PROJECT DESIGN DOCUMENT FORM
FOR CDM PROJECT ACTIVITIES (F-CDM-PDD)
Version 04.1

PROJECT DESIGN DOCUMENT (PDD)

Title of the project activity	Landfill Gas Recovery and Flaring Project in the El Verde Landfill, León.
Version number of the PDD	Version 13
Completion date of the PDD	01/07/2013
Project participant(s)	Promotora Ambiental S.A.B. de C.V Gazprom Marketing & Trading Limited
Host Party(ies)	Mexico (Host)
Sectoral scope and selected methodology(ies)	Sectoral scopes: • Sectoral scope 1 : Energy industries (renewable - / non-renewable sources) • Sectoral scope 13 : Waste handling and disposal Methodologies applied to the project activity: • ACM0001 ver. 10 - Consolidated baseline and monitoring methodology for landfill gas project activities
Estimated amount of annual average GHG emission reductions	177,537

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The El Verde landfill is located in the Municipality of León de los Adamas (also called León), about 15 kilometres northwest of the centre of the city. The address is Carretera León, Lagos de Morenos km 18.5, León City, Guanajuato State.

El Verde landfill is owned by Promotora Ambiental S.A.B. de C.V (hereinafter called PASA). PASA is a private waste collection and disposal firm that offers integral solutions in the management of industrial and municipal solid wastes. PASA has more than 15 years of experience and, currently, has activities in 23 landfills in Mexico.

The El Verde landfill was designed for municipal waste treatment with a total area of 60 ha. The landill is divided in two macro cells, with a total area of approximatly 51 ha planned for waste disposal. The remaining 9 ha include roads, buffer zone, and the administrative area. The proposed project activity covers the entire 60 ha, i.e. including future expansion as more waste is received. The area around the landfill has an average annual precipitation of 697 mm and an annual average temperature of 19.2°C. The climate is classified as Mexican high altitude (in Spanish, “Mexicano de altura”).

The landfill began accepting waste in June 2001. By the end of September 2007, more than 2.9 million of tonnes of waste have been filled. Upon completion, maximum waste thickness is expected to be about 34 meters; current maximum landfill height is about 28 meters. Recently (Jan. to March 2009), the landfill was filling at an average rate of about 1,211 tonnes per day or greater than 442,000 tonnes per year. In the coming years, projecting the population increase rate, we expect the disposal rate to increase by 2.7% per year from 2009 to 2017. The landfill is expected to close at the end of 2017. Please note that operational lifetime of the project may be extended beyond 2017 in case there is still space available for waste disposal. In such case, PASA would require additional permits, and any disposing activity would not be undertaken until such appropriate authorizations are available.

Currently, waste is disposed at one macro cell, covering a 30 ha area, of which 25 hectares are for waste disposal and 5 hectares comprise a buffer zone. The macro cell 1 is subdivided into 5 cells, with a total of 48 landfill gas vents (or passive gas wells), i.e. a well density of 1.6 wells per hectare. In the baseline scenario (future scenario), macro cell 2, with an approximately area of 26 hs, is assumed to be divided in 16 cells, with 5 landfill gas vents in each cell. The wells in macro cell 1 are venting the gas from inside the waste mass to the top of each vent. Current practice in the country is the uncontrolled release of landfill gas. This is also the case for El Verde landfill, with no presence of flames at any of the vents.

The initial project activity would consist of landfill gas capture and use of LFG for energy, with excess LFG flared. The LFG extraction system would consist of a series of vertical extraction wells interconnected by header piping. The LFG would be extracted from the landfill by a blower and conducted to a single point. Recovered LFG would firstly be flared and once the project has achieved the required LFG, project proponent proposes to install electricity generation equipment sized to the amount of LFG actually captured.. Any LFG remaining after electricity generator needs would be flared. Electricity generated would meet landfill needs and excess electricity would be sold to other users.

Baseline scenario

The baseline scenario is arrived at after considering:

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

Current situation before the project implementation is the atmospheric release of landfill gas generated at the landfill site. The situation before project implementation coincides with the baseline scenario, with no landfill gas capture and destruction.

How proposed activity reduces greenhouse gas emissions

The principal components of landfill gas are methane (CH_4) and carbon dioxide (CO2), both of which are greenhouse gases (GHG) listed as such in the Kyoto Protocol. This carbon dioxide is of biogenic origin and therefore does not contribute to net GHG emissions. However, the landfill gas is a combustible gas, and when used as a fuel—used as heat or to generate electricity—can offset CO2 emissions that would be generated if fossil fuel were used to produce heat or generate electricity. The project developer anticipates reducing greenhouse gas emission in two different ways. Firstly, by destroying methane contained in the landfill gas, either through its use as a fuel, and also from flaring any LFG that is not used as fuel. Secondly, by producing electricity from landfill gas, the project will lead to CO2 emission reductions attributable to the displacement of electricity, the emissions reductions being determined by the emissions factor of the interconnected power grid where the landfill is located (EF_{grid}).

Thus in the baseline scenario, all the methane generated at the landfill is released into the atmosphere. In the project scenario most of the LFG released is captured and burnt, thus considerably reducing methane emissions. Moreover, in the baseline scenario, since LFG is not used to generate electricity, an equivalent amount of electricity must be generated at power plants that are in the grid to which the LFG power plant would be connected in the project scenario. Hence LFG used for electricity generation reduces CO2 emissions that would have occurred in the baseline scenario.

Contribution of the project activity to sustainable development

Besides climate change mitigation, the project would have important local environmental benefits. All the landfill gas is currently released to the atmosphere without any treatment. This implies a potential fire and explosion risk as well as bad odours. Moreover, landfill gas (LFG) contains trace amounts of volatile organic compounds, which are air pollutants. The capture and combustion of the LFG in the electricity generator and flare would greatly reduce all these risks and thereby contribute to sustainable development.

The project would have important local environmental benefits as listed below:

- Destruction of air pollutants, such as hydrogen sulphide, that is present in trace quantities in LFG.
- Reduced fire and explosion risk through improved management of landfill gas.
- Reduced odour as landfill gas is captured and burnt for energy or flared.

A.2. Location of project activity

A.2.1. Host Party(ies)

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Mexico.

A.2.2. Region/State/Province etc.

