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

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Title:	Culiacan Northern Landfill Gas Project.
Version:	Version Number 5.2
Date:	06/07/2010.

A.2. Description of the project activity:

The project objective is to collect and flare the landfill gas (LFG) generated by the decomposition of the organic wastes disposed at the Northern Landfill of Culiacan. The project requires the installation of a gas collection system, flaring equipment and a modular electricity plant.

Culiacan Northern Landfill Gas Project is developed by Promotora Ambiental S.A.B de C.V., and is operated by its subsidiary Promotora Ambiental de la Laguna S.A de C.V., this LFG collection and utilization project takes place at the landfill knows as Culiacan in the city of Culiacan, Sinaloa, Mexico.

The Landfill was opened in 1992, as a controlled dump. It is located outside of the city of Culiacan in the state of Sinaloa. The total amount of waste disposed is around 2.86 million tons[1]. Until 2007, the site received about 850 tons of municipal solid waste (MSW) daily. However, since 2008 it has received on average 450-500 tons per day, because the municipality has a new site for the final disposal of MSW. According to the information provided by the Municipality and Promotora Ambiental S.A.B. de C.V. the final disposal will continue to be at the Culiacan Northern Landfill with the quantity mentioned for 2008 (conservatively 450 tons per day). For this project activity , cells number one to number ten will be considered for the project activity. At the end of 2008, all these cells had been closed and they will not receive any more waste on them.

The composition of the waste received is primarily residential with 73.9% of organic waste[2]. The site natural form was a low hill of approximately 20 meters of height, native soil is clay. The Culiacan Northern Landfill occupied site area is around 33 ha (from a total area of 100 ha) of non-hazardous waste disposal. It has an average annual precipitation of 673.5 mm/yr and an average temperature of 25.6 °C[3].

Currently there is no system in place to actively capture or flare the landfill gas generated and it is vented to the atmosphere. The situation prior to the implementation of the proposed project activity (venting of the landfill gas generated) is the same as the baseline scenario. The common practice for the handling of the leachate is to reinject it, without any control of the filtrations to the underground. However, a remediation

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[1] Landfill Gas Collection System Design Report(for Culiacan Landfill), by SCS Energy. Page 2. December 2007.

[2] Municipal Solid Waste Characterization for the Northern Landfill Project, by Auditoria y Gestión Ambiental Company. May 2007.

[3] Information provided by the National Institute of Statistic and Geography ("Instituto Nacional de Estadística y Geografía", INEGI) <http://www.inegi.gob.mx/est/contenidos/espanol/sistemas/cem05/info/sin/m006/c25006_01.xls>

program is being carried out, to improve the integrity of closed areas of the landfill and reducing impacts on the surrounding environment after closure.

The project activity has been designed in a first phase and includes the construction and operation of a landfill gas (LFG) collection and flare system. The purpose of LFG flaring is to safely dispose of the flammable constituents, particularly methane, and to control odour nuisance, health risks and adverse environmental impacts. This will involve investment in a highly efficient and enclosed landfill gas collection system, and the requisite flaring equipment.

If the project secures the LFG flow for the electricity generation, a second project phase would be carried out where a reciprocating engine facility will be installed. This phase implies the installation of generating equipments that would combust the methane of the LFG in order to produce electricity. Excess LFG, and all gas collected during periods when electricity is not produced, shall be flared. In the absence of the proposed project activity (baseline scenario) electricity would be generated by the operation of grid fossil fuel fired power plants, this situation is the same prior to the implementation of the project activity.

Following the implementation of the proposed CDM project, the predicted LFG recovery rate for the Landfill in 2010 wil be 784 m3/h (assuming 45% capture of LFG generated, according to the design report from the technologist), decreasing to 464 m3/h at the end of the crediting period (10 years) of the proposed CDM project.

The Project Developer therefore anticipates reducing greenhouse gas emission reductions in two different manners. Firstly, by capturing, flaring and combusting LFG, the project activity avoids the uncontrolled release of methane into the atmosphere. Secondly, by producing electricity from LFG, the Project will lead to emission reductions attributable to the displacement of electricity that would have been more carbon intensive otherwise.

Promotora Ambiental S.A.B. de C.V. has more than 15 years of experience dedicated to the collection and disposal of domestic and private wastes, it actually participates in 23 landfills in Mexico; in this project it will have the collaboration of SCS Engineers, company with 37 years of experience in the planning, permitting, investigation, design, construction, and operation of LFG control and energy recovery systems.

The Project will have several positive social, economic and environmental impacts that will contribute with the international efforts of climate change mitigation:

- The objective of LFG flaring is to dispose the methane, in a safe manner, and to control and reduce odour nuisance and health risks.
- It is intended to capture the methane that would be released to the atmosphere. Not only the project will confront global warming, it will also provide an environmental solution to minimize risks such as possible explosions for accumulated methane and a secure health for the local community at the landfill site.
- It will add to the national private expertise in the installation and operation of on-grid biogas power generation technology and flaring systems and strengthen institutional capacities.

- It will increase technology diversification in the power sector, enhancing the robustness of the power system and contributing to the security and reliance of supply.
- It will strengthen Mexico's participation in international carbon markets.
- Increase of job opportunities related to the management, operation and maintenance of the landfill, the landfill gas system and the power plant.

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 (host)	Promotora Ambiental de la Laguna S.A. de C.V (private entity) (*)	No
(*) In accordance with the CDM modalities and procedures, at the time of making the CDM-PDD public at the stage of validation, a Party involved may or may not have provided its approval. At the time of requesting registration, the approval by the Party(ies) involved is required.		

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Mexico

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

State of Sinaloa

A.4.1.3. City/Town/Community etc:

Municipality of Culiacan

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

The Site is located at Km. 2.5, Pitayita way, without number in the City of Culiacan, Sinaloa. The geographic coordinates of the site are the parallel 24°52’50.46” Northern Latitude (N.L.) and meridian 107°22’04.51” West Longitude (W.L.). The GPS coordinates were taken from the center point of Culiacan Northern Landfill, based on the latest version of Google Earth.

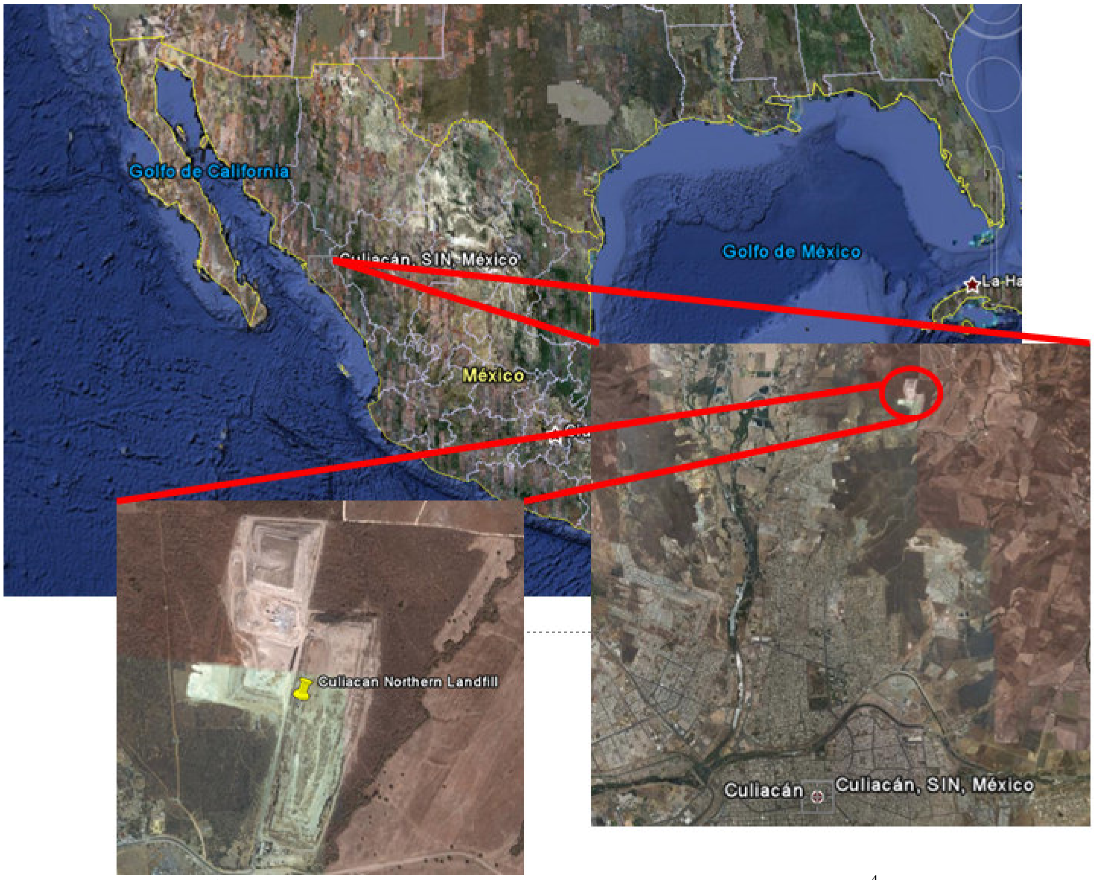

Figure 1.- General map indicating the regional area of the site project[4].

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

Type and Category

This project is categorized under :

- Sectoral Scope 13. "Waste handling and disposal" by the capture of the biogas resulting from anaerobic decomposition of organic waste deposited in the landfill site;
- Sectoral Scope 1. "Energy Industries (Renewable/non – renewable sources)" for the purpose of electric generation from the biogas captured at the landfill.

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[4] Images obtained from Google Earth software version 5.0.11337.1968.

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

For an appropriate design, construction, installation, collection and operation of the LFG plant, it will be necessary to cover different settings to ensure the capture and flaring of the biogas generated.

The installations of the LFG capture and collection system, within the flare components, are composed by the following subsystems:

1. Collection: Consist of a set of vertical wells installed into the refuse, where the LFG is extracted from the degraded refuse. Construction of vertical wells is in closed areas, to different depths, this kind of action does not interfere with the landfill operation. Depending on future development plans, some horizontal wells might be installed, to capture the landfill gas in areas that continue to be filled.
2. Extraction and piping: This is conformed by a network of pipes of specific diameter calculated for the suitability of the anticipated flow rates, and equipment to extract the LFG to the flare system or power generation plant. Along the circuit there are condensed traps, and wellheads with monitoring ports.
3. Monitoring/Analysis: Installed between the subsystems of extraction/conduction and flaring with the objective to accurately register the quantity of methane to be sent to the power generation plant. It is integrated by a flow meter and inline with the main pipe, which will be measuring the flux of the LFG that will be incinerated; there is also a gas analyzer which will analyze and determine the methane content present in the LFG previous to be burned at the flare system.
Measurements at the LFG collection system extraction wells will include gas temperature, landfill gas quality (methane, oxygen, and carbon dioxide), and pressure/vacuum. Such data will be measured with an infrared gas analyzer (or equivalent) with a built in microprocessor for storing data electronically. Data collected at the flare station will be accomplished by an automated system that provides continuous measurement of the necessary parameters. Results will be stored electronically and accessible remotely via modem or internet connection.
4. Incineration (or flaring): Based on a burner that has a combustion chamber for the landfill gas and the chimney to vent the exhaust gas to the atmosphere. The collected biogas is flared at high efficiency/high temperature flare (871 to 982 ° C, with about 98% of effectiveness[5]).

The system is equipped with a monitoring system for CH_4, O_2, flow, pressure and temperature of the LFG. The project will produce electricity and will be used for auto consumption purposes (i.e. electricity required by the equipment) and also to supply to the national grid if the flow and quality of the LFG is adequate.

Flare technology

Design criteria

- The landfill gas flare system is designed to operate continuously
- The flare will be complete with adjustment features that will allow odor-free operation of the flare under significant changes in gas composition.

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[5] Efficiency of the flare specified according to the proposal from manufacturer. Information is contained in the Landfill Gas Collection System Design Report.

- The flare will provide a minimum 98 percent by weight, destruction and removal efficiency of methane.
- The burner heads will be designed to provide a sufficient pressure drop at minimum flow and heat content conditions in order to maintain a stable flame and proper destruction. The burners must operate with a stable flame over the entire operating range.
- The burner shall be designed so that flame lift-off from the burner does not occur, and shall be an anti-flash back design.
- Exhaust from the flare stack will have no visible flame and no visible emissions

Electricity Generation Technology

As when the project secures the landfill gas flow, and a power purchase agreement is in place that will enable the generation of electricity, a modular reciprocating engine facility will be installed. The electricity generation project component will involve the construction of a concrete base that supports the engine unit. There will be an electrical sub-station constructed that will contain all suitable switching and metering equipment to facilitate a connection to the grid network. There will be one small support building for an office. A series of pipes and ducts will be built to carry both electrical cables and gas pipes. The whole area will be securely fenced.

The packaged generation system consists of an outdoor acoustic container generating set comprising an engine/alternator device.

The maximum installed capacity of electricity generator will be of 1-1.06 MW through all the project lifetime, according to the expected electricity generation**.**

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

Years	**Annual estimation of emission reduction in tonnes of CO2e**
2010	50,417
2011	52,390
2112	49,373
2013	46,541
2014	43,882
2015	41,386
2016	39,041
2017	36,838
2018	34,768
2019	32,822
Total estimated reductions (tonnes of CO2 e)	427,456
Total number of crediting years (first period)	10

Annual average over the crediting period estimated reductions (tonnes of CO2 e)	42,746

A.4.5. Public funding of the project activity:

Public funds will not be requested or utilized in the development of the project.

SECTION B. Application of a baseline and monitoring methodology

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

The baseline and monitoring methodology used for the proposed project activity is the approved consolidated baseline methodology ACM0001, version 11, (EB47): *"Consolidated baseline methodology for landfill gas project activities"*. Using the latest versions of:

- "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site". Version 4
- "Combined tool to identify the baseline scenario and demonstrate additionality". Version 2.2
- "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion". Version 2
- "Tool to calculate the emission factor for an electricity system". Version 1.1
- "Tool to determine project emissions from flaring gases containing methane". Version 1
- "Tool for the demonstration and assessment of additionality". Version 5.2
- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". Version 1

The methodology including the respective tools 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 consist of the collected gas that is flared.

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

The selected methodology (ACM0001, version 11) is appropriate to LFG project activities, where the baseline scenario is either the partial or total atmospheric release of the LFG. In this case the total atmospheric release of the LFG is considered as the baseline scenario.
The project activity fulfills the following applicability conditions of the methodology:

(a) The captured gas is flared; and/or
(b) The captured gas is used to produce energy (e.g. electricity/thermal energy). Emission reductions can be claimed for thermal energy generation, only if the LFG displaces use of fossil fuel either in a boiler or in an air heater. For claiming emission reductions for other thermal energy equipment (e.g. kiln), project proponents may submit a revision to this methodology;
(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 methodology AM0053.

The proposed project activity matches options a) and b).The Northern Landfill Gas Project will collect LFG, flaring it and in a second phase using it to produce energy.

ACM0001 also considers the project emissions from flaring of the residual gas stream and refers for its determination to the procedure described in the *"Tool to determine project emissions from flaring gases containing methane"*, which is applicable given that the LFG produced contains methane.

The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources. The ACM0001 methodology requires the use of the "Tool to calculate the emission factor for an electricity system" to determine the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the "operating margin" (OM) and "build margin" (BM) as well as the "combined margin" (CM).

There will be no sale of the captured gas, the electricity to be produced will be used for self consumption and will reduce the amount of electricity to be provided by the grid, thus reducing emissions in the generation plants, as shown in Annex 3.

The project emissions from fossil fuel consumption will be calculated following the latest version of "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion". For this purpose, the processes j in the tool corresponds to all fossil fuel combustion in the landfill.

In addition, the applicability conditions included in the tools referred to above, apply according to ACM0001.

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

The definition of the project boundary states that it shall encompass all anthropogenic emissions by sources of greenhouses gases (GHG) under the control of the project participants that are significant and reasonably attributable to the CDM project activity.

As per ACM0001, the gases involved in the project activity to determine GHG emissions sources are identified as follows:

	Source	Gas	Included?	Justification / Explanation
Baseline	Emissions from decomposition of waste at the landfill site (Passive LFG venting and no flaring)	CH_4	Yes	The major source of emissions in the baseline.
		N_2O	No	N2O emissions are small compared to CH4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	No	CO2 emissions from the decomposition of organic waste are not accounted. Exclusion of this gas is conservative.
	Emissions from electricity	CH_4	No	Excluded for simplification. This emission source is assumed to be very small.

	Source	Gas	Included?	Justification / Explanation
	consumption	N_2O	No	Excluded for simplification. This emission source is assumed to be very small.
		CO_2	Yes	Electricity generated by fossil fuel power stations operating in the project grid system.
Project Activity	On-site fossil fuels consumption due to the active LFG capture and flaring	CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded. This emission source is assumed to be very small.
		CO_2	Yes	Only CO_2 emission derived from the fossil fuel-fired generator will be included.
	Emissions from on-site electricity use	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.

