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:

León Landfill Gas to Energy Project (the "Project")
Version: Document Version Number 1.
Date: 14/05/2008

A.2. Description of the project activity:

The León Landfill Gas Combustion Project (hereafter, the "Project") developed by Técnicas Medioambientales de México, S.A. de CV (hereafter referred to as the "Project Developer") is a landfill gas (LFG) collection and utilisation project taking place at the La Reserva landfills at the city of León, Mexico, hereafter referred to as the "Host Country". The project will have an electricity component with an installed capacity between 1 and 2 MW.

The location of the project is in the city of León that pertains to Guanajuato Departament. The León landfill was opened in 1986, operated as an open dump from 1986 until 2001 receiving municipal waste from the city of León. The amount of waste placed in the landfill is approximately 6 million tonnes, the landfill has been filled at a rate of about 1.600 ton/day. Currently the landfill operator is only passively venting ant the collected gas produced in the landfill is not burned.

The objective of the Project is to collect and flare the LFG generated at the León landfill, this will involve investing in a highly efficient gas collection system, flaring equipment, and a modular electricity generation plant. The engines will combust the methane in the LFG to produce electricity for export to the regional grid. Excess LFG, and all gas collected during periods when electricity is not produced, will be flared. Emission reductions are estimated at 99.299 tonnes of CO_{2e} / year over the lifetime of the Project.

The site operations at La Reserva landfill is a concession by the León City Council to Técnicas Medioambientales de México, S.A. de CV.

The Project will have several positive social and environmental impacts:

- First, properly collecting and destroying flammable LFG will reduce the risks associated with explosions in and around the landfill. This is particularly important as the LFG collection system will minimise the potential for LFG migration, which can infiltrate zones outside of the landfill's boundaries and pose dangers to the surrounding population and structures.
- Second, the destruction of the LFG will improve the local environment by reducing the amount of noxious air pollution arising from the landfill, resulting in a considerable reduction of nuisance caused by the odours and also health risks associated to these emissions, especially for the surrounding population located nearby La Reserva landfill.
- Third, the project will provide a model for managing LFG, a key element in improving landfill management practices throughout the Host Country.
- Fourth, the project will act as a clean technology demonstration project, encouraging less dependency on grid-supplied electricity, and will represent a technology transfer from the USA (equipment supplier) to the Host Country.

- Fifth, the project will provide for both short- and long-term employment opportunities for local people. Local contractors and labourers will be required for construction, and long-term staff will be used to operate and maintain the system.
- Finally, by paying the local authority a royalty fee from the sale of the carbon credits, the project will be injecting capital into the local economy, and its use will be entirely decided upon by the local authority.

The Project is helping the Host Country fulfil its goals of promoting sustainable development. Specifically, the project:

- Increases employment opportunities in the area where the project is located;
- Diversifies the sources of electricity generation;
- Uses clean and efficient technologies, and conserves natural resources;
- Acts as a clean technology demonstration project, encouraging development of modern and more efficient generation of electricity using landfill gas throughout the Country;
- Optimises the use of natural resources; and
- Improves the overall management practices of the landfill.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Mexico	TECMED -Técnicas Medioambientales de México, S.A de C.V.	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.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Mexico (the “Host Country”)

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

State of Guanajuato

A.4.1.3. City/Town/Community etc:

Municipality of León.

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

La Reserva landfill is located in the south western part of the Municipality of León. The site is located at the following UTM coordinates:

- North: X=214050;Y=2334750
- South: X=213900;Y=2333850
- East: X=214200; Y=2334000
- West: X=213450; Y=2334150

Figure 1: León Landfill

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

According to Annex A of the Kyoto Protocol, this project fits Sectoral Category 13, Waste Handling and Disposal.

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

In order to maximize LFG recovery rates, and thus GHG emission reductions, an active LFG collection system will need to be installed. The system will consist of a series of vertical and horizontal extraction wells interconnected by header piping. The LFG will be extracted from the landfill by a blower and conducted to a single point for flaring. Some LFG may be burnt to produce electricity. The essential characteristics of the LFG collection and flaring system are listed below:

- Construction of deep and shallow vertical wells in intermediate or closed areas, trying to not interfere with the landfill operation. Depending on future development plans, some horizontal wells might be installed, to capture the gas in areas that continue to be filled.
- Installation of a piping network to include connection to extraction wells, serving the blower/flare station with a specific diameter piping, suitable for the anticipated flow rates.
- Installation of a leachate pumping system to re-inject the excess of leachate to the landfill.
- Installation of a condensate management system. The LFG collection piping will be designed to include self-draining condensate traps and condensate manholes with pumps where necessary.
- Installation of the blower and flaring station. The flaring station will consist of an enclosed flare, purchased from USA, which will enable the measurement of exhaust gas composition (in case it is required).
- Installation of an LFG-fuelled power generator is being considered.

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

Year	Estimation of emission reduction tCO_{2e}
2008	62.250
2009	119.169
2010	114.086
2011	109.270
2012	104.702
2013	100.380
2014	96.264
2015	92.374
2016	80.577
2017	77.058
2018	36.862
Total estimated reductions (tonnes of CO2e)	992.993
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tonnes of CO_{2e})	99.299

Table 1: Estimation of emission reduction at La Reserva landfill, including methane destruction and electricity (from fossil fuel combustion) displacement

A.4.5. Public funding of the project activity:

The project will not receive any public funding from Parties included in Annex I of the UNFCCC.

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 the approved consolidated baseline methodology ACM0001, version 8, December 14, 2007: *"Consolidated baseline and monitoring methodology for landfill gas project activities"*.

For project emissions calculation or emissions reduction associated with electricity generation using landfill gas and eventual project emissions from electricity consumption from the grid, ACM0001 recommends the "Tool to calculate the emission factor for an electricity system", from CDM Executive Board 35th Meeting, Annex 12. This is Version 1 of the Tool.
Also, we used the "Tool to calculate project emissions from electricity consumption", recommended by the Executive Board 32nd Meeting Report, Annex 10. This is Version 1 of the Tool.

For additionality assessment, we used the tool recommended by the CDM Executive Board (as Annex 1 of their 16th Meeting Report) "Tool for the demonstration and assessment of additionality, version 4".
In order to determine the flare efficiency and/or to monitor the flare exhaust gases, we applied the "Tool to determine project emissions from flaring gases containing methane" recommended by the CDM Executive Board 28th Meeting Report, Annex 13.
In order to estimate the potential LFG recovery rate for the landfill, we used the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", recommended by the CDM Executive Board at its 35th Meeting Report, Annex 10.

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

The methodology chosen is applicable to 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. If emissions reductions are claimed for displacing natural gas, project activities may use approved methodologies AM0053.

The proposed project activity corresponds to the first and second of these three alternatives. The collected landfill gas will generally be flared —option a) above— or would be used to produce energy.
Thus, the gas would be used on-site as fuel to generate electricity to meet power requirements of the project itself or for other applications at the landfill site, and for sale to the power grid and municipality. Emissions reductions would be claimed for displacing or avoiding energy from other sources.

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

For the baseline determination, the project boundary is the site of the project activity where the gas will be captured and utilised/destroyed.

According to ACM0001 baseline methodology (gas flaring), the project boundary is the site of the project activity where the gas will be captured and destroyed/used. According to ACM0002 CDM methodology (electricity generation), project boundary should encompass the physical, geographical site of the renewable generation source.

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

- CH_4 emissions from the un-recovered LFG liberated from the landfill sites. It is estimated that only 70% of LFG generated at La Reserva landfill will be captured, which means that the remaining 30%, will be released as fugitive emissions.
- CO_2 from the combustion of landfill gas in the flares and electricity generator. When combusted, methane is converted into CO_2. As the methane is organic in nature these emissions are not counted as project emissions. The CO_2 released during the combustion process was originally fixed via biomass so that the life cycle CO_2 emissions of LFG are zero. The CO_2 released is carbon neutral in the carbon cycle.
- Electricity required for the operation of the project activity should be accounted for in the project emissions and they need to be monitored. However, as the project activity involves electricity generation and uses electricity generated from LFG, only the net quantity of electricity fed into the grid should be used to account for emission reductions due to displacement of electricity in other power plants.

For the determination of baseline emissions of the electricity generation component of the project, the project boundary will account for the CO_2 emissions from electricity generation in fossil fuel power stations operating in the Project grid system, which will be displaced by the Project activity. The spatial extent of the project boundary is defined as the project site and the plants connected to the grid system to which the project will be connected.

A full flow diagram of the project boundaries is presented in the figure below. The flow diagram comprises all possible elements of the LFG collection systems and the equipment for electricity generation.

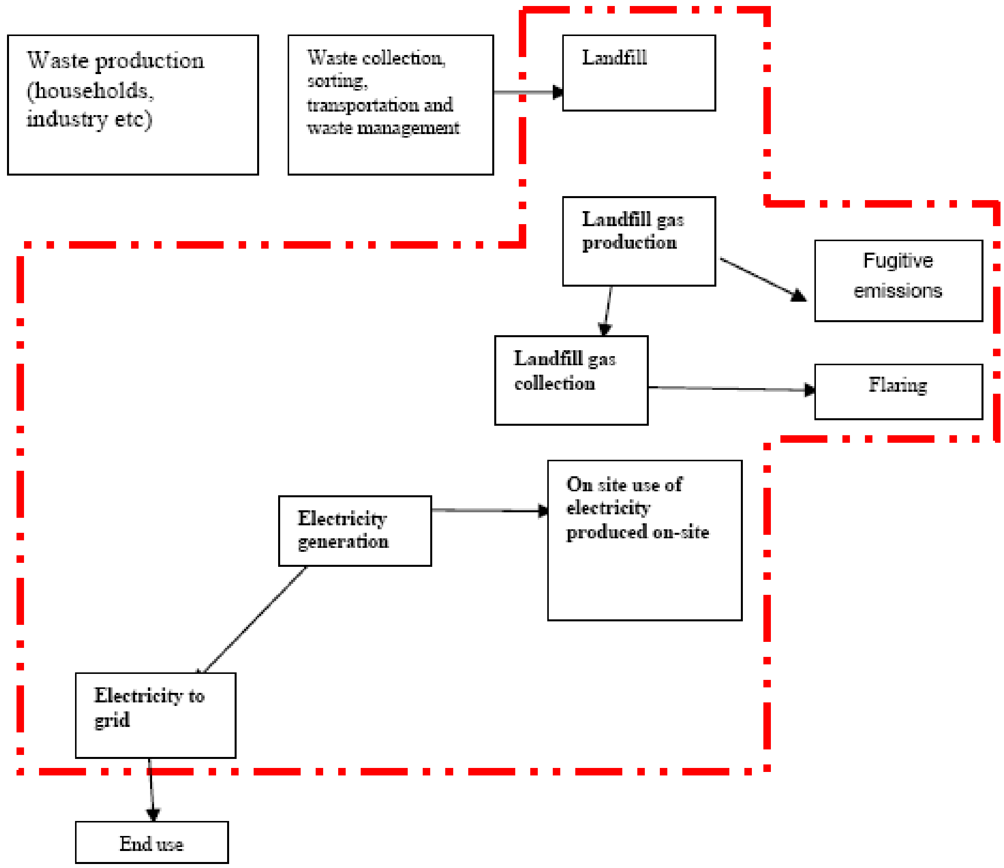

Figure 2: Flow chart of projects boundaries (staggered line indicates boundaries)

	Source	Gas	Included?	Justification/Explanation
Baseline	Emissions from decomposition of waste at the landfill site (Passive LFG venting and no flaring)	CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted.
		CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N_2O emissions are very small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
Project Activity	Emissions from on-site electricity use (Active LFG capture and flaring)	CO_2	Yes	May be an important emission source.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
	LFG combustion for power generation	CO_2	No	It is not considered because it is part of the natural carbon cycle.
		CH_4	Yes	Included as main component of LFG.
		N_2O	No	Not applicable

Table 2: Summary of gases and sources included in the project boundary, and justification/explanation where gases and sources are not included.

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

The methodology will be applied by using options a) and b) of the consolidated methodology ACM0001:
a) The captured gas is flared; and/or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy);

ACM0001 requires the use of the "*Tool for demonstration and assessment of additionality*" to demonstrate that the project is not the baseline scenario and the use of the "*Tool to determine project emissions from flaring gases containing Methane*".

ACM0001, version 8, establishes procedures for the selection of the most plausible scenario. According to them, there are two steps to be followed:

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

The methodology states:

"Project participants should use step 1 of the latest version of the "Tool for the demonstration and assessment of additionality", to identify all realistic and credible baseline alternatives. In doing so, relevant policies and regulations related to the management of landfill sites should be taken into account. Such policies or regulations may include mandatory landfill gas capture or destruction

requirements because of safety issues or local environmental regulations. Other policies could include local policies promoting productive use of landfill gas such as those for the production of renewable energy, or those that promote the processing of organic waste. In addition, the assessment of alternative scenarios should take into account local economic and technological circumstances."

Step 1 of the tool (Identification of alternatives to the project activity consistent with current laws and regulations) comprises a number of sub-steps:

"Sub-step 1a. Define alternatives to the project activity."

ACM0001, version 8, indicates the separate determination of applicable baselines for landfill capture, for electricity generation and for thermal use of LFG. The possible alternatives for each part are considered below, using the codes defined in ACM0001, ver. 8:

ACM0001, ver. 8 states:

"Alternatives for the disposal/treatment of the waste in the absence of the project activity, i.e. the scenario relevant for estimating baseline methane emissions, to be analysed should include, inter alia:

- *LFG1. 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;*
- *LFG2. 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."*

"Alternatives for the disposal/treatment of the waste in the absence of the project activity, i.e. the scenario relevant for estimating baseline methane emissions, to be analysed should include, inter alia:

a) The captured gas is flared; and/or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy);"

In principle, solid waste could be disposed off in other ways besides landfills, e.g. incineration, composting, conversion to Refuse-derived fuel (RDF), thermochemical gasification, and biomethanation. None of these are realistic alternatives for the project proponents, who have an obligation to the local government to dispose solid waste at the specific landfill, and there is enough space and capacity to use the 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. Finally, there is only limited experience with these alternative processes in Annex 1 countries, and almost none in non-Annex 1 countries, except for a handful of projects being submitted through the CDM.

Therefore, options LFG1 and LFG2 are the only realistic alternatives.

The project proposes to generate a certain amount of electricity. ACM0001 states:

"If energy is exported to a grid and/or to a nearby industry, or used on-site realistic and credible alternatives should also be separately determined for power generation in the absence of the 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;
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."