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State of Guanajuato.

A.2.3. City/Town/Community etc.

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León de los Adamas City.

A.2.4. Physical/Geographical location

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The El Verde landfill is located in the Municipality of León de los Adamas (also called León), about 15 kilometres northwest of the centre of the city. The address is Carretera León, Lagos de Morenos km 18.5, León City, Guanajuato State.

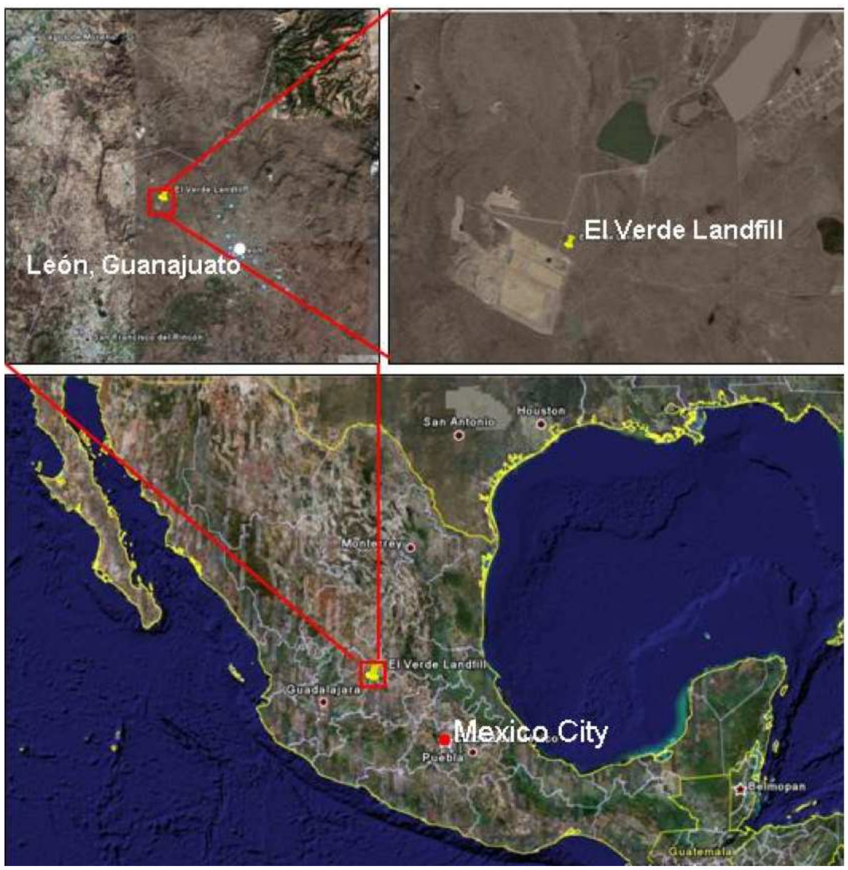

Figure 1. Location of El Verde landfill

Guanajuato State is located in Central Mexico, about 350 kilometres northwest of Mexico City. León is located 45 kilometres northwest of the Del Bajío International Airport. León city has a population of about 1,020,000 habitants. Geographic Coordinates: N 21°10'14"; W 101°46'30".

A.3. Technologies and/or measures

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Purpose of project activity

The objective of El Verde Landfill Gas Project is to capture landfill gas (LFG) and initially flare it to destroy the methane contained in the LFG. Once LFG capture has been established, and the volume of LFG captured is known, project proponent would install LFG-fired power generation equipment. From then on, LFG would be used to generate electricity, and only send the excess LFG to the flare. Thus all LFG will be combusted in one of these two ways, and methane contained in LFG would be destroyed.

The principal components of landfill gas are methane (CH4) and carbon dioxide (CO2), both of which are greenhouse gases (GHG) listed as such in the Kyoto Protocol. Flaring involves methane destruction leading to GHG emissions reductions.

Scenario existing prior to the start of the implementation of the project activity

Current practice in the country is the uncontrolled release of landfill gas. At the El Verde landfill project, currently there are 48 landfill gas vents (or passive gas wells) distributed in the 5 cells, in macro cell 1. Such wells are venting the gas from inside the waste mass to the top of each vent, with no presence of flames.

The overall LFG generation rate will continue to increase until the landfill closes, after which the rate will decrease as the organic fraction is degraded.

Activities/measures implemented within project activity

In order to maximize LFG recovery rates, and thus GHG emission reductions, an active LFG collection system will need to be installed. The system will consist of a series of vertical extraction wells interconnected by header piping. The LFG will be extracted from the landfill by a blower and will initially be flared. Once LFG gas recovery is operational, project proponent would install LFG-fired power generation equipment. Subsequently, LFG would be used for power generation, with any excess LFG flared. Electricity generated would be used to meet requirements at the landfill, with excess generation sold to local municipalities.

The essential characteristics of the LFG collection and flaring system, and possible power generation system are listed below:

- Construction of deep and shallow vertical wells in intermediate or closed areas, trying not to interfere with landfill operation. Depending on future development plans, some horizontal wells might be installed, to capture the gas in areas that continue to be filled;

- Installation of a piping network to include connection to extraction wells, serving the blower/flare station with a specific diameter piping, suitable for the anticipated flow rates. In general, connection should be made to those extraction wells that have been constructed to final or intermediate grade, and to which the piping connection will have a minimal impact on current filling operations. Installation of a leachate pumping system (if needed); Installation of a condensate management system. The LFG collection piping will be designed to include selfdraining condensate traps and condensate manholes with pumps where necessary;

- Installation of the blower and flaring station;

- Confirm the reliability of electrical service to the blower and flaring station, if necessary, installing backup power capacity (e.g. diesel generator);

- Installation of a LFG-fuelled power generator is being considered. It is recognized that power generation would require additional permits, and any power generation activity would not be undertaken until such appropriate authorizations are available. Technology choice for power generation would involve engine/generator equipment specifically designed for use with landfill gas, sourced from reliable manufacturers. According to an SCS Engineers study[1], 2.4 MW LFG power generators would be purchased in order to start operations in January 2012[2]. They assume 3 Caterpillar generators model CAT3516s each of capacity 0.8 MW. Further 0.8 MW units would be added as LFG is available and at the end of operational lifetime of the generators previously installed. Electricity generated by these power plants would offset emissions at power plants elsewhere in the grid.