The following chart represents the project boundaries:

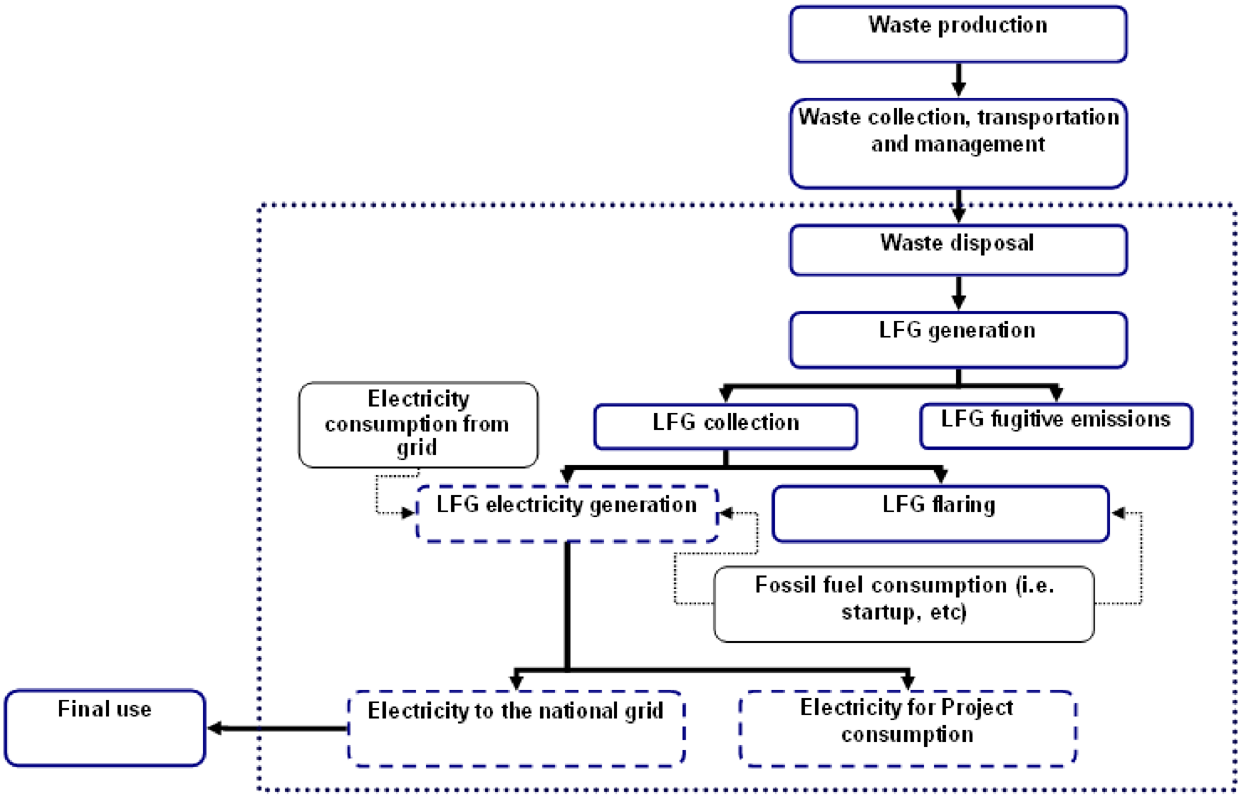

Figure 2.- Flow chart of project boundaries (staggered line indicates boundaries)

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

To determine the baseline, the project boundary is the site of the project activity where the gas will be captured and utilized. There are three plausible scenarios to the project activity:

- Alternative 1: The landfill operator would invest in a landfill gas collection system of high efficiency as well as a high efficiency power generator to supply power to the national grid system without being registered as a CDM project activity.
- Alternative 2: The business as usual scenario. The landfill gas would continue being released to the atmosphere as there are no requirements in place that would mandate LFG capture and flaring.
- Alternative 3: The landfill operator would invest in a landfill gas collection system of high efficiency as well as a high efficiency power generator to supply power to the national grid system (the proposed project activity).

In the case of the Culiacan Northern Landfill Gas Project the baseline scenario is the continued release of the LFG to the atmosphere which constitutes a common practice in Mexico. There are no mandatory regulations or incentives to capture, flare and/or use the LFG. In the absence of the Project, the Culiacan Northern

Landfill would continue to release GHG emissions to the atmosphere. The proposed project will, at the least, capture and flare the LFG generated by the landfill, thus converting its methane content into CO_2 and reducing its greenhouse gas impact.

As indicated in the methodology, a procedure will be applied for the selection of the most plausible scenario. First, it is needed to identify all realistic and credible baseline alternatives to the project activity consistent with current laws and regulations (applying step 1 of the *"Tool for the demonstration and assessment of additionality*").

In the section B.5 a detailed description will be presented 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. The determination of project scenario additionality is done using *"the tool for the demonstration and assessment of additionality*".

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): >>

Promotora Ambiental de la Laguna S.A de C.V. has been working in the analysis of the CDM project feasibility since 2007, next is described how the project was conceived and the different events that have occurred to decide the project development under the Clean Development Mechanism:

- May 25th, 2007: The municipality of Culiacan, put out to tender the for the development of the project activity for the closure of the Culiacan Northern Landfill through the design, construction and operation of the biogas capture and combustion system, this should be carried out in conjunction with the development of this activity as a CDM project in accordance with the requirements established in the Kyoto Protocol for the commercialization of the Certified Emission Reductions (CERs).[6]
- September 21st, 2007: Promotora Ambiental de la Laguna S.A de C.V. signed the concession contract[7] with Culiacan Municipality for the development of the project activity for the closure of Culiacan Landfill and the installation and operation of the capturing and combustion system for the biogas generated with the objective of developing and registering the project under the CDM scheme. The agreement was signed in order to develop the proposed activity as a CDM project, taking into account the future submission and approval of the project by the United Nations to obtain the certified emission reductions (CERs) and start obtaining all the required permits and authorizations for the project development This agreement was not fixed as the starting date of the project activity, since it will only be applicable if the project implementation success[8].
- October 26th, 2007: Signature of the contract with the SCS Engineers[9] for professional services required for the development of the project activity.
- November 30th, 2007: The stakeholders consultation process was carried out.

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[6] Culiacan municipality official announcement. See document reference: "Convocatoria_Culiacan.pdf"

[7] Signed contract between Culiacan Municipality and the project proponent See document reference: "Contrato Biogas Culiacán.pdf"

[8] View clarification document: "Clarification_concession contract_Culiacan_DOE_v1.pdf"

[9] See reference document: "PASA - SCS- Contract Signature Page 10-26-07.pdf"

- November 2007 – March 2008: Development of the PDD document.
- April 2nd, 2008: Date of publication of the PDD for global stakeholder consultation.
- June 5th, 2008: Date of the Proforma Invoice from Landtec[10] (technology provider) with the purchase orders for the equipment required for the project implementation (This date has been selected as the project activity starting date, because this represents a real action for the implementation of the proposed CDM project activity).

Based on the above, and taking into account that the Culiacan Municipality conceived the Culiacan Northern Landfill project activity as a CDM project since the public tender, it is confirmed that Promotora Ambiental de la Laguna S.A de C.V. considered seriously CDM mechanism for the decision to implement and develop the proposed project activity. In fact, as it is described in the additionality analysis, the benefit of the CDM was a decisive factor in the decision to proceed with the project activity.

The determination of project scenario additionality is done using *"the tool for the demonstration and assessment of additionality*".

Step 1: **Identification of alternatives to the project activity consistent with current laws and regulations.**

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

As it is indicated in ACM0001, version 11, among other scenarios, the following will be included:

- Alternative 1 (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;
- Alternative 2 (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 odor concerns.

These options are the most common and realistic alternatives for the context of the project activity.

It was mentioned before that the project activity proposes to generate electricity. In this case, the methodology proposes to include the following alternatives, among others:

- Alternative 1 (P1): Power generated from landfill gas undertaken without being registered as a CDM project activity.
- Alternative 2 (P2): Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant.
- Alternative 3 (P3): Existing or Construction of a new on-site or off-site renewable based cogeneration plant.
- Alternative 4 (P4): Existing or Construction of a new on-site or off-site fossil fuel fired captive power plant.

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[10] According to Landtec invoice. See reference document: "Pasa Proforma Invoice Q47855 Culiacan"

- Alternative 5 (P5): Existing or Construction of a new on-site or off-site renewable based captive power plant.
- Alternative 6 (P6): Existing and/or new grid-connected power plants.

It is not intended for the project any renewable source that could be available (if any) around the region, then options P3 and P5 are dismissed. For fossil-fuel based captive power plants or cogeneration plants, the comparison with purchasing the electricity from the grid is remarkable, even better than any fossil fuel power plant, because it would require to acquire the fuels, transport them to the site and install them within the equipment for a plant of this magnitude; therefore P2 and P4 can be dismissed.

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

The project does not include thermal energy generation because the project activity only proposes to generate electricity with LFG.

In order to represent the real alternatives of the project activity the listed above (LFG1 and LFG2; P1 and P6) are the only alternatives to be considered as possible alternative baselines.

There are no other alternatives that deliver outputs and services (e.g. methane destruction, with the methane being used to generate electricity or useful heat to a process) with comparable quality, properties and application.

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

Regulation NOM-083-SEMARNAT-2003[11] 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, in Mexico. The regulation provides guidelines for the construction and operation of landfills, and also provides guidance regarding LFG, including recommendations for the collection, utilization and/or flaring of the LFG. However, the regulation does not specify minimum requirements regarding the amount of gas to be collected and utilized or flared.

The NOM- 083-SEMARNAT-2003 is not enforced in Mexico, for the following circumstances:

- NOM-083-SEMARNAT-2003 is a federal law, however, landfills are the responsibility of the municipalities, who have sovereignty in solid waste disposal. Thus, NOM-083-SEMARNAT- 2003 would only be legally binding if the local authorities adopt it. In this case, local authorities have not adopted this regulation.

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[11] Available at <http://www.semarnat.gob.mx/leyesynormas/Normas%20Oficiales%20Mexicanas%20vigentes/NOM-083-SEMAR-03-20-OCT-04.pdf>

- NOM-083-SEMARNAT-2003 has never been enforced. Even the earlier regulation (NOM-083-SEMARNAT-1996) which NOM-083-SEMARNAT-2003 replaced and which only required the active venting of LFG for safety reasons, was not enforced.
- Given these circumstances, NOM-083-SEMARNAT-2003 has become more of a document outlining policy guidance than a mandatory requirement.
- Finally, NOM-083-SEMARNAT-2003 does not indicate any mandatory requirement for LFG capture and its flaring, it only mentions LFG venting (for security reasons regarding exploit limits), but not any system for LFG capture.

Since the publication of NOM-083-SEMARNAT-2003, no new proper LFG collection and flaring or utilization systems have been developed in the Host Country without carbon revenues. Until 2003, there was only one landfill in México with complete landfill gas collection and utilization system: Simeprodeso Landfill in Monterrey[12]. However, Simeprodeso Landfill has been developed by the World Bank, prior to the ratification of the Kyoto Protocol, as a demonstration project. Since there was financing from the World Bank, the viability could be reached without carbon finance. All projects similar to the proposed project activity have developed after 2003, under the CDM, and are therefore excluded from the common practice analysis.

Table 1 below presents information regarding a representative sample (it is considered representative because it includes the largest landfills in the country[13]) of landfills throughout the Host Country. As the table 1 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 utilize the LFG.

Landfill Name	Location	Waste Deposition Rate (tons/day)	Current Status
Bordo Poniente	Mexico City	12,000	No system for collecting, venting or flaring LFG
Chiltepeque landfill	Puebla City, Puebla	1,595	No system for collecting, venting or flaring LFG
Bordo Neza	Nezahualcoyotl, State of Mexico	1,500	Passive system for venting of LFG only (no flaring)
Culiacan	Culiacan, Sinaloa	850	Passive system for venting of LFG only (no flaring)
Cancun landfill	Cancun, Quintana Roo	700	Passive system for venting and flaring LFG
Socavon San Jorge	Metepec, State of Mexico	500	Passive system for venting and flaring LFG
Santa Rita	San Luis Potosi	340	Passive system for venting of LFG only (no flaring)

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[12] *Pilot project of capture and use of the gas methane for the generation of electrical energy in domestic sanitary fillings.* SEDESOL
Available at <http://sedesol2006.sedesol.gob.mx/subsecretarias/desarrollourbano/sancho/gasmetano.htm>

[13] See <http://www.cronica.com.mx/nota.php?id_nota=410170>. This note from the newspaper stats that Bordo Poniente landfill is the largest in Latin America.

Landfill Name	Location	Waste Deposition Rate (tons/day)	Current Status
Simeprodeso landfill (phase I)	Monterrey, Nuevo Leon	Closed	Landfill gas collection and utilisation Project, funded with support from the GEF as demonstration project
Prados de la Montaña	Mexico City	Closed	LFG collection and flaring system installed prior to the commercial development of the surrounding zone

Table 1 Landfills common practice in the Host country.

Table 1 shows that the common practice of existing landfills in the Host Country do not adequately capture and utilize their LFG according to the federal norm NOM-083-SEMARNAT-2003. This confirms the previous statement that NOM-083-SEMARNAT-2003 has never been enforced and it has become more of a document outlining policy guidance than a mandatory requirement

As stated in the "Tool for the demonstration and assessment of additionality", only laws that are systematically enforced and widespread in the Host Country need to be considered in the determination of the baseline scenario legal compliance. Therefore NOM-083-SEMARNAT-2003 shall not be taken into account in the establishment of the legal compliance of a baseline scenario for LFG projects in Mexico.

The current configuration of the Northern Landfill of Culiacán may be characterized as follows:

- The place consists of passive venting systems .
- In general there is no infrastructure for the control of the landfill gas and leachates that are generated in the place.
- Due to this, it is considered that in this place, landfill gas is not being burned and it is released into the atmosphere.

With this acknowledgment, both considered alternatives comply with the laws and regulations. The current situation at the Culiacan Northern Landfill Gas Project corresponds to Alternative 2 (LFG2) – (*See Sub-step 1a*).

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, there were two scenarios remaining:

- Alternative 1 (P1): Power generated from landfill gas undertaken without being registered as a CDM project activity, and
- Alternative 6 (P6): Power plants connected to the grid.

The fuels in the power plants connected to the grid are defined by the corresponding company (Federal Commission Electricity, "CFE"[14]), and their emissions factors are determined by the "Tool to calculate the

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[14] CFE is a national company that provides services of generation, transmission and distribution of electrical power services. <http://www.cfe.gob.mx/en/>

emission factor for an electricity system" (version 1.1), that would be generated in the grid in the baseline. The baseline scenario in this particular case is the atmospheric release of the landfill gas (venting for security reasons) or its partial capture (but not burned), which happens in most of the existing landfills in the Host Country. There is no incentive to utilize the LFG to produce thermal energy, since there are no potential off-takers for thermal energy.

The additionality tool offers two options after Step 1: Investment Analysis (Step 2) or Barrier Analysis (Step 3), with a third option of applying both Steps.

Step 2. Investment Analysis

Sub-step 2a: Determine appropriate analysis method

According to the "*tool for the demonstration and assessment of additionality*", one of three options must be applied for this step: (1) simple cost analysis (where no benefits other than CDM income exist for the project), (2) investment comparison analysis (where comparable alternatives to the project exist), or (3) benchmark analysis.

In the case of the Culiacan Northern Landfill, where the project activity involves collection and utilization of the LFG for electricity generation, the most likely alternative to the project is to simply not install flaring and generation equipment at the site, i.e., the alternative does not involve investments of a similar scale to the project. Therefore, option (3) benchmark analysis will be applied.

Sub-step 2b: Option III - Apply benchmark analysis

According to the methodology for determination of additionality, if the alternatives to the CDM project activity do not include investments of comparable scale to the project, then Option III must be used. In this case, as stated above, the most likely alternative to the project is just not to install the flaring and generation equipment in site, and therefore does not involve investments of a similar scale to the project. Because of this, benchmark analysis will be applied.

During the landfill operation, Promotora Ambiental de la Laguna S.A de C.V., the project participant , provided a solid waste management services only. As stated before the national regulation for landfill management does not specify minimum requirements regarding the amount of gas to be collected and utilized or flared, therefore the current practice in the counrty is venting the LFG. Due to the above, Promotora Ambiental de la Laguna S.A de C.V. does not have experience in the implementation of LFG collection and recovering projects, hence there is not available an specific IRR benchmark value for this type of projects in the company. It is in the best interest of Promotora Ambiental de la Laguna S.A de C.V. to handle a suitable referential rate to conclude on the financial analysis of the proposed project activity, therefore this referential rate will be an internally estimated rate of return taking into account interests rates as well as risk premims, as a reference.

Based on the above and according to the "Tool for the demonstration and assessment of additionality" (Version 5.2) option a) was used by the project proponent to determine the most suitable discount rate and benchmark value to be used for the benchmark analysis.

(a) Government bond rates, increased by a suitable risk premium to reflect private investment and/or the project type, as substantiated by an independent (financial) expert or documented by official publicly available financial data;

In order to estimate an adequate discount rate to evaluate the project activity financial feasibility the following was considered by Promotora Ambiental de la Laguna S.A de C.V.:

- Government bond rates: In February 2008, the Bank of Mexico indicates that the rates of 364 day for Treasury Certificates (CETES) in Mexico were 7.4%[15].
- Country risk: There are several methods for estimating the country risk premium such as the utilization of the relative volatilities of the U.S. and foreign stock markets or the utilization of the default spread on country bonds and the relative volatilities of the foreign equity and debt markets, depending on the methods used the country risk premium can vary. However, based on a country risk classification[16] carried out by the "Organisation for Economic Co-operation and Development (OECD)" the country risk premium for Mexico is 2.00% for years 2007 and 2008.

Hence, the benchmark rate of return involved can be set at least at 9.4%. The project is considered as a project IRR (after taxes), since all the required investment will be proportioned by Promotora Ambiental de la Laguna S.A de C.V. Following option a) from the "Tool for the demonstration and assessment of additionality" (Version 05.2) the estimated benchmark value by the project proponent (Government bonds + country risk) was chosen to demonstrate that the project activity is not economically feasible without the CDM benefits.

Sub-step 2c: Calculation and comparison of financial indicators

The calculation of the financial indicator for the project activity includes the initial investments costs, the operation and maintenance cost and revenues associated with the operation of the project activity. The timeline includes the crediting period plus five year (2010-2025), meaning fifteen (15) years, considering the lifetime of the main equipments for the proposed activity. Investments costs are around 36.85 million of Pesos (taking into account that 77% would be for equipment).

