resources, organizational capacity, financial resources, or capacity to absorb new technologies, emissions would have been higher.

Common Practice
A project that is economically the most attractive course of action can be additional if there is an indication that the project type is not common practice (e.g. occurs in less than 5 percent of similar cases) in the proposed area of implementation, and is not required by recent/pending legislation/regulations.

The scheme visualises additionality testing in this methodology.



Select baseline scenario
The baseline scenario is the scenario that is most likely to occur in absence of the proposed project. I.e. from the above analysis it is either:

- the scenario with the lowest cost / highest IRR;
- the scenario that would occur after considering common practice or the barriers to investment.

In case the baseline scenario reflects a situation with full atmospheric release of CH_4, baseline emissions are calculated as the amount of LFG captured and measured ex post. Current production and delivery patterns provide the starting point for defining the baseline scenario and a reference point for monitoring activities.

In case the baseline scenario foresees any capture of CH_4, a percentage should be calculated. This methodology does not provide this calculation and is therefore not applicable to these situations.

Estimating baseline emissions
In LFG projects baseline emissions are determined ex post by monitoring the amount of LFG extracted. As such the estimation of baseline emissions ex ante as part of the PDD is not so relevant.
However, in order to facilitate forward sale of CERs from these projects, this methodology gives some guidance for estimating emission reductions. The user of this methodology however should feel free to use other estimation methods.

A simple first model decay model[1] can be used for the estimation of methane to be emitted through time.

$$Q_x = L_0 R\left(e^{-kc} - e^{-kt}\right) \quad \textbf{(A3.1)}$$

[1] Revised 1996 IPCC Guidelines for National Greenhouse Gas inventories: Reference Manual, Chapter 6, Waste

In which

Q_x = total methane released in year x (m^3/yr)

L_0 = theoretic potential amount of methane generated (m^3/ton). This amount is dependent on the composition of the waste and may vary from less than 100 t o over 200 m^3/ton.

R = waste disposal rate (ton/yr)

t= time since landfill opened (yrs)

c= time since landfill closed (yrs)

k = rate of landfill gas generation (yr^{-1}). Values may range from less than 0.005 to 0.4 per year. Higher k values are associated with greater moisture content. In case of an existing landfill, the current amount of methane emitted from the land fill can be estimated by measuring the methane flow on several locations and extrapolating these data tot the total landfill. Using these data, a more accurate estimate of k can be made.

To be able to estimate the variables for this model, the user of this methodology should compare the sites with comparable .

An upgrade of this first order decay model is preferred if available, making use of site-specific characteristics, e.g. temperature in landfill, waste composition, landfill depth etc .

To calculate the methane emissions expressed in tonnes per yr the following formula is used.

$$M = \frac{0.016 * Q_x}{22.4} \qquad \textbf{(A3.2)}$$

In which

M = methane emissions (ton/yr)

0.016 = molecular weight methane (ton/kmol)

22.4 = molecular volume at 0 °C(m^3/kmol) (to be adapted for different temperatures)

Q_x = total methane generated in year x (m^3/yr)

The greenhouse gas emissions are calculated as follo ws:

$$\mathbf{GHG_b = 21 * M_b} \qquad \textbf{(A3.3)}$$

In which

GHG_b = Baseline GHG emissions (ton CO_2e/yr)

21= GWP of methane (ton CO_2e/ton methane)[2]

M= methane emissions in baseline situation (ton/yr)

Estimating Project Emissions

To determine the project emissions, first it is estimated how much of the emitted methane will be recovered. The rate of landfill gas recovery generally ranges between 50 and 90 percent of the total emission. A description is given on how this rate is determined, as it is strongly dependent on the technologies used and the way the landfill will be filled. The following formulae are used to estimate the greenhouse gas emission in the project situation:

$$\mathbf{Q_c = E * Q_x} \qquad \textbf{(A3.4)}$$

In which

Q_c = total methane recovered in year x (m^3/yr)

Q_x = total me thane released in year x (m^3/yr)

E = extraction efficiency (%)

$$\mathbf{Q_p = Q_x - Q_c} \qquad \textbf{(A3.5)}$$

[2] Revised 1996 IPCC Guidelines for National Greenhouse Gas inventories.