- Operation and maintenance cost for power generation equipment is assumed to be USD 33.78/MWh. This is based on the SCS Engineers study cited above.

- The individual landfill gas vacuum blower for the flare and electricity generation, when operating together, will balance the gas flows proportionately, following initial tuning operations.. Technical details would be provided once electricity generation option has been assessed and approved by the project participant.

Baseline scenario

The baseline scenario is characterised by:

- LFG2. Atmospheric release of the landfill gas; and
- P6. Power plants connected to the grid.

The terminology LFG2 and P6 is explained in Section B.4 and B.5, where the baseline scenario is described in detail.

Methane destruction in baseline scenario

In the current situation, prior to project implementation, there is no combustion of LFG, either for energy use or in a flare, and therefore no methane destruction.

Main sources of greenhouse gases

The main GHG emissions source in the baseline is methane, from the decay of organic matter present in the waste, and these emissions will be reduced by the project activity. Project implementation will require some electricity consumption for operating the active landfill extraction system, pumps, etc. Thus the project will produce CO2 emissions at the fossil-fired power plants supplying the landfill.

Transfer of environmentally safe and sound technology, and know-how to the Host Party

[1] See file "SCS PASA Cost Estimate report 29feb08.pdf".
[2] The date of January 2012 is an estimation made for the purpose of conducting the Investment Analysis contained in this CDM-PDD. The date is an indication only as the best estimate at the time of validation and the PP reserves the right to postpose such date in accordance with technical, economic and political considerations.

Until recently, there were no projects to capture and flare (or otherwise use) landfill gas in Mexico, with the exception of one project supported by the Global Environment Facility. In recent years, several other projects in Mexico have been presented for implementation under the CDM. Some of the key equipment: enclosed flare, blowers, LFG treatment, flow measurement devices, gas analysers, etc. will be provided by specialty manufacturers from Annex 1 countries. The project would provide a significant opportunity for technology transfer, with design, equipment and installations complying with international standards with regard to quality, reliability, operational safety and environmental aspects.

A.4. Parties and project participants

Party involved (host) indicates a host Party	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Mexico (host)	Promotora Ambiental S.A.B. de C.V Public entity. Project Sponsor	No

A.5. Public funding of project activity

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The project sponsors will not receive any international public funding whatsoever for the development of this project.

SECTION B. Application of selected approved baseline and monitoring methodology

B.1. Reference of methodology

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The baseline and monitoring methodology to be applied for the proposed project activity is the approved consolidated baseline methodology ACM0001, version 10: ***"Consolidated baseline and monitoring methodology for landfill gas project activities"***[3]**.**

Also, in order to determine emissions associated with electricity consumption in the baseline and project scenarios, we use the ***"Tool to calculate baseline, project and/or leakage emissions from electricity consumption"***[4], recommended by the Executive Board 39th Meeting Report, Annex 7. This is Version 1 of the Tool.

In case the project proponent chooses to generate electricity, and obtain the necessary permissions, the generated electricity would offset emissions at power plants elsewhere in the interconnected power grid. These emissions reductions are determined using the "***Tool to calculate the emission factor for an electricity system***"[5], version 1.1 of the Tool.

We also use the ***"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion"***[6] version 2. This tool is used in case any fossil fuels are used on site, e.g. as a start-up fuel for the flare or for on-site power generation when electricity is not available from the power grid.

[3] http://cdm.unfccc.int/filestorage/C/D/M/CDMWF_AM_966E1RSS33CHOSKBU3DTFBP8SZ8EEQ/EB45_repan09_ACM0001_ver10.pdf?t=Sk18bW9vdmo4fDDKIgUA8BGTbJAtgNd_C5gU

[4] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf

[5] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v1.1.pdf

[6] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf

For additionality assessement, we used the ***"Tool for the demonstration and assessment of additionality***"[7], version 5.2.

In order to determine the flare efficiency and/or to monitor the flare exhaust gases, we applied the "***Tool to determine project emissions from flaring gases containing methane***"[8] recommended by the CDM Executive Board 28th Meeting Report, Annex 13. It is implicitly version 1 of the Tool.

In order to estimate the potential LFG recovery rate for the landfill, we used the "***Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site***"[9], version 4.

B.2. Applicability of methodology

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The methodology chosen is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:

a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy);
c) The captured gas is used to supply consumers through natural gas distribution network. If emissions reductions are claimed for displacing natural gas, project activities may use approved methodologies AM0053, but no emission reductions are claimed for displacing or avoiding energy from other sources.

The proposed project activity corresponds to alternatives a) and b). The collected landfill gas will be flared initially. Later, after the project secures permits to generate electricity, surplus gas will be used to generate electricity, and any remaining gas would be flared.

B.3. Project boundary

According to ACM0001 methodology, the project boundary is the site of the project activity where the gas will be captured and destroyed/used. The project boundary should encompass the physical, geographical site of the renewable generation source.

ACM0001 version 10 states: "I*f the electricity for project activity is sourced from grid or electricity generated by the LFG captured would have been generated by power generation sources connected to the grid, the project boundary shall include all the power generation sources connected to the grid to which the project activity is connected*."

The initial project activity would comprise landfill gas (LFG) capture and the installation of a flare to destroy the methane. Once the project is operational, project proponent may decide to generate electricity using LFG, subject to additional authorizations. In all cases, the project boundary includes the landfill site as well as the interconnected power grid. If no power is generated on site in the project scenario, any power consumed on site supplied by the grid causes emissions at power plants elsewhere. If project proponents decide to generate electricity, then electricity generated by this power plant would offset emissions at power plants elsewhere in the grid.

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

[7] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-01-v5.2.pdf
[8] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v1.pdf
[9] http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v4.pdf

Source		GHGs	Included?	Justification/Explanation
Baseline scenario	Emissions from decomposition of waste at the landfill site (Passive LFG venting and no flaring)	CO_2	No	CO2 emissions from decomposition of organic waste are not accounted.
		CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N2O emissions are very small compared to CH4 emissions from landfills. Exclusion of this gas is conservative.
	Emissions from electricity consumption	CO_2	Yes	Electricity generated from the grid
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project scenario	On-site fossil fuel consumption due to the project activity other than for electricity generation	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.
	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.