Other renewable sources are not applicable to the project site, so that options P3 and P5 may be discarded. Similarly fossil-fuel based captive power plants or cogeneration plants would not be economically competitive with purchasing power from the grid, so that P2 and P4 may also be discarded.

The only remaining options for plausible baselines are then:
P1. Power generated from landfill gas undertaken without being registered as CDM project activity, and
P6. Power plants connected to the grid.

ACM0001, ver. 8 states how national and sectoral policies must be taken into account using Sub-step 1b of the additionality tool and the adjustment factor AF.

"Sub-step 1b. Consistency with mandatory laws and regulations".

This sub-step requires that:

"The alternative(s) shall be in compliance with all mandatory applicable legal and regulatory requirements, even if these laws and regulations have objectives other than GHG reductions, e.g. to mitigate local air pollution."

The proposed project activity complies with all the applicable laws and regulations. Regulation NOM-083-SEMARNAT-2003 defines the specifications for environmental protection from the selection, design, construction and operation, monitoring and closure of final disposal sites for urban and special solid waste. This comprehensive regulation defines guidelines for the construction and operation of landfills, and also provides guidance regarding LFG, including recommendations for the collection, utilisation and/or flaring of the LFG. As such, the regulation does not specify minimum requirements regarding the amount of gas to be collected and utilised or flared. The regulation notwithstanding, common practice demonstrates that existing landfills in the country do not capture and flare or utilise their landfill gas.
The tool for the demonstration and assessment of additionality clearly states that only laws that are enforced need to be considered in the determination of the baseline scenario. NOM-083-SEMARNAT-2003 is clearly not enforced in Mexico:

- Norma 083 is a federal law that given the sovereignty of local authorities in this area (landfills are within the responsibility of the municipalities) only becomes legally binding if it is adopted by the local authorities. So far, no local authorities have adopted NOM-083-SEMARNAT-2003.

- NOM-083-SEMARNAT-2003 has not been effectively enforced since its adoption. Even the earlier norm, which NOM-083-SEMARNAT-2003 replaced and which only required the active venting of LFG for safety reasons, was not enforced.
- Finally, NOM-083-SEMARNAT-2003 has more the character of a policy.

In short, NOM-083-SEMARNAT-2003 shall not be taken into account in the establishment of a baseline scenario for LFG projects in Mexico.

Thus, the adjustment factor AF was set at 0%. This value is justified based on the fact that the regulatory requirements above indicated do not indicate any specific amount of gas collection and estruction or utilisation and that in practice, no LFG is actually flared. Currently the landfill operator is only passively venting and the collected gas produced in the landfills, primarily for safety purposes.

The tool for demonstration of additionality states that:
"If an alternative does not comply with all mandatory applicable legislation and regulations, then show that, based on an examination of current practice in the country or region in which the law or regulation applies, those applicable legal or regulatory requirements are systematically not enforced and that non-compliance with those requirements is widespread in the country. If this cannot be shown, then eliminate the alternative from further consideration."

The current configuration of the project comprises passive venting with no burning.

We can modify Scenarios LFG1 and LFG2 as follows:

LFG1: Disposal of the waste at the landfill with active extraction of landfill gas and centralised flaring or use of gas captured.
LFG2: Disposal of the waste at the landfill with no burning of gas from the landfill, so that baseline destruction of LFG is 0% of the value with an active extraction system with centralised flaring.

Therefore both LFG1 and LFG2 would comply with local regulations.

The current situation at the La reserva landfill corresponds to LFG2 above and this situation meets all applicable legal requirements and has all its necessary permits up to date.

ACM0001, ver. 8 further declares:

"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 we have considered two plausible baselines:
P1. Power generated from landfill gas undertaken without being registered as CDM project activity, and
P6. Power plants connected to the grid.

There is no specific fuel choice to be made. The fuels in the power plants connected to the grid are what they are, with their emissions factor determined by the "tool to calculate the emission factor for an electricity system", that would be generated in the grid in the baseline.

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):

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.

Following a review of how individual baseline methodologies deal with the issue of additionality, the CDM Executive Board published, as Annex 1 of their 16th Meeting Report, a "Tool for the demonstration and assessment of additionality." Note that version 8 of *Approved consolidated baseline methodology ACM0001* "Consolidated baseline methodology for landfill gas project activities" makes the following comment regarding additionality:

> *"Step 2 and/or step 3 of the latest approved version of the "Tool for demonstration and assessment of additionality" shall be used to assess which of these alternatives should be excluded from further consideration."*

Thus, in keeping with ACM0001, we apply the mentioned "Tool for the demonstration and assessment of additionality, version 4".

After applying Step 1 of the Additionality Tool in section B.4 above, the additionality tool then offers two options: Step 2 (Investment Analysis) or Step 3 (Barrier Analysis), with a third option of applying both Steps.

ACM0001, ver. 8 requires that the additionality test "*shall be applied for each component of the baseline, i.e. baseline for waste treatment, electricity generation and heat generation*".

With this in mind, the alternative LFG1 may be further subdivided as follows:
LFG1.1 Disposal of the waste at the landfill with ***active*** extraction of landfill gas and centralised flaring;
LFG1.2 Disposal of the waste at the landfill with ***active*** extraction of landfill gas and use of landfill gas for electricity generation;

Then we apply ***Step 2 (Investment Analysis)*** of the Additionality Tool to the different alternatives above included.

Case 1: LFG collection and centralised flaring without the CDM

Here it can be seen that LFG1.1 (active landfill gas collection and centralised flaring) involves substantial investments and no revenues, in the absence of the CDM. Hence, on the basis of a Simple Cost Analysis (Investment Analysis, Option 1), we can discard this option as a possible baseline scenario.

Case 2: LFG collection and electricity generation without the CDM

Considering LFG 1.2. for electricity generation, there are substantial investments as well as revenues from electricity sales. We determine the cost effectiveness for LFG capture and power generation in the absence of the CDM. Our analysis is based on the following assumptions:

- Substantial investments are required to capture LFG. These include the construction of active extraction wells, a well field and blowers, etc. to collect the LFG and take it to the location where the power plant would be located. For this project, this involves about US$ 4,1 million in 2008.
- Operating costs for landfill gas collection are expected to be US$ 69.200 in 2008 and increase slowly as the landfill expands.
- Two 1 MW LFG power generator would be purchased, for a total investment (including auxiliary equipment, such as power conditioning and connections) of 4,3 million dollars.
- The two generators would cost US$ 3.100.000. This does not include power conditioning equipment, engine room, engineering and installation costs. Including these elements, we estimate total investments to be US$ 4,300,000 previously stated.
- Equipment life: 10 years.
- Electricity sale price (levelised): US$ 0,057 per kWh, for sale to the grid, including estimated wheeling charges. There are no official projections for electricity prices, determined by market forces in Mexico.
- Corporate tax rate: 28%.
- Discount rate: 9%. Note that in November 2007, the Interbank Rates TIIE (28 days) and one year Mexibor rates were all around 7.5% (http://www.banxico.org.mx/). Five-year Mexican government bonds had an interest rate of 7.55% on November 4, 2007 (http://www.banxico.org.mx/polmoneinflacion/estadisticas/tasasInteres/tasasInteres.html). For a small or medium-sized company borrowing a relatively small amount of money, the applicable interest rate is likely to be about 5% higher, i.e. about 12.5%. Considering the risks of this new technology as well as the risks in effective biodegradation of waste and effective methane capture, another 5% may be added. Thus an appropriate benchmark rate for this type of investment would be 17.5%. The chosen benchmark discount rate of 9% is therefore very conservative.

For the assumptions stated above, the NPV for LFG capture and electricity generation is negative (about US$ -7,5 million), in the absence of the CDM. Indeed the value is so negative, that no meaningful IRR can be determined. (This means that even if the discount rate were zero, the revenues are less than expenses.) It is also included a sensitivity analysis with respect to the key assumptions, electricity sale price, O&M costs and investment requirements, in each case considering values ± 20% with respect to the assumptions above. The results of the sensitivity analysis are shown in the table below. Over the range considered, the NPV remains negative (and the IRR remains meaningless), which means that the project is not profitable without CER revenues.

Electricity Sale Price

	-20%	-10%	-	10%	20%
NPV	- $ 8.883.348	- $ 8.437.520	- $ 7.991.692	- $ 7.545.864	- $ 7.100.036
IRR	N.A.	N.A.	N.A.	N.A.	N.A.

O&M Costs

	-20%	-10%	-	10%	20%
NPV	- $ 7.265.594	- $ 7.628.643	- $ 7.991.692	- $ 8.354.741	- $ 8.717.790
IRR	N.A.	N.A.	N.A.	N.A.	N.A.

Investment

	-20%	-10%	-	10%	20%
NPV	- $ 6.259.526	- $ 7.125.609	- $ 7.991.692	- $ 8.857.775	- $ 9.723.858
IRR	N.A.	N.A.	N.A.	N.A.	N.A.

Table 3: Sensitivity Analysis for LFG collection and electricity generation

With CER revenues, assuming a CER price of US$ 11 per tCO_2e, the NPV would be US$ - 396.000 and the IRR would be 7,88 %, and the project would be profitable. Thus, for this case, the proposed project meets the condition of economic additionality.

Case 3: LFG collection and flaring through CDM and electricity generation without the CDM

The assumptions are similar to those above, the only difference being that investments and operating costs for LFG collection are not considered, since these are justified on the basis of CDM revenues (only revenues as far as flared is concerned). In other words, we determine if the electricity generation component is additional.

In the absence of CDM revenues, the NPV would be negative, about: US$ -7,5 million. Indeed the value is so negative, that no meaningful IRR can be determined. (This means that even if the discount rate were zero, the revenues are less than expenses.) The electronic workbook also includes a sensitivity analysis with respect to the key assumptions, electricity sale price, O&M costs and investment requirements, in each case considering values ± 20% with respect to the assumptions above. The results of the sensitivity analysis are shown in the table below. Over the range considered, the NPV remains negative (and the IRR remains meaningless), which means that the project is not profitable without CER revenues.

Electricity Sale Price

	-20%	-10%	-	10%	20%
NPV	- $ 8.451.229	- $ 8.005.401	- $ 7.559.573	- $ 7.113.745	- $ 6.667.917
IRR	N.A.	N.A.	N.A.	N.A.	N.A.

O&M Costs

	-20%	-10%	-	10%	20%
NPV	- $ 6.833.475	- $ 7.196.524	- $ 7.559.573	- $ 7.922.622	- $ 8.285.671
IRR	N.A.	N.A.	N.A.	N.A.	N.A.

Investment

	-20%	-10%	-	10%	20%
NPV	- $ 5.882.156	- $ 6.720.864	- $ 7.559.573	- $ 8.398.281	- $ 9.236.990
IRR	N.A.	N.A.	N.A.	N.A.	N.A.

Table 4: Sensitivity Analysis for electricity generation only

The economic additionality for Case 2 and Case 3 was clearly established above. Therefore, a barrier analysis is not needed to demonstrate additionality.

Step 4. Common Practice Analysis

Sub-step 4a: Analyse other activities similar to the proposed project activity

To date there has been very limited development of LFG projects in the Host Country. The tables below present information regarding a representative sample of landfills throughout the Host Country. As the table indicates, landfills in Host Country either have: (1) no system for collecting, venting or flaring LFG; (2) a passive system for venting LFG only (no flaring); (3) a passive system for venting and flaring LFG; or (4) a system to actively collect and flare or utilise the LFG.

As the table 6 indicates, only two of the sites have LFG collection and flaring or utilisation systems. The Prados de la Montaña landfill collects and partially flares the LFG generated at the site because the area where its located was slated to become a prime real estate investment opportunity at the time, and the landfill was closed and "cleaned up" (i.e., to avoid nuisances and risks to nearby buildings) in order to encourage investment there. Needless to say, the Prados de la Montaña landfill now sits amongst the most prized real estate in the entire country, flanked by headquarters of important Mexican and international corporations, top-level academic institutions, and highly valued residential properties and commercial centres. Despite the completion of this system years ago, it is not surprising that it took Global Environment Facility financing to build the second LFG capture system in Mexico – this one at the Simeprodeso landfill in Monterrey completed in 2003 and designed specifically as a demonstration project to promote the development of CDM projects. Since then, no LFG collection and flaring or utilisation systems have been developed in Mexico without considering carbon revenues.
As it is shown in table 5 there are however several projects in Mexico registered as CDM projects (flaring + electric generation).

Methodology	CDM Project Name
ACM0001	Aguascalientes – Ecomethane Landfill Gas to Energy Project (15/07/06) Ciudad Juarez Landfill Gas to Energy Project (30/11/07) Proactiva Mérida Landfill Gas Capture and Flaring project (30/11/07)
ACM0001 AMS – I.D.	Ecatepec – Ecomethane Landfill Gas to Energy Project (02/10/06)
ACM0001 ACM0002	Hasars Landfill Gas Project (05/10/07) Tultitlan – EcoMethane Landfill Gas to Energy Project (30/11/07)

Table 5: Landfills in Mexico registered as CDM projects. Source: UNFCCC.

Landfill Name	Location	Waste Deposition Rate (tonnes/day)	Current Status
Prados de la Montaña	Mexico City	Closed	System to actively collect and partially flare the LFG
Simeprodeso landfill (phase I)	Monterrey, Nuevo Leon	Closed	Landfill gas collection and utilisation project, funded with support from the GEF as demonstration project
Durango	Durango City, Durango	500	No system for collecting, venting or flaring LFG
Culiacan	Culiacan, Sinaloa	850	Passive system for venting of LFG only (no flaring)
Socavon San Jorge	Metepec, State of Mexico	500	Passive system for venting and flaring LFG
El Verde	Leon, Guanajuato	1,450	Passive system for venting and flaring LFG
Bordo Neza	State of Mexico	1,500	No system for collecting, venting or flaring LFG
Chiltepeque landfill	Puebla City, Puebla	1,595	No system for collecting, venting or flaring LFG
Santa Marta Chiconautla	Ecatepec, State of Mexico	1,600	Passive system for venting of LFG only (no flaring)
Bordo Poniente	Mexico City	12,000	No system for collecting, venting or flaring LFG

Table 6: Current practices in landfills in Mexico.

Thus, with the exception of the Prados de la Montaña and the first phase of the Simeprodeso landfills, none of the other landfills have proper LFG collection and flaring systems. In some cases, the LFG is vented passively to atmosphere for safety purposes, and if the vents are lit manually a small percentage of the LFG is combusted. Indeed, this is reflected in the Adjustment Factor. The reason for the lack of widespread LFG collection and combustion systems is that that there currently is no economic incentive for capturing and utilising the LFG. In summary, the passive venting method is still a common practice in landfills throughout Mexico.