The following values were considered for the financial analysis:

Key parameter	Value	Source	Notes	Date of Source
Base Price of EE	0.9068 pesos / kWh	See web site: <http://www.sener.gob.m	Information given by SENER.	2007 annual data

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[15] Government bond rates can be consulted at: <http://www.banxico.org.mx/portalesEspecializados/tasasInteres/valoresgubernamentales.html>

[16] See web site: http://www.oecd.org/document/49/0,2340,en_2649_34171_1901105_1_1_1_1,00.html

Key parameter	Value	Source	Notes	Date of Source
		x/webSener/res/PE_y_DT/ee/Precios_Medios1.xls>		
Type of change	10.9366 pesos per US dollar	See web site: <http://www.sat.gob.mx/sitio_internet/asistencia_contribuyente/informacion_frecuente/tipo_cambio/428980.html>	Published information by Tributary Administration Service, SAT (Servicio de Administración Tributaria) -- SHCP mexican organism.	2007 averaged data
INVESTMENTS				
LFG Capture System	2,835,030 Pesos	Complete Culiacan Landfill Design Report.pdf (file)	Based on the Final Design Report of SCS Engineers for Culiacan Landfill.	December, 2007
LFG Conduction System	4,432,059 Pesos			
LFG Extraction System	1,969,464 Pesos			
LFG Flaring System	2,874,139 Pesos			
Site adecuation	7,380,688 Pesos	PASA costs.tif (file)	Part of the investment concept. Implicated costs for site preparation of Culiacan Landfill.	May 2007
Energy Production Equipment	16,404,905 pesos	SCS-Culiacan Letter.pdf (file)	It has been set US$1,500 per kW installed. Project will have 1 MW installed SCS Engineers company reference.	January 28, 2008 (original communication)
Rooms and offices	300,000 Pesos	PASA costs.tif	Administrative costs of the Project Participant.	May 2007
Mobilization and Project Management	656,196 Pesos	Complete Culiacan Landfill Design Report.pdf	Part of the investment concept. Based on the Final Design Report of SCS Engineers for Culiacan Landfill.	December, 2007
EXPENSES (O&M)				
Capture and conduction, extraction and flaring	1,211,069 Pesos per year	Project proponent and technologist	It was considered 10% of the corresponding capital cost.	December, 2007
Electrical Production Unit(s)	0.273 Pesos / kWh	SCS-Culiacan Letter.pdf (file)	O&M cost for electricity generation system	January 28, 2008 (original

Key parameter	Value	Source	Notes	Date of Source
				communication)
Rooms and offices (O&M)	15,000 Pesos / year	Project proponent	It was considered 5% of total annual cost for offices cost	December, 2007
Plant´s superintendent	180,000 Pesos / year	PASA costs.tif	Administrative costs of the Project Participant.	May 2007
Administrative accountant	96,000 Pesos / year	PASA costs.tif	Administrative costs of the Project Participant.	May 2007
Supervisors	360,000 Pesos / year	PASA costs.tif	Administrative costs of the Project Participant.	May 2007
Papers	144,000 Pesos / year	PASA costs.tif	Administrative costs of the Project Participant.	May 2007
OTHER ECONOMICAL INPUT VALUES				
Taxes	28%	Diario Oficial de la Federacion.pdf	Income Tax Law	First publication: January 1, 2002 Last Modification: December 27, 2006
Mexican Inflation	**Year** – **%** 2007 – 3.76 * 2008 – 6.53 * 2009 – 3.58 $^{+}$ 2010 – 3.45 $^{+}$ 2011 – 3.46 $^{+}$ 2012 – 3.46 $^{+}$ 2013 to 2025 – 3.46	*Central Bank of Mexico (“Banco de México”) website[17]. $^{+}$Survey on the expectations of the specialists in the economy of the Private Sector: May 2008. Published by the Central Bank of Mexico[18].	Information proportioned by Central Bank of Mexico. It was assumed the latest inflation for the rest of the years (2013 to 2015).	* Online information from Central Bank of Mexico website. $^{+}$ Publication dated on June 2, 2008.

Table 2. Project economical data and parameters.

The financial analysis was carried out using two scenarios:

1. Without carbon credit revenues.
2. With carbon credit revenues

The results of the financial analysis are:

1. Without carbon credit revenues and assuming a base electricity price of 0.9068 pesos / kWh, the IRR is 2.3%.
2. With carbon credit revenues assuming an electricity a base price of 0.9068 pesos / kWh, and CERs prices of $15 USD/tonCO2e, the IRR is 16.2 %.

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[17] Information available at < http://www.banxico.org.mx/PortalesEspecializados/inflacion/inflacion.html>

[18] Available at <http://www.banxico.org.mx/documents/{05E17D58-E68F-24B2-6115-3F0B0F3F9CF3}.pdf>

The results of the financial analysis were obtained taking into consideration the data shown in table 2, and trying to obtain the best IRR scenario possible. Without the carbon credit revenues the project is under the IRR benchmark indicated.

Sub-step 2d: Sensitivity analysis

A sensitivity analysis was conducted changing the following parameters:

- Increasing and decreasing the total investment costs.
- Increasing and decreasing the energy price.
- Increasing and decreasing the operating and maintenance cost.
- Increasing and decreasing the amount of electricity generated.

Variation in the carbon credit prices was not considered. Financial analyses were performed varying the parameters 10%, and assessing what the impact on the project IRR would be:

	Variation	
	(+10%)	**(-10%)**
	IRR	**IRR**
Investment cost	1.1%	3.4%
Energy price	4.4%	-0.7%
O&M cost	1.2%	3.2%
Amount of electricity generated	4.4%	-0.7%

Table 3. Sensitivity Analysis

In conclusion, in all cases the project IRR remains lower than the benchmark value (9.4%). Therefore it is not feasible for a risky enterprise such as the construction and operation of a landfill gas to energy project. Consequently, the Project cannot be considered as financially attractive without CDM revenues.

Taking into consideration the benchmark (9.4%), it is presented a chart varying the amount of the key parameters in order to evaluate the scenarios on which the benchmark value is met and why this is not likely to happen:

Main Parameter	Variation	Value to meet the benchmark	Scenario analysis
Investment cost	**-46.4%**	19,768 thousands of Mexican pesos	One of the main percentage of the investment comes from the cost for the power generation, meaning, power plant components (45% of the total investment approximately), which is also the only income that would have the project without carbon credits. Decreasing the costs for the power plant components are not likely to happen considering that the main investment amount is coming from the cost per MW installed; and

<table>
<tr><th>Main Parameter</th><th>Variation</th><th>Value to meet the benchmark</th><th>Scenario analysis</th></tr>
<tr><td></td><td></td><td></td><td>considering the type of technology employed would be one of the most well known technologies (Internal Combustion type).This type is one of the most economical values for LFG energy recovery. It should be expected that this well developed known technology would become only more efficient along the years, but not as cheap as the same way.

Note also that even in the case of an absence of a power plant, the amount of this investment would not be still enough to reach the benchmark but also it would mean no incomes to solve the investment (except for the carbon credits, if CDM project activity is registered).</td></tr>
<tr><td>Energy price</td><td>+37.5%</td><td>
<table>
<tr><th>Year</th><th>pesos per kWh</th></tr>
<tr><td>2010</td><td>1.423</td></tr>
<tr><td>2011</td><td>1.472</td></tr>
<tr><td>2012</td><td>1.523</td></tr>
<tr><td>2013</td><td>1.576</td></tr>
<tr><td>2014</td><td>1.630</td></tr>
<tr><td>2015</td><td>1.687</td></tr>
<tr><td>2016</td><td>1.745</td></tr>
<tr><td>2017</td><td>1.805</td></tr>
<tr><td>2018</td><td>1.868</td></tr>
<tr><td>2019</td><td>1.932</td></tr>
<tr><td>2020</td><td>1.999</td></tr>
<tr><td>2021</td><td>2.069</td></tr>
<tr><td>2022</td><td>2.140</td></tr>
<tr><td>2023</td><td>2.214</td></tr>
<tr><td>2024</td><td>2.291</td></tr>
<tr><td>2025</td><td>2.370</td></tr>
</table>
</td><td>Whether or not to an increase in energy prices would be expected in the Host Country, this scenario would not be likely to occur at this rate due to the following reasons:

1) The lately sharp fall in international oil prices[19]. CFE electricity prices are established from fossil-fuel based electricity generation units, the electricity prices at which CFE will buy the power generation from the project activity will be directly related to the international oil and fossil fuel prices, that currently are expected to decrease.

2) Within this, and in the aim to stand against effects of national and international recession, Mexico' federal government implemented a National Agreement in favor of the Economy Family and Employment ("<i>Acuerdo Nacional en Favor de la Economía Familia y el Empleo</i>"); one of the objectives of this agreement is to reduce electricity prices in 20% in order to stimulate competitiveness in national companies for the present year[20].

Therefore, based on the above it can be stated that is scenario would not be likely to occur.</td></tr>
<tr><td>O & M cost</td><td>-84.4%</td><td>
<table>
<tr><th>Year</th><th>000 pesos $</th></tr>
<tr><td>2010</td><td>191.12</td></tr>
<tr><td>2011</td><td>520.44</td></tr>
<tr><td>2012</td><td>501.55</td></tr>
<tr><td>2013</td><td>483.82</td></tr>
<tr><td>2014</td><td>467.18</td></tr>
<tr><td>2015</td><td>451.56</td></tr>
</table>
</td><td>This is not likely a realistic scenario, O&M costs depend mainly of the amount of investment made in the equipments for the project activity (flare, power generators, etc).

Therefore, this would mean that first it would be required a significant reduction on the investment in order to reduce the O&M costs.</td></tr>
</table>

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[19] *Oil Market Report.* Internacional Energy Agency. Available at: <http://omrpublic.iea.org/currentissues/full.pdf>. (January 16, 2009). Page 37

[20] *National Agreement in favor of the Economy Family and Employment.* Mexican Federal Government. Official Site <http://www.presidencia.gob.mx/infografias/2009/enero/070109_economia_empleo/index.html>

Main Parameter	Variation	Value to meet the benchmark		Scenario analysis
		2016	423.09	
		2017	410.13	
		2018	397.95	
		2019	397.95	
		2020	386.50	
		2021	375.72	
		2022	365.59	
		2023	356.05	
		2024	347.08	
		2025	338.63	
Amount of energy generated	**+37.5%**	**Year**	**MWh**	This is not a realistic scenario since it would imply different aspects and considerations: a) More installed capacity for power generation will be required, this would increase the total investment amount and the operational costs, reducing the cost benefit from the project activity. b) Considering a limited quantity of LFG available, it would be needed to increase, perhaps, the efficiency of the LFG capture system, but this also implies technological difficulties.
		2010	0	
		2011	10,863	
		2012	10,240	
		2013	9,656	
		2014	9,107	
		2015	8,591	
		2016	8,107	
		2017	7,652	
		2018	7,225	
		2019	6,823	
		2020	6,445	
		2021	6,090	
		2022	5,755	
		2023	5,441	
		2024	5,145	
		2025	4,866	

Table 4. Parameter values to meet the benchmark.

Step 3: Barrier analysis:

Sub-step 3a. Identify barriers that would prevent the implementation of the proposed CDM project activity:
N/A

Step 4. Common practice analysis.

Sub-step 4a. Analyze other activities similar to the proposed project activity.

As mentioned previously, there are other LFG recovery projects currently operating in Mexico, in Monterrey, Aguascalientes and Ecatepec, all financed through climate change mitigation resources.

In the Host Country (Mexico), the common practice for the landfills are, at most, a passive vent of the biogas[21]. In the following chart are described some characteristics of landfills in the Host Country[22]:

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[21] *Landfill Gas Capture and Utilisation Projects.* World Bank. April 9, 2008
Available at: <http://siteresources.worldbank.org/INTUWM/Resources/340232-1208964677407/Veolia_4-9-08.pdf>

Municipality	Site type	Characteristics	Notes	Disposal Rate (tonnes/day)
Distrito Federal	Landfill	Landfill with insufficient control in leachate and biogas management.	With biogas capture system.	12,010
Monterrey	Landfill	Landfill, 75% of the NOM03 is fulfilled. Site controlled with cover of waste.	With recovery and/or use of biogas.	4,107
Guadalajara	Controlled open dump	Landfill with insufficient control in leachate and biogas management.	With biogas capture system.	1,994
Puebla	Landfill	Open dump without control.	With biogas capture system.	1,532
Zapopan	Landfill	Open dump without control.	No presence of capture of biogas and/or biogas vented.	1,263
Chihuahua	Landfill	Landfill with insufficient control in leachate and biogas management.	No presence of capture of biogas and/or biogas vented.	1,057
San Luis Potosí	Landfill	Landfill with insufficient control in leachate and biogas management.	No presence of capture of biogas and/or biogas vented.	890
Aguascalientes	Landfill	Landfill with insufficient control in leachate and biogas management.	With capture of biogas system.	820
Culiacán	Landfill	Open dump without control.[23]	No presence of capture of biogas and/or biogas vented.	774
Acapulco de Juárez	Landfill	Controlled open dump with waste cover with a certain periodicity.	No presence of capture of biogas and/or biogas vented.	750
Metepec	Controlled open dump	Landfill with insufficient control in leachate and biogas management.	With biogas capture system.	750
Toluca	Controlled open dump	Open dump without control.	No presence of capture of biogas and/or biogas vented.	739

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[22] References:

- *Management of Urban Solid Waste ("El Manejo de los Residuos Sólidos Urbanos").* SEDESOL. Chart B-5 (page 83). Mexico, 2005 ; and
- *The Waste in the Oblivion: Performance of the Local Governments and Private Participation in the handling of the Urban Solid Wastes ("Evaluación del Desempeño Municipal en el Manejo de Residuos Urbanos, La Basura en el Limbo: Desempeño de Gobiernos Locales y Participación Privada en el Manejo De Residuos Urbanos").* Mexican Commission of Environmental Infrastructure & Agency of German Technical Cooperation-GTZ ("Comisión Mexicana de Infraestructura Ambiental & Agencia de Cooperación Técnica Alemana –GTZ"). Chapter VII (pages 55 to 66). Mexico, 2003. <http://www.bvsde.paho.org/bvsacd/cd48/limbo-final.pdf>

[23] The table states as a characteristic of the Culiacan landfill to be a "Open dump without control", this was the condition of the landfill at the time when the studies were performed, this was in the years 2003 – 2005. However, after this time the Culiacan landfill improved its management until become a controlled waste disposal site. That's why in the entire PDD document the Culiacan landfill has been defined as a "managed solid waste disposal site". This situation was confirmed by the DOE during the site visit on 2008 where it was verified that the project landfill has a controlled placement of waste and uses cover material and mechanical compacting. In fact the objective of the table is not to show the characteristics of the landfill but to demonstrate that the current practice is the passive vent of the biogas.

Municipality	Site type	Characteristics	Notes	Disposal Rate (tonnes/day)
Morelia	Controlled open dump	Controlled open dump with waste cover with a certain periodicity.	No presence of capture of biogas and/or biogas vented.	650
Saltillo	Landfill	Landfill with insufficient control in leachate and biogas management.	No presence of capture of biogas and/or biogas vented.	600
Hermosillo	Landfill	Landfill with insufficient control in leachate and biogas management.	No presence of capture of biogas and/or biogas vented.	590
Durango	Landfill	Landfill, 75% of the NOM03 is fulfilled. Site controlled with cover of waste.	No presence of capture of biogas and/or biogas vented.	494
Benito Juárez	Landfill	Controlled open dump, waste cover with certain frequency.	With capture of biogas system.	480
Tlaquepaque	Landfill	Open dump without control.	No presence of capture of biogas and/or biogas vented.	455
Irapuato	Controlled open duma	Landfill with insufficient control in leachate and biogas management.	No presence of capture of biogas and/or biogas vented.	450

Hence, the common practice in Mexico is the passive vent of the biogas without active capture, and exceptions to this practice are:

- The Landfill to Energy Project subsided by the Global Environmental Facility (GEF) in Simeprodeso Monterrey Landfill[24]; and
- The CDM projects that are registered or requesting registration.

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

The Simeprodeso landfill project was financed through a GEF grant. There are a few projects of gas collection and flaring or use currently under development in Mexico and all these projects are being presented under the CDM.

For all the reasons above the project is considered to be additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

As the applicability of the methodology indicates, the Culiacan Northern Landfill Gas Project fulfills the conditions of option a) and b) of methodology ACM0001, version 11: "The captured gas is flared; and/or is used to produce energy (e.g. electricity/thermal energy)".

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[24] *Pilot project of capture and use of the gas methane for the generation of electrical energy in domestic sanitary fillings.* SEDESOL
Available at <http://sedesol2006.sedesol.gob.mx/subsecretarias/desarrollourbano/sancho/gasmetano.htm>

The objective of the Culiacan Northern Landfill Gas Project is to avoid methane emissions to the atmosphere by the installation of an efficient landfill gas collection and flaring system.

In conclusion, the project has two main activities:

- Capture and flare/combustion of the LFG methane to decrease its harmful effects (i.e. to the environment and also to human health by reducing odors).
- A reduction in fossil fuel consumption used to produce electricity (because new energy is produced by burning methane).

In this way, the project activity accomplishes the necessary conditions to use the methodology ACM0001, version 11.

Baseline emissions:

It was identified that the baseline consists in a simple passive venting system where no pumping equipment is used and there is no LFG actually used for generation of electricity purposes.
The baseline emissions reductions due to the partial collection of the LFG (if any) will be taken into account by applying the AF (Adjustment Factor).

These facts are taken into account where the methodology estimates the baseline emissions as follows:

$$BE_y = \left(MD_{project,y} - MD_{BL,y}\right) * GWP_{CH_4} + EL_{LFG,y} * CEF_{elec,BL,y} + ET_{LFG,y} * CEF_{ther,BL,y} \quad \textbf{(1)}$$

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 in the project scenario (tCH_4)
$MD_{BL,y}$	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 onsite/offsite fossil fuel based captive power generation, during year y, in megawatt hours (MWh).
$CEF_{elecy,BL,y}$	CO_2 emissions intensity of the baseline source of electricity displaced (tCO_{2e}/MWh)
$ET_{LFG,y}$	The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from onsite/offsite fossil fuel fired boiler/air heater, during the year y in TJ.
$CEF_{ther,BL,y}$	CO_2 emissions intensity of the fuel used by the boiler to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_{2e}/TJ.

$\mathbf{ET}_{\mathbf{PRy}}$	Fossil fuel consumption on-site during project activity in year *y* (TJ)
$\mathbf{EF}_{\mathbf{fuel,PR,y}}$	CO_2 emissions factor of the fossil fuel used in the project activity during year *y* (tCO2e/TJ)

Because the project activity will not generate thermal energy from landfill gas, this implies $\mathbf{CEF_{ther,BL,y}=ET_{LFG,y}=0}$ in Equation 1.

For $MD_{BL,y}$ since there is no regulatory or contractual requirements, an Adjustment Factor **(AF)** will be used and justified, therefore , the estimation of the variable uses the following equation:

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

The specific system for collection and destruction of methane is not mandated by regulatory or contractual requirements nor is undertaken for other reasons; for this, the ratio of the destruction efficiency of the baseline system to the destruction efficiency of the system used in the project activity is zero.