For the determination of baseline emissions of the possible electricity generation component of the project, the project boundary will account for the CO2 emissions from electricity generation in fossil fuel power stations operating in the grid system, which will be displaced by electricity generated in the project activity. For the electricity generation component, according to the methodological "**tool to calculate the emission factor for an electricity system** version 1.1,"*a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity"*.

Version 7 of "Guidelines for Completing the Project Design Document (CDM-PDD) and the Proposed New Baseline and Monitoring Methodologies (CDM-NM)" (EB41, An 12): states:
"In addition to the table, present a flow diagram of the project boundary, physically delineating the project activity, based on the descriptions provided in section "A.4.3. Technology to be employed by the project activity". Include in the flow diagram all the equipments, systems and flows of mass and energy described in that section. Particularly, represent in the diagram the emissions sources and gases included in the project boundary and the monitoring variables."

The flow diagram is shown in the following page.

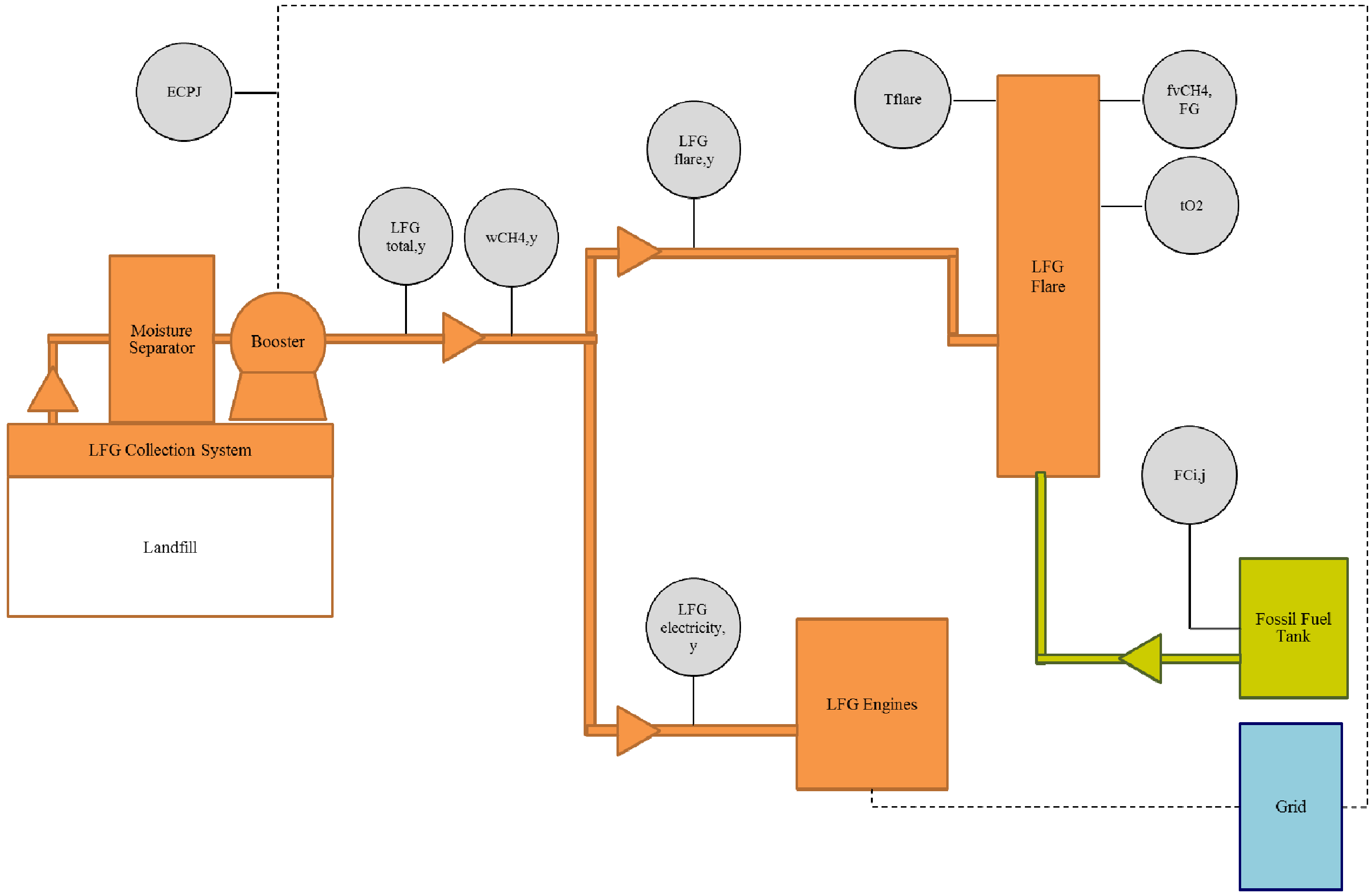

Figure 2. Project boundary flow diagram: The project boundary comprises the landfill site and all power plants in the interconnected power grid. The key monitoring variables are indicated in the figure. See Section B.7.1 for definitions of monitoring variables.

B.4. Establishment and description of baseline scenario
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ACM0001, version 10, establishes procedures for the selection of the most baseline plausible scenario. According to them, there are four steps to be followed:

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

Project participants should use step 1 of the latest version of the "Tool for the demonstration and assessment of additionality" to identify all realistic and credible baseline alternatives. Version 5.2 of the Additionality Tool was used in this PDD.

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

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

ACM0001, version 10, indicates the separate determination of applicable baselines for landfill capture, for electricity generation and for thermal use of LFG. The possible alternatives for each part are considered below, using the codes defined in ACM0001, version 10.