Sub-step 4b: Discuss any similar options that are occurring

As mentioned above in sub-step 4a, only two landfills in the Host Country have collection and flaring or utilisation schemes on them, and the conditions for the development of each of these systems was quite special. There are some preliminary plans to install efficient gas collection and flaring systems in other landfills, but all of these are in the context of the CDM.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

According to ACM0001, version 8:
The greenhouse gas baseline emissions during a given year "y" (BEy) is given by:

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

Where:

BE_y	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 escenario.
$MD_{Bl,y}$	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)
$CEF_{elec, BL, y}$	CO_2 emissions intensity of the baseline source of electricity displaced, in tCO_2e/MWh.
$ET_{LFG,y}$	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,

	during the year y, in TJ.
$CEF_{ther, BL, y}$	CO_2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by landfill gas based thermal energy generation, in tCO_2/TJ.

ACM0001, version 8 offers several ways for determining $MD_{BL, y}$.
One option is *"In the case where the $MD_{BL,y}$ is given/defined in the regulation and/or contract as a quantity that quantity will be used"*. This is not the case here.
ACM0001 further adds*: "In situations where in the baseline LFG is captured and destroyed, for reasons other than regulation and/or contract, historic data on actual amount captured shall be used as $MD_{BL,y}$"*.
Since no LFG was captured and destroyed historically, and none will be captured and destroyed until the proposed project is operational, this is not the case here.
Another option is *"In cases where regulatory or contractual requirements do not specify $MD_{BL,y}$ or no historical data exist for LFG captured and destroyed, an "Adjustment Factor" (AF) shall be used and justified, taking into account the project context."*

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

There are no regulations requiring LFG capture and flaring and the configuration at La Reserva landfill is passive venting and no burning of the LFG. Thus an appropriate value of AF is 0%, and is the value used for the first crediting period.
Since a specific system for the collection and destruction of methane is not mandated by regulatory or contractual requirements, Eqs. (3) to (7) and associated text of ACM0001, ver. 8 are not applicable.
In order to calculate $MD_{project,y}$, the methodology (ACM0001 ver. 8) states:
"The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and/or produce thermal energy, and/or supply to end users via natural gas pipeline, if applicable, and the total quantity of methane captured."
And,
"The sum of the quantities fed to the flare(s), to the power plant(s) and to the boiler(s) and to the natural gas distribution network (estimated using equation (3)), must be compared annually with the total quantity of methane captured[1] The lowest value of the two must be adopted as $MD_{project,y}$"
This is meant to be conservative, claiming the lower amount of methane destroyed. In case the total methane collection is the highest, $MD_{project,y}$ is given by:

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

[1] ACM0001 version 8 (and earlier versions) refers to the total quantity of methane generated, it is not possible to monitor methane generation. Moreover, the quantities of methane captured will be fed to the flare(s), power plant(s) and thermal plant(s), thus methane destroyed in project will be related to methane *captured.*

Then, the methodology states: *"Right Hand Side of the equation (3) is sum over all the points of captured methane use in case the methane is flared in more than one flare, and/or used in more than one electricity generation source, and/or more than one thermal energy generator. The supply to each point of methane destruction, through flaring or use for energy generation, shall be measured separately."*
In the case of La Reserva landfill project, the right hand side of the equation (3) will be simplified to only the components of methane flared ($MD_{flared,y}$) and methane used for electricity generation ($MD_{electricity,y}$), because thermal energy generation and LFG sent to pipelines are not part of the scope of this project.

Calculation of $MD_{flared,y}$:

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

Where, according to ACM0001, "$MD_{flared,y}$ is the quantity of methane destroyed by flaring, $LFG_{flare,y}$ is the quantity of landfill gas fed to the flare during the year measured in cubic meters (m^3), $w_{CH4,y}$ is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3CH_4/m^3LFG), D_{CH4} is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3CH_4) and $PE_{flare,y}$ are the project emissions from flaring of the residual gas stream in year y (tCO_{2e}) determined following the procedure described in the "Tool to determine project emissions from flaring gases containing methane. If methane is flared through more than one flare, the $PE_{flare,y}$ shall be determined for each flare using the tool."

In order to determine the amount of methane sent to the flare in a year, we need to sum the mass of methane over the year. Since the methane fraction of landfill gas and gas density are, in general, changing with time, a more precise formula for methane destroyed by flaring is:

$$MD_{flared,y} = \left(\sum_{h=1}^{8760}\left(LFG_{flare,h} * w_{CH4,h} * D_{CH4,h}\right)\right) - \left(\frac{PE_{flare,y}}{GWP_{CH4}}\right) \quad \textbf{(9a)}$$

Here the mass of methane sent to the flare is determined hourly, with hourly values added over the year. The gas density depends on temperature and pressure, and flow meter likely to be used for monitoring in LFG capture projects automatically compensate for gas density in flow measurement, so that in Eq (9a), $LFG_{flare,h}$ is already expressed in terms of standard temperature and pressure, so that $D_{CH4,h}$ (methane density) is in fact a constant, 0.0007168 tonnes/m³, at standard temperature and pressure conditions (0°C, 1.013 bar). Thus, in practice, there is no difference between equations (9) and (9a).

Not all the methane that reaches the flare is destroyed, and the "Tool to determine project emissions from flaring gases containing methane" is meant to take this into account.

The tool differentiates between open and enclosed flares. The project proposed here would use enclosed flares, since these are more effective in destroying methane.

For enclosed flares, the Tool proposes two options to determine the flare efficiency:

> *(a) To use a 90% default value. Continuous monitoring of compliance with manufacturer's specification of flare (temperature, flow rate of residual gas at the inlet of the flare) must be performed. If in a specific hour any of the parameters are out of the limit of manufacturer's specifications, a 50% default value for the flare efficiency should be used for the calculations for this specific hour.*
>
> *(b) Continuous monitoring of the methane destruction efficiency of the flare (flare efficiency).*

The project is likely to use the 90% default value. However, if project operator decides to monitor emissions continuously, then the Tool procedures for continuous monitoring will be applied. When continuous monitoring is not in place, the default value will be applied.

The Tool further requires that the temperature in the exhaust gas of the flare to be measured in order to determine whether the flare is operating or not. "In both cases, if there is no record of the temperature of the exhaust gas of the flare or if the recorded temperature is less than 500 °C for any particular hour, it shall be assumed that during that hour the flare efficiency is zero."

"This tool involves the following seven steps:
STEP 1: Determination of the mass flow rate of the residual gas that is flared
STEP 2: Determination of the mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas
STEP 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis
STEP 4: Determination of methane mass flow rate of the exhaust gas on a dry basis
STEP 5: Determination of methane mass flow rate of the residual gas on a dry basis
STEP 6: Determination of the hourly flare efficiency
STEP 7: Calculation of annual project emissions from flaring based on measured hourly values or based on default flare efficiencies.

Project participants shall apply these steps to calculate project emissions from flaring ($PE_{flare,y}$) based on the measured hourly flare efficiency or based on the default values for the flare efficiency ($h_{flare,h}$). Note that steps 3 and 4 are only applicable in case of enclosed flares and continuous monitoring of the flare efficiency.

The calculation procedure in this tool determines the flow rate of methane before and after the destruction in the flare, taking into account the amount of air supplied to the combustion reaction and the exhaust gas composition (oxygen and methane). The flare efficiency is *calculated for each hour of a year based either on measurements or default values plus operational parameters.*

Project emissions are determined by multiplying the methane flow rate in the residual gas with the flare efficiency for each hour of the year."

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."

$$FM_{RG,h} = \rho_{RG,n,h} * FV_{RG,h}$$

Where:

$FM_{RG,h}$	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 hour *h*

And:

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

Where:

$\rho_{RG,n,h}$	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:

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

Where:

$MM_{RG,h}$	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

The Tool states that "As a simplified approach, project participants may only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2)". Note that the Tool is applicable to a wide variety of residual gases to be flared, while landfill gas is the product of anaerobic decomposition, which does not produce hydrogen or carbon monoxide, so these two gases can be eliminated from the calculations, without any assumptions. The simplification proposed in the tool involves considering CO_2 and O_2 as N_2. While this leads to minor errors, we use this simplified approach, since it greatly simplifies measurements, and does not significantly affect the estimate of flare efficiency.

With this simplification, the equation becomes:

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

Where:

$MM_{RG,h}$	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, N_2 (Note that only CH_4 would be measured and N_2 determined as the balance)

Note that elemental hydrogen is a part of methane and therefore the hydrogen content of the residual gas affects its stoichiometry.

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

Step 2 states:

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:

$$fm_{j,h} = \frac{\sum_{i} fv_{i,h} * AM_j * NA_{j,i}}{MM_{RG,h}}$$

Where:

$fm_{i,h}$	-	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. Note that the simplified approach, involving measurement of methane and assuming the balance to be nitrogen, implies that there is no elemental oxygen in the gas, and that all the carbon is in the form of methane. The only hydrogen is also in methane, but this does not involve any simplification, since there is no H_2 in the other components that might be present in landfill gas: CO_2 and O_2.

I The components CH_4 and N_2 (Note that with the simplified approach, the concentrations of other gases would not be determined)

Step 3: Determination of the volumetric flow rate of the exhaust gas on a dry basis

The Tool states:

"This step 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"

$$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h}$$

Where:

$TV_{n,FG,h}$ 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

$$V_{n,FG,h} = V_{n,CO_2,h} + V_{n,O_2,h} + V_{n,N_2,h}$$

Where:

$V_{n,FG,h}$ 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 CO2 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 N2 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 O2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h

$$V_{n,O_2,h} = n_{O_2,h} \times MV_n$$

$V_{n,O2,h}$ m^3/kg residual gas Quantity of O2 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 O2 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)

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

$V_{n,N2,h}$ m^3/kg residual gas Quantity of N2 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 O2 required for a complete oxidation of one kg residual gas in hour h

$n_{O2,h}$ kmol/kg residual gas Quantity of moles O2 in the exhaust gas of the flare per kg residual gas flared in hour h

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

$V_{n,CO2,h}$ m^3/kg residual gas Quantity of CO2 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)

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

$n_{O2,h}$ kmol/kg residual gas Quantity of moles O2 in the exhaust gas of the flare per kg residual gas flared in hour h
$t_{O2,h}$ - Volumetric fraction of O2 in the exhaust gas in the hour h
MF_{O2} - Volumetric fraction of O2 in the air (0.21)
F_h kmol/kg residual gas Stochiometric quantity of moles of O2 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
AM_j kg/kmol Atomic mass of element j
j The elements carbon (index C) and nitrogen (index N)

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

F_h kmol O_2/kg residual gas Stoichiometric quantity of moles of O2 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
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

The Tool states:
"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"

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH4,FG,h}}{1000000}$$

$TM_{FG,h}$ 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 Tool states:
"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)."

The Tool further elaborates:

"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)."

$$TM_{RG,h} = FV_{RG,h} * fv_{CH_4,RG,h} * \rho_{CH_4,n}$$

$TM_{RG,h}$	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).
ρ	kg/ m^3	Density of methane at normal conditions (0.7168)

Note that the Tool denominates density by the traditional Greek letter (ρ), while ACM0001 uses the letter D. Moreover, density is expressed in kg/m3 in the tool and tonne/m3 in ACM0001. Care should be taken with the units to avoid errors.

Step 6: Determination of the hourly flare efficiency

The Tool states:
"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 in the hour h ($\eta_{flare,h}$) is:

- *0% if the temperature of the exhaust gas of the flare (T_{flare}) is below 500 °C during more than 20 minutes during the hour h.*

• *determined as follows in cases where the temperature of the exhaust gas of the flare (T_{flare}) is above 500 °C for more than 40 minutes during the hour h :*

$$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}}$$

Where:

$\eta flare_{,h}$	-	Flare efficiency in hour *h*
$TM_{RG,h}$	kg/h	Methane mass flow rate in exhaust gas averaged in hour *h*.
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in hour *h*t.

STEP 7. Calculation of annual project emissions from flaring

The Tool states:

"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:"

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} * \left(1 - \eta_{flare,h}\right) * \frac{GWP_{CH_4}}{1000}$$

Where:

$PE_{flare\ y}$	tCO_2e	Project emissions from flaring of the residual gas stream in year
$TM_{RG,\ h}$	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

"In case of use of the default value for the methane destruction efficiency, the manufacturer's specifications for the operation of the flare and the required data and procedures to monitor these specifications should be documented in the CDM PDD."

Once project emissions PEflare, y has been calculated, the next formula from the methodology ACM0001 ver. 8 is:

$$MD_{electricity,y} = LFG_{electricity,y} * w_{CH_4,y} * D_{CH_4}$$

Where:

$MD_{electricity,y}$ = quantity of methane destroyed by generation of electricity (tCH_4/yr)
$LFG_{electricity,y}$ = quantity of landfill gas fed into electricity generator (m_3/yr)
$w_{CH4,y}$ = average methane fraction of the landfill gas as measured during the year (m^3 CH_4 /m^3 LFG)
D_{CH4} = methane density at normal conditions (tCH_4/m^3 CH_4)

Considering hourly variations in methane density and methane concentration in LFG, a more precise form of equation is:

$$MD_{electricity,y} = \sum_{h=1}^{8760} (LFG_{electricity,h} * w_{CH_4,h} * D_{CH_4})$$

By an apparent typographical error, versions 5 and 6 of ACM0001 do not include the following equation, which, fortunately, can be rescued from version 4.

$$MD_{thermal,y} = LFG_{thermal,y} * w_{CH4,y} * D_{CH4}$$

Where:

$MD_{thermal,y}$ = quantity of methane destroyed for generation of thermal energy
$LFG_{thermal,y}$ = quantity of landfill gas fed into the boiler or into the industrial wastewater evaporation system

Applying the same reasoning as that applied to electricity generation, the formula is modified as follows:

$$MD_{thermal,y} = \sum_{h=1}^{8760} (LFG_{thermal,h} * w_{CH_4,h} * D_{CH_4})$$

Finally, we have:

$$MC_{total,y} = LFG_{total,y} * w_{CH4} * D_{CH4}$$

Where:

$MC_{total,y}$ = total quantity of methane captured
$LFG_{total,y}$ = total quantity of landfill gas captured

Considering hourly variations in density and methane concentration in LFG, a more precise form of equation would be:

$$MC_{total,y} = \sum_{h=1}^{8760}(LFG_{total,h} * w_{CH_4,h} * D_{CH_4})$$

Then, ACM0001 establishes different ways to determine the CO2 emissions factors involved in the estimation of project emissions and in the estimation of additional emissions reduction due to energy displacement.

Ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane ($MD_{project,y}$)

Further, ACM0001 version 8 requires that:
"The ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (MD project,y) will be done with the latest version of the approved "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".

This tool was elaborated to calculate baseline emissions of methane from waste that would in the absence of the project activity, be disposed at solid waste disposal sites (SWDS). Emissions reductions are calculated with a first order decay model. Despite the fact that this tool is for avoided waste to disposal sites, it is very useful in order to calculate the quantity of methane generated by the waste landfilled in this project case.

The main formula is:

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

Where:

$BE_{CH4,SWDS,y}$	Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO_2e).
φ	Model correction factor to account for model uncertainties (0,9).
f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner.
GWP_{CH4}	Global Warming Potential (GWP) of methane, valid for the relevant commitment period.

OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering waste).
F	Fraction of methane in the SWDS gas (volume fraction)
DOC_f	Fraction of degradable organic carbon (DOC) that can descompose.
MCF	Methane correction factor.
$W_{j,x}$	Amount of organic type j prevented from disposal in the SWDS in the year x (tonnes).
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	Year since the landfill started receiving wastes [x runs from the first year of landfill operation (x=1) to the year for which emissions are calculated (x=y)]. Note: this definition represents a correction of the Tool as given in ACM0001, ver. 8.
y	Year for which methane emissions are calculated.

ACM0001, ver. 8 further clarifies that *"Sampling to determine the different waste types is not necessary, the waste composition can be obtained from previous studies"*.

ACM0001, ver. 8 also states: *"The efficiency of the degassing system which will be installed in the project activity should be taken into account while estimating the ex-ante estimation"*. This is taken into consideration in the value assumed for f in the equation above.

The value and source of information for each of the variables above are given in section B.6.2. and Annex 3.

ACM0001 ver. 8 further states:

$$MD_{project,y} = BE_{CH4,SWDS,y}/GWP_{CH4}$$

Determination of $CEF_{elec,BL,y}$:

The methodology states: *"In case the baseline is electricity generated by plants connected to the grid the emission factor should be calculated according to "Tool for calculation of emission factor for electricity systems"*.
The calculation of the emission factor for the electricity system is demonstrated in Annex 3 using the tool recommended.
Since there is no thermal use of LFG either in the baseline or in the project, the following section of ACM0001 may be skipped: "Determination of $CEF_{ther,BL,y}$".

We next determine emissions associated with the project activity.

Project Emissions:

$$PE_y = PE_{EC,y} + PE_{FC,j,y}$$

Where:

$PE_{EC,,y}$ = Emission from consumption of electricity in the project case.
$PE_{FC,j,y}$ = Emissions from consumption of heat in the project case.

When there is not electricity generation with the landfill gas, $PE_{EC,y}$ will be calculated using "*Tool to calculate project emissions from electricity consumption*".
The tool presents three different possibilities, and the La Reserva Landfill Project is inserted in Case A: Electricity consumption from the grid. In this case, the tool declares: *"Project emissions from consumption of electricity from the grid are calculated based on the power consumed by the project activity and the emission factor of the grid, adjusted for transmission losses, using the following formula:"*

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

$PE_{EC,y}$ = Project emissions from electricity consumption by the Project activity during year y (tCO_2/yr)
$EC_{pJ,y}$ = Quantity of electricity consumed by the project activity during the year y (MWh)
$EF_{grid,y}$ = Emission factor for the grid in year y (tCO2/MWh)
TDL_y = Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from grid at the project site.

The value and source of information for the elements above are given in section B.6.3 and B.7.1.

$PE_{FC,j,y}$ will be calculated according to the *"Tool to calculate project or leakage CO_2 emissions from* *fossil fuel combustion"*. $PE_{FC,j,y}$ will be zero because there is no consumption of fossil fuel in the project activity.

Finally, according to ACM0001 ver.8, emission reductions can be calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

$ER_{,y}$	=	Emission reductions in year y (tCO_2e/yr).
$BE_{,y}$	=	Baseline emissions in year y (tCO_2e/yr).
$PE_{,y}$	=	Project emissions in year y (tCO_2e/yr).

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

Some of the parameters and data used in these equations are not monitored since they are constants, as listed in the table below. Most of the table is taken directly from the Methane Flaring Tool. The remaining parameters and data that are available at the time of validation, and are not monitored are listed in individual data tables further below.

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
P_n	Pa	Atmospheric pressure at normal conditions	101,325
R_u	Pa m^3/kmol K	Universal ideal gas constant	8,314.472
T_n	K	Temperature at normal conditions	273.15
MF_{O2}	Dimensionless	O_2 volumetric fraction of air	0.21
GWP_{CH4}	tCO_2/tCH_4	Global warming potential of methane	21
MV_n	m^3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure	22.414
$\rho_{CH4,n}$ / D_{CH4}	kg/m^3	Density of methane gas at normal conditions	0.7168
$NA_{i,j}$	Dimensionless	Number of atoms of element *j* in component *i*, depending on molecular structure	

Data / Parameter:	**Regulatory requirements relating to landfill gas projects**
Data unit:	Dimensionless
Description:	Regulatory requirements relating to landfill gas projects
Source of data used:	Estimate (see justification below)
Value applied:	0%
Justification of the choice of data or description of measurement methods and procedures actually applied :	In the absence of the proposed project, all the landfill gas will be released to the atmosphere. As explained in B.4, the current configuration of passive venting and **no** burning at La Reserva landfill.
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 credit period. Hence, because this value may change at the end of each crediting period, in case of changes in regulatory requirements, it will be monitored as table for variable 9 in B.7.1 below.

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e/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 :	For the first commitment period. Shall be updated according to any future COP/MOP decisions.
Any comment:	

Data / Parameter:	**D_{CH4}**
Data unit:	tCH_4/m^3CH_4
Description:	Methane density
Source of data used:	
Value applied:	0,0007168
Justification of the choice of data or description of measurement methods and procedures actually applied :	At standard temperature and pressure (0º and 1,013 bar).
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 "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".
Value applied:	See B.6.3 and Annex 3.
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per "Tool to determine methane emissions avoided from dumping 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:	$CEF_{elec,BL,y}$
Data unit:	tCO_2e/MWh
Description:	CO_2 emissions intensity of the baseline source of electricity displaced.
Source of data used:	CO_2 emissions factor for electricity generation in the Mexican grid connected to the project site, tCO_2e/MWh. Power generated using landfill gas would displace power generated in the interconnected power grid.
Value applied:	0,6284 (combined Margin).
Justification of the choice of data or description of measurement methods and procedures actually applied :	For power generation below 15 MW, the emissions factor may be calculated using *"tool to calculate the emission factor for an electricity system",* recommended by ACM0001 ver 8.
Any comment:	A single, fixed value is used for each crediting period. More calculation details are provided in Annex 3.

B.6.3 Ex-ante calculation of emission reductions:

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An ex-ante emission reduction calculation requires an estimation of landfill gas production from the waste at the site. This estimation is made using the "*Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*". For more information on this model and the parameters used, pleased refer to Annex 3.

According to the "*Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*", total methane released from solid waste at a landfill is given by the following formula:

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

Where:

$BE_{CH4,SWDS,y}$	Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO_2e).
φ	Model correction factor to account for model uncertainties (0,9).
f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner.
GWP_{CH4}	Global Warming Potential (GWP) of methane, valid for the relevant commitment period.
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering waste).
F	Fraction of methane in the SWDS gas (volume fraction)
DOC_f	Fraction of degradable organic carbon (DOC) that can descompose.
MCF	Methane correction factor.
$W_{j,x}$	Amount of organic type j prevented from disposal in the SWDS in the year x (tonnes).
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	Year since the landfill started receiving wastes [x runs from the first year of landfill operation (x=1) to the year for which emissions are calculated (x=y)]. Note: this definition represents a correction of the Tool as given in ACM0001, ver. 8.
y	Year for which methane emissions are calculated.

Using the formula above we estimated the potential methane to be produced at the landfill, during the 10-year fixed crediting period. The LFG collection efficiency for ex-ante estimates is assumed to be 70%, considering the use of a geomembrane as final cover. Results are shown in Table 5 below.

Year	Potential landfill gas produced (m3 LFG/h) (m^3/hr)	Gas captured system efficiency (%)	Potential landfill gas captured (m^3/hr)
2008	1.254	70%	878
2009	2.384	70%	1.669
2010	2.266	70%	1.586
2011	2.155	70%	1.508
2012	2.049	70%	1.434
2013	1.949	70%	1.364
2014	1.854	70%	1.298
2015	1.764	70%	1.235
2016	1.678	70%	1.175
2017	1.596	70%	1.118
2018	760	70%	532

Table 7: Potential landfill gas produced and landfill gas captured ($LFG_{total,y}$) at La Reserva Landfill

Additionally, there is the possibility of installing an electricity generation plant, thus most of the methane destruction would normally take place at the power plant. When those plants are not operational or when there is excess flow, the methane would be sent to the flare and destroyed there.

The maximum electricity generation potential (MW) can be estimated from the flow rate of landfill gas collected (m^3/h). We estimated that a dedicated LFG engine-generator would need a flow of 1028 m^3/h of landfill gas (52% methane) to generate 2,0 MWe. This assumption was based on information sent by an LFG engine manufacturer.
This allows us to calculate the maximum power generation potential if all the LFG were converted to electricity.
While LFG generation may vary continuously over time, power generation equipment is only available at specific power output capacities. While the LFG model indicates that gas may be available to generate almost 2 MW during the 10-year crediting period, given that no firm decision on power generation has yet been made, the present estimate limits power generation to a maximum of 2 MW. It is envisioned that two 1 MW-capacity generators would be installed in 2008.

Other assumptions related to electricity generation, made for the ex-ante estimations, are as follows:

- Operation of the power plant: It is expected that the electricity generation facility would operate 7.700 h/yr (87,6% of the year).
- Operation of the flare station: It was assumed that the flare station will operate 8,000 h/yr (91.3% of the year).

Year	Possible scenario for power generation	Possible scenario for power generation $EL_{LFG,y}$	Landfill gas sent to power plant, $LFG_{electricity,y}$	Methane destroyed at the power plant, $MD_{electricity,y}$
	MW	MWh/yr	m3 LFG/yr	tCH4/yr
2008	2,0	7.700	4.504.529	1.679,00
2009	2,0	15.400	9.009.057	3.358,00
2010	2,0	15.400	9.009.057	3.358,00
2011	2,0	15.400	9.009.057	3.358,00
2012	2,0	15.400	9.009.057	3.358,00
2013	2,0	15.400	9.009.057	3.358,00
2014	2,0	15.400	9.009.057	3.358,00
2015	2,0	15.400	9.009.057	3.358,00
2016	1,0	7.700	4.504.529	1.679,00
2017	1,0	7.700	4.504.529	1.679,00
2018	1,0	3.850	2.252.264	839,50

Table 8: Possible scenario for power generation at La Reserva Landfill

All the remnant gas will be combusted in an enclosed flare. For conservativeness, the ex-ante estimates assume a default flare efficiency of 90%.

Year	Landfill gas sent to flare, $LFG_{flare,y}$	Methane destroyed at the flare, $MD_{electricity,y}$
	m3 LFG/yr	tCH4/yr
2008	3.183.012	1.068
2009	5.609.287	1.882
2010	4.887.752	1.640
2011	4.204.119	1.410
2012	3.555.689	1.193
2013	2.942.179	987
2014	2.357.911	791
2015	1.805.724	606
2016	5.784.468	1.940
2017	5.284.944	1.773
2018	2.405.841	807

Table 9: Possible scenario for landfill gas flaring at La Reserva Landfill

Methane destroyed in the project, $MD_{project,y}$, is the sum of methane destruction by thermal energy, by electricity generation and by flaring (see Eq. 3), and is shown in Table 6 below for the 10-year fixed crediting period.

Year	Methane destroyed at the power plant, $MD_{electricity,y}$	Landfill gas sent to flare, $LFG_{flare,y}$	Methane destroyed at the flare, $MD_{electricity,y}$	Methane destroyed at the thermal plant, $MD_{thermal,y}$	Methane destroyed in Project, $MD_{project,y}$
	tCH4/yr	m3 LFG/yr	tCH4/yr	tCH4/yr	tCH4/yr
2008	1.679	3.183.012	1.068	0	2.747
2009	3.358	5.609.287	1.882	0	5.240
2010	3.358	4.887.752	1.640	0	4.998
2011	3.358	4.204.119	1.410	0	4.768
2012	3.358	3.555.689	1.193	0	4.551
2013	3.358	2.942.179	987	0	4.345
2014	3.358	2.357.911	791	0	4.149
2015	3.358	1.805.724	606	0	3.964
2016	1.679	5.784.468	1.940	0	3.619
2017	1.679	5.284.944	1.773	0	3.452
2018	840	2.405.841	807	0	1.647

Table 10: Potential methane destroyed in Project at La Reserva

No fossil fuel based thermal energy is considered to be displaced in this PDD, thus $CEF_{ther,BL}$,y is not applicable here. For the ex-ante estimates we assume that no fossil fuels are used, either in the baseline scenario or in the project activity.

The project activity involves LFG recovery, which requires a blower for gas pumping, and electricity is needed for this purpose. If the project does not generate electricity, or until the power plant is operational, this electricity will be purchased from the grid and will constitute $EL_{PR\ y}$. In case of electricity generation using the methane collected in the project, emissions reductions would be determined by the sum of the amount of electricity exported from the project site to the grid and the amount of electricity used on-site unrelated to the project activity –as it would have been imported in the absence of the project activity–. This will constitute $EL_{LFG,y}$.
When the LFG power plant is not operational, recovered LFG would be flared, and again the blower consumption would be supplied from the grid. This would add to project electricity imports and would constitute project emissions.

Blower electricity consumption is estimated assuming that a blower will use 75 HP or about 56 kW to pump 5,000 m^3/h of LFG (50% methane), based on flare station providers.
Emissions from this power consumption in the project activity will also depend on the emissions factor for electricity generation, $CEF_{elec,PR,y}$, which is estimated in Annex 3. A value of 0,6284 tCO_2/MWh (combined margin) was used in this project for imported electricity.
Project emissions from electricity consumption by the blower would be the 7% of the electricity obtained from LFG. When LFG is used for electricity generation, electricity sent to the public grid would displace electricity generated elsewhere in the grid. Additionally, all the electricity consumed from the grid by the landfill site in the baseline scenario would be replaced by the use of this renewable energy. This would offset CO_2 emissions from power plants in the interconnected grid.