Q_p = total methane emitted in project situation in year x (m^3/yr)
Q_x = total methane released in year x (m^3/yr)
Q_c = total methane recovered in year x (m^3/yr)

To calculate the methane emissions expressed in ton per yr the following formula is used.

$$M_p = \frac{0.016 * Q_p}{22.4} \quad \text{(A3.6)}$$

In which
M_p = methane emissions in project situation(ton/yr)
0.016 = molecular weight methane (ton/kmol)
22.4 = molecular volume at 0 °C(m^3/kmol) (to be adapted for different temperatures)
Q_p = total methane emitted in year x (m^3/yr)

The greenhouse gas emissions are calculated as follows:

$$GHG_p = 21 * M_p \quad \text{(A3.7)}$$

In which
GHG_p = project GHG emissions (ton CO_2e/yr)
21= GWP of methane (ton CO_2e/ton methane)[3]
M_b= methane emissions in project situation (ton/yr)

Actual project emissions are dependent on the use of the recovered methane. If the methane is combusted (e.g. flared), the methane is reacting to form CO2. However, methane originates from the organic material that can be classified as biomass. The CO2 emissions resulting from the flaring of this methane therefore do not have to be accounted for.

In case other significant greenhouse gas emissions arise within the selected project boundary, e.g. from the use of fuel for the ignition of a flare, these have to be calculated as well.

If the methane is used for the production of electricity, additional emission reductions will be the result, mostly off-site. It is possible that the project will displace the power from other existing power plants, or that the project will make an investment in a new power plant unnecessary. Dependent on the situation, an accepted baseline methodology for electricity projects should be chosen to determine the additional emission reductions by the production of electricity using methane.

Estimate Emission Reductions

The estimated emission reductions are calculated. Yearly emission reductions are estimated by distracting the project emissions with the baseline emissions. It is acceptable to assume that the volume of methane actually recovered is an indication of the volume of methane that would have been emitted without the project. This volume will be monitored.

7. Description of how the baseline methodology addresses any potential leakage of the project activity:

(Please note: Leakage is defined as the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary and which is measurable and attributable to the CDM project activity.)

(Formulae and algorithms used in section E.5)

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[3] Revised 1996 IPCC Guidelines for National Greenhouse Gas inventories.

For landfill gas recovery projects, no leakage risk is identified, as landfill operation is considered a closed system that does not influence off-site emissions.

8. Criteria used in developing the proposed baseline methodology, including an explanation of how the baseline methodology was developed in a transparent and conservative manner:

The purpose of a baseline study is to provide a transparent picture of what would be emitted without the project, (construction of a baseline scenario) and what the project emissions are expected to be. With this an assessment emissions reductions can be made. A key requirement is that the emission reduction from the CDM proje ct is *real, measurable and long-term.*

The study should be specified in such a manner that it provides a complete understanding of the assessment and calculation process.

Consequently, a baseline study document:

- Clearly, correctly and completely describes the reference case of greenhouse gas emissions without implementation of the project, including a description and justification of all assumptions and calculations as well as the underlying data and references.
- Clearly, correctly and completely describes the project and the factors causing and influencing greenhouse gas emissions (reduction) of the project, including a description and justification of all assumptions and calculations.
- Clearly and correctly defines project boundaries, including the assumptions and method for defining such boundaries.
- Identifies and describes the potential size and impact of any relevant foreseeable indirect greenhouse gas emissions outside the project's boundaries.
- Includes data sources and references to other documents in a traceable manner.
- Clearly presents the baseline calculations and the underlying data to the validator separately. This happens in such an orderly manner (preferably in a spreadsheet file) that not only recalculation can be easily carried out, but also that any sensitivity analysis the project developer has done in determining the most feasible baseline can easily be repeated by the validator.

The following key concepts (presented in alphabetical order) have been used as guidance for the establishment of this methodology and should be used when a baseline study is prepared, for validation as well as for monitoring, reporting and verification purposes.