ACM0001, Ver. 10 states:
"Alternatives for the disposal/treatment of the waste in the absence of the project activity, i.e. the scenario relevant for estimating baseline methane emissions, to be analyzed should include, inter alia:
- *LFG1. The project activity (i.e. capture of landfill gas and its flaring and/or its use) undertaken without being registered as a CDM project activity;*
- *LFG2. Atmospheric release of the landfill gas or partial capture of landfill gas and destruction to comply with regulations or contractual requirements, or to address safety and odour concerns."*

In principle, solid waste could be disposed off in other ways besides landfills, e.g. incineration, composting, conversion to Refuse-derived fuel (RDF), thermochemical gasification, and biomethanation. None of these are realistic alternatives for the project proponents, who have the concession to dispose solid waste at the specific landfill, and there is enough space and capacity to use the landfill for many years in the future. Moreover, these alternatives all involve advanced processes for treatment of solid waste; they all require very large investments and high operating costs compared to landfilling[10]. Finally, there is only limited experience with these alternative processes in Annex 1 countries, and almost none in non-Annex 1 countries, except for a handful of projects being submitted through the CDM.

Therefore, options LFG1 and LFG2 are the only realistic alternatives for the disposal/treatment of the waste.

ACM0001, Ver. 10 states:
"If LFG is used for generation of electric or heat energy for export to a grid and/or to a nearby industry or used on-site, realistic and credible alternatives should also be separately determined for:

[10] For instance, even the least expensive of these alternatives, composting, to be economically viable, the waste management company must receive USD 20 - 40 per tonne of waste. Source: International Source Book on Environmentally Sound Technologies (ESTs) for Municipal Solid Waste Management (MSWM), Report of the United Nations Environment Programme, Division of Technology, Industry, and Economics. http://www.unep.or.jp/ietc/ESTdir/Pub/MSW/sp/sp4/sp4_1.asp

- *Power generation in the absence of the project activity;*
- *Heat generation in the absence of the project activity."*

The project proponent does not propose to use the captured LFG for heat generation. According to ACM0001, Ver. 10, for heat generation, the realistic and credible alternative(s) may include, inter alia:

- *H1. Heat generated from landfill gas undertaken without being registered as CDM project activity;*
- *H2. Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant;*
- *H3. Existing or Construction of a new on-site or off-site renewable based cogeneration plant:*
- *H4. Existing or new construction of on-site or off-site fossil fuel based boilers. air heaters or other heat generating equipment (e.g. kilns);*
- *H5. Existing or new construction of on-site or off-site renewable energy based boilers, air heaters or other heat generating equipment (e.g. kilns);*
- *H6. Any other source such as district heat, and*
- *H7. Other heat generation technologies (e.g. heat pumps or solar energy).*

Since there has never been heat generation in the past, and it will not be implemented in the project activity, alternatives H1 through H7 can be eliminated as potential baseline scenarios. These scenarios would require substantial investment as well as fuel and other operating cost to produce heat but there would be no economic benefits (without the CDM). Note that the choice of fuel is not relevant, since all fuels are expected to have a cost.

The project proponent may generate a certain amount of electricity using LFG and ACM0001 Ver. 10 states:

"For power generation, the realistic and credible alternative(s) may include, inter alia:

- *P1. Power generated from landfill gas undertaken without being registered as a CDM project activity;*
- *P2. Existing or Construction of a new on-site or off-site fossil fuel fired cogeneration plant;*
- *P3. Existing or Construction of a new on-site or off-site renewable based cogeneration plant;*
- *P4. Existing or Construction of a new on-site or off-site fossil fuel fired captive power plant;*
- *P5. Existing or Construction of a new on-site or off-site renewable based captive power plant;*
- *P6. Existing and/or new grid-connected power plants."*

In principle, the project proponent could undertake any of the activities listed under P1 through P6, with or without the CDM.

There are numerous renewable power generations options, but many resources (such as hydro, wave, marine currents, etc.) are not available at a landfill site. A landfill that is receiving solid waste on a daily basis is not a suitable location for locating windmills or solar power stations. Even after the landfill is closed, LFG continues to leak out, the ground subsidizes, making landfills unsuitable for any constructions. Therefore renewable power generation options at the landfill site do not comprise realistic nor credible baseline scenarios. Hence options P3 and P5 can be eliminated.

Fossil-fuel-based captive power plants or cogeneration plants would not be economically competitive with purchasing power from the grid, so that P2 and P4 may also be discarded.

The project proponent and its parent company provide solid waste management services. They are not involved in power generation, so that off-site power generation is not an alternative to the proposed activity.

Indeed, any one, including the project proponents, may decide to install cogeneration systems or power plants anywhere in the world. However, they do not comprise alternatives to the proposed activity, since these other projects would have no bearing to the proposed activity. There is no reason why the implementation of such other projects would mean that the proposed project would not be undertaken.

Power plants connected to the grid are not operated by the project proponent. Most electricity users meet their demand from such power plants, and the project proponent does so now, and would continue to do so even after initial project implementation, unless it decides to generate power on site using LFG. Therefore P6 remains a valid baseline scenario.

The only remaining options for plausible baselines for power generation are then:

- P1. Power generated from landfill gas undertaken without being registered as CDM project activity, and
- P6. Power plants connected to the grid.

Thus the options listed above (LFG1 and LFG2; P1 and P6) are the only realistic alternatives to be considered as possible alternative baselines. These alternatives will be considered below and further analyzed, in Section B.5.

ACM0001, Ver. 10 states how national and sectoral policies must be taken into account using Sub-step 1b of the additionality tool and the adjustment factor AF.

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

This sub-step requires that:

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

In Mexico, Regulation NOM-083-SEMARNAT-20033 defines the specifications for environmental protection from the selection, design, construction and operation, monitoring and closure of final disposal sites for urban and special solid waste. This comprehensive regulation provides guidelines for the construction and operation of landfills, and also provides guidance regarding LFG, including recommendations for the collection, utilisation and/or flaring of the LFG. However, the regulation does not specify minimum requirements regarding the amount of gas to be collected and utilised or flared.

NOM- 083-SEMARNAT-2003[11] 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. So far, no local authorities have adopted NOM-083-SEMARNAT-2003.

- 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.

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

Given these circumstances, NOM-083-SEMARNAT-2003 has become more of a document outlining policy guidance than a mandatory requirement.

While NOM-083-SEMARNAT-2003 does not indicate a mandatory requirement for LFG capture and flaring, the current situation implies LFG venting, without any active system for capturing LFG.

Thus, the adjustment factor AF is 0%.

The tool for demonstration of additionality states that:

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

The current configuration comprises passive venting with no burning.