For the variable $MD_{project,y}$, the methodology dictates a conservative way to select the most appropriate and representative value by comparing between 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. In case the total methane collection is the highest, $MD_{project,y}$ is given by:

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} + MD_{PL,y} \qquad \textbf{(3)}$$

Where:

$\mathbf{MD_{flared,\,y}}$	Quantity of methane destroyed by flaring (tCH_4).
$\mathbf{MD_{electricity,y}}$	Quantity of methane destroyed by generation of electricity (tCH_4).
$\mathbf{MD_{thermal,y}}$	Quantity of methane destroyed for the generation of thermal energy (tCH_4).
$\mathbf{MD_{PL,y}}$	Quantity of methane sent to the pipeline for feeding to the natural gas distribution network (tCH_4).

Since there is no intention to collect landfill gas for thermal generation and neither for the gas distribution network, $\mathbf{MD_{thermal} = MD_{PL} = 0}$ in Equation 3.

The supply to each point of methane destruction, through flaring or use for energy generation, shall be measured separately.

For methane destroyed by flaring ($\mathbf{MD_{flared,y}}$), Equation 4 states its calculation:

$$MD_{flared,y} = (LFG_{flare,y} * w_{CH4} * D_{CH4}) - \left(\frac{PE_{flare,y}}{GWP_{CH4}} \right) \qquad \textbf{(4)}$$

Where:

$\mathbf{LFG}_{\mathbf{flare,y}}$	Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m^3).
$\mathbf{w}_{\mathbf{CH4}}$	Average methane fraction of the landfill gas as measured[25] during the year and expressed as a fraction (in m^3 CH_4 / m^3 LFG).
$\mathbf{D}_{\mathbf{CH4}}$	Methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3\ CH_4$)[26]
$\mathbf{PE}_{flare,y}$	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.

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 will use enclosed flares, because they are more effective in destroying methane.

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

For enclosed flares, either of the following two options can be used 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 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."*

For ex-ante purposes, the project is likely to use a 98% value according to the technology supplier data. The project participant has decided to monitor the emissions continuously, so the Tool procedures for continuous monitoring will be applied.

The tool involves the following seven steps:

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[25] Methane fraction of the landfill gas and LFG flow have to be measured on same basis (either wet or dry). For the "Tool to determine project emissions from flaring gases containing Methane" , it will be followed the standard approaches to convert the flow on wet basis to dry basis.

[26] At standard temperature and pressure (0 degree Celsius and 1,013 bar) the density of methane is 0.0007168 $tCH4/m^3CH4$.

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.

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.

$$FM_{RG,h} = \rho_{RG,n,h} * FV_{RG,h} \qquad \text{Tool Equation (1)}$$

Where:

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

$$\rho_{RG,h} = \frac{P_n}{\frac{R_u * T_n}{MM_{RG,h}}} \qquad \text{Tool Equation (2)}$$

Where:

Variable	**SI Unit**	**Description**
ρRGn,h	kg/m^3	Density of the residual gas at normal conditions in hour *h*
Pn	Pa	Atmospheric pressure at normal conditions (101 325)
Ru	Pa.m3/kmol.K	Universal ideal gas constant (8 314)
MMRG,h	kg/kmol	Molecular mass of the residual gas in hour *h*
Tn	K	Temperature at normal conditions (273.15)

and:

$$MM_{RG,h} = \sum_i \left(fv_{i,h} * MM_i \right) \qquad \text{Tool Equation (3)}$$

Where:

Variable	SI Unit	Description
MMRG,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*
MMi	kg/kmol	MMi kg/kmol Molecular mass of residual gas component *i*
I		The components CH_4 ,CO, CO_2, O_2, H_2, N_2

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). While this leads to minor errors, the simplified approach greatly simplifies measurements, and does not significantly affect the estimate of flare efficiency.

With this simplification, Tool Equation (3) becomes:

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

Variable	SI Unit	Description
MMRG,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*
MMi	kg/kmol	MMi 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).

Step 2 states:

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

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

$$fm_{j,y} = \frac{\sum_i fv_{i,h} * AM_j * NA_{j,i}}{MM_{RG,h}} \qquad \textit{Tool Equation (4)}$$

Where:

Variable	SI Unit	Description
$fm_{i,y}$	-	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 H2 in the other components that might be present in landfill gas: CO_2 and O2.
i	The components are 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

Since the methane combustion efficiency is to be continuously measured in the proposed project, this step is applicable.

Determine the average volumetric flow rate of the exhaust gas in each hour *h* based on a stoichiometric calculation of the combustion process, which depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas, as follows:

$$TV_{n,FG,h} = V_{n,FG,h} * FM_{RG,h} \qquad \textit{Tool Equation (5)}$$

Where:

Variable	SI Unit	Description
$TV_{n,FG,h}$	m3/h	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour h
$V_{n,FG,h}$	m3/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 hour h

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

Where:

Variable	SI Unit	Description
$V_{n,FG,h}$	m_3/kg residual gas	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in the hour *h*
$V_{n,CO2,h}$	m_3/kg residual gas	Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$V_{n,N2,h}$	m_3/kg residual gas	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
$V_{n,O2,h}$	m_3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*

$$V_{n,O2,h} = n_{O2,h} + MV_n \qquad \textit{Tool Equation (7)}$$

Where:

Variable	SI Unit	Description
$V_{n,\,O2,\,h}$	m_3/kg residual gas	Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in hour *h*
$n_{O2,\,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h*
MV_n	m_3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 litres/mol)

The Tool states:

$$V_{n,N2,h} = MV_n * \left\{ \frac{fm_{N,h}}{2AM_N} + \left(\frac{1 - MF_{O2}}{MF_{O2}} \right) * \left[F_h + n_{O2,h} \right] \right\} \qquad \textit{Tool Equation (8)}$$

Where:

Variable	SI Unit	Description
$V_{n,N2,h}$	m_3/kg residual gas	Quantity of N_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h*
MV_n	m_3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m^3/Kmol)
$fm_{N,h}$	-	Mass fraction of nitrogen in the residual gas in the hour *h*
AM_n	kg/kmol	Atomic mass of nitrogen
MF_{O2}	-	O_2 volumetric fraction of air
F_h	kmol/kg residual gas	Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h*
$n_{O2,h}$	kmol/kg residual gas	Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h*

$$V_{n,CO2,h} = \frac{fm_{C,h}}{AM_C} * MV_n \qquad \textit{Tool Equation (9)}$$

Where:

Variable	SI Unit	Description
$V_{n,CO2,h}$	m_3/kg residual gas	Quantity of CO_2 volume free in the exhaust gas of the flare at normal

		conditions per kg of residual gas in the hour *h*
$fm_{C,h}$	-	Mass fraction of carbon in the residual gas in the hour *h*
AM_C	kg/kmol	Atomic mass of carbon
MV_n	m$_3$/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 m$_3$/Kmol)

$$n_{O2,h} = \frac{t_{O2,h}}{\left(1-(t_{O2,h}/MF_{O2})\right)} * \left\{ \frac{fm_{C,h}}{AM_C} + \frac{fm_{N.h}}{2AM_N} + \left(\frac{1-MF_{O2}}{MF_{O2}}\right) * F_h \right\} \quad \textit{Tool Equation (10)}$$

Where:

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

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

Where:

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

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

This step is only applicable if the methane combustion efficiency of the flare is continuously monitored.

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

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH4,FG,h}}{1{,}000{,}000} \qquad \textit{Tool Equation (12)}$$

Where:

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

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

The 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)."

$$TM_{RG,h} = FV_{RG,h} * fv_{CH4,RG,h} * \rho_{CH4,n} \qquad \text{Tool Equation (13)}$$

Where:

Variable	**SI Unit**	**Description**
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*
$FV_{RG,h}$	m_3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour *h*
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour *h* (NB: this corresponds to $fv_{i,RG,h}$ where *i* refers to methane)
$\rho_{CH4,n}$	kg/m_3	Density of methane at normal conditions (0.716)

Step 6: Determination of the hourly flare efficiency

The 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 (ηflare,h) is:

- *0% if the temperature of the exhaust gas of the flare (Tflare) is below 500 °C during more than 20 minutes during the hour h.*
- *η determined as follows in cases where the temperature of the exhaust gas of the flare (Tflare) is above 500 °C for more than 40 minutes during the hour h :*

$$\eta_{Flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}} \qquad \textit{Tool Equation (14)}$$

Where:

Variable	SI Unit	Description
$\eta_{flare,h}$	-	Flare efficiency in hour *h*
$TM_{FG,h}$	kg/h	Mass flow methane rate in exhaust gas averaged in hour *h*
$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour *h*

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 (TMRG,h) and the flare efficiency during each hour h (η flare,h), as follows:"

$$PE_{flare,h} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flare,h}) * \frac{GWP_{CH4}}{1000} \text{.....................} \textit{Tool Equation (15)}$$

Where:

Variable	SI Unit	Description
$PE_{flare,y}$	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*
$\rho_{flare,h}$		Flare efficiency in hour *h*
GWP_{CH4}	tCO_2e/tCH_4	Global Warming Potential of methane valid for the commitment period

For methane used for electricity generation purposes (**$MD_{electricity,y}$**), Equation 5 states its calculation:

$$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4} \qquad \textbf{(5)}$$

Where:

$\mathbf{MD}_{\mathbf{electricity,y}}$	Quantity of methane destroyed by generation of electricity (tCH_4/yr)
$\mathbf{LFG}_{\mathbf{electricity,y}}$	Quantity of landfill gas fed into electricity generator (m^3/yr)

It should be noted that for landfill gas flows captured either for flaring or electrical purposes ($\mathbf{LFG}_{\mathbf{flare,y}}$ and $\mathbf{LFG}_{\mathbf{electricity,y}}$), it must be taken into account the annual hours of plant operation. It is recommended to register each hour of operation.

The ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year, in tonnes of methane ($MD_{project,y}$) is done with the latest version of the approved *"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"*, considering the following additional equation:

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

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 oxidized in the soil or other material covering the waste)
F = Fraction of methane in the SWDS gas (volume fraction) (0.5)
DOC_f = Fraction of degradable organic carbon (DOC) that can decompose
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. 11.
y Year for which methane emissions are calculated

ACM0001, ver. 11 further clarifies that "*Sampling to determine the different waste types is not necessary; the waste composition can be obtained from previous studies*."

ACM0001, ver. 11 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 through the utilization of a 45% capture efficiency value for the total of biogas generated..

$$MD_{project,y} = \frac{BE_{CH4,SWDS,y}}{GWP_{CH4}} \quad \textbf{(6)}$$

<u>Net quantity of electricity produced using LFG ($EL_{LFG,y}$)</u>

Since the project activity has as it purpose to generate electricity using LFG, during the crediting period, it will be measured the electricity produced in power plant station at the site. In the absence of the project activity, this electricity would have been produced by power plants connected to the grid.

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

Because it was identified that in the baseline the electricity generated would come most probably from plants connected to the national grid, the emission factor is calculated according to the *"Tool for calculation of emission factor for electricity systems*". The calculation of the emission factor for the electricity system is showed in Annex 3.

The grid emission factor is calculated as follows:

$$EF_{grid} = wOM * EF_{OM} + wBM * EF_{BM} \quad \textbf{(7)}$$

<u>Quantity of thermal energy generated using LFG ($ET_{LFG,y}$)</u>

The purpose of this project activity does not involve thermal generation using LFG. Therefore, $\mathbf{ET_{LFG,y} = 0}$.

For Net Calorific Value and Emission factor of each type of fuel , it was chosen the default 2006 IPCC Values to be conservative.

Project Emissions from flaring:

Project emissions from flaring will be calculated and monitored according to the procedures described in *"Tool to determine project emissions from flaring gases containing methane"*, using the option for continuous monitoring of the methane destruction efficiency of the flare. For *ex-ante* calculations of emission reductions, a 98% efficiency ($\eta_{flare,h}$) value will be assumed for the project (according to the flare´s manufacturer specifications).

Project emissions:

Possible CO_2 emissions coming from other fuels than the recovered methane (contained in the landfill gas), should be accounted for as project emissions.

The general equation for Project emissions is stated as follows:

$$PE_Y = PE_{EC,Y} + PE_{FC,j,y} \qquad \textbf{(8)}$$

Where:

$PE_{EC,y}$	Emissions from consumption of electricity in the project case. The project emissions from electricity consumption ($PE_{EC,y}$) will be calculated following the latest version of *"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"*. If in the baseline a part of LFG was captured then the electricity quantity used in calculation is electricity used in the project activity net of that consumed in the baseline.
$PE_{FC,j,y}$	Emissions from consumption of heat in the project case. The project emissions from fossil fuel consumption ($PE_{FC,j,y}$) will be calculated following the latest version of *"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion"*. For this purpose, the processes j in the tool corresponds to all fossil fuel combustion in the landfill, as well as any other on-site fuel combustion for the purposes of the project activity. If in the baseline part of a LFG was captured, then the heat quantity used in calculation is fossil fuel used in project activity net of that consumed in the baseline.

The determination of the emission factors for electricity generation was made using option A1 because when the project does not generate electricity, the assumption made was that the electricity needed for the operation of the project activity will be supplied by the national grid.

$$PE_{EC,y} = EC_{PJ,y} * EF_{grid} * (1+TDL_y) \qquad \textbf{(9)}$$

Where:

$PE_{EC,y}$	Are the project emissions from electricity consumption by the project activity during the year y (tCO_2 / yr)
$EC_{PJ,y}$	Is the quantity of electricity consumed by the project activity during the year y (MWh)
$EF_{grid,y}$	Is the emission factor for the grid in year y (tCO_2/MWh)
TDL_y	Are the 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.

A default 20% was used for the ex-ante calculation (option A1) for the **TDL_y**. Also, the emission factor of the grid (**$EF_{grid,y}$**) used is 0.538 tCO_2/MWh (see annex 3).

When the project does not generate electricity in the first project stage, the assumption made was that the electricity needed for the operation of the project activity will be supplied by the national grid. When the project generates electricity, there is a net export of electricity to the grid. For these reasons, the emissions coming from the electricity use are deducted from the overall emissions reductions (this means that only emissions reductions for the net electricity generation are claimed).

The determination of the emission factors for electricity generation was made using option A1 because when the project does not generate electricity, the assumption made was that the electricity needed for the operation of the project activity will be supplied by the national grid.

$PE_{FC,y}$ will be calculated using the "*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*".

$$PE_{FC,j,y} = \Sigma FC_{i,j,y} * COEF_{i,y} \qquad \textbf{(10)}$$

Where:

$PE_{FC,j,y}$	CO_2 emissions from fossil fuel combustion in process *j* during the year *y* (tCO_2/yr)
$FC_{i,j,y}$	Is the quantity of fuel type *i* combusted in process *j* during the year *y* (mass or volume unit/yr);
$COEF_{i,y}$	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2 / mass or volume unit); **i** are the fuel types combusted in process *j* during the year *y*.

The CO_2 emission coefficient $COEF_{i,y}$ will be calculated using option B based on net calorific value and CO_2 emission factor of the fuel(s) type(s) used. Option A can not be applied because the necessary data is not available.

The type(s) of fossil fuel(s) to be used will depend on the choice of the developer (i.e. natural gas, fuel oil, diesel, etc.), and the corresponding emission factors will be taken from the IPCC[27] 2006 default values, in case there is no data available.

At this moment, for the Culiacan Northern Landfill Gas Project, it is considered that there will not be any heat consumption, so **$PE_{FC,j,y} = 0$.**

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

Emission reductions:

According to the Methodology the greenhouse gas emission reductions achieved by the project activity during a given year "*y*" (ERy) shall be estimated as follows:

$$ER_y = BE_y - PE_y \qquad \textbf{(11)}$$

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

Some of the parameters and data used in equations that are not monitored are constants, as listed in the table below.

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_{2e}/tCH_4

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[27] IPCC 2006 Guidelines for National Greenhouse Gas Inventories

Description:	Global warming potential of CH_4
Source of data used:	2006 IPCC value
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value determined as a conservative manner for calculations.
Any comment:	The GWP shall be updated accordingly to any future COP/MOP decisions

Data / Parameter:	**D_{CH4}**
Data unit:	$tCH_4 / m^3 CH_4$
Description:	Methane density.
Source of data used:	As indicated in the present methodology
Value applied:	0.0007168
Justification of the choice of data or description of measurement methods and procedures actually applied :	Value applied for the density of methane at standard temperature and pressure (0 degree Celsius and 1,013 bar).
Any comment:	-

Data / Parameter:	**AF**
Data unit:	%
Description:	Adjustment factor (for methane destruction in the baseline)
Source of data used:	Estimated if there is a contractual or regulations requirements
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	The regulatory requirements do not indicate any specific amount of landfill gas to collect and destruct or for its utilization. There are no registered amounts of landfill gas that are actually burned at the Culiacan Northern Landfill Gas Project; in any case, only passive venting is used for safety purposes and no methane destruction is occurring previous to the project activity. With these facts, an adjustment factor of 0% is the most proper value to be adopted.
Any comment:	-

Data / Parameter:	**$BE_{CH4,SWDS,y}$**
Data unit:	tCO2e
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:	φ
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Source of data used:	As per “Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site”
Value applied:	0.9
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:	Oonk et al. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results.