Comparability
Emissions' projections should be comparable between their calculated carbon emission factors for the baseline scenario and for the project on the one hand, and for the calculated baseline carbon emission factors for similar projects on the other hand. This should enable validators/verifiers to compare the real project emissions with the baseline emissions, and to determine a baseline's further applicability for comparable projects. To enhance comparability, project developers should use the methodologies and formats as provided in these guidelines.

Conservatism
Estimates should always be made conservative. E.g. for determining an estimate of the annual activity level, if feasible, the lower parameter value based on a 95% confidence interval (the expected average value minus twice the standard deviation if a normal distribution applies) should be used. In case choices

are to be made between two equally plausible courses of action, the one resulting in the lowest emission reductions should be chosen.

Consistency
The monitoring plan should address the same key factors as used to calculate the project emissions' estimates to allow for a consistent review of performance indicators over time. To guarantee consistency with the validation/verification stage, to the extent possible, the methodologies and measurements identified in the baseline study should also be addressed in the monitoring plan.

Practicability
Approaches employed for project documentation, implementation, monitoring, reporting, validation and verification should be based on simple, well-tested and functional principles.

Reliability
For the estimation of emission reductions from project-based activities the most likely development shall be chosen as reference case. The baseline estimate should be subject to validation by operational/independent entities as appropriate.

Transparency
Assumptions, calculations, references and methodologies used for baseline setting and for the estimation of emission reductions from project-based activities shall be clearly explained and described to facilitate replication and assessment of the baseline estimation by validator or verifier. Sources of all data should be public and explicitly mentioned in the documentation so that they can be verified. If non-public data are used, it should be motivated why; such data can only be accepted if they are verifiable by the validator /verificator.

Validity of the baseline
The validity of the baseline can only be ensured if it is based on a clearly motivated scenario which is the most likely one, given the current knowledge about to-be-expected legal and institutional reforms, technological developments, policy developments, and other new developments affecting future emission patterns relevant for the project. These factors are covered by the list of key factors as described to be discussed in the project description.

9. Assessment of strengths and weaknesses of the baseline methodology:

The following strengths of the methodology are identified:

- Because the baseline emissions are determined ex post, consequently reflecting the most probable GHG reductions;
- The methodology results in just one –realistic, credible and probable - baseline scenario.
- Determining additionality is easy, once the baseline scenario and related baseline carbon emissions factor have been set.

The following weaknesses of the methodology are identified:

- GHG reductions can not be determined beforehand;
- the methodology does not consider partial capture of CH_4 in the baseline scenario.

10. Other considerations, such as a description of how national and/or sectoral policies and

circumstances have been taken into account:

The CERUPT methodology for landfill gas recovery considers how national and /or sectoral policies affect the extraction and capture of LFG. The project developer should analyse the present and expected legal requirements thoroughly in step 6 of this methodology.

Annex 3.1 Glossary of terms

Activity level:
Output level per year of the proposed project, expressed in e.g. GWh/yr.
Additionality:
A project activity is additional if greenhouse gas emissions with the project activity are lower than those hat would have occurred in the absence of the proposed project activity
Baseline:
The baseline for a CDM project activity is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity. A baseline shall cover emissions from all gases(of gases), sectors and source categories listed in Annex A (of the Kyoto Protocol) within the project boundary. A baseline shall be deemed to reasonably represent the anthropogenic emissions by sources that would occur in the absence of the proposed project activity if it is derived using a baseline methodology referred to in paragraphs 37 and 38 of the CDM modalities and procedures.
Baseline approach:
A baseline approach as described in para. 48 MA is the basis for a baseline methodology.
Baseline carbon emission factor (cef):
Greenhouse gas emissions per output unit in a certain year that would occur in the absence of the proposed project activity, usually expressed in kton CO_2eq/kWh (or other unit of output)
Baseline emissions
Greenhouse gas emissions per year that would occur in the absence of the proposed project activity, usually expressed in kton CO_2eq/yr.
Baseline methodology
A methodology is an application of an approach or a combination of approaches as defined in paragraph 48 of the CDM modalities and procedures, to an individual project activity, reflecting aspects such as sector and region.
Fixed carbon emission factor
A baseline carbon emission factor that is not recalculated during the crediting period. The level of the carbon emission factor can vary over time, so fixed does not mean constant.
Global warming potential
The ratio of global warming from one unit mass of a greenhouse gas to that of one unit mass of carbon dioxide over hundred years
Key Factor
Those factors that significantly influence the future situation within a sector/country/project, thus determining the baseline scenario
Leakage:
Leakage is defined as the net change of anthropogenic emissions by sources of greenhouse gases which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity.
Measurable and attributable
In an operational context, the terms measurable and attributable in paragraph 51 (project boundary) of the CDM modalities and procedures should be read as “which can be measured” and “directly attributable”, respectively
Monitoring of a CDM project activity:
Monitoring refers to the collection and archiving of all relevant data necessary for determining the baseline, measuring anthropogenic emissions by sources of greenhouse gases within the project boundary of a CDM project activity and leakage, as applicable.
Off-site
Not on the physical location of the project