Thus we can modify Scenarios LFG1 and LFG2 as follows:

- LFG1: Disposal of the waste at the landfill with active extraction of landfill gas and centralized flaring or use of gas captured.
- LFG2: Disposal of the waste at the landfill with no burning of gas passively vented from the landfill, so that baseline destruction of LFG is 0% of the value with an active extraction system with centralized combustion of LFG (flaring or use as fuel).

Therefore both LFG1 and LFG2 would comply with local regulations.

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

ACM0001, Ver. 10 further declares:

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

For power generation we have considered two plausible baselines:

- P1. Power generated from landfill gas undertaken without being registered as CDM project activity, and
- P6. Power plants connected to the grid.

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

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

"STEP 3: Step 2 and/or Step 3 of the latest approved version of the "Tool for demonstration and assessment of additionality" shall be used to assess which of these alternatives should be excluded from

from further consideration (e.g. alternatives facing prohibitive barriers or those clearly economically unattractive).

At this point, the possible baseline scenarios are:

- Combination of LFG1+P1. 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.

- Combination of LFG2+P6. Current situation at the El Verde landfill.

An investment analysis for the combination of options LFG1+P1 is presented in section B.5. It is demonstrated that it is not an economically feasible option and therefore can be excluded from further consideration.

Therefore the only remaining option is the combination of alternatives LFG2 and P6 which is the continuation of current practice.

Step 4: Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario. The least emission alternative will be identified for each component of the baseline scenario. In assessing these scenarios, any regulatory or contractual requirements should be taken into consideration.

There is no need to apply this step since after applying steps 1 through 3 we conclude that the baseline scenario is the continuation of current practice (LFG2+P6).

B.5. Demonstration of additionality
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Starting date of project activity

Glossary of CDM terms version 04 states: "*start date of a CDM project activity is the earliest of the dates at which the implementation or construction or real action of the project activity begins*". It is also mentioned that "*the start date shall be considered to be the date on which the project participant has committed to expenditures related to the implementation or related to the construction of the project activity"*.

The key dates for the project activity are shown in the table below.

Table 1. Decision points, dates and supporting documents

Date	Document	File name (submitted for validation)
13/04/2006	Technical Memorandum from Conestoga Rovers & Associates for PASA	Conestoga Rovers Tech Memo.pdf
20/03/2007	Agreement between León Municipality and PASA (landfill operator and CDM project sponsor) with respect to the CER rights	Contrato Leon CERs.jpg
24/10/2007	Contract with MGM International for PDD preparation	contrato MGM PASA Verde Leon.pdf
26/10/2007	Contract with SCS Engineers for engineering services related to landfill gas capture and use	PASA - SCS- Contract Signature Page 10-26-07.pdf
01/11/2007	Letter of no objection from Mexican government climate change office	Carta de No Objeción El Verde PASA.pdf
14/12/2007	Letter of Approval Mexican government	LOA MX El Verde PASA 14dic07.pdf
21/12/2007	Contract SGS for CDM validation	CDM.VAL0950 PA04 21.12.07.pdf
06/02/2008	Price quote for flare	John Zink - Cot flare 6feb08.doc, also submitted as “CL 34a- John Zink Flare Quote Feb08.pdf”
11/02/2008	Modality of Communications with CDM EB	MOC PASA 11FEB08.jpg
05/03/2008	Letter of Approval UK government	EL VERDE LOA UK 5mar08.pdf
24/06/2008	Invoice for flare	invoice flare 24jun08.jpg

Based on definition above, the starting date of the project activity is 26/10/2007, corresponding to the contract with SCS Engineers for engineering services related to landfill gas capture and use This is the most conservative (i.e. earliest) date of real action, since project participant has committed to make this expenditure for CDM project activity.

As proof that CDM was taken into consideration prior to the earliest possible starting date (26/10/2007), we have (a) the Technical Memorandum submitted by Conestoga Rovers & Associates on 13/04/2006 which estimates CER revenues and (b) the agreement signed with the Municipality on 20/03/2007 and (c) the contract with MGM International for PDD preparation on 24/10/2007. Note that the associated documents are both official as well as third-party. The dates of CDM consideration are, respectively, 18 months, seven months and 2 days prior to the starting date of project activity.

Additionality

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

Following a review of how individual baseline methodologies deal with the issue of additionality, the CDM Executive Board published the “Tool for the demonstration and assessment of additionality.” Note that version 10 of “*Approved consolidated baseline methodology for landfill gas project activities*” makes the following comment regarding additionality: “Step 2 and/or step 3 of the latest approved version of the *“Tool for demonstration and assessment of additionality” shall be used to assess which of these alternatives should be excluded from further consideration.”*

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

Sub-step 2a involves a determination of the appropriate analysis method. Several options are offered:

I. Simple cost analysis
II. Investment comparison analysis, or
III. Benchmark analysis

According with the scenarios previously identified in section B.4, we have:

- Combination of LFG1+P1: 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).

- Combination of LFG2+P6: Current situation at the El Verde landfill.

For the combination LFG1+P1, there are substantial investments as well as revenues from electricity sales. Therefore, a benchmark analysis method was chosen. We determine the cost effectiveness for LFG capture and power generation in the absence of the CDM. Our analysis is based on the following assumptions, which are based on detailed study conducted by SCS Engineers, a major US consulting company on landfill gas capture and use[12]:

- Substantial investments are required to capture LFG. These include the construction of active extraction wells, a well field and blowers, etc. to collect the LFG and take it to the location where the power plant would be located. For this project, this involves about USD 723,939[13] in 2009, and an additional yearly investment for well field expansion as the landfill expands until the end of 2017, when the landfill is expected to close.

- Annual operating costs for landfill gas collection are expected to be 10% of initial investment, considered to be USD 128,585 starting in 2010.

- As of 2011, three Caterpillar generators model CAT3516s, with a total installed capacity of 2.4MW would be purchased (0.8 MW each), for a total investment including auxiliary equipment, such as power conditioning and connections, of USD 5,432,835, as per detailed estimates provided by SCS Engineers.