For this project, CO_2 emissions factor for power generation was determined using the "*Tool to calculate the emission factor for an electricity system*" that allows for $CEF_{elec,BL}$,y to remain fixed for each crediting period. This approach was taken here, and the value of $CEF_{elec,BL}$,y was given above, as the same value given for $CEF_{elec,PR,y}$. Emissions reductions from power generation using landfill gas and project emissions due to fossil fuel based energy consumption are shown in Table 11 for the 10-year fixed crediting period.

Year	Possible scenario for power generation $EL_{LFG,y}$	Energy consumption in project activity, $EL_{PR,y}$	Project Emissions, $EL_{PR,y}$ * $CEF_{elec,PR,y}$	Emissions reduction by electricity displacement $EL_{LFG,y}$ * $CEF_{elec,BL,y}$
	MWh/yr	MWh/yr	tCO_{2e}/yr	tCO_{2e}/yr
2008	7.700	431	271	4.839
2009	15.400	862	542	9.677
2010	15.400	862	542	9.677
2011	15.400	862	542	9.677
2012	15.400	862	542	9.677
2013	15.400	862	542	9.677
2014	15.400	862	542	9.677
2015	15.400	862	542	9.677
2016	7.700	431	271	4.839
2017	7.700	431	271	4.839
2018	3.850	216	135	2.419

Table 11: Additional emissions reduction by LFG power generation (electricity displacement) and project emissions due to fossil fuel based energy consumption.

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

Year	Project Emissions, $EL_{PR,y}$ * $CEF_{elec,PR,y}$	Emissions reduction by electricity displacement $EL_{LFG,y}$ * $CEF_{elec,BL,y}$	Methane destroyed at the power plant, $MD_{electricity,y}$	Methane destroyed at the flare, $MD_{electricity,y}$	Methane destroyed at the thermal plant, $MD_{thermal,y}$	Methane destroyed in Project, $MD_{project,y}$	Estimation of emission reduction
	tCO_{2e}/yr	tCO_{2e}/yr	tCH4/yr	tCH4/yr	tCH4/yr	tCH4/yr	tCO_{2e}
2008	271	4.839	1.679	1.068	0	2.747	62.250
2009	542	9.677	3.358	1.882	0	5.240	119.169
2010	542	9.677	3.358	1.640	0	4.998	114.086
2011	542	9.677	3.358	1.410	0	4.768	109.270
2012	542	9.677	3.358	1.193	0	4.551	104.702
2013	542	9.677	3.358	987	0	4.345	100.380
2014	542	9.677	3.358	791	0	4.149	96.264
2015	542	9.677	3.358	606	0	3.964	92.374
2016	271	4.839	1.679	1.940	0	3.619	80.577
2017	271	4.839	1.679	1.773	0	3.452	77.058
2018	135	2.419	840	807	0	1.647	36.862

Table 12: Ex-ante estimation of total emission reduction at La Reserva Project.

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

B.7.1 Data and parameters monitored:

Data / Parameter:	**1. $LFG_{total,y}$**
Data unit:	m^3
Description:	Total amount of landfill gas captured at normal temperature and pressure.
Source of data to be used:	Measured by a flow meter.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Details of assumptions, calculations and resulting data are presented in sections B.6.3 and B.6.4.
Description of measurement methods and procedures to be applied:	Continuous mass flow meters will be used to measure flow rates. Data will be measured at least once per hour, recorded electronically, and data will be kept during the crediting period and two years after. Data will also be aggregated monthly/yearly.
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy. Also, an independent company, accredited by local authorities, will conduct contrasting and data checking in accordance with manufacturer specifications, to ensure accuracy.
Any comment:	Flow meter would adjust volume flow for temperature and pressure.

Data / Parameter:	**2. $LFG_{flare,y}$**
Data unit:	m^3
Description:	Total amount of landfill gas flared at normal temperature and pressure.
Source of data to be used:	Measured by a flow meter.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Details of assumptions, calculations and resulting data are presented in sections B.6.3 and B.6.4.
Description of measurement methods and procedures to be applied:	Data will be measured for each flare at least once per hour, recorded electronically, and data will be kept during the crediting period and two years after. Data will also be aggregated monthly/yearly.
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy. Also, an independent company, accredited by local authorities, will conduct contrasting and data checking in accordance with manufacturer specifications, to ensure accuracy.
Any comment:	Flow meter would adjust volume flow for temperature and pressure.

Data / Parameter:	**3. $LFG_{electricity,y}$**
Data unit:	m^3
Description:	Amount of landfill gas combusted in power plant(s) (fed into electricity generator (s)) at normal temperature and pressure.
Source of data to be used:	Measured by a flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Details of assumptions, calculations and resulting data are presented in sections B.6.3 and B.6.4.
Description of measurement methods and procedures to be applied:	Continuous mass flow meters will be used to measure flow rates. Data will be measured for each power plant at least once per hour, recorded electronically, and data will be kept during the crediting period and two years after. Data will also be aggregated monthly/yearly.
QA/QC procedures to be applied:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy. Also, an independent company, accredited by local authorities, will conduct contrasting and data checking in accordance with manufacturer specifications, to ensure accuracy.
Any comment:	Flow meter would adjust volume flow for temperature and pressure.

Data / Parameter:	**4. $PE_{flare,}$**
Data unit:	tCO_2e
Description:	Project emissions from flaring of the residual gas stream in year *y*.
Source of data to be used:	On-site measurements / calculations.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	10% of CH_4 in gas stream.
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* (**$PE_{flare,y}$**) will be monitored as per the *"Tool to determine project emissions from flaring gases containing methane"*. The parameters used for the determination of $PE_{flare,y}$ are $LFG_{flare,y}$, $w_{CH4,y}$, $fv_{i,h}$, $fv_{CH4,FG,h}$ and $t_{O2,h}$.
QA/QC procedures to be applied:	Regular maintenance will ensure optimal operation of the flare. Analysers will be calibrated annually according to manufacturer's recommendations.
Any comment:	Note: A determination of **$PE_{flare,y}$** using the flaring tool requires the measurements of a number of additional parameters. These are listed and described following the variables specifically mentioned in ACM0001.

Data / Parameter:	**5. w_{CH4}**
Data unit:	m^3CH_4 / m^3LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	Measured by a gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	52%
Description of measurement methods and procedures to be applied:	Methane content will be measured using a continuous gas analyser. Data will be measured at least once per hour, recorded electronically, and data will be kept during the crediting period and two years after. Data will also be aggregated monthly/yearly.
QA/QC procedures to be applied:	Gas analyzers should be subject to a regular maintenance and testing regime to ensure accuracy. Also, an independent company will contrast certified instruments with reference instruments, in accordance with manufacturer specifications.
Any comment:	

Data / Parameter:	**6. T**
Data unit:	ºC (Celsius degrees)
Description:	Temperature of the landfill gas
Source of data to be used:	Measured
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 (At STP conditions)
Description of measurement methods and procedures to be applied:	Data will be measured at least once per hour, recorded electronically. Data will also be aggregated monthly/yearly. Records will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Measuring instruments should be subject to a regular maintenance and testing regime to ensure accuracy. Also, an independent company will contrast the thermometers used for measurements with certified equipment.
Any comment:	No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (Nm^3).

Data / Parameter:	**7. P**
Data unit:	Pa (Pascal)
Description:	Pressure of the landfill gas
Source of data to be used:	Measured by pressure analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	101,325 (1 atm at STP conditions)
Description of measurement methods and procedures to be applied:	Data will be measured at least once per hour, recorded electronically. Data will also be aggregated monthly/yearly. Records will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Measuring instruments should be subject to a regular maintenance and testing regime to ensure accuracy. Also, an independent company will contrast the thermometers used for measurements with certified equipment.
Any comment:	No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (Nm^3).

Data / Parameter:	**8. EL_{LFG}**
Data unit:	MWh
Description:	Net amount of electricity generated using landfill gas, which in the absence of the project activity would have been produced by power plants connected to the grid.
Source of data to be used:	Measured by electricity meter.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Details of assumptions, calculations and resulting data are presented in sections B.6.3 and B.6.4.
Description of measurement methods and procedures to be applied:	The quantities will be measured with electricity meters installed on the generators units. The readings will be made at least once per hour and electronically stored in a spreadsheet. Data will be recorded during crediting period and two years after.
QA/QC procedures to be applied:	Electric meters are quite accurate. Moreover, the meter will be calibrated periodically, according to manufacturer's specification.
Any comment:	Required to estimate the emission reductions from electricity generation from LFG, if credits are claimed.

Data / Parameter:	9. Regulatory requirements relating to landfill gas projects
Data unit:	Test (dimensionless)
Description:	The regulatory demands for gas collection and destruction are reflected in the adjustment factor (AF, for methane destruction in the baseline scenario).
Source of data to be used:	National legislation and mandatory regulations
Value of data applied for the purpose of calculating expected emission reductions in section B.5	AF=0%
Description of measurement methods and procedures to be applied:	Although the methodology only requires recording at the renewal of the crediting period, the information related to all relevant policies and circumstances will be collected and recorded annually. Information will be kept during crediting period and two years after.
QA/QC procedures to be applied:	Legal documents
Any comment:	The information, though recorded annually, is used for changes in the adjustment factor (*AF*) or directly $MD_{reg,y}$ at renewal of the crediting period.

Data / Parameter:	10. Operation of the energy plant
Data unit:	Hours
Description:	Operation of the energy plant.
Source of data to be used:	Measured with run meter connected to the power plant.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	7.700
Description of measurement methods and procedures to be applied:	Records will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Meters are quite accurate. But it will be calibrated according to manufacturer specifications.
Any comment:	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational.

Data / Parameter:	11. Operation of the flare station
Data unit:	Hours
Description:	
Source of data to be used:	Measured with run meter connected to the blower.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8.000
Description of measurement methods and procedures to be applied:	Records will be kept during the crediting period and two years after
QA/QC procedures to be applied:	Meters are quite accurate. But it will be calibrated according to manufacturer specifications.
Any comment:	

Data / Parameter:	12. $PE_{EC,y}$
Data unit:	tCO_2
Description:	Project emissions from electricity consumption by the project activity during the year y
Source of data to be used:	Calculated as per the "Tool to calculate project emissions from electricity consumption".
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Details of assumptions, calculations and resulting data are presented in section B.6.3.
Description of measurement methods and procedures to be applied:	As per the "Tool to calculate project emissions from electricity consumption".
QA/QC procedures to be applied:	As per the "Tool to calculate project emissions form electricity consumption".
Any comment:	

Data / Parameter:	13. $PE_{FC,j,,y}$
Data unit:	tCO_2e
Description:	Project emissions from fossil fuel combustion in process j during the year y.
Source of data to be used:	Calculated as per the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0
Description of measurement methods and procedures to be applied:	As per the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
QA/QC procedures to be applied:	As per the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
Any comment:	For ex-ante calculation purposes, there will be no fossil fuel consumption at project scenario, but any eventual fossil fuel consumption will be accounted.

The following variables are required to determine flare efficiency using the Tool. A fixed flare efficiency is assumed, so estimates of these data are not needed for ex-ante estimates.

Data / Parameter:	14. $FV_{RG,h}$
Data unit:	m^3/h
Description:	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*.
Source of data to be used:	On-site measurements.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used in ex – ante estimates
Description of measurement methods and procedures to be applied:	Measured at least one per hour and electronically using a flow meter, and will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Flow meters will be periodically calibrated according to the manufacturer's recommendation.
Any comment:	The same basis (dry or wet) is considered for this measurement when the residual gas temperature exceeds 60ºC.

Data / Parameter:	15. $fv_{i,h}$
Data unit:	-
Description:	Volumetric fraction of component *i* in the residual gas in the hour *h*.
Source of data to be used:	On-site measurements using a continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used in ex – ante estimates
Description of measurement methods and procedures to be applied:	As a simplified approach (see Eq. 3a), only methane content of the residual gas will be measured and the remaining part will be considered as N_2. Methane concentration would be measured at least once per hour using a continuous gas analyser, and data records will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Analysers will be periodically calibrated according to the manufacturer's recommendation. A zero check and typical value check to be performed by comparison with a standard certified gas.
Any comment:	The same basis (dry or wet) is considered for this measurement when the residual gas temperature exceeds 60ºC.

If project operator decides to monitor emissions continuously, the following two variables should be monitored:

Data/Parameter	16. $t_{O2,h}$
Data unit:	-
Description:	Volumetric fraction of O_2 in the exhaust has of the flare in the hour h.
Source of data:	On-site measurements using a continuous gas analyser.
Value of data applied for the purpose of calculating expected emission reductions in sections B.5	Not used in ex-ante estimates.
Description of measurement methods and procedures to be applied:	Measured at least on once per hour and electronically using a continuous gas analyser, and will be kept during the crediting period and two years after. Extractive sampling analysers with water and particulates removal devices or in situ analyser for wet basis determination. The point of measurement (sampling point) will be in the upper section of the flare (80% of total flare height). Sampling will be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes).
QA/QC procedures to be applied	Analysers will be periodically calibrated according to the manufacturer's recommendation. A zero check and typical value check to be performed by

	comparison with a standard certified gas.
Any comment	

Data/Parameter:	**17.** $fv_{CH4,FG,h}$
Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*
Source of data:	Measurements by project participants using a continuous gas analyser
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used in ex-ante estimates.
Description of measurement methods and procedures to be applied:	Extractive sampling analysers with water and particulates removal devices or in situ analyser for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height). Sampling shall be conducted with appropriate.

If project proponent decides to use the 90% default value for enclosed flares, the following two variables should be monitored:

Data / Parameter:	**18.** T_{flare}
Data unit:	ºC
Description:	Temperature in the exhaust gas of the flare
Source of data to be used:	On-site measurements using a thermocouple
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used in ex – ante estimates
Description of measurement methods and procedures to be applied:	Continuous measurement of the temperature of the exhaust gas stream in the flare by a thermocouple. A temperature above 500 ºC indicates that a significant amount of gases are still being burnt and that the flare is operating.
QA/QC procedures to be applied:	Thermocouples will be replaced or calibrated every year.
Any comment:	An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow.

Data / Parameter:	19. $\eta_{flare,h}$
Data unit:	Dimensionless
Description:	Flare efficiency in hour h
Source of data to be used:	Values specified in Methane Flaring Tool
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not used in ex – ante estimates
Description of measurement methods and procedures to be applied:	Calculated as specified in Methane Flaring Tool as follows: • 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*. • 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*.
QA/QC procedures to be applied:	
Any comment:	

The following variables are required to determine the electricity consumption from the grid using the "Tool to calculate project emissions from electricity consumption".