On-site
On the physical location of the project

Project activity:
A project activity is a measure, operation or an action that aims at reducing greenhouse gases emissions. The Kyoto Protocol and the CDM modalities and procedures use the term “project activity” as opposed to “project”. A project activity could, therefore, be identical with or a component or aspect of a project undertaken or planned.

Project boundary:
The project boundary shall encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that are significant and reasonably attributable to the CDM project activity.

Scenario
An account or synopsis of a possible course of action or events.

Significant
Greenhouse gas emissions from a source are considered to be significant if they account to at least one percent of the total baseline emissions expressed in kton CO_2 equivalent.

Small Scale Project electricity project:
Renewable energy project activities with a maximum output capacity equivalent of up to 15 MW (or an appropriate equivalent)

Transparent and conservative:
Establishing a baseline in a transparent and conservative manner (paragraph 45 (b) of the CDM modalities and procedures) means that assumptions are made explicitly and choices are substantiated. In case of uncertainty regarding values of variables and parameters, the establishment of a baseline is considered conservative if the resulting projection of the baseline does not lead to an overestimation of emission reductions attributable to a CDM project activity (that is, in the case of doubt, values that generate a lower baseline projection shall be used).

ANNEX 4 NEW CERUPT MONITORING METHODOLOGY

Proposed new monitoring methodology

CERUPT monitoring methodology for land fill gas recovery

1. Brief description of new methodology

The CERUPT monitoring methodology for land fill gas recovery is designed primarily to be used in relation with the CERUPT methodology for landfill gas recovery. It is acceptable to assume that the volume of LFG actually recovered is an indication of the volume of gas that would have been emitted without the project. This will be monitored.

2. Data to be collected or used in order to monitor emissions from the project activity and how this data will be archived

The emission reductions are defined as the difference of emissions in the baseline situation and in the project situuation. This means that all landfill gas emissions that are recovered and combusted lead to emission reductions.

$$\mathbf{Q_x = concentration\, Q_c} \qquad \textbf{(A4.1)}$$

Q_c = total landfill gas recovered in year x (m^3/yr)
Concentration = % of methane in landfill gas (measured
Q_x = total methane recovered in year x (m^3/yr)

To calculate the methane emissions expressed in ton per yr the following formula is used.

$$\mathbf{M} = \frac{\mathbf{0.016*Q_p}}{\mathbf{22.4}} \qquad \textbf{(A4.2)}$$

In which
M = methane recovered (ton/yr)
0.016 = molecular weight methane (ton/kmol)
22.4 = molecular volume at 0 °C(m^3/kmol)
Q_x = total methane recovered in year x (m^3/yr)

The greenhouse gas emission reductions are calculated as follows:

$GHG = 21 * M$ **(A4.3)**

In which

GHG = GHG emission reductions (ton CO_2e/yr)

21= GWP of methane (ton CO_2e/ton methane)[4]

M= methane recovered (ton/yr)

Please add rows to the table below, as needed)