- As of 2013, four additional Caterpillar generators model CAT3516s, with a total installed capacity of 3.2MW would be added as LFG is available, for a total investment of USD 6,177,433. Operation and maintenance cost for power generation equipment is assumed to be 33.78USD/MWh, considering a cost of 648,500 per year as per SCS report (SCS PASA Cost Estimate report 29feb08.pdf) and a generation of 19,200 MWh/year (2.4MW@ 8,000 hours per year)

[12] Note that this analysis was done assuming that landfill gas capture equipment would be operational in the last quarter of 2008, and that following the installation of LFG capture and flaring equipment, electricity generation equipment would be installed late in 2009 to be operational from the start of 2010. To be conservative, investments for flaring start in 2009 and electricity sales start in 2012.

[13] Note that SCS provides low and high estimates for this activity of $990,950 and $1,469,475. See file "SCS PASA Cost Estimate report 29feb08.pdf". We have considered the arithmetic mean in our calculations. In addition, for the well field investment estimation, MGM excluded values reported by SGS associated with the flaring station. See details of the well field cost estimation in the sheet "Flare station investment" in the file "El_Verde_Economic_Analysis_04Nov09.xls"

- LFG flare and electricity generation equipment life: 20 years. Flare station is replaced in 2028. There is no need for electricity generation equipment replacement for the following reason: the initial purchase of generation equipment, of 2.4 MW in 2011 for use from Jan. 2012 would last until Dec. 2031 (20 years). The second acquisition of generation equipment of 3.2 MW would take place in 2013, and would last until 2032. After the first set of generators are retired in 2031, the total capacity would fall from 5.6 MW to 3.2 MW. However, by 2031, the available LFG could only generate 1.7 MW (see cell Z24 in sheet "Elec gen no CERs" of Economic workbook). Thus the second set of generators would be more than adequate capacity, and the first set of generators will not need to be replaced at the end of their 20-year life. The initial equipment (2.4 MW) purchased in 2011 and operational in 2012 would last until the end of 2031. The second set of generation equipment would last until 2033. The project life has been considered to end in 2032, so that the second set of generation equipment would not need to be replaced. Indeed the project life has been determined precisely to avoid this major investment.

- According to Mexican law, independent generators can use the power for their own use or sell it to the National Electricity Commission (CFE) at a price that is 10% below CFE's short-term marginal cost. The short term marginal costs (called CTCP) are published by CFE for all electricity interconnection points, called nodes[14]. See file "CFE price summary 2006-2008.xls" for further details. Leon belongs to the "Nodo Occidental" Nodo#33. See map at http://www.cfe.gob.mx/aplicaciones/otros/costostotales/Imagenes/mapactcp.jpg). Calculaton shown in "Summary" tab of Excel file. Value used = 0.0538 USD/kWh.

- Corporate tax rate: 28%. According to the tax law "Ley de Impuesto sobre la renta", most recent update 4/06/09. An additional 10% is employee profit sharing, and this is based on 1) the Mexican Constitution, section A, Article 123, "fraction" IX, referring to general principles for workers' rights; and 2) Resolution of the Fourth National Commission on Employee Profit Sharing, published in the Official Bulletin (Diario Oficial de la Federación) on 26/12/1996; this latter document specifies the percentage to be shared.

- Discount rate: 10.6%. Note that in November 2007, the commercial interest rate for fixed rate loan was 10.6%[15], according to data published by Central Bank of Mexico.

- Inflation: 4.54%. Inflation rate has been determined from consumer price index data published by the Mexican central bank[16]

The detailed economic analysis is shown in the electronic workbook: El Verde Economic Analysis 4Nov09.xls, which includes a sheet "Inputs and data source" with further details on assumptions and data sources. The results are given in the sheet "Elec gen no CERs".

For the assumptions stated above in the absence of the CDM, the NPV is negative. The electronic workbook also includes a sensitivity analysis with respect to the key assumptions, electricity sale price, O&M costs and investment requirements, in each case considering values ± 20% with respect to the assumptions above. The results of the sensitivity analysis are shown in the table below. For the entire range of assumptions, the NPV remains negative, which means that the project is not profitable without

[14] http://www.cfe.gob.mx/aplicaciones/otros/costostotales/consultaarchivoproyectado.aspx

[15] Source: http://www.banxico.org.mx/sistemafinanciero/estadisticas/MercadoDineroValores/tasasInteres.html. See details in the file "Mexican interest rates 2007.xls" prepared by MGM based on information provided in the Banco de Mexico website.

[16] http://www.banxico.org.mx/polmoneinflacion/estadisticas/indicesPrecios/indicesPreciosConsumidor.html. The calculations are shown in file "inflation.xls", prepared by MGM based on information provided in the Banco de Mexico website.

CER revenues. In fact, electricity price would have to be 43.3% higher for all years in the future for NPV to become positive.

Table 2. Sensitivity Analysis for LFG collection and electricity generation

Electricity Sale Price	-20%	-10%	0%	10%	20%
NPV	$ (7,619,587)	$ (6,048,064)	$ (4,779,661)	$ (3,676,120)	$ (2,567,291)

O&M Costs	-20%	-10%	0%	10%	20%
NPV	$ (3,192,304)	$ (3,992,798)	$ (4,779,661)	$ (5,683,967)	$ (6,659,047)

Investment	-20%	-10%	0%	10%	20%
NPV	$ (2,948,734)	$ (3,864,197)	$ (4,779,661)	$ (5,695,124)	$ (6,610,588)

Thus, the proposed project meets the condition of economic additionality, even for extreme values in the range of sensitivity considered. In other words, the combination LFG1+P1 may be eliminated as possible baseline scenario. The remaining baseline alternative is then the combination LFG2+P6 (for power generation) which is the current situation at El Verde landfill.

Since economic additionality is cleary demonstrated above, we do not apply ***Step 3 (Barrier Analysis)*** of the Additionality Tool, and proceed to Step 4.

"Step 4. Common practice analysis".

Version 5.2 of the Additionality Tool states:

"Unless the proposed project type has demonstrated to be first-of-its kind (according to Sub-step 3a), the above generic additionality tests shall be complemented with an analysis of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and region. This test is a credibility check to complement the investment analysis (Step 2) or barrier analysis (Step 3)."

Step 4 comprises two Sub-Steps, which are discussed below.

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

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

As shown in the table below, there are some other activities currently operating in Mexico that are similar to the proposed project activity (active LFG gas recovery, flaring and/or use as energy) but all are supported through the CDM, which may be disregarded according to the Additionality Tool, version 5.2. The only other exception is a landfill gas to energy project in Monterrey, Nuevo Leon funded with subsidies from the Global Environment Facility.