Data/Parameter:	20. $EC_{pj,y}$
Data unit:	MWh
Description:	On-site consumption of electricity provided by the grid and/or captive power plant(s) and attributable to the project activity during the year y
Source of data:	On site measurements
Value of data applied for the purpose of calculating expected emission reduction in section B.5	Details of assumptions, calculations and resulting data are presented in section B.6.3
Description of measurement methods and procedures to be applied	Measured continuously, aggregated at least annualy
QA/QC procedures to be applied	Meters will be calibrated according to manufacturer's specifications. Cross check measurements results with invoices for purchased electricity if relevant.
Any comment:	

Data/Parameter:	21. EFgrid,y
Data unit:	tCO_2/MWh
Description:	Emission factor for the grid in year y
Source of data:	As per "Tool to calculate the emission factor for an electricity system"
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.6284
Description of measurement methods and procedures to be applied:	As per "Tool calculate the emission factor for an electricity system". See Annex 3 of this document.
QA/QC procedures to be applied:	As per "Tool to calculate the emission factor for an electricity system" See Annex 3 of this document.
Any comment:	

Data/Parameter	22. TDL_y
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:	As per "Tool to calculate project emissions from electricity consumption"
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The default value is chosen, i.e., 20%.
Description of measurement methods and procedures to be applied:	Not applicable
QA/QC procedures to be applied:	As per "Tool calculate project emissions from electricity consumption".
Any comment:	

B.7.2 Description of the monitoring plan:

Unlike most methodologies that determine baseline and project emissions separately, and calculate emissions reductions as the difference between the two, the methodology ACM0001 determines emissions reductions directly. ACM0001 version 8 states:

"The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform(s) and the electricity generating/thermal energy unit(s) to determine the quantities as shown in Figure 1 [of ACM0001, ver. 8]. The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared. The main variables that need to be determined are the quantity of methane actually destroyed $MD_{project,y}$, *quantity of methane flared* ($MD_{flared,y}$), *the quantity of methane used to generate electricity* ($MD_{electricity,y}$)*/thermal energy* ($MD_{thermal,y}$), *and the quantity of methane captured* ($MC_{total,y}$)[4]. *The methodology also measures the energy generated by use of LFG* ($EL_{LFG,y}$, $ET_{LFG,y}$) *and energy consumed by the project activity that is produced using fossil fuels."*

Since the proposed project involves flaring, electricity generation, Figure 1 of ACM0001 ver. 6 simplifies to Figure 3 below.

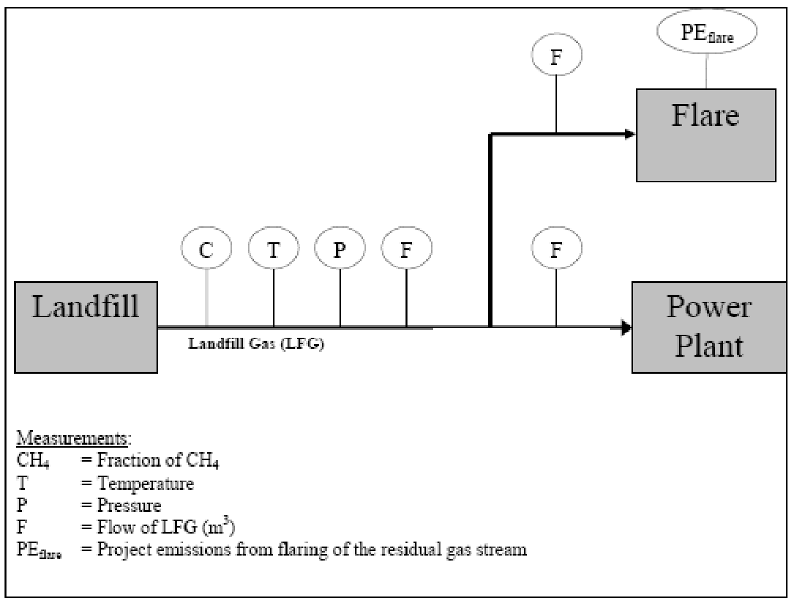

Figure 3: Schematic of the monitoring system at La Reserva Landfill, according to ACM0001 version 8

The variables to be monitored were all listed and described in Section B.7.1.

The overall management structure responsible for project monitoring is as follows:

The landfill is owned and operated by Técnicas Medioambientales de México, S.A. de C.V. (hereinafter TECMED). They would be involved in investments for gas collection and power generation, as well as additional operation, maintenance and monitoring costs.

4 ACM0001 version 8 (and earlier versions) refers to the total quantity of methane generated, using the variable MD_{total}, but this is believed to be an error because it is not possible to monitor methane generation. This should be "methane captured". Then, as the symbol "MD" (methane destroyed) would be misleading, we renamed the variable as MC_{total}.

The Technical Team of TECMED will be responsible for the day-to-day operation of the landfill gas collection, flaring and use system. This Technical Team would also be responsible for monitoring key variables required for meeting the CDM monitoring requirements.

Data monitoring will be conducted by Landfill Gas Technical Operators supervised by the Landfill Gas Project Engineer. Other staff persons will be assigned by the Landfill Gas Project Engineer to assist in the monitoring tasks, as needed.

Certain activities (calibration of flow meters and electric meters) would be conducted by independent, outside laboratories, with the data archived by TECMED.

TECMED will count on supervision from the flare supplier for training, commissioning and start-up. If TECMED decides to generate electricity using landfill gas, it will also acquire either from equipment supplier and/or specialist consultant all the services needed for training related to the operation of the LFG generation system.TECMED staff to be trained will be selected from those with extensive experience at the landfill.

All data recorded would be transferred to and stored as electronic spreadsheets and other electronic files. Calibration certificates would be stored as paper copies, although scanned copies may also be stored electronically. TECMED will be responsible for oversight on all aspects involving monitoring and quality control. and will maintain copies of all data collected, including calibration certificates for all instruments.

Following the internal audit, the electronic data would be used in a spreadsheet procedure in order to calculate emissions reductions. The original data, the calculation procedures and the resulting emission reductions will be verified by an independent Designated Operational Entity (DOE). The DOE would issue a Verification Report based on its findings and submit it to the CDM Executive Board for the issuance of CERs.

The operational and management structure for specific monitoring tasks is described in the following table:

	Task name	Responsible	Frequency	Internal procedures of Quality Control	Documentation
1	Reading of landfill gas capture and gas flared/ used	Technical Team of TECMED	Weekly. Data will be entered into a spreadsheet on a weekly basis, permitting continuous monitoring.	Yes	The data will be monitored and filed by the Technical Team of TECMED.
2	Calibration of the flow meters	External calibration laboratory	Every 2 years	Yes	Calibration certificate will be issued by the Calibration Laboratory. This certificate will be filed by the Technical Team of TECMED.
3	Measurement related to the determination of flare efficiency	Technical Team of TECMED	Continuous	Yes	The data will be monitoring and filed by Technical Team of TECMED.
4	Measurement of methane fraction in the landfill gas	Technical Team of TECMED or external laboratory	Continuous measurement, recording on a weekly basis.	Yes	Measured value will be used, together with corresponding measurement of pressure, temperature and flow rate of landfill gas, and other parameters that are periodically upgraded. Measurement of methane fraction would be recorder in an appropriate computer file, which would indicate start and end time of measurements corresponding to each data file. The data records will be filed by the person responsible for data filing and the Head the Technical Team of TECMED.
5	Measurement of Pressure and Temperature	Technical Team of TECMED	Weekly. Data will be entered into a spreadsheet on a weekly basis, permitting continuous monitoring.	Yes	Daily data on pressure and temperature would be recorded in a spreadsheet file. The data records will be filed by the person responsible for data filing and the Head of Technical Team of TECMED.
6	Other environmental indicators (see below)	Technical Team of TECMED	Annual	Yes	This data file will be completed and filed by the person responsible for data filing at Technical Team of TECMED.
7	Monitoring of regulatory requirements relating to landfill gas projects	Technical Team of TECMED	Annual	No	TECMED will prepare the report on the current situation with respect to legal requirements.
8	Electricity generation and consumption from the grid	Technical Team of TECMED	Hourly	Yes	Data tables showing date, hour, and meter reading to be recorded in a spreadsheet file, and filed by the person responsible for data filing and the Head of the Technical Team of TECMED.

	Task name	Responsible	Frequency	Internal procedures of Quality Control	Documentation
9	Fossil fuel use (propane, diesel, etc)	Technical Team of TECMED	Fossil fuel purchase will be recorded on delivery, with totals recorded monthly (in case of fossil fuel use in the project activity)	Yes	Data tables showing date and amount of fossil fuel purchase (data obtained from invoices) to be recorded in a spreadsheet file, and filed by the person responsible for data filing and the Head the Technical Team of TECMED.
10	Operation of the flare station (s), power plant (s), thermal plant (s)	Technical Team of TECMED	Continuous	Yes	The data will be monitored and filed by the Technical Team of TECMED
11	Electric meter calibration	External calibration laboratory	Twice a year	Yes	Calibration certificate will be issued by the Calibration Laboratory. This Certificate will be filed by the Technical Team of TECMED .
12	Internal Audit	Landfill Gas Technical Operators	Twice a year	Yes	The internal auditor will prepare a report to the Manager of the landfill site and the Head of Technical Team of TECMED on the state of items 1 to 8. In case of non conformity, they will attempt to resolve problems prior to the annual Verification carried out by a Designated Operational Entity. A copy of this report should be filed by the Technical Team of TECMED

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 completion of the baseline study: 14/05/2008

Baseline and monitoring analysed prepared by: Garrigues Medio Ambiente (not a project participant).

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:

17/11/2006

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

15 years

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

C.2.1. Renewable crediting period

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

Not selected

C.2.1.2. Length of the first crediting period:

Not selected

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/10/2008

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

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

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The project will collect and combust LFG, thereby improving overall landfill management and reducing adverse global and local environmental effects of uncontrolled releases of landfill gas. While the main global environmental concern over gaseous emissions of methane is the fact that it is a potent greenhouse gas and thus contributes importantly to global warming, emissions of LFG can also have significant health and safety implications at the local level. For example:•

- Although the majority of LFG emissions are quickly diluted in the atmosphere, in confined spaces there is a risk of explosion and/or fire, either within the landfill or outside its boundaries.
- Another potential threat of concentrated emissions of LFG is asphyxiation and/or toxic effects on humans.
- Landfill gas also contains over 150 trace components that can cause other local and global environmental effects such as odour nuisances, stratospheric ozone layer depletion, and ground-level ozone creation.

Note that LFG combustion would produce small amounts of nitrogen oxides (NOx), particulate matter and carbon monoxide (CO), as would be the case in the kitchen stove or any other device burning natural gas. The project would use enclosed flares specially designed to reduce these emissions to levels below that of an open flame. Note, however, that since the main fuel is methane, the emissions of particulate matter would be minimal. On the other hand an LFG flare is especially designed to operate at high temperature in order to burn the volatile organic compounds.

The installation of the LFG collection and combustion systems is part of a broader effort by the landfill operator to continue improving its waste management practices. Overall, sustainable management of the landfill will result in accelerating waste stabilisation such that the full decomposition of the waste in the landfill will be largely complete within 30- 50 years.

For the LFG flaring component of the project activity, no Environmental Impact Assessment is required by the Federal Government of the host country. However, as part of the efforts of the landfill operator to meet all the legal requirements for the concession of the landfill, the landfill fulfils with the minimum requirements stated in the NOM-083-SEMARNAT-2003. Some of those activities include compacting and capping of the landfill cells, leachate management and precipitation runoff and catchments systems, among others.

For the LFG utilisation component, only projects with an installed electricity generating capacity greater than 2 MW require an Environmental Impact Assessment (EIA) from the Federal

Government. In this case, the electricity generation estimated at the La Reserva landfill is expected to range between 1 and 2 MW.

Thus, the proposed project meets all environmental regulations.

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:

No significant impacts are applicable.

SECTION E. Stakeholders' comments

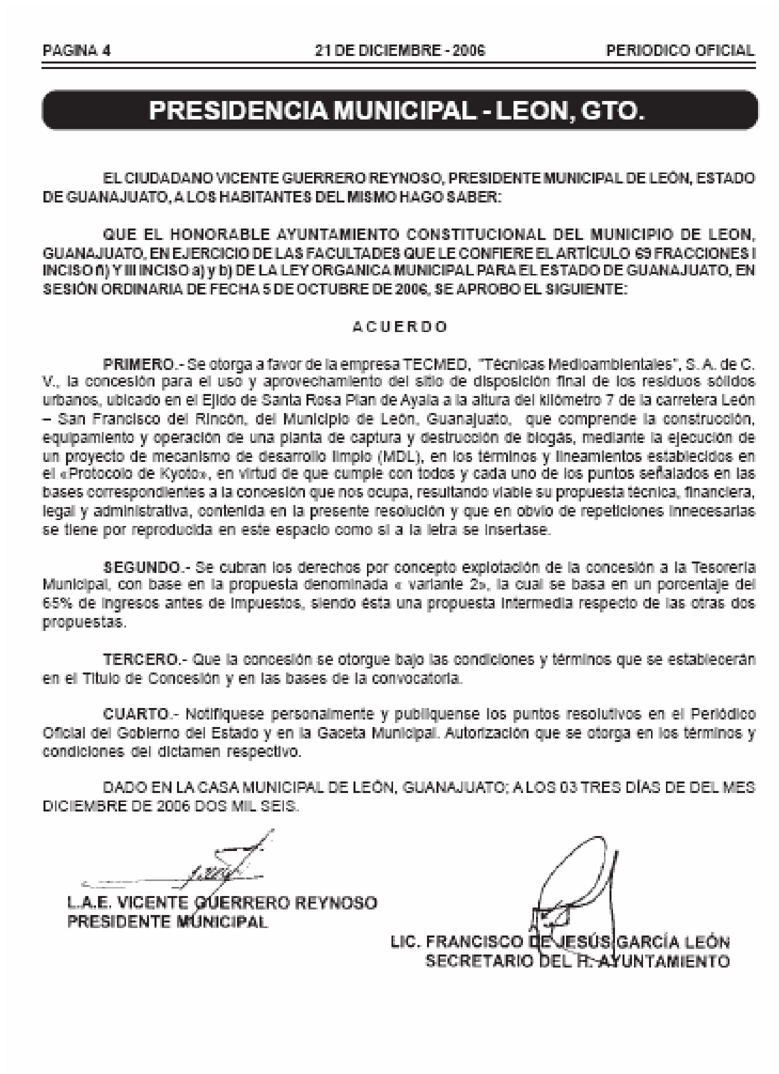
>>

The stakeholder consultation took place on 19th December 2006 at "La Estancia" Hotel, León. The event allowed stakeholders to understand the basic concepts related to climate change, its consequences and the aims of the Kyoto Protocol, as well as the most important features of the La Reserva Landfill Gas to Energy Project undertaken by the Project Developer.