ID number *(Please use numbers to ease cross-referencing to table 5)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?	Comment
1	*Landfill gas recoverd (Q)*		*m3/hr*	*m*		*100%*	*Paper or electronic*	*Two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later)*	*See par. 4*
2	*Landfill gas comp osit iot*		*% CO2 and % CH4r*	*m*		*100%*	*Paper of electronic*	*Two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later)*	*See par. 4*
3	*LFG flared*		*M3/hr*	*m*		*100%*	*Paper or electronic*	*Two years after the end of the crediting period or the last*	*See par. 4*

[4] Revised 1996 IPCC Guidelines for National Greenhouse Gas inventories.

								issuance of CERs for this project activity, whatever occurs later)	
4	*LFG vented*		*M3/hr*	*m*		*100%*	*Paper or electronic*	*Two years after the end of the crediting period or the last issuance of CERs for this project activity, whatever occurs later)*	*See par. 4*

In the monitoring plan it should be clearly identified the frequency of, responsibility and authority for registration, monitoring and measurement activities. In the monitoring plan the project organisation should describe the methods it will employ for data registration, monitoring, measurement and calibration.

Wherever possible internationally recognised methods for monitoring, measurement and calibration should be applied. When other methods are used, the project organisation shall clearly establish conformity or correlation between the methods used and internationally recognised methods.

Records proving method validity and accuracy shall be kept and be available on request.

3. Potential sources of emissions which are significant and reasonably attributable to the project activity, but which are not included in the project boundary, and identification if and how data will be collected and archived on these emission sources

(Please add rows to the table below, as needed.)

ID number *(Please use numbers to ease cross-referencing to table 5)*	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	For how long is archived data kept?	Comment

Monitoring of indicators must ensure that the indicators are reliable. Reliability means that the indicators give consistent and accurate values/readings when they are measured by the determined method.

For project leakage indicators, business-linked indicators are not likely to be available for all purposes. Projects generally will be less in control of the measurement and/or monitoring of leakage effects than of variables with direct impact on project operations. The nature of the project will determine the need and possibility to estimate project leakage. Data from suppliers/utilities may be of help to monitor and report leakage effects, as well as available public statistics. Specific surveys with the aim to monitor and estimate project leakage, *e.g.* in energy efficiency projects, may also be required.

4. Assumptions used in elaborating the new methodology:
(Please list information used in the calculation of emissions which is not measured or calculated, e.g. use of any default emission factors)

5. Please indicate whether quality control (QC) and quality assurance (QA) procedures are being undertaken for the items monitored. *(see tables in sections 2 and 3 above)*

Data *(Indicate table and ID number e.g. 3.-1; 3.-2.)*	Uncertainty level of data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.

Where applicable the methods used for quality assurance of monitoring and measurement activities should be described. Where deemed necessary accredited laboratories or inspection bodies should be used for monitoring and/or measurement.

Where statistical techniques are used for recording, monitoring and measurement these shall be documented and used in a conservative manner.

6. What are the potential strengths and weaknesses of this methodology? *(please outline how the accuracy and completeness of the new methodology compares to that of approved methodologies).*

The strength of this methodology is that the monitoring and verification activities are relatively low. This results in relatively low costs for monitoring and validation.

7. Has the methodology been applied successfully elsewhere and, if so, in which circumstances?
After completing above, please continue filling sub-sections D.2. and following.

Up until the moment this methodology has been submitted to the EB, it has not been used before.

ANNEX 5 TABLE BASELINE DATA

Please see E.1 for a description of data used for estimation of emission reductions.

The estimated quantity and composition of waste deposited at the SASA landfill is based on the actual amounts in the years 1996-2000. The expected organic content of the waste is determined by using biographical data and measurements in laboratory column test.
The expected methane generation decay rate is based on the results of the research project “BIOSAR” conducted by Geolia and CREED, Onyx Research and Development Division.

ANNEX 6 LETTERS FROM THE ENVIRONMENTAL REGULATOR CETESB

ANNEX 7 LETTER FROM THE ASSOCIATION OF RESIDUE TREATMENT FACILITIES

ANNEX 8 STAKEHOLDER MEETING