Data / Parameter:	**OX**
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data used:	Assessment of the type of cover of the solid waste disposal site; and following IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Value applied:	0
Justification of the choice of data or description of measurement methods and procedures actually applied :	Oxidation factor in a well managed landfill with a good cover is not considerable and can be estimated as zero.
Any comment:	-

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

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

Data / Parameter:	DOC_f
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	A default value of 0.5 is recommended by the IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Any comment:	-

Data / Parameter:	DOC_j
Data unit:	-
Description:	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value applied:	See table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	Default values for DOC and fossil carbon content in different waste types for garden and park waste, and disposable nappies according to the IPCC.
Any comment:	-

Waste type *j*	**DOCj**
Wood and wood products	0.43
Pulp, paper and cardboard (other than sludge)	0.40
Food, food waste, beverages and tobacco (other than sludge)	0.15
Textiles	0.24
Garden, yard and park waste	0.20
Glass, plastic, metal, other inert waste	0.00
Nappies	0.24
Rubber and Leather	0.39

Data / Parameter:	**kj**
Data unit:	-
Description:	Decay rate for the waste type j
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value applied:	Apply the following default values for the different waste types *j*

Waste type *j*	**kj**
Wood and wood products	0.025
Pulp, paper and cardboard (other than sludge)	0.045
Food, food waste, beverages and tobacco (other than sludge)	0.085
Textiles	0.045
Garden, yard and park waste	0.065
Glass, plastic, metal, other inert waste	0.000
Nappies	0.045
Rubber and Leather	0.045

	NB: MAT – mean annual temperature, MAP – Mean annual precipitation, PET – potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The annual precipitation (average from 1986 to 2004) is 673.5 mm, and the annual temperature (average to 1986 to 2004) is 25.6 °C.
Any comment:	Source: INEGI <http//www.inegi.gob.mx/est/contenidos/espanol/sistemas/cem05/info/sin/m006/c25006-01.xls>

Data / Parameter:	**Carbon Emission Factor ($CEF_{electricity,y}$)**
Data unit:	tCO_2/GWh
Description:	CO2 emissions intensity of the electricity displaced
Source of data used:	Electricity Sector Outlooks: 2006-2015, 2007-2016, 2008-2017
Value applied:	0.538 tCO2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	The $CEF_{electricity,y}$ is calculated according to the "Tool to calculate the emission factor for an electricity system".
Any comment:	The value will be keep fixed for the entire crediting period.

The following parameters were used for the $CEF_{electricity,y}$ factor calculation. (See Annex 3 for detailed data and calculation).

Data / Parameter:	**$FC_{i,m,y}$, $FC_{i,y}$, $FC_{i,j,y}$, $FC_{i,k,y}$, $FC_{i,n,y}$ and $FC_{i,n,h}$**
Data unit:	Mass or volume unit
Description:	Amount of fossil fuel type i consumed by power plant / unit m, j, k or n (or in the project electricity system in case of $FC_{i,y}$) in year y or hour h
Source of data used:	Electricity Sector Outlooks: 2006-2015, 2007-2016, 2008-2017
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the "Tool to calculate the emission factor for an electricity system".

Any comment:	

Data / Parameter:	**$NCV_{i,y}$**
Data unit:	GJ / mass or volume unit
Description:	Net calorific value (energy content) of fossil fuel type i in year y
Source of data used:	IPCC default values as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the "Tool to calculate the emission factor for an electricity system".
Any comment:	

Data / Parameter:	**$EF_{CO2,i,y}$ and $EF_{CO2,m,i,y}$**
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of fossil fuel type i in year y
Source of data used:	IPCC default values as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the "Tool to calculate the emission factor for an electricity system".
Any comment:	

Data / Parameter:	**$EG_{m,y}$, EG_y, $EG_{j,y}$, $EG_{k,y}$ and $EG_{n,h}$**
Data unit:	MWh
Description:	Net electricity generated and delivered to the grid by power plant / unit m, j, k or n (or in the project electricity system in case of EG_y) in year y or hour h
Source of data used:	Electricity Sector Outlooks: 2006-2015, 2007-2016, 2008-2017
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the "Tool to calculate the emission factor for an electricity system".
Any comment:	

Data / Parameter:	$\eta_{m,y}$
Data unit:	-
Description:	Average net energy conversion efficiency of power unit m in year y
Source of data used:	Electricity Sector Outlooks: 2006-2015, 2007-2016, 2008-2017
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	According to the "Tool to calculate the emission factor for an electricity system".
Any comment:	

B.6.3 Ex-ante calculation of emission reductions:

An ex-ante emission reduction calculation requires an estimation of landfill gas production from the waste at the site. This estimation was 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, please refer to Annex 3.

The LFG collection efficiency for ex-ante estimations is assumed to be 45%, which is a conservative value. The amount of methane collected would represent $MD_{project,y}$.

It is expected to collect and flare landfill gas initially. Afterward, it may be decided to generate electricity, in which case a part of the landfill gas collected would be sent to the electricity generation unit. Generation could start in 2011. The maximum electricity generation potential (MW) can be estimated from the flow rate of landfill gas collected (m3/h). It is estimated that a maximum power plant capacity will need a gross heat rate of 10,800 BTU per kW-hr (hhv). This allows to calculate the maximum power generation potential if all the LFG were converted to electricity. However Landfill gas generation may vary continuously over time, power generation equipment is only available at specific power output capacities. Based on the amount of landfill gas estimated, it is assumed that initial power generation in 2011 would be almost 1 MW and decreasing along the years .

80% of the total landfill gas captured is used for generation of electricity, and the remaining 20% is flared at the enclosed flare.

All the landfill gas not sent to the power plant will be combusted in an enclosed flare. In order to be conservative, the ex-ante estimations assume a default flare efficiency of 98%. The project activity involves Landfill gas 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. Other assumptions made for the ex-ante estimations, are as follows:

- **Operation of the power plant:** It is expected that the electricity generation facility will operate 8,000 h/yr.
- **Operation of the flare station:** It was assumed that the flare station will operate 8,600 h/yr.
- **Blower electricity consumption:** Based on manufacturer's information, it is assumed that two blowers will have an installed capacity consumption of 25 hp each one (approximately 40 kW in total) in order to pump the LFG. Electricity consumption from the blowers will depend on the operating hours per year, however it is estimated to be almost 344,000 kWh/year.

Emissions from this power consumption from the grid in the project activity will also depend on the emission factor for electricity generation, which is estimated in Annex 3, according to the *"Tool to calculate the emission factor for an electricity system"*. A value of 0.538 tCO2/MWh (combined margin) was used in this project for imported (grid) electricity. This CO_2 emission factor for power generation was determined using the same procedure indicated in the tool which allows for *EFgrid,y* to remain fixed for each crediting period.

The landfill project does not contemplate thermal generation, and has no fossil fuel consumption at the baseline scenario.

For ex-ante calculation purposes, there will be no fossil fuel consumption in the project scenario ($PE_{FC,j,y}$), but any eventual fossil fuel consumption will be accounted for. $PE_{FC,j,y}$ will depend on the fossil fuel consumed and its value will be taken from IPCC 2006 default emission factors, in case no other data is available.

Year	**$LFG_{total,y}$ m^3 LFG/yr**	**$LFG_{thermal,y}$ m^3 LFG/yr**	**$LFG_{electricity,y}$ m^3 LFG/yr**	**$LFG_{flare,y}$ m^3 LFG/yr**	**$LFG_{PL,y}$ m^3 LFG/yr**	**$PE_{flare,y}$ tCO_{2e}**
2010	6,868,513	0	0	6,868,513	0	845.2
2011	6,472,806	0	5,178,245	1,294,561	0	159.3
2012	6,101,540	0	4,881,232	1,220,308	0	150.2
2013	5,753,112	0	4,602,490	1,150,622	0	141.6
2014	5,426,027	0	4,340,822	1,085,205	0	133.5
2015	5,118,896	0	4,095,117	1,023,779	0	126.0
2016	4,830,423	0	3,864,339	966,085	0	118.9
2017	4,559,402	0	3,647,522	911,880	0	112.2
2018	4,304,708	0	3,443,766	860,942	0	105.9
2019	4,065,292	0	3,252,234	813,058	0	100.0

Table 5: Ex-ante estimation of landfill gas collected and flared.

Year	**$MD_{PL,y}$ tCH_4/yr**	**$MD_{thermal,y}$ tCH_4/yr**	**$MD_{electricity,y}$ tCH_4/yr**	**$MD_{flare,y}$ tCH_4/yr**	**$MD_{project}$ tCH_4/yr**	**MD_{reg} tCH_4/yr**
2010	0	0	0	2,411	2,411	0
2011	0	0	1,848	454	2,303	0
2012	0	0	1,742	428	2,171	0
2013	0	0	1,643	404	2,047	0
2014	0	0	1,549	381	1,930	0
2015	0	0	1,462	359	1,821	0
2016	0	0	1,379	339	1,719	0

Year	$MD_{PL,y}$ tCH_4/yr	$MD_{thermal,y}$ tCH_4/yr	$MD_{electricity,y}$ tCH_4/yr	$MD_{flare,y}$ tCH_4/yr	$MD_{project}$ tCH_4/yr	MD_{reg} tCH_4/yr
2017	0	0	1,302	320	1,622	0
2018	0	0	1,229	302	1,531	0
2019	0	0	1,161	285	1,446	0

Table 6: Ex-ante estimation of net emission reductions by methane destruction.

Year	Electricity consumption $EC_{PJ,y}$ MWh/yr	Electricity generated $EL_{LFG,y}$ MWh/yr
2010	344.0	0.00
2011	344.0	7,903.01
2012	344.0	7,449.71
2013	344.0	7,024.30
2014	344.0	6,624.94
2015	344.0	6,249.95
2016	344.0	5,897.73
2017	344.0	5,566.83
2018	344.0	5,255.86
2019	344.0	4,963.54

Table 7: Ex-ante estimation of net emission of net reduction by fossil fuels displacement, due to electricity generation using landfill gas.

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

Year	Estimation of project activity emissions (tones of CO_2e)	Estimation of baseline emissions (tones of CO_2e)	Estimation of leakage (tonnes of CO2 e)	Emissions Reduction tCO_2e/yr
2010	222	50,639	0	50,417
2011	222	52,613	0	52,390
2012	222	49,595	0	49,373
2013	222	46,763	0	46,541
2014	222	44,104	0	43,882
2015	222	41,608	0	41,386
2016	222	39,263	0	39,041
2017	222	37,060	0	36,838
2018	222	34,990	0	34,768
2019	222	33,044	0	32,822

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

B.7.1 Data and parameters monitored:

Data / Parameter:	$LFG_{total,y}$

Data unit:	Cubic meters (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 section B.6.3 and Table 5
Description of measurement methods and procedures to be applied:	Continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions). Data will be recorded electronically, and 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
Any comment:	Methane fraction of the landfill gas and LFG flow have to be measured on same basis (either wet or dry).

Data / Parameter:	**$LFG_{flare,y}$**
Data unit:	Cubic meter (m^3)
Description:	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 section B.6.3 and Table 5.
Description of measurement methods and procedures to be applied:	Continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions) Data will be recorded electronically, and 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
Any comment:	

Data / Parameter:	**$LFG_{electricity,y}$**
Data unit:	Cubic meter (m^3)
Description:	Amount of landfill gas combusted in power plant at Normal Temperature and Pressure
Source of data to be used:	Measured by a flow meter
Value of data applied	Details of assumptions, calculations and resulting data are presented in section

for the purpose of calculating expected emission reductions in section B.5	B.6.3 and Table 5.
Description of measurement methods and procedures to be applied:	Continuous (average value in a time interval not greater than an hour shall be used in the calculations of emission reductions) Data will be recorded electronically, and 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
Any comment:	

Data / Parameter:	**$PE_{flare,y}$**
Data unit:	tCO2e
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	See section B.6.3 and Table 5.
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}, are LFGflare, w_{CH4}, $fv_{i,h}$, $fv_{CH4, FG, h}$ and tO_2
QA/QC procedures to be applied:	Regular maintenance will ensure optimal operation of the flare. Analyzers 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. The flare efficiency is 98%

Data / Parameter:	**w_{CH4}**
Data unit:	m³ CH_4 / m³ LFG
Description:	Methane fraction in the landfill gas
Source of data to be used:	Measured continuously by the project participant using certified equipment
Value of data applied for the purpose of calculating expected emission reductions in	50%

section B.5	
Description of measurement methods and procedures to be applied:	It shall be measured using equipment that can directly measure methane content in the landfill gas, estimation of methane content of landfill gas based on measurement of other constituents of the landfill gas such as CO2 is not permitted. It will be measured by continuous gas quality analyzer Data results will be stored electronically and they will be kept during the crediting period and two years after.
QA/QC procedures to be applied:	Methane content will be measured using a continuous gas analyzer. The gas analyzer should be subject to a regular maintenance and testing regime to ensure accuracy
Any comment:	Methane fraction of the landfill gas and LFG flow have to be measured on same basis (either wet or dry).

Data / Parameter:	**T**
Data unit:	Celsius degrees
Description:	Temperature of the landfill gas
Source of data to be used:	Proper measuring instrument.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0 (In accordance for STP conditions).
Description of measurement methods and procedures to be applied:	Measured to determine the density of methane D_{CH4}. No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.
QA/QC procedures to be applied:	Measuring instrument should be subject to a regular maintenance and testing regime in accordance to the manufacturer specification to ensure accuracy and the proper calibration of the instrument.
Any comment:	

Data / Parameter:	**P**
Data unit:	Pa (Pascal)
Description:	Pressure of landfill gas
Source of data to be used:	Proper measuring instrument.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	101,325 Pa (1 atm and for STP conditions)
Description of	Measured to determine the density of methane D_{CH4}.

measurement methods and procedures to be applied:	No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.
QA/QC procedures to be applied:	Measuring instrument should be subject to a regular maintenance and testing regime in accordance to the manufacturer specification to ensure accuracy and the proper calibration of the instrument.
Any comment:	

Data / Parameter:	**$EL_{LFG,y}$**
Data unit:	MWh
Description:	Net quantity of electricity generated using LFG
Source of data to be used:	Electricity meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Details of calculations and resulting data are presented in section B.6.3 (Table 7).
Description of measurement methods and procedures to be applied:	Electricity meters will be used
QA/QC procedures to be applied:	Data will be measured continuously, recorded electronically, and data will be kept during the crediting period and two years after. Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy
Any comment:	Includes both exports to other on-site activities as well as sold to the power grid.

Data / Parameter:	**Operation of the energy (electrical) plant**
Data unit:	Hours
Description:	Hours of operation of the electrical energy plant
Source of data to be used:	Records on-site by the personnel.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	It was assumed 8,000 hours per year.
Description of measurement methods and procedures to be applied:	Daily records of the operation of the equipments at the project site for the Project activity.
QA/QC procedures to	

be applied:	
Any comment:	

Data / Parameter:	**Operation of the flare station**
Data unit:	Hours
Description:	Measurement with run meter connected to the blower
Source of data to be used:	Records on-site by the personnel.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	It was assumed 8,600 hours per year.
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:	
Any comment:	

Data / Parameter:	**$PE_{EC,y}$**
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 baseline, project and or leakage emissions from electricity consumption”.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	221 (See section B.6.4 as the estimation of project activity emissions)
Description of measurement methods and procedures to be applied:	The calculation procedures and methods will be defined according to the case presented during the crediting period for the project activity, according to one of the following possible scenarios: a) Electricity consumption from the grid; or b) Electricity consumption from (an) off-grid captive power plant(s); or c) Electricity consumption from the grid and (a) captive power plant(s).
QA/QC procedures to be applied:	As per the latest version of the “Tool to calculate baseline, project and or leakage emissions from electricity consumption”.
Any comment:	For ex-ante purposes, it was followed case a) in order to estimate project emissions from electricity consumption from the grid.

Data / Parameter:	**$PE_{FC,j,y}$**
Data unit:	tCO_2
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 CO2 emissions from fossil fuel combustion”.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	As per the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.
Description of measurement methods and procedures to be applied:	As per the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.
QA/QC procedures to be applied:	As per the “Tool to calculate project or leakage CO2 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 during project activity will be accounted for with purchase receipts or invoices.

The following variables are monitored, as required to determine flare efficiency using the Tool (**$PE_{flare,y}$**).

Data / Parameter:	**$FV_{RG,h}$**
Data unit:	m^3/hr
Description:	Volumetric flow rate of the residual gas in a dry basis at normal conditions in the hour *h*.
Source of data to be used:	Measurements by project participants using a flow meter
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See table 5 in section B.6.3. (See parameter $LFG_{flare,y}$) Note: The quantity of landfill gas that is needed to generate electricity was assumed at least 80% of the recovered landfill gas therefore and that the remaining 20% of the total landfill gas captured will be sent to the flare (except the first year where no electric generation is intended to occur).
Description of measurement methods and procedures to be applied:	Data will be stored electronically and will be kept during the crediting period and two years after. Values to be averaged hourly or at a shorter time interval . 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.
Any comment:	The same basis (dry or wet) is considered for this measurement when the residual gas temperature exceeds 60ºC Note this parameter would measure the same flow as it does the parameter $LFG_{flare,y}$. Therefore it would be expected the same instrument for this purpose.

Data / Parameter:	**$fv_{i,h}$**
Data unit:	(fraction)
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 analyzer.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	See section B.6.1 and B.6.3 for details.
Description of measurement methods and procedures to be applied:	Methane concentration would be measured at least once per hour using a continuous gas analyzer, and data records will be kept during the crediting period and two years after.Same basis (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceeds 60 ºC
QA/QC procedures to be applied:	Analyzer(s) will be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas.
Any comment:	-

Data / Parameter:	**$t_{O2,h}$**
Data unit:	(fraction)
Description:	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*.
Source of data to be used:	On-site measurements using a continuous gas analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.2
Description of measurement methods and procedures to be applied:	Measured at least once per hour and electronically using a continuous gas analyzer, and will be kept during the crediting period and two years after. Extractive sampling analyzers with water and particulates removal devices or in situ analysers 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 sampling probes adequate to high temperatures level (e.g. inconel probes). 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.
QA/QC procedures to be applied:	Analyzers will be periodically calibrated according to the manufacturer's recommendation.
Any comment:	This parameter will be monitored as it will be used an enclosed flare and it will be a continuous monitoring of the flare efficiency.

Data / Parameter:	**$fv_{CH4,FG,h}$**
Data unit:	mg/m^3
Description:	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*
Source of data to be used:	Measurements using a Flare Emissions Analyzer
Value of data applied for the purpose of calculating expected emission reductions in section B.5	It was assumed 60 mg/m^3 of methane present in the exhaust gas (dry basis) at normal conditions.
Description of measurement methods and procedures to be applied:	The emissions monitor measures the emissions gas existing at the flare stack on a parts per million (ppm) range and a conversion unit is used form ppm to mg/m^3. The frequency of monitoring will be continuous: values are to be averaged hourly or at a shorter time interval.
QA/QC procedures to be applied:	Analyzers will be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check will be performed by comparison with a standard gas.
Any comment:	Measurement instruments may read ppmv or % values. To convert from ppmv to mg/m^3, multiply by 0.716. 1% equals 10 000 ppmv.