The event was properly announced by sending more than 50 invitations cards. Specifically, local authorities, labour unions, industry, local media, and members of the community participated in the event which lasted approximately 3 hours. Most of the participants represented local communities. All participants were registered with appropriate formats kept in the Project Developer's files.

The stakeholder consultation included an introduction from a Municipal Member, a brief description of the project by the landfill operator as well as presentations by the Project Developer including the following topics: climate change; how this project is mitigating climate change through the Clean Development Mechanism of the Kyoto Protocol; the technical details of the project; and a session aimed at addressing questions posed by the stakeholders.

At the same time, as shown in the next picture, the Project was properly announced in the main local newspaper "*Periodico Oficial del Gobierno del Estado de Guanajuato*"



PAGINA 4 | 21 DE DICIEMBRE - 2006 | PERIODICO OFICIAL

PRESIDENCIA MUNICIPAL - LEON, GTO.

EL CIUDADANO VICENTE GUERRERO REYNOSO, PRESIDENTE MUNICIPAL DE LEÓN, ESTADO DE GUANAJUATO, A LOS HABITANTES DEL MISMO HAGO SABER:

QUE EL HONORABLE AYUNTAMIENTO CONSTITUCIONAL DEL MUNICIPIO DE LEON, GUANAJUATO, EN EJERCICIO DE LAS FACULTADES QUE LE CONFIERE EL ARTÍCULO 69 FRACCIONES I INCISO f) Y III INCISO a) y b) DE LA LEY ORGANICA MUNICIPAL PARA EL ESTADO DE GUANAJUATO, EN SESIÓN ORDINARIA DE FECHA 5 DE OCTUBRE DE 2006, SE APROBO EL SIGUIENTE:

A C U E R D O

PRIMERO.- Se otorga a favor de la empresa TECMED, "Técnicas Medioambientales", S. A. de C. V., la concesión para el uso y aprovechamiento del sitio de disposición final de los residuos sólidos urbanos, ubicado en el Ejido de Santa Rosa Plan de Ayala a la altura del kilómetro 7 de la carretera León – San Francisco del Rincón, del Municipio de León, Guanajuato, que comprende la construcción, equipamiento y operación de una planta de captura y destrucción de biogás, mediante la ejecución de un proyecto de mecanismo de desarrollo limpio (MDL), en los términos y lineamientos establecidos en el «Protocolo de Kyoto», en virtud de que cumple con todos y cada uno de los puntos señalados en las bases correspondientes a la concesión que nos ocupa, resultando viable su propuesta técnica, financiera, legal y administrativa, contenida en la presente resolución y que en obvio de repeticiones innecesarias se tiene por reproducida en este espacio como si a la letra se insertase.

SEGUNDO.- Se cubran los derechos por concepto explotación de la concesión a la Tesorería Municipal, con base en la propuesta denominada « variante 2», la cual se basa en un porcentaje del 65% de ingresos antes de impuestos, siendo ésta una propuesta intermedia respecto de las otras dos propuestas.

TERCERO.- Que la concesión se otorgue bajo las condiciones y términos que se establecerán en el Título de Concesión y en las bases de la convocatoria.

CUARTO.- Notifíquese personalmente y publíquense los puntos resolutivos en el Periódico Oficial del Gobierno del Estado y en la Gaceta Municipal. Autorización que se otorga en los términos y condiciones del dictamen respectivo.

DADO EN LA CASA MUNICIPAL DE LEÓN, GUANAJUATO; A LOS 03 TRES DÍAS DE DEL MES DICIEMBRE DE 2006 DOS MIL SEIS.

L.A.E. VICENTE GUERRERO REYNOSO
PRESIDENTE MUNICIPAL

LIC. FRANCISCO DE JESÚS GARCÍA LEÓN
SECRETARIO DEL H. AYUNTAMIENTO

Figure 4: Project announced in the main local newspaper "Periodico Oficial del Gobierno del Estado de Guanajuato"

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

To date no formal comments have been received from stakeholders.

E.2.	**Summary of the comments received:**

There have been no formal comments submitted by any of the stakeholders regarding this project. Overall, the stakeholder consultation was a positive event with stakeholders being informed about the project activities.

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

There have been no formal comments submitted by any of the stakeholders regarding this project. Overall, the stakeholder consultation was a positive event with stakeholders being informed about the project activities.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	TECMED, Técnicas Medioambientales de Mexico, SA de CV
Street/P.O.Box:	Mariano Escobedo # 375, Desp. 604
Building:	
City:	Ciudad de Mexico, DF
State/Region:	Ciudad de Mexico DF
Postfix/ZIP:	11570
Country:	Mexico
Telephone:	55-5402-4040
FAX:	
E-Mail:	
URL:	
Represented by:	E. Gil Aranda R
Title:	Project Manager
Salutation:	Mr
Last Name:	Gil
Middle Name:	
First Name:	
Department:	
Mobile:	04455-5402-4040
Direct FAX:	
Direct tel:	
Personal E-Mail:	egar@tecmedmx.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No funds from public national or international sources will be used in any aspect of the proposed project.

Annex 3

BASELINE INFORMATION

Emissions reductions result mainly from methane destruction resulting from the capture and burning of landfill gas. Additional emissions reductions take place if the landfill gas is used to generate electricity, thereby offsetting carbon dioxide emissions at power plants elsewhere in the interconnected grid.

The Annex contains two items:

1. A derivation of the parameters used to estimate landfill gas generation from solid waste using the "*Tool to determine methane emissions from dumping waste at a solid waste disposal site*" from Executive Board 35th Meeting Report, Annex 10. Version 1 of the Tool was used in this PDD. These parameters are only used in the ex-ante estimation of emissions reductions; and
2. A calculation of the emissions factor for power generation in the interconnected power grid in Mexico, using the "*Tool to calculate the emission factor for an electricity system*", from Executive Board 35th Meeting Report, Annex 12. Version 1 of the Tool was used here.

Methane emissions reductions from landfill gas capture

Landfill gas is generated by the anaerobic decomposition of solid waste within a landfill. It is typically composed of approximately 40 to 60 percent methane, with the remainder primarily being carbon dioxide.

The rate at which LFG is generated is largely a function of the type of waste buried and the moisture content and age of the waste. It is widely accepted throughout the industry that the LFG generation rate generally can be described by a first-order decay equation.

The k-parameters needed as input in the "*Tool to determine methane emissions from dumping waste at a solid waste disposal site*" model are based on IPCC recommendations (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5). The tool is described in detail below.

The tool states:
"The amount of methane that would in the absence of the project activity be generated from disposal of waste at the solid waste disposal site ($BE_{CH4,SWDS,y}$) is calculated with a multi-phase model. The calculation is based on a first order decay (FOD) model. The model differentiates between the different types of waste j with respectively different decay rates kj and different fractions of degradable organic carbon (DOC_j). The model calculates the methane generation based on the actual waste streams $W_{j,x}$ disposed in each year x, starting with the first year after

the start of the project activity until the until end of year y, for which baseline emissions are calculated (years x with x=1 to x=y).”

The amount of methane produced in the year y ($BE_{CH4,SWDS,y}$) is calculated as follows:

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

Where:

$BE_{CH4,SWDS,y}$	Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO_2e).
φ	Model correction factor to account for model uncertainties (0,9).
f	Fraction of methane captured at the SWDS and flared, combusted or used in another manner.
GWP_{CH4}	Global Warming Potential (GWP) of methane, valid for the relevant commitment period.
OX	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering waste).
F	Fraction of methane in the SWDS gas (volume fraction)
DOC_f	Fraction of degradable organic carbon (DOC) that can descompose.
MCF	Methane correction factor.
$W_{j,x}$	Amount of organic type j prevented from disposal in the SWDS in the year x (tonnes).
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	Year since the landfill started receiving wastes [x runs from the first year of landfill operation (x=1) to the year for which emissions are calculated (x=y)]. Note: this definition represents a correction of the Tool as given in ACM0001, ver. 8.

y	Year for which methane emissions are calculated.

The tool used is usually for project activities that would avoid methane avoiding waste disposal at landfills. But in the same way, the methane generation can be estimated for landfills, only taking into account different years: the first year is the year of landfill opening and the last year is the last year of the project activity.
Hence, the above equation is used to estimate methane generation for a given year from all waste disposed up through that year. Multi-year projections are developed by varying the projection year and re-applying the equations. The year of maximum LFG generation normally occurs in the closure year or the year following closure (depending on the final year's disposal rate).

The value choice for each variable according to the tool recommendations are the following:

Variable	Value	Justification
φ	0,9	Default value recommended in methodology is used here
f	50%	Conservative value according to observation to other landfills with active LFG extraction systems in place.
GWP_{CH4}	21	Global Warming Potential (GWP) of methane, valid for the relevant commitment period.
OX	0	Oxidation factor in a well managed landfill with a good cover is not considerable and can be estimated as zero.
F	0,52	Fraction of methane in the SWDS gas (value according to observation to the landfill tests).
DOC_f	0,5	The decomposition of degradable organic carbon does not occur completely and some of the potentially degradable material always remains in the site even over a very long period of time. IPCC recommends that values should vary from 0.5 to 0.77. Default value recommended in methodology is used here.

<table>
<tr><td>MCF</td><td>1</td><td>El Verde landfill is very well managed, with daily cover with soil, leachate drainage system and waste thickness is higher than 5 meters. The value is chosen according to IPCC table, cited in methodology.</td></tr>
<tr><td>$W_{j,x}$</td><td>
<table>
<tr><th rowspan="2">Year</th><th>Waste input</th></tr>
<tr><th>Tonnes</th></tr>
<tr><td>1985</td><td>108.870</td></tr>
<tr><td>1986</td><td>122.230</td></tr>
<tr><td>1987</td><td>137.355</td></tr>
<tr><td>1988</td><td>154.352</td></tr>
<tr><td>1989</td><td>173.452</td></tr>
<tr><td>1990</td><td>194.916</td></tr>
<tr><td>1991</td><td>219.036</td></tr>
<tr><td>1992</td><td>246.140</td></tr>
<tr><td>1993</td><td>276.599</td></tr>
<tr><td>1994</td><td>310.826</td></tr>
<tr><td>1995</td><td>349.289</td></tr>
<tr><td>1996</td><td>392.512</td></tr>
<tr><td>1997</td><td>441.083</td></tr>
<tr><td>1998</td><td>495.664</td></tr>
<tr><td>1999</td><td>557.000</td></tr>
<tr><td>2000</td><td>625.925</td></tr>
<tr><td>2001</td><td>703.380</td></tr>
<tr><td>2002</td><td>790.420</td></tr>
</table>
</td><td>The historical filling rates were provided by landfill personnel.</td></tr>
<tr><td>DOC_j</td><td>
<table>
<tr><th>Waste type j</th><th>DOCi (% wet waste)</th><th>Fraction of Waste Type j</th></tr>
<tr><td>Wood and wood products (moderately)</td><td>43%</td><td>3,9%</td></tr>
<tr><td>Wood and wood products (slowly)</td><td>43%</td><td>1,6%</td></tr>
<tr><td>Pulp, paper and cardboard (moderately)</td><td>40%</td><td>4,7%</td></tr>
<tr><td>Pulp, paper and cardboard (slowly)</td><td>40%</td><td>11,0%</td></tr>
<tr><td>Textiles</td><td>24%</td><td>4,2%</td></tr>
<tr><td>Garden, Yard & Park Waste (rapidly)</td><td>20%</td><td>2,0%</td></tr>
<tr><td>Garden, Yard & Park Waste (moderately)</td><td>20%</td><td>2,0%</td></tr>
<tr><td>Food, food waste, beverages and tobacco</td><td>15%</td><td>36,0%</td></tr>
<tr><td>Fruits</td><td>15%</td><td>7,7%</td></tr>
<tr><td>Total</td><td></td><td>73,1%</td></tr>
</table>
</td><td>Waste composition in La Reserva</td></tr>
<tr><td>k_j</td><td>
<table>
<tr><th>Waste type j</th><th>Type of k</th></tr>
<tr><td>Wood and wood products (moderately)</td><td>0,05</td></tr>
<tr><td>Wood and wood products (slowly)</td><td>0,02</td></tr>
<tr><td>Pulp, paper and cardboard (moderately)</td><td>0,05</td></tr>
<tr><td>Pulp, paper and cardboard (slowly)</td><td>0,04</td></tr>
<tr><td>Textiles</td><td>0,04</td></tr>
<tr><td>Garden, Yard & Park Waste (rapidly)</td><td>0,06</td></tr>
<tr><td>Garden, Yard & Park Waste (moderately)</td><td>0,05</td></tr>
<tr><td>Food, food waste, beverages and tobacco</td><td>0,06</td></tr>
<tr><td>Fruits</td><td>0,06</td></tr>
</table>
</td><td>Value according to IPCC 2006. Waste section, table 3.3</td></tr>
<tr><td>j</td><td>According to IPCC recommendations and for the categories in DOC_j</td><td></td></tr>
</table>

x	1985	Start of landfill operations
y	2008	Year for which methane emissions are calculated for first crediting period

Emission Factor for Electricity Generation in the Mexican Grid ($CEF_{elec,BL}$ and $CEF_{elec,PR}$)

- ***Fuel Consumption:***

	2004				2005			
	Fuel share	Fuel Consumption [TJ]	Carbon Content [tC/TJ]	Emission CO2 [tCO2]	Fuel share	Fuel Consumption [TJ]	Carbon Content [tC/TJ]	Emission CO_2 [tCO_2]
Fuel oil	41,1%	632.013	21,1	48.896.754	39,1%	624.664	21,1	48.328.137
Natural Gas	42,6%	655.079	15,3	36.749.953	39,6%	632.652	15,3	35.491.754
Diesel	1,0%	15.377	20,2	1.138.956	0,9%	14.378	20,2	1.064.963
Coal	15,3%	235.275	25,8	22.257.014	20,5%	327.509	25,8	30.982.354
Total		1.537.745		**109.042.677**		1.599.203		**115.867.208**

Table 16: Fuel consumption per fuel type during years 2004 and 2005.