Table 3. Landfill gas projects registered or requestion registration under the CDM

Project number	Project name	LFG energy use	Registration date (as of 26 April 2009)
0425	Aguascalientes – EcoMethane Landfill Gas to Energy Project	Electricity generation	15 July 2006
0523	Ecatepec – EcoMethane Landfill Gas to Energy Project	Electricity generation	2 October 2006
1240	Hasars Landfill Gas Project	Possible electricity generation	5 October 2007
1242	Tultitlan – EcoMethane Landfill Gas to Energy Project	Possible electricity generation	30 November 2007
1123	Ciudad Juarez Landfill Gas to Energy Project	Electricity generation	30 November 2007
1371	Proactiva Mérida Landfill Gas Capture and Flaring project	(Flaring only)	31 January 2008
1307	Durango – EcoMethane Landfill Gas to Energy Project	Flaring, initially; later electricity generation	25 February 2008
1944	Milpillas Landfill Gas Recovery Project	(Flaring only)	6 November 2008
2186	Monterrey II LFG to Energy Project	Electricity generation	12 February 2009
2271	Tecamac – EcoMethane Landfill Gas to Energy Project	Flaring, initially; later electricity generation	21 March 2009
1699	Landfill Gas Management Project Puerto Vallarta Landfill site	Leachate evaporation	Pending corrections for registration

"Sub-step 4b: Discuss any similar options that are occurring", does not apply since no similar activities exist. There are no other similar projects of gas collection and energy generation in Mexico, with exception of the Monterrey project mentioned above and projects under CDM structure, which are happening due to carbon credits revenues.

Further the tool states that:

"If sub-steps 4a and 4b are satisfied, i.e. (i) similar activities cannot be observed or (ii) similar activities are observed, but essential distinctions between the project activity and similar activities can be reasonably be explained, then the proposed project activity is additional"

The proposed project activity meets the conditions of Step 4 of the Additionality tool. Thus, we can assert that the proposed project activity is additional.

B.6. Emission reductions

B.6.1. Explanation of methodological choices

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According to ACM0001, version 10:

The greenhouse gas baseline emissions during a given year "y" (BE_y) are given by:

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

Where:

BE_y	= Baseline emissions in year y (tCO_2e).
$MD_{project,y}$	= Amount of methane that would be destroyed/combusted during the year, in tonnes of methane (tCH_4) in project scenario.
$MD_{BL,y}$	= Amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirement, in tonnes of methane (tCH_4).
GWP_{CH4}	= Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4.
$EL_{LFG,y}$	= Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year y, in megawatt hours (MWh).
$CEF_{elec,BL,y}$	= CO_2 emissions intensity of the baseline source of electricity displaced, in tCO_2e/MWh. This is estimated as per equation (9) below.
$ET_{LFG,y}$	= The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from on-site/off-site 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 boiler/air heater to generate thermal energy which is displaced by LFG based thermal energy generation, in tCO_2e/TJ. This is estimated as per equation (10) below.

Since thermal energy will not be produced using landfill gas in the project scenario, it is assumed that this thermal energy would not be derived from the combustion of fossil fuels in the absence of the project activity. Hence the parameters $ET_{LFG,y}$ and $CEF_{ther,BL,}$ y are not relevant to the proposed project, and Eq. (1) reduces to:

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

ACM0001, version 10 offers several ways for determining $MD_{BL,y}$

One option is *"In the case where the $MD_{BL,y}$ is given/defined in the regulation and/or contract as a quantity that quantity will be used"*. This is not the case here.

ACM0001 further adds: *"In situations where in the baseline LFG is captured and destroyed, for reasons other than regulation and/or contract, historic data on actual amount captured shall be used as $MD_{BL,y}$.* Since no LFG was captured and destroyed historically, and none will be captured and destroyed until the proposed project is operational, this is not the case here.

Another option is *"In cases where regulatory or contractual requirements do not specify $MD_{BL,y}$ or no historical data exist for LFG captured and destroyed, an "Adjustment Factor" (AF) shall be used and justified, taking into account the project context."*

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

As explained in section B.4 above, despite the fact that the federal norm "NOM-083-SEMARNAT-2003 prescribes in point 7.2 the combustion of LFG through the means of individual wells or a network of central incinerators, it is known that this norm is not systematically enforced in Mexico.

Therefore, since prior to the project implementation there was no methane capture and destruction by flaring or other means, the value of AF is zero.

In order to calculate MDproject,y, the methodology (ACM0001 Ver. 10) states:

"The methane destroyed by the project activity ($MD_{project,y}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity and/or produce thermal energy, and/or supply to end users via natural gas pipeline, if applicable, and the total quantity of methane captured."

And,

"The sum of the quantities fed to the flare(s), to the power plant(s) and to the boiler(s)/air heater(s)/heat generating equipment(s) and to the natural gas distribution network (estimated using equation (8)[17]), must be compared annually with the total quantity of methane captured[18]. The lowest value of the two must be adopted as $MD_{project,y}$".

This is meant to be conservative, claiming the lower amount of methane destroyed. In case the total methane collection is the highest, MDproject,y is given by:

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

Where:

$MD_{flared,y}$	= Quantity of methane destroyed by flaring (tCH4)
$MD_{electricity,y}$	= Quantity of methane destroyed by generation of electricity (tCH4)
$MD_{thermal,y}$	= Quantity of methane destroyed for the generation of thermal energy (tCH4)
$MD_{PL,y}$	= Quantity of methane sent to the pipeline for feeding to the natural gas distribution network (tCH4)

In the case of El Verde Landfill project, the right hand side of the equation (3) will be simplified to only the components of methane flared (MDflared,y) and methane used for electricity generation (MDelectricity,y), because methane used for thermal energy generation and LFG sent to pipeline is not part of the scope of this project.

Thus we need to determine methane destroyed by flaring and by electricity generation. Therefore Eq. (8) reduces to:

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

Calculation of $MD_{flared,y}$:

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

Where:

$LFG_{flare,y}$	= Quantity of landfill gas fed to the flare(s) during the year measured in cubic meters (m3)

[17] ACM0001