Data / Parameter:	**T_{flare}**
Data unit:	°C
Description:	Temperature in the exhaust gas of the flare.
Source of data to be used:	On-site measurements
Value of data applied for the purpose of calculating expected emission reductions in section B.5	It was assumed 800°C.
Description of measurement methods and procedures to be applied:	Measure 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 burned 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 indicate that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. A thermocouple will be used to measure temperature (maintained between 500 °C to 700 °C for optimum operation).

The following variables are required to determine annual consumption of electricity on the project site using the Tool (**$PE_{EC,y}$**)

Data / Parameter:	**$EC_{PJ,y}$**
Data unit:	MWh
Description:	On-site consumption of electricity provided by the grid and attributable to the project activity during the year y
Source of data to be used:	Onsite measurements
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:	Measured continuously, aggregated at least monthly/annually.
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:	**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 to be used:	One of the following options will be used: a) Recent, accurate and reliable data available within the host country. b) A default value of 20%.
Value of data applied for the purpose of 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:	For a): *TDLy* should be estimated for the distribution and transmission networks of the electricity grid of the same voltage as the connection where the proposed CDM project activity is connected to. The technical distribution losses should not take into account other types of grid losses (e.g. commercial losses/theft). The distribution losses can either be calculated by the project participants or be based on references from utilities, network operators or other official documentation.
QA/QC procedures to be applied:	In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.

Any comment:	Technical distribution losses do not take into account other types of grid losses (e.g. commercial losses/theft). In case there are not any official data and/or figures available at all, it will be employed the default value.

The following variables are relevant to determinate the project emissions coming from fossil fuel consumption using the Tool (**$PE_{FC,j,,y}$**).

Data / Parameter:	**$FC_{i,i,y}$**
Data unit:	Mass or volume unit per year (e.g. ton/yr or m^3/yr)
Description:	Quantity of fuel type *i* combusted in process *j* during the year *y*
Source of data to be used:	Onsite 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:	It will be used one of the following options: • Use either mass or volume meters. In cases where fuel is supplied from small daily tanks, rulers can be used to determine mass or volume of the fuel consumed, with the following conditions: The ruler gauge must be part of the daily tank and calibrated at least once a year and have a book of control for recording the measurements (on a daily basis or per shift); • Accessories such as transducers, sonar and piezoelectronic devices are accepted if they are properly calibrated with the ruler gauge and receiving a reasonable maintenance; • In case of daily tanks with pre-heaters for heavy oil, the calibration will be made with the system at typical operational conditions. These will depend according to the type of fuel to be employed for the captive power plant, if implemented.
QA/QC procedures to be applied:	The consistency of metered fuel consumption quantities should be cross-checked with an annual energy balance that is based on purchased quantities and stock changes. If purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should be cross-checked with available purchase invoices from the financial records.
Any comment:	-

Data / Parameter:	$NCV_{i,y}$
Data unit:	GJ per mass or volume unit (e.g. GJ/m³, GJ/ton)
Description:	Weighted average net calorific value of fuel type *i* in year *y*

<table>
<tr><td>Source of data to be used:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source if the carbon fraction of the fuel is not provided (Option A)</td></tr>
<tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available
These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).</td></tr>
<tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.</td><td>If a) is not available</td></tr>
</table>
Further considerations will be made according to the type of information available from the supplier of the fuel(s), if implemented.</td></tr>
<tr><td>Value of data applied for the purpose of calculating expected emission reductions in section B.5</td><td>Not used in ex-ante estimates.</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>For a) and b): Measurements should be undertaken in line with national or international fuel standards
For a) and b): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated
For c): Review appropriateness of the values annually
For d): Any future revision of the IPCC Guidelines should be taken into account</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>For the cases a), b) or c) only:
For values under a), b) and c) should be verified within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.
If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements.
The laboratories in a), b) or c) should have ISO17025 accreditation or justify that</td></tr>
</table>

	they can comply with similar quality standards.
Any comment:	Considerations were made for Option B to calculate the CO_2 emission coefficient of fuel type *i* ($COEF_{i,y}$) : - CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type *i*

Data / Parameter:	$\mathbf{EF_{CO2,i,y}}$
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor of fuel type *i* in year *y*
Source of data to be used:	The following data sources may be used if the relevant conditions apply: (see table below) Further considerations will be made according to the type of information available from the supplier of the fuel(s), if implemented.
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:	Only for cases of a) and b): Measurements should be undertaken in line with national or international fuel standards. For c): Review appropriateness of the values annually.

Data source	**Conditions for using the data source**
a) Values provided by the fuel supplier in invoices	This is the preferred source if the carbon fraction of the fuel is not provided (Option A)
b) Measurements by the project participants	If a) is not available
c) Regional or national default values	If a) is not available These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances).
d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories.	If a) is not available

	For d): Any future revision of the IPCC Guidelines should be taken into account.
QA/QC procedures to be applied:	Only for cases a) and b): The CO_2 emission factor should be obtained for each fuel delivery, from which weighted average annual values should be calculated.
Any comment:	Applicable where option B is used. For a): If the fuel supplier does provide the NCV value and the CO_2 emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, Options b), c) or d) should be used.

B.7.2 Description of the monitoring plan:

The responsible entity for the monitoring system is Promotora Ambiental de la Laguna S.A de C.V. personnel. The monitoring activities will primarily involve two types of personnel: the Field Technician and the System Manager.

The Field Technician will perform activities such as monitoring and adjusting LFG extraction wells, checking operations of the blower and flare, recording data at the blower/flare station, routine maintenance of collection system components, preparing daily logs and completing check lists, and send data with the System Manager.

The System Manager's responsibilities include reviewing the data collected both manually by the Field Technician and the one recorded automatically by analytical equipment, making recommendations and/or implementing system adjustments to maximize methane capture and destruction, scheduling monitoring and O&M activities, performing quality assurance checks on operations, coordinating with system component manufacturers as needed, to maintain proper operations and calibration, and compiling data as required by the Methodology.

Only for manual data collection, the Landfill manager will be responsible of review the data collected.

Project Management Responsibility

The project implementation and operation will be under the direct supervision of the Landfill Manager. Technical documentation on the monitoring and maintenance plan has been developed by Promotora Ambiental de la Laguna S.A de C.V

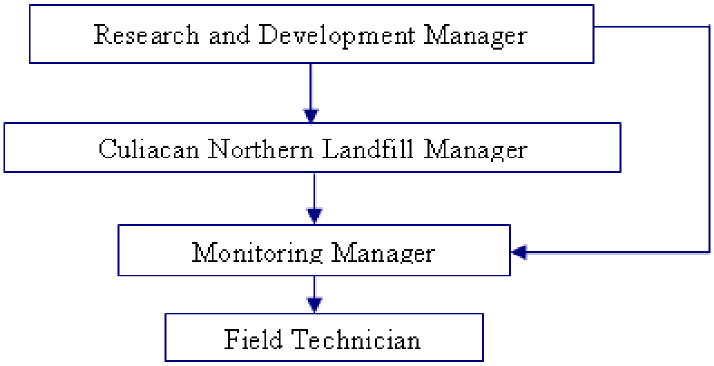

Figure 3.- Organization chart

The quality actions that will guarantee the success of the monitoring plan are the following:

Maintenance Plan

The following aspects are core to the maintenance of the monitoring system in order to assure proper data monitoring during the project:

- Equipment preventive maintenance
- Equipment calibration

Since the proposed project involves flaring and electricity generation, the following figure shows a general monitoring system chart

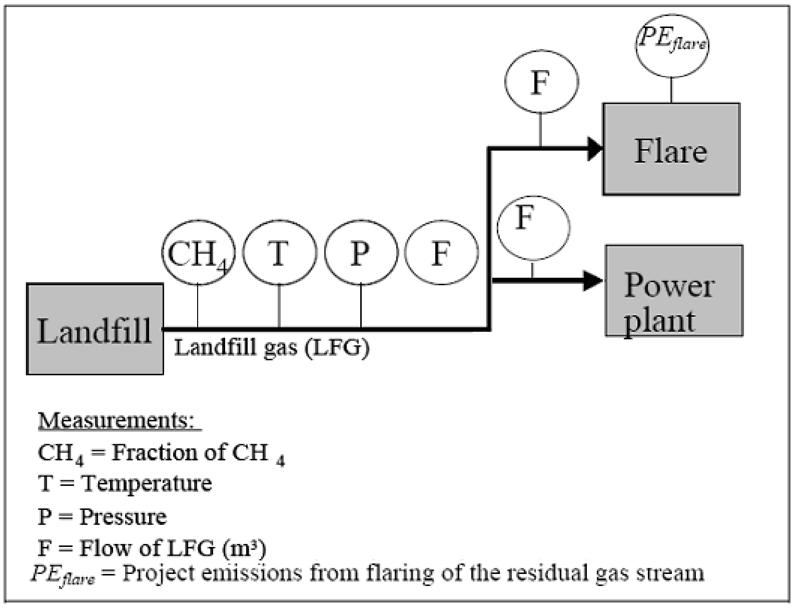

Figure 4. Monitoring system chart

Monitoring Frequency

As noted above, most of the data at the flare station will be automatically recorded on a continuous basis. Under normal operation, monitoring of the collection system (extraction wells) will be conducted on a monthly or more frequent basis defined by PALA.

Future monitoring frequencies will be based on the results of the initial collection system monitoring. Sometimes, certain extraction wells require more frequent adjustments than others.

The flare station operation will be observed by the Field Technician. Data to be recorded manually during these observations will include current LFG flow rate, methane content, flare temperature, which blowers are in operation, running time on each blower, blower bearing temperatures (if applicable), pressure drop across the flame arrester and condensate knockout pot, and liquid level in the knockout pot.

Although this manually collected information is not normally needed for CER quantification, it is a best management practice to alert the technician of changed conditions and may serve as a backup to electronic data that is lost or corrupted.

When data needs to be recorded manually, all monitoring parameters that will be collected by the technician will be review by the Landfill manager. The technician and/or the Landfill manager and/or the monitoring manager will review the data collected (manually) to give an alert to the technician to solve the situation.

Data Analysis

The collected data will be reviewed and analyzed on a daily basis by the Monitoring Manager. In case of a drift of one parameter the Manager or Technician can react quickly to fix potential problems. All data required for the emission reduction calculations will be kept in the onsite-monitoring database. The Monitoring Manager will be the responsible to report the necessary information to Promotora Ambiental de la Laguna S.A de C.V

Training of Monitoring Personnel

The monitoring personnel will be trained in the beginning of the project; the purpose of this training is to operate the project in a well manner. Periodical training will be defined by PALA.

Emergencies Procedures

If the flare is shut down, no landfill gas will be combusted and no credits will be claimed during this period. The running hours of the flares will be monitored as part of the monitoring procedures. In case of failure of one of the monitoring devices, portable instruments will be used in order to carry out periodic daily monitoring of the missing parameter(s). These data will be recorded on paper. PALA will define emergencies procedures according to the provider recommendations.

Calibration of the measurement equipment

The calibration of the measurement equipment and/or monitoring will be done periodically, considering the provider recommendations

Periodical Inspection

Inspections will be carried out by the person in charge of the technical team, related to: overview of the operation; inspection of the equipment and analysis of the data collected and indexes of maintenance and regularity of the functioning of the equipment.

Personnel Training

Special training will be performance by specialist as it is needed.

Blower/Flare Station Monitoring and Maintenance

SCS will provide training on the proper operation of the equipment contained in the Blower/Flare Station. The monitoring and maintenance will be performed as PALA considers properly.

Procedures for record handling

On a monthly basis, the Monitoring manager team will review the performance of the project activity. He will be responsible for monitoring key variables required for meeting the CDM monitoring requirements and to comply with the latest regulation.

All data will be kept on site for the duration of the crediting period plus, at least, 2 years after the end of the crediting period.

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: 30/01/2008

Alfonso Lanseros Valdés
Partner consultant
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Fax: (+34) 91 7814149
www.co2-solutions.com

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

The starting date of the project activity (real action).

05/06/2008

This date was chosen because it is the date of the Proforma Invoice from Landtec (technology provider) with the purchase orders for the equipment. The contracts for landfill gas flare and blower skid assembly as well as the contract for CDM project development are available upon request.

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

More than 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 applicable

C.2.1.2. Length of the first crediting period:

Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

15/01/2010, but not earlier than registration.

C.2.2.2. Length:

10 years, 0 months

SECTION D. Environmental impacts

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

The environmental impacts associated with the construction and operation of this project are discussed below.

Vegetation
Landfill gas collection will improve landfill surface and vegetation. To reduce surface emissions on the landfill, we will be creating a more suitable environment for vegetation to grow. Landfill gas in the soil and air tend to prevent vegetation from growing, which is why there is currently no vegetation on the Northern Landfill Gas Project.

Water quality
Landfill gas condensate will be collected by condensate traps and returned to a leachate treatment facility subject to forced evaporation. The project will reduce aquifer and underground impact due to the inadequate disposition of the leachate in the place.

Air Quality
The implementation of the LFG collection and flaring system will significantly decrease the environmental impacts that occur under the present operating conditions of the landfill site. Methane and other compounds which are normally released from landfills that do not contain a LFG collection and flaring system will be greatly reduced. The control of LFG emissions through the employment of the LFG collection and flaring system represents many significant environmental and health benefits to the landfill site and local areas including:

- Reduction of LFG migration throughout the landfill.
- Improvement of landfill surface and vegetation.
- Sustained local wildlife habitats.
- Increased safety of landfill site operations through decreased potential for landfill fires.
- Reduction of GHG emissions to the atmosphere.
- Reduction in pollution from volatile organic compound (VOC)
- Reduction of acid rain
- Reduction of nuisance odors.
- Reduction of health problems related to the landfill (respiratory distress, asthma, asphyxia).
- Enhancement of the quality of life and the public safety for the population living close to the landfill.

Noise

The use of an enclosed flare will reduce the emitted noise from the system.

Visual impact

The operation of the LFG collection will not have environmental impacts on the surrounding areas of the landfill.

No transboundary environmental impacts will occur from the project implementation.

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 environmental impacts

SECTION E. Stakeholders' comments

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

The stakeholder meeting was held at the Lucerna Hotel, in Culiacan, Sinaloa, Mexico, on November 30th, 2007. The participants were the project developer and stakeholders comprising representatives from the federal and local governments (both State and Municipal levels), deputy's chamber and neighborhoods that included local population, professionals and NGOs.

All of the stakeholders identified received an invitation by mail and a call a few days before the event.

The stakeholders meeting included: a presentation of the project participant (by Alfonso Martínez), who described the project and project technology, an explanation of the Kyoto, environmental and economic benefits of the project, and a period for questions and comments.
During the meeting, Paola Del Rio, presented a description of the CDM process, the objective of the consultation and its implications.

Overall participants showed interest on the project and made some comments (below). After the presentation doubts were cleared and it was given questionnaires to each participant to ask their opinion about the project, their concerns and if they agreed with the development of the project.

List of participants in the event:

	Name	Position/Labor
1	Ma. De Jesus Millar	Municipal worker
2	Antonia Barraza	Secretary
3	Petra García	Administrative at Municipal Presidency
4	Evangelina García	Municipal Presidency
5	David Aguilar	Autonomous University of Sinaloa
6	Claudia Camacho	City Council
7	Salvador Aragón	Autonomous University of Sinaloa

	Name	Position/Labor
8	Juan Lopez Ortiz	Autonomous University of Sinaloa
9	José Gabriel A.	Autonomous University of Sinaloa
10	Jesus Manuel López	City Council
11	Rosario Medrano	City Council
12	Sergio Torres	Congress
13	Raúl Terrazas	Ecoregion
14	Carlos Contreras	Municpal Ecology
15	Lorenzo Gomez	PROFEPA (Federal Environmental Protection)
16	Francisco Picusar	PROFEPA (Federal Environmental Protection)
17	Teseni Avendio	PROFEPA (Federal Environmental Protection)
18	Rigoberto Felix Díaz	JAPAC
19	Miguel Angel Lafraga	State Government
20	Rosa Ivera Casten	CANACO
21	Tomas Villar	City Council
22	Guadalupe Canedo	City Council
23	Adriana Sese	City Council
24	Raclamés Rubio	City Council
25	Santana Felix	JAPAC
26	Ma. Carmen Teny	SEMARNAT (Ministry of the Environment)
27	Camerino Aguirre	City Council
28	Carlos Llanes	City Council
29	Victor Salas	Lomas de R
30	Dulce Ma. Saucedo	Pracifico

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

The stakeholder consultation allowed stakeholders to understand the basic concepts regarding climate change, its consequences and the objectives of the Kyoto Protocol, as well as the most important features and benefits of the Project. The consultation was conducted by local and state authorities, as well as with the project participant.

The consultation was announced in the main local newspaper *El Financiero de Culiacan.* It was well-attended, with more than 30 members of the community participating, and it lasted approximately 2 hours. Most of the participants represented in the event were local and state officials and others from local communities. Participants filled out registration forms, which were kept in the Project Developer's files. These, as well as the questionnaires answered by each participant at the meeting are available to the DOE upon request.

E.2. Summary of the comments received:

Received comments show that stakeholders (both council members and residents) agree with the project. Stakeholders understand that the project generates benefits to the local communities, and general environmental protection.
During the consultation, the stakeholders raised various questions regarding the Project and the benefits it may bring to the community, and they are enlisted as follows:

1) When will the project begin? August 2008, the process has started with the digging of three wells. The digging is made to determine depth and for the structure design for the extraction. Afterwards, the closure of the landfill proceeds.
2) What kind of technology will be used for flaring? A closed flare with 98% efficiency. The participant mentioned that the State government supports 100% the development of the project and that the environmental benefit of the project is very important for them.
3) When will Promotora Ambiental recover its investment? It will depend on the market price of the CERs, however, the final objective is to obtain the highest possible price. It is worth mentioning that this kind of projects is perceived as risky because not all projects get to be registered.
4) Carlos Contreras from Municipal Ecology strongly suggested using biogas for electricity generation.

The consultation was closed and it was emphasized the importance of getting feedback from the community for the continuation of the Project and underlined the environmental benefits of this Project over economic benefits.