Source: Sener, "Prospectiva del sector eléctrico 2005-2014", "Prospectiva del sector eléctrico 2006-2015" and IPCC Guidelines 2006.

	2006			
	Fuel share	Fuel Consumption [TJ]	Carbon Content [tC/TJ]	Emission CO_2 [tCO_2]
Fuel oil	32,0%	514.738	21,1	39.823.532
Natural Gas	47,0%	756.021	15,3	42.412.770
Diesel	1,0%	16.086	20,2	1.191.403
Coal	20,0%	321.711	25,8	30.433.861
Total		1.608.555		**113.861.566**

Table 17: Fuel consumption per fuel type during year 2006.

Source: Sener, "Prospectiva del sector eléctrico 2007-2016", and IPCC Guidelines 2006.

- ***Generation by sources:***

	2002	2003	2004	2005	2006	% of total generation
Exports (GWh)	344	953	1.006	1.291	1.299	0,63%
Imports (GWh)	531	71	47	87	523	0,25%
Net Exchange (GWh)	-187	882	959	1.204	776	

Table 18: Electricity imports and exports. Source: Sener, "Prospectiva del sector eléctrico 2007-2016".

		2004	2005	2006
Fuel-oil	(termoeléctrica convencional)	31,8%	29,7%	23,1%
Combined Cycle	(ciclo combinado)	34,7%	33,5%	40,5%
Renewable + Hydro	(hidroeléctrica + geo y eolo)	15,1%	15,9%	16,5%
Coal	(carboeléctrica)	8,6%	8,5%	14,1%
Dual (coal + fuel oil)	(dual)	3,8%	6,5%	-
Turbogas	(turbogás)	1,3%	0,6%	0,7%
Nuclear	(nuclear)	4,4%	4,9%	4,8%
Diesel	(combustión interna)	0,3%	0,4%	0,4%
Free		-	-	-
Net generation [GWh]		**189.857**	**199.264**	**206.623**

Table 19: Generation by sources during years 2004, 2005, and 2006.

Source: Sener, "Prospectiva del sector eléctrico 2007-2016".

	2004 [%]	2005 [%]
Renewable + Hydro + Nuclear	19,5%	20,8%
Others	80,5%	79,2%

2004 [GWh]	2005 [GWh]
37.022	41.447
152.835	157.817

Net GWh under methodology

2004 [GWh]	2005 [GWh]
152.882	157.904

Table 20: Generation by sources during years 2004 and 2005.

Source: Sener, "Prospectiva del sector eléctrico 2005-2014" and "Prospectiva del sector eléctrico 2006-2015".

	2006 [%]
Renewable + Hydro + Nuclear	21,3%
Others	78,7%

2006 [GWh]
44.011
162.612

Net GWh under methodolog

2006 [GWh]
163.135

Table 21: Generation by sources during year 2006.

Source: Sener, "Prospectiva del sector eléctrico 2007-2016"

According to these tables, the total percentage of low-cost/must-run generation sources (renewable+hydro, nuclear) was, 19,5%, 20,8% and 21,3% in 2004, 2005 and 2006 respectively. The total generation of other sources (those included in baseline calculations) was 152.835 GWh, 157.817 Gwh and 162.612 GWh in 2004, 2005 and 2006, respectively.

According to the most recent data available, power plants that came on line in the most recent years are presented in the following table:

Power Plant	Start of operation	Technology *	Installed Capacity (MW)	Generation (GWh)	% Self-use rate	Net generation (GWh)	% Over the system generation in 2006
Valladolid III	2006	CC	525,0	1.869,00	2,70%	1.818,54	0,88%
Tuxpan V	2006	CC	495,0	1.674,00	2,70%	1.628,80	0,79%
Altamira V	2006	CC	1.121,0	2.044,00	2,70%	1.988,81	0,96%
Los Cabos	2006	GT	27,2	0,00	1,20%	0,00	0,00%
Chihuahua II	2006	CC	65,3	340,32	2,70%	331,13	0,16%
Atenco	2006	GT	32,0	0,00	1,20%	0,00	0,00%
Tuxpango U-1,2,3 y 4	2006	H	36,0	0,00	0,80%	0,00	0,00%
Tepexic (LFC)	2006	H	15,0	0,00	0,80%	0,00	0,00%
Hermosillo CFE	2006	CC	1,9	11,57	2,70%	11,26	0,01%
Huinalá	2006	GT	10,3	47,89	1,20%	47,31	0,02%
Hermosillo CFE	dec-2005	CC	93,3	568,02	2,80%	552,12	0,27%
La Laguna II	mar-2005	CC	498,0	3.823,00	2,70%	3.719,78	1,80%
Rio Bravo IV	2005	CC	500,0	3.086,00	2,70%	3.002,68	1,45%
Baja California Sur I	2005	IC	42,9	225,00	7,40%	208,35	0,10%
Holbox	2005	IC	0,8	0,00	9,10%	0,00	0,00%
Yécora	2005	IC	0,7	0,00	9,10%	0,00	0,00%
Botello U-2	2005	H	9,0	0,00	0,80%	0,00	0,00%
Ixtaczoquitlán U-1	sep-2005	H	1,6	0,00	0,80%	0,00	0,00%
El Sauz CFE	2004	CC	128,0	625,94	2,70%	609,04	0,29%
Rio Bravo III	2004	CC	495,0	2.548,00	2,70%	2.479,20	1,20%
San Lorenzo Potencia	jan-2004	GT	266,0	0,00	1,20%	0,00	0,00%
Tuxpan U-7	2004	GT	163,0	800,95	1,20%	791,34	0,38%
Guerrero Negro II	2004	IC	10,8	0,00	9,10%	0,00	0,00%
Chicoasén U-6, 7 y 8	apr-2004	H	900,0	2.505,75	0,80%	2.485,70	1,20%
Altamira III y IV	dic-2003	CC	1.036,0	6.644,00	2,70%	6.464,61	3,13%
Naco Nogales	oct-2003	CC	258,0	1.947,00	2,80%	1.892,48	0,92%
Chihuahua III	sep-2003	CC	259,0	1.226,00	2,80%	1.191,67	0,58%
Mexicali	jul-2003	CC	489,0	2.545,00	2,70%	2.476,29	1,20%
Campeche	may-2003	CC	252,0	1.861,00	2,80%	1.808,89	0,88%
Tuxpan III y IV	may-2003	CC	983,0	7.253,00	2,70%	7.057,17	3,42%
Los Azufres	2003	GEO	106,0	827,34	0,80%	820,72	0,40%
			Total	**42.473**		**41.386**	20,03%

*Technology (CC:Combined Cycle; H:Hydro;
GT: Gas Turbine; GEO: Geothermal; IC: Internal Combustion)

Table 22: New power plants installed recently.

Source: Sener, "Prospectiva del sector eléctrico 2007-2016", POISE 2007-2016 and CFE website: http://www.cfe.gob.mx/es/..

	Power (MW)	Efficiency (%)	Life cycle
Combined Cycle	1 x 291	51,83%	30
	1 x 583	51,99%	30
	1 x 400	52,28%	30
	1 x 802	52,47%	30
Diesel	2 x 18,4	45,17%	25
	4 x 9,7	43,64%	25
	3 x 3,4	40,40%	25
Gas Turbine "F"	1 x 190	33,49%	30
Gas Turbine "G"	1 x 267	35,55%	30

Table 23: Technical data and characteristics of typical projects.

Source: Sener, "Prospectiva del sector eléctrico 2007-2016".

Efficiency for each plant has been considered depending on the capacity that has been added and the total capacity of the analyzed plant. A conservative criterion has been follow, knowing that the most efficient factor means lowest emission factor.

- ***Operating Margin:***

$$EF_{OM,simple,y} = \frac{\sum_{i,j} F_{i,j,y} \cdot COEF_{i,j}}{\sum_{j} GEN_{j,y}}$$

We know the numerator of the above expression for the years 2004, 2005 and 2006. Therefore:

$$EF_{OM,simple,2004} = \frac{109.042.677 tCO_2}{152.882 GWh} = 713{,}248 \text{ tCO}_2\text{/GWh}$$

$$EF_{OM,simple,2005} = \frac{115.867.208 tCO_2}{157.904 GWh} = 733{,}784 \text{ tCO}_2\text{/GWh}$$

$$EF_{OM,simple,2006} = \frac{113.861.566 tCO_2}{163.135 GWh} = 697{,}959 \text{ tCO}_2\text{/GWh}$$

$$EF_{OM,simple}(ex-ante) = \frac{(713{,}248 \cdot 152.882 + 733{,}784 \cdot 157.904 + 697{,}959 \cdot 163.135)}{(152.882 + 157.904 + 163.135)} = 714{,}828 \text{ tCO}_2\text{/GWh}$$

- ***Build Margin:***

$$EF_{BM,2006} = \frac{\sum_{i,m} F_{i,m,2006} \cdot COEF_{i,m}}{\sum_{m} GEN_{m,2006}} = 369{,}19 \text{ tCO}_2\text{/GWh}$$

The product $\sum_{i,m} F_{i,m,y} \cdot COEF_{i,m}$ for each plant has been obtained from:

$$F_{i,k,2006} = \frac{GEN_{i,k,2006} \cdot 3{,}6}{\eta_{i,k,2006} \cdot NCV_i}$$

$$COEF_{i,k} = NCV_i \cdot EF_{CO_2,i} \cdot \frac{44}{12} \cdot OXID_i$$

Therefore, $F_{i,m,2006} \cdot COEF_{i,m} = \dfrac{GEN_{i,k,2006} \cdot 3{,}6 \cdot EF_{CO_2,i} \cdot \frac{44}{12} \cdot OXID_i}{\eta_{i,k,2006}}$

Power Plant	Technology *	Installed Capacity (MW)	Generation (GWh)	% Self-use rate	Net generation (GWh)	% Over the system generation in 2006	Efficiency (%)	NCV (TJ/Gg)	Carbon Content (tC/TJ)	OXID (%)
Valladolid III	CC	525,0	1.869,00	2,70%	1.818,54	0,88%	52,47%	48	15,3	100,00%
Tuxpan V	CC	495,0	1.674,00	2,70%	1.628,80	0,79%	52,47%	48	15,3	100,00%
Altamira V	CC	1.121,0	2.044,00	2,70%	1.988,81	0,96%	52,47%	48	15,3	100,00%
Los Cabos	GT	27,2	0,00	1,20%	0,00	0,00%	35,55%	48	15,3	100,00%
Chihuahua II	CC	65,3	340,32	2,70%	331,13	0,16%	52,47%	48	15,3	100,00%
Atenco	GT	32,0	0,00	1,20%	0,00	0,00%	35,55%	48	15,3	100,00%
Tuxpango U-1,2,3 y 4	H	36,0	0,00	0,80%	0,00	0,00%	-	-	-	-
Tepexic (LFC)	H	15,0	0,00	0,80%	0,00	0,00%	-	-	-	-
Hermosillo CFE	CC	1,9	11,57	2,70%	11,26	0,01%	52,47%	48	15,3	100,00%
Huinalá	GT	10,3	47,89	1,20%	47,31	0,02%	35,55%	48	15,3	100,00%
Hermosillo CFE	CC	93,3	568,02	2,80%	552,12	0,27%	52,28%	48	15,3	100,00%
La Laguna II	CC	498,0	3.823,00	2,70%	3.719,78	1,80%	52,47%	48	15,3	100,00%
Rio Bravo IV	CC	500,0	3.086,00	2,70%	3.002,68	1,45%	52,47%	48	15,3	100,00%
Baja California Sur I	IC	42,9	225,00	7,40%	208,35	0,10%	43,64%	43	20,2	100,00%
Holbox	IC	0,8	0,00	9,10%	0,00	0,00%	40,40%	43	20,2	100,00%
Yécora	IC	0,7	0,00	9,10%	0,00	0,00%	40,40%	43	20,2	100,00%
Botello U-2	H	9,0	0,00	0,80%	0,00	0,00%	-	-	-	-
Ixtaczoquitlán U-1	H	1,6	0,00	0,80%	0,00	0,00%	-	-	-	-
El Sauz CFE	CC	128,0	625,94	2,70%	609,04	0,29%	52,47%	48	15,3	100,00%
Rio Bravo III	CC	495,0	2.548,00	2,70%	2.479,20	1,20%	52,47%	48	15,3	100,00%
San Lorenzo Potencia	GT	266,0	0,00	1,20%	0,00	0,00%	35,55%	48	15,3	100,00%
Tuxpan U-7	GT	163,0	800,95	1,20%	791,34	0,38%	35,55%	48	15,3	100,00%
Guerrero Negro II	IC	10,8	0,00	9,10%	0,00	0,00%	40,40%	43	20,2	100,00%
Chicoasén U-6, 7 y 8	H	900,0	2.505,75	0,80%	2.485,70	1,20%	-	-	-	-
Altamira III y IV	CC	1.036,0	6.644,00	2,70%	6.464,61	3,13%	52,47%	48	15,3	100,00%
Naco Nogales	CC	258,0	1.947,00	2,80%	1.892,48	0,92%	52,28%	48	15,3	100,00%
Chihuahua III	CC	259,0	1.226,00	2,80%	1.191,67	0,58%	52,28%	48	15,3	100,00%
Mexicali	CC	489,0	2.545,00	2,70%	2.476,29	1,20%	52,47%	48	15,3	100,00%
Campeche	CC	252,0	1.861,00	2,80%	1.808,89	0,88%	52,28%	48	15,3	100,00%
Tuxpan III y IV	CC	983,0	7.253,00	2,70%	7.057,17	3,42%	52,47%	48	15,3	100,00%
Los Azufres	GEO	106,0	827,34	0,80%	820,72	0,40%	-	-	-	-
		Total	**42.473**		**41.386**	20,03%				

*Technology (CC:Combined Cycle; H:Hydro;
GT: Gas Turbine; GEO: Geothermal; IC: Internal Combustion)

Table 24. New power plants installed recently.

Source: Sener, "Prospectiva del sector eléctrico 2007-2016", POISE 2007-2016 and CFE website: http://www.cfe.gob.mx/es/.

The Build Margin is considered to remain constant during the crediting period due to Combined Cycle forecast installation.

- ***Emission Factor:***

$EF_{electricity,\ 2006} = 0{,}75 \cdot 0{,}7148 + 0{,}25 \cdot 0{,}3692 = 0{,}6284\ tCO_2e/MWh$

Annex 4

MONITORING INFORMATION

Detailed information is in B.7.