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

All questions were addressed at the stakeholder consultation and received comments have been positive so far. The consultation was regarded by the local stakeholders as a helpful event where they understood the project activity and the CDM process.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Promotora Ambiental de la Laguna S.A de C.V
Street/P.O. Box:	Los Andes 204 Coyoacan
Building:	
City:	Guadalupe
State/Region:	Nuevo León
Postfix/ZIP:	64510
Country:	Mexico
Telephone:	8122-7600
FAX:	
E-Mail:	amartinezmu@gen.tv
URL:	http://www.gen.tv/
Represented by:	
Title:	Manager of Research and Development
Salutation:	PhD
Last Name:	Muñoz
Middle Name:	Martinez
First Name:	Alfonso
Department:	R&D
Mobile:	8115313173
Direct FAX:	52 8183227600 ext. 194
Direct tel:	52 81227600 ext. 316
Personal E-Mail:	amartinezmu@gen.tv

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding will be used for this project.

Annex 3

BASELINE INFORMATION

A.3.1 General Information of the Northern Landfill Gas Project

Landfill Information	
Location	Culiacán, Sinaloa
Country	Mexico
Area of the site	100 ha
Year of starting operations	1992
Estimated total of tons of waste accumulated at the Closure Area.	2.86 million tons

Waste Filling History

The historical filling rates were provided by the Municipality's personnel. At the time, it will have reached a capacity of approximately 2.86 million tonnes. The historical data registered by Municipality personnel is presented in the table below:

Waste filling rate per year in the landfill

Year	Waste input (tonnes)
1992	50,000
1993	55,000
1994	65,000
1995	75,000
1996	85,000
1997	106,000
1998	139,355
1999	172,154
2000	208,067
2001	213,915
2002	223,000
2003	243,351
2004	272,139
2005	273,304
2006	274,370
2007	235,662
2008	169,496

Energy generation (MW Projection)

Data	Unit
0.018	mmBTU/m3 lfg
10.80	mmBTU/ MWh (hhv – gross heat rate)

Year	$MD_{project,y}$	$LFG_{electricity,y}$		H_{LFG} (Energy content of LFG)		Power
	tCH_4	m3 LFG/yr	m3 LFG/yr	mmBTU/yr	mmBTU/hr	MW e
2010	2,414	0.00	0	0.00	0.00	0.0
2011	2,303	5,178,244.91	591.12	85,352.52	10.67	1.0
2012	2,171	4,881,232.30	557.22	80,456.89	10.06	0.9
2013	2,047	4,602,489.53	525.40	75,862.40	9.48	0.9
2014	1,931	4,340,821.93	495.53	71,549.35	8.94	0.8
2015	1,822	4,095,117.03	467.48	67,499.42	8.44	0.8
2016	1,719	3,864,338.67	441.13	63,695.53	7.96	0.7
2017	1,622	3,647,521.52	416.38	60,121.75	7.52	0.7
2018	1,532	3,443,766.07	393.12	56,763.27	7.10	0.7
2019	1,447	3,252,233.91	371.26	53,606.26	6.70	0.6

Emissions reductions

Emissions reductions result mainly from methane destruction resulting from the capture and burning of landfill gas.

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 avoided from disposal of waste at a solid waste disposal site"*. Version 4 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". Version 1.1 of the Tool was used here.

<u>1) Methane emissions reductions from landfill gas capture</u>

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 avoided from disposal of 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 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 ($BECH_{4,SWDS,y}$) 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 (DOCj). The model calculates the methane generation based on the actual waste streams Wj,x disposed in each year x, starting with the first year after the start of the project activity until the 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 (BECH4,SWDS,y) is calculated as follows:

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

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 oxidized in the soil or other material covering the waste)
F = Fraction of methane in the SWDS gas (volume fraction) (0.5)
DOC_f = Fraction of degradable organic carbon (DOC) that can decompose
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. 11.

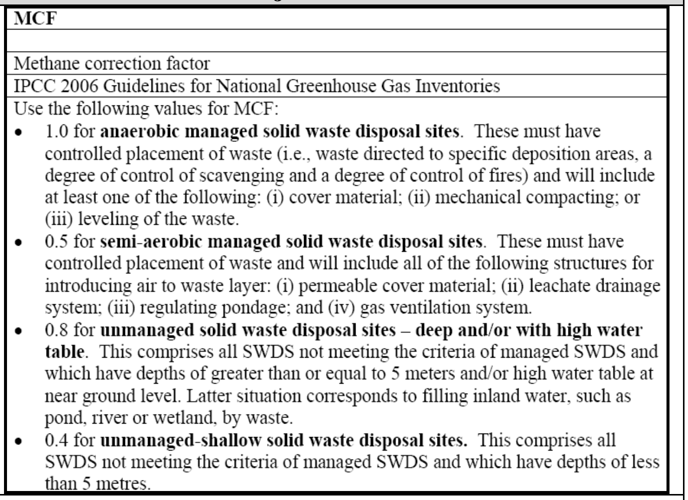
y Year for which methane emissions are calculated

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 to that year. Multi-year projections are developed by varying the projection year and re-applying the equations.

The values choices for the variables according to the tool recommendations are the following:

Table A3-1.- Tool values choices

Var.	Value	Justification
ϕ	0.9	Default value recommended in methodology
f	0	Value corresponding to the characteristics of Culiacan Northern Landfill. As documented, currently there isn't any capture, combustion or flaring of the LFG presented on the site.
GWP_{CH4}	21	Global Warming Potential (GWP) of methane, valid for the first commitment period of the Kyoto Protocol (up to 2012).
OX	0	Oxidation factor in a well managed landfill with a good cover is not considerable and can be estimated as zero.
F	0.5	Most waste in SWDS generates a gas with approximately 50 percent of CH4. Only material including substantial amounts of fat or oil can generate gas with substantially more than 50 percent of CH4. Taking into account the 2006 IPCC default value, SCS estimates future methane content in landfill gas to be 50 percent.
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. 2006 IPCC recommends that values should vary from 0.5 to 0.77. Default value recommended in methodology is used here.
MCF	1.0	The landfill is well managed, with daily cover with soil, leachate drainage system and waste thickness higher than 5 meters. The value is chosen according to 2006 IPCC table, cited in methodology:

<table>
<tr><th>Var.</th><th>Value</th><th>Justification</th></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>MCF</td></tr>
<tr><td></td></tr>
<tr><td>Methane correction factor</td></tr>
<tr><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories</td></tr>
<tr><td>Use the following values for MCF:
• 1.0 for anaerobic managed solid waste disposal sites. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste.
• 0.5 for semi-aerobic managed solid waste disposal sites. These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system.
• 0.8 for unmanaged solid waste disposal sites – deep and/or with high water table. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste.
• 0.4 for unmanaged-shallow solid waste disposal sites. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 metres.</td></tr>
</table></td></tr>
<tr><td><i>Wj,x</i></td><td>
<table>
<tr><th>Year</th><th>Tonnes / yr</th></tr>
<tr><td>1992</td><td>50,000</td></tr>
<tr><td>1993</td><td>55,000</td></tr>
<tr><td>1994</td><td>65,000</td></tr>
<tr><td>1995</td><td>75,000</td></tr>
<tr><td>1996</td><td>85,000</td></tr>
<tr><td>1997</td><td>106,000</td></tr>
<tr><td>1998</td><td>139,355</td></tr>
<tr><td>1999</td><td>172,154</td></tr>
<tr><td>2000</td><td>208,067</td></tr>
<tr><td>2001</td><td>213,915</td></tr>
<tr><td>2002</td><td>223,000</td></tr>
<tr><td>2003</td><td>243,351</td></tr>
<tr><td>2004</td><td>272,139</td></tr>
<tr><td>2005</td><td>273,304</td></tr>
<tr><td>2006</td><td>274,370</td></tr>
<tr><td>2007</td><td>235,662</td></tr>
<tr><td>2008</td><td>169,496</td></tr>
<tr><td>2009</td><td>0</td></tr>
</table></td><td>The historical filling rates were provided by landfill personnel and the total amount accumulated is around 2.86 million tonnes.</td></tr>
<tr><td><i>DOCj</i></td><td>
<table>
<tr><th>Waste type <i>j</i></th><th>DOCj</th></tr>
<tr><td>Wood and wood products</td><td>0.43</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>0.40</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>0.15</td></tr>
<tr><td>Textiles</td><td>0.24</td></tr>
<tr><td>Garden, yard and park waste</td><td>0.20</td></tr>
<tr><td>Glass, plastic, metal, other inert</td><td>0.00</td></tr>
</table></td><td>Waste composition in the Landfill</td></tr>
</table>

<table>
<tr><th>Var.</th><th>Value</th><th>Justification</th></tr>
<tr><td></td><td><table>
<tr><td>waste</td><td></td></tr>
<tr><td>Nappies</td><td>0.24</td></tr>
<tr><td>Rubber and Leather</td><td>0.39</td></tr>
</table></td><td></td></tr>
<tr><td>k_j</td><td><table>
<tr><th>Waste type <i>j</i></th><th>kj</th></tr>
<tr><td>Wood and wood products</td><td>0.025</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>0.045</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>0.085</td></tr>
<tr><td>Textiles</td><td>0.045</td></tr>
<tr><td>Garden, yard and park waste</td><td>0.065</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0.000</td></tr>
<tr><td>Nappies</td><td>0.045</td></tr>
<tr><td>Rubber and Leather</td><td>0.045</td></tr>
</table></td><td>Default values from the Tool (according to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3), taking into considerations the weather conditions of the region (MAT above 20°C and MAP less than 1).</td></tr>
<tr><td>j</td><td><u>Total Organic Waste Fraction: 73.9%</u><table>
<tr><th>Organic Waste type category <i>j</i></th><th>% Composition <i>∑pj,x / z)</i></th></tr>
<tr><td>Wood and wood products</td><td>1.83%</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>20.82%</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>20.14%</td></tr>
<tr><td>Textiles</td><td>1.82%</td></tr>
<tr><td>Garden, yard and park waste</td><td>26.38%</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>26.1%</td></tr>
<tr><td>Nappies</td><td>2.46%</td></tr>
<tr><td>Rubber and Leather</td><td>0.45%</td></tr>
<tr><td><i>TOTAL</i></td><td><i>73.90%</i></td></tr>
</table></td><td>Waste types and Organic Waste Fraction are contained in the study of waste[28] as well as indicated in the technical feasibility report.</td></tr>
<tr><td>x</td><td>1992</td><td>Start of landfill operations</td></tr>
<tr><td>y</td><td>2010-2019</td><td>Year for which methane emissions are calculated</td></tr>
</table>

LFG System Coverage or collection efficiency

The Landfill closed area is considered to be a well-managed landfill, the maximum gas collection efficiency is expected to be around 45%.

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[28] Municipal Solid Waste Characterization for the Northern Landfill Project, by Auditoria y Gestión Ambiental Company. May 2007

2) Emission Factor for Electricity Generation in the Mexican Grid (EFgrid)

Step 1.Identify the relevant electric power system.

The regions in the Mexican grid are interconnected; for this, the relevant electric power system is the entire Mexican grid (Source: SENER "Prospectiva Sector Eléctrico 2008-2017"), moreover the public information of the Mexican Energy Ministry "SENER" is for type of fuel for consumption and fuel share and technology for gross generation and power share, not for regions.

For determining the Operating Margin (OM) emission factor, it is necessary to determine the net electricity imports. There are no imports from other systems inside Mexico. The Mexican electricity imports and exports with other electric systems in other countries (imports from USA and exports to Belize) are:

	2004	**2005**	**2006**	**2007**	**% of total generation**
Imports (GWh)	47	87	523	277	0.119%
Exports (GWh)	1,006	1,291	1,299	1,451	0.624%
Net Exchange (GWh)	959	1,204	776	1,174	

Source: SENER. "Electricity Sector Outlook 2008-2017. Chart 22 p. 111"

Imports and exports of electricity are treated as defined in the methodology:
For imports from an on-line electricity system located in another country, the emission factor is 0 tCO_2/MWh in order to ensure a conservative approach. Electricity exports will not be subtracted from electricity generation data used for calculating the baseline emission factor.

Step 2. Select an operating margin (OM) method.

The Operating Margin refers to the actual energy generation mix installed in Mexico. The total fuel consumption for generation is divided into the different types of power plants, in order to determine the weighted average of the actual CO_2 emissions in Mexico.

For its calculations, the simple OM method has been selected from the four options proposed in the *"Tool to calculate the emission factor for an electricity system"*. Dispatch data analysis would be more accurate and therefore preferable, but this method cannot be applied for this project due to the lack of available published data. To be able to use the Dispatch data analysis method, the hourly generation-weighted average emissions per electricity unit (tCO_2/MWh) of a set of plants in the top 10% of the grid system dispatch order is needed. For confidentiality reasons, hourly-based dispatch order generation is not publicly available, so this method cannot be used for calculating the Operating Margin emission factor.

The reason for selecting the simple OM method over the other two methods (simple adjusted OM or Average OM) is that the low-cost/must-run resources in Mexico are well below 50% of total grid generation in both the average of the five most recent years and in the long-term normal for hydroelectricity production:

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**

	2000	2001	2002	2003	2004	2005	2006	2007
Hydro	17.16%	14.43%	12.37%	9.70%	12.02%	12.61%	13.46%	11.63
CC	9.21%	12.87%	22.26%	27.04%	34.64%	33.51%	40.46%	44.15%
Diesel	2.71%	2.77%	3.18%	3.41%	1.33%	0.62%	0.68%	1.15%
Internal	0.22%	0.24%	0.28%	0.37%	0.29%	0.36%	0.38%	0.49%
Wind	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.11%
Fuel-Oil	46.63%	45.86%	39.44%	36.23%	31.79%	29.72%	23.07%	21.28%
Geo	3.06%	2.82%	2.68%	3.09%	3.15%	3.33%	2.97%	3.18%
Coal	9.70%	9.42%	8.03%	8.19%	8.57%	8.39%	7.97%	7.78%
Dual	7.04%	7.16%	6.90%	6.81%	3.79%	6.52%	6.16%	5.75%
Nuclear	4.26%	4.43%	4.85%	5.16%	4.41%	4.93%	4.83%	4.48%
Low-cost/must run %	24.49%	21.68%	19.90%	17.95%	19.58%	20.88%	21.28%	19.40%

Source: SENER. “Electricity Sector Outlook 2008-2016. Chart 22. p. 111”

The average low-cost/must-run generation resource in the last five years is 19.40%, well below the 50% threshold defined by the baseline methodology.

In addition, data for calculating the emission factor using the simple OM method is very robust and reliable. In accordance with the approved methodology chosen, the simple OM method has been finally chosen to determine the relevant operating margin.

The Simple OM emission factor can be calculated using either of the two following data vintages for year (s):

- A 3-year average, based on the most recent statistics available at the time of PDD submission (*ex-ante*), or
- The year in which project generation occurs, if EF_{OM} is updated based on *ex-post* monitoring.

We have chosen the first option because the yearly statistics provided by SENER that are necessary to calculate the OM *ex-post* are published normally more than one year after the end of the reporting year, leading to large delays between emission reduction on one hand and monitoring, verification and issuance of CERs on the other. Another reason to choose this option is that *ex-ante* monitoring is simpler for the project development and also for the emission reduction verification.

Step 3: Calculate the operating margin emission factor according to the selected method.

For calculating the Simple OM, the generation-weights average emission per electricity unit (tCO_2/MWh) of all generating sources serving the system excluding the low-cost/must-run generation units is used. It may be calculated:

- Based on data on fuel consumption and net electricity generation of each power plant / unit (Option A), or
- Based on data on net electricity generation, the average efficiency of each power unit and the fuel type(s) used in each power unit (Option B), or
- Based on data on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system (option C).

Option C is used because total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system is available and is calculated as follows:

$$EF_{grid,OM,simple,y} = \frac{\sum_i FC_{i,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{EG_y} \tag{1}$$

Where:

$EF_{grid,OM,simple,y}$	Simple operating margin CO_2 emission factor in year *y* (tCO_2/MWh).
$FC_{i,y}$	Amount of fossil fuel type *i* consumed in the project electricity system in year *y* (mass or volume unit).
$NCV_{i,y}$	Net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/mass or volume unit).
$EF_{CO2,i,y}$	CO2 emission factor of fossil fuel type *i* in year *y* (tCO2/GJ).
EG_y	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year *y* (MWh).
i	All fossil fuel types combusted in power sources in the project electricity system in year *y*.
y	Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex-ante option).

This $EF_{CO2,i,y}$ (in tC/TJ) can be found in the Reviewed 2006 IPCC Guidelines for Greenhouse Gas Inventories: Workbook,. Data for $FC_{i,m,y}$ can be found in TJ/day in the three Prospective Reports (*Prospectivas)* so total annual consumption per fuel source can be calculated by multiplying by 365.

Step 4: Identify the cohort of power units to be included in the build margin (BM).

This sample for power plants can be chosen from the two options proposed under the methodology. We have chosen Option 1. Calculate the Build Margin emission factor $EF_{BM,y}$ ex-ante based on the most recent information available on plants already built for sample group *m* at the time of PDD submission. For this option, the sample has to be either:

- Option A: The five power plants that have been built most recently.
- Option B: Or the power plants capacity additions in the electricity system that comprises 20% of the system generation (in GWh) and that have been built most recently.

Option B has been selected to calculate the BM because generation of five power plants built most recently is lower than 20% of the system generation (in MWh).

Step 5: Calculate the build margin (BM) emissions factor.

The build margin emissions factor is the generation-weighted average emission factor (tCO2/MWh) of all power units m during the most recent year *y* for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad \textbf{(2)}$$

Where:

$EF_{grid,BM,y}$	Build margin CO2 emission factor in year y (tCO2/MWh).
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh).
$EF_{EL,m,y}$	CO2 emission factor of power unit m in year y (tCO2/MWh).
m	Power units included in the build margin.
y	Most recent historical year for which power generation data is available.

Step 6: Calculate the combined margin (CM) emissions factor.

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \qquad \textbf{(3)}$$

Where:

$EF_{grid,OM,y}$	Operating margin CO2 emission factor in year y (tCO2/MWh).
$EF_{grid,BM,y}$	Build margin CO2 emission factor in year y (tCO2/MWh).
w_{OM}	Weighting of operating margin emissions factor (%).
w_{BM}	Weighting of build margin emissions factor (%).

The default weights are as follows: $w_{OM} = 0.50$ and $w_{BM} = 0.50$

For the calculation of these two terms (BM and OM), the information used can be found in the "*Electricity Sector Outlook 2008-2017; 2007-2016; 2006-2015*", prepared by the SENER.
These documents can be accessed at <http://www.sener.gob.mx/webSener/portal/ index.jsp?id=48>

Total Fuel consumption:

2005: 1,597,605 TJ
2006: 1,608,555 TJ
2007: 1,652,355 TJ

	2005			
	Fuel share	Fuel consumption	Carbon content	Emission CO_2 (tCO_2)

		(TJ)	(tC/TJ)	
Fuel Oil	39.10%	624,664	21.1	48,328,137
Natural Gas	39.50%	631,054	15.3	35,402,128
Diesel	0.90%	14,378	20.2	1,064,963
Coal	20.50%	327,509	25.8	30,982,354
Total	100%	1,597,605		115,777,582

Fuel consumption per fuel type. Source: *Electricity Sector Outlook 2006-2015 Figure 31 p.90.*

	2006			
	Fuel share	Fuel consumption (TJ)	Carbon content (tC/TJ)	Emission CO_2 (tCO_2)
Fuel Oil	32.00%	514,738	21.1	39,823,532
Natural Gas	47.00%	756,021	15.3	42,412,770
Diesel	1.00%	16,086	20.2	1,191,403
Coal	20.00%	321,711	25.8	30,433,861
Total	100%	1,608,555		113,861,566

Fuel consumption per fuel type. Source: *Electricity Sector Outlook 2007-2016 Figure 40 p.116.*

	2007			
	Fuel share	Fuel consumption (TJ)	Carbon content (tC/TJ)	Emission CO_2 (tCO_2)
Fuel Oil	28.90%	477,531	21.1	36,944,950
Natural Gas	52.00%	859,225	15.3	48,202,500
Diesel	0.50%	8,262	20.2	611,922
Coal	18.50%	305,686	25.8	28,917,865
Total	100%	1,652,355		

Fuel consumption per fuel type. Source: *Electricity Sector Outlook 2008-2017 Figure 39 p.148.*

Generation by sources:

	2005		2006		2007	
	Power share	Annual Generation (MWh)	Power share	Annual Generation (MWh)	Power share	Annual Generation (MWh)
Dual	6.50%	12,945,855	0.00%	0	5.75%	12,161,569
Combined cycle	33.50%	66,720,945	40.50%	83,380,590	44.15%	93,359,025
Gas turbine	0.60%	1,195,002	0.70%	1,441,146	1.15%	2,424,130
Coal	8.40%	16,730,028	14.10%	29,028,798	7.78%	16,458,809
Internal	0.40%	796,668	0.40%	823,512	0.49%	1,035,666
Nuclear	4.90%	9,759,183	4.80%	9,882,144	4.48%	9,475,567
Standard Thermoelectric	29.70%	59,152,599	23.10%	47,557,818	21.28%	44,992,805
Renewables (Hydro, Geo, Wind …)	15.90%	31,667,553	16.50%	33,969,870	14.92%	31,546,429

Total Generation	-	218,971,000	-	225,079,000		232,552,000
Self-consumption	-	19,804,000	-	19,201,000		21,098,000
Total	100%	199,167,000	100%	205,878,000	211,454,000	

Generation by sources. Source: SENER. "*Electricity Sector Outlook 2008-2017 Figure 39 p.148*" ; "*Electricity Sector Outlook 2007-2016 Figure 39 p.116*"; "*Electricity Sector Outlook 2006-2015 Figure 30 p.89*". *Self-consumption data* obtained from: SENER. "*Electricity Sector Outlook 2008-2017* Chart 22. p. 111".

Total % under methodology				
2003	2004	2005	2006	2007
17.95%	19.50%	20.80%	21.30%	19.40%

Total generation in baseline (MWh)		
2005	2006	2007
157,541,097	162,231,864	170,432,004

Imports (MWh)		
2005	2006	2007
87,000	523,000	277,000

- **Operating Margin:**

Operating Margin = total CO_2 emission / (total generation under baseline + imports)

Operating Margin 2005 = 115,777,582 / (157,541,097 + 87,000) = 0.734 tCO_2/MWh
Operating Margin 2006 = 113,861,566/ (162,231,864 + 523,000) = 0.700 tCO_2/MWh
Operating Margin 2007 = 114,677,237 / (170,432,004 + 277,000) = 0.672 tCO_2/MWh

OM = 0.734* (157,541,097 + 87,000) + 0.700* (162,231,864+523,000))+ 0.672*(170,432,004 + 277,000) / ((157,541,097 + 87,000) + (162,231,864 + 523,000)+(170,432,004 + 277,000)) = **0.701 tCO_2/MWh**

- **Build Margin:**

Calculation of Build Margin:

Build Margin = (Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh) * CO2 emission factor of power unit *m* in year *y* (tCO2/MWh)) / Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)

CO2 emission factor of power unit = 3.6 * Average CO2 emission factor of fuel type *i* used in power unit *m* in year *y* (tCO2/GJ) / Average net energy conversion efficiency of power unit *m* in year *y* (%)

Plant Name	Technology	Capacity (MW)	Net Electricity Generation (MWh)	Efficiency (%)	Fuel Type	Cumulative percentage (%)	Fuel Consumption (TJ)

Plant Name	Technology	Capacity (MW)	Net Electricity Generation (MWh)	Efficiency (%)	Fuel Type	Cumulative percentage (%)	Fuel Consumption (TJ)
Additions 2007							
La Venta II	Wind	0	0	100.00%	N.A	0.00%	0
El Cajón (Leonardo Rodríguez Alcaine)	Hydro	750	989000	53.11%	N.A	0.47%	27153
El Cajón (Leonardo Rodríguez Alcaine)	Hydro	0	0	53.11%	N.A	0.47%	0
Tamazunchale (PIE)	CC	1135	4005841	53.11%	GAS	2.36%	0
Río Bravo (Emilio Portes Gil)	CC	0	0	53.11%	GAS	2.36%	2823
Río Bravo (Emilio Portes Gil)	CC	0	0	39.42%	GAS	2.36%	0
Río Bravo (Emilio Portes Gil)	CC	511	416444	39.42%	COM Y GAS	2.56%	0
Ecatepec (LFC)	GT	0	0	39.42%	GAS	2.56%	0
Remedios (LFC)	GT	0	0	39.42%	GAS	2.56%	0
Victoria (LFC)	GT	0	0	39.42%	GAS	2.56%	0
Villa de Flores (LFC)	GT	0	0	39.42%	GAS	2.56%	0
Cuautitlán (LFC)	GT	0	0	39.42%	GAS	2.56%	0
Coyotepec (LFC)	GT	0	0	39.42%	GAS	2.56%	0
Coyotepec (LFC)	GT	0	0	45.07%	GAS	2.56%	0
Vallejo (LFC)	GT	0	0	45.07%	GAS	2.56%	0
Santa Rosalía	IC	0	0	45.07%	DI	2.56%	0
Santa Rosalía	IC	0	0	45.07%	DI	2.56%	0
Santa Rosalía	IC	0	0	45.07%	DI	2.56%	0
Holbox	IC	0	0	45.07%	DI	2.56%	3301
Holbox	IC	0	0	100.00%	DI	2.56%	0
Baja California Sur I	IC	79	413230	53.11%	COM Y DI	2.75%	27153
Additions 2006							
Tuxpan V (PIE)	CC	495	3815133	53.11%	GAS	4.56%	25860
Valladolid III (PIE)	CC	525	3476529	53.11%	GAS	1.64%	23565
Altamira V (PIE)	CC	1121	8164443	53.11%	GAS	8.42%	55342
Chihuahua II (El Encino)	CC	65.3	4184873	53.11%	GAS	3.62%	28367
Los Cabos	GT	27.2	0	39.42%	GAS	8.42%	0
Atenco	GT	32	0	39.42%	GAS	3.62%	0
Additions 2005							
Ixtaczoquitlán	Hydro	1.6	0.000	100.00%	n.a.	12.04%	0
Botello	Hydro	9	0.000	100.00%	n.a.	12.04%	0
Hermosillo	CC	93.3	1329118	53.11%	GAS	12.67%	9009
Rio Bravo IV	CC	500	2506448	53.11%	GAS	13.86%	16990

Plant Name	Technology	Capacity (MW)	Net Electricity Generation (MWh)	Efficiency (%)	Fuel Type	Cumulative percentage (%)	Fuel Consumption (TJ)
La Laguna II	CC	498	3425933	53.11%	GAS	15.48%	23222
Yécora	IC	0.7	0.000	45.07%	DI	15.48%	0
Hol Box	IC	0.8	0.000	45.07%	DI	15.48%	0
Baja California Sur I	IC	43			COM y DI		
Additions 2004							
Chicoasén (Manuel Moreno Torres)	Hydro	900	3378000	100.00%	na	17.07%	12161
El Sauz	CC	128		53.11%	NG	18.13%	15130
Rio Bravo III	CC	495	2007299	53.11%	NG	19.08%	13606
Tuxpan (Pdte. Adolfo López Mateos)	GT	163	10036165	39.42%	NG	23.83%	91654
San Lorenzo Potencia	GT	266	0	39.42%	NG	23.83%	0
Guerrero Negro II	IC	10.8	0	45.07%	DI	23.83%	0
Additions 2003							
Los Azufres	GEO	106.6	1494000	100.00%	na	24.53%	5378
Transalta Chihuahua III	CC	259	1389444	53.11%	NG	25.19%	9418
Transalta Campeche	CC	252.4	1666749	53.11%	NG	25.98%	11298
Naco Nogales	CC	258	1942108	53.11%	NG	26.90%	13164
Mexicali	CC	489	2362444	53.11%	NG	28.01%	16014
Tuxpan III y IV	CC	983	6689375	53.11%	NG	31.18%	45343
Altamira III y IV	CC	1036	5888596	53.11%	NG	33.96%	39915
El Verde	GT	0	0.000	39.42%	NG	33.96%	0
Las Cruces	GT	0	0.000	39.42%	NG	33.96%	0
Dos Bocas	GT	0	2717615	39.42%	NG	35.25%	24818
Calera	IC	0	0.000	45.07%	DI	35.25%	0

New power plants installed. Source: SENER. "*Electricity Sector Outlook 2008-2017 Chart 19 p 101*; "*Electricity Sector Outlook 2007-2016 Cuadro 19 p.77; Electricity Sector Outlook 2006-2015 Cuadro 13 p.57; Electricity Sector Outlook 2005-2014 Cuadro 14 p.51; Electricity Sector Outlook 2004-2013 Cuadro 9 p.44* and *Electricity Sector Outlook 2003-2012 Cuadro 8 p.39"*. Abbreviations: Hydro: hydropower plant; Geo: geothermal plant, CC: combined cycle plant, fuelled with natural gas, GT/GAS: Gas turbine, fuelled with natural gas. IC: Internal combustion. Generation by power plant for 2007. Source: SENER. "Electricity Sector Outlook 2008-2017 Table 5 p.205"

BM factor: **0.375** tCO2/MWh

Emission factor ex-ante = 0.50*OM+ 0.50*BM = **0.538** tCO_2/MWh

Annex 4

MONITORING INFORMATION

Item	Variable	Unit	Measured (m) Calculated(c) Estimated (e)	Frequency of registration	Responsible	Form of registration (electronic / paper)	Internal Quality Control procedures	Comments
1	Total landfill gas captured ($LFG_{total,y}$)	m^3	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	Measured by a flow meter. Data to be aggregated in a monthly/yearly basis.
2	Total landfill gas flared ($LFG_{flare,y}$)	m^3	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	Measured by a flow meter. Data to be aggregated in a monthly/yearly basis.
3	Total landfill gas used for electricity generation ($LFG_{electricity,y}$)	m^3	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	Measured by a flow meter. Data to be aggregated in a monthly/yearly basis.
4	Methane fraction contained in the landfill gas ($w_{CH4,y}$)	m^3 CH_4 / m^3 biogas	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	It will be used a continuous analyzer. It will be subject to a strict program of maintenance and calibration.
5	Landfill gas temperature (T)	°C	m	Continuously (at least each hour)	Project Developer	Both	Yes	Measured to determine density of methane. It could be admitted from flow meters that report this parameter too.
6	Landfill gas pressure (P)	Pascals (Pa)	m	Continuously (at least each hour)	Project Developer	Both	Yes	Measured to determine density of methane. It could be admitted from flow meters that report this parameter too.

Item	Variable	Unit	Measured (m) Calculated(c) Estimated (e)	Frequency of registration	Responsible	Form of registration (electronic / paper)	Internal Quality Control procedures	Comments
7	Net electricity generation (EL_{LFG})	MWh	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	For each electricity engine generator, the instrument will be subject to maintenance programs and test applications to accurate its exactitude.
8	Hours of operation of the electrical plant	Hours	m	Daily	Project Developer	Both	No	The real hours of operation of the electrical engine generators will be registered.
9	Hours of operation of the en flare station	Hours	m	Daily	Project Developer	Both	No	The real hours of operation of the electrical engine generators will be registered.
The following variables corresponds for the Project Emissions from flaring gases containing methane (**$PE_{flare,y}$**) in the enclosed flare.								
10	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h. ($FV_{RG,h}$)	m^3/h	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	Measured by a flow meter. Data to be aggregated in a monthly/yearly basis. Note this parameter would measure the same flow as it does the parameter LFGflare,y ; except this is required in a dry basis. Therefore it would be expected the same instrument for this purpose, if possible.
11	Volumetric fraction of component i in the gas in hour h where i = CH4, CO, CO2, O2, H2, N2	(fraction)	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	As a simplified approach, only methane content of the residual gas will be measured and the remaining part will be considered as N2

Item	Variable	Unit	Measured (m) Calculated(c) Estimated (e)	Frequency of registration	Responsible	Form of registration (electronic / paper)	Internal Quality Control procedures	Comments
12	Volumetric fraction of oxygen in the exhaust gas ($t_{O2,h}$)	(fraction)	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	The sample should be made it at the 80% of the height of the flare. A temperature above 700°C in the sample point could indicate that the equipment is not correctly operated or that its capacity or is not the most adequate for the actual flow. It should have a maintenance program of calibration.
13	Methane concentration in the exhaust gas (on the exit of the enclosed flare) ($fv_{CH4,FG,h}$)	mg / m^3 (Could be in ppmv or %)[29]	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	The simple should be made it at the 80% of the height of the flare. A temperature above 700°C in the sample point could indicate that the equipment is not correctly operated or that its capacity or is not the most adequate for the actual flow. It should have a maintenance program of calibration.
14	Temperature in the exhaust gas of the flare (T_{flare})	°C	m	Continuously (values to be averaged hourly or at a shorter time interval)	Project Developer	Both	Yes	It should be employed a thermocouple, N type. A temperature above 500°C in the sample point could indicate that considerable quantities of gases are still being flared. The thermocouples will be replaced and/or calibrated each year.

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[29] 1ppmv equals 0.716 mg/m^3. 1% equals 10 000 ppmv.

Item	**Variable**	**Unit**	**Measured (m) Calculated(c) Estimated (e)**	**Frequency of registration**	**Responsible**	**Form of registration (electronic / paper)**	**Internal Quality Control procedures**	**Comments**
The following variables corresponds for the Project Emissions for electrical consumption (**$PE_{EC,y}$**), such as blowers, use of the electrical grid, etc.								
15	Average technical transmission and distribution losses in the grid for the voltage level at which electricity is obtained from the grid at the project site (TDL_y)	%	e	Annual check	Project Developer	paper	No	Within the same type of voltage, it should be estimated for the electrical losses in the transmission and distribution of electricity in the grid. If there is no data during the year, it could be used any data that could be available in the previous 5 years. This data is intended to be updated if proper information is available, if not, it will be used the default data suggested by the "Tool to determine the project emissions from flaring gases containing methane", which is 20%.
16	Quantity of fossil fuels used in the captive power plant ($FC_{k,i,y}$)	m^3, tons or liters[30]	m	Each hour	Project Developer	Both	Yes	If it is used a captive power plant, it should be used weight or volume meters. The consistency of metered fuel consumption quantities should be cross-checked with an annual energy balance that is based on purchased quantities and stock changes. This applies for captive power plants.[31]

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[30] According to the type of fossil fuel employed.

[31] Applies only for cases B2 and C1 of the tool.

Item	Variable	Unit	Measured (m) Calculated(c) Estimated (e)	Frequency of registration	Responsible	Form of registration (electronic / paper)	Internal Quality Control procedures	Comments
17	Total net amount of electricity produced by captive power plant *k*. ($EC_{PJ,y}$)	MWh	m	Each hour	Project Developer	Both	Yes	If applies, it is the electricity produced by the captive power plant. It will be cross checked with records of sold electricity where relevant.[32] It will be used the invoices from CFE for sold electricity and the records of the electricity meters.
The following variables are relevant to determinate the project emissions coming from fossil fuel consumption using the Tool ($\mathbf{PE_{FC,j,,y}}$), if applicable								
18	Quantity of fuel type i combusted in process j ($FC_{i,i,y}$)	Mass or volume unit per year (e.g. ton/yr or m^3/yr)	m	It will depend according to the type of fuel used.	Project Developer	Both	Yes	Any eventual fossil fuel consumption will be accounted.
19	Weighted average net calorific value of fuel type i ($NCV_{i,y}$)	GJ per mass or volume unit (e.g. GJ/m³, GJ/ton)	c	Annually	Project Developer	Both	No	Any eventual fossil fuel consumption will be accounted.

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[32] Applies only for cases B2 and C1 of the tool.

Item	Variable	Unit	Measured (m) Calculated(c) Estimated (e)	Frequency of registration	Responsible	Form of registration (electronic / paper)	Internal Quality Control procedures	Comments
20	CO2 emission factor of fossil fuel ($EF_{CO2,i,y}$)	tCO2e/TJ	c	Monthly, or annually[33]	Project Developer	Both	No	Further considerations will be made according to the type of information available from the supplier of the fuel(s), if implemented. If data is not available, the value will be taken from credible sources such as from IPCC recommended values.

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[33] Considering the type of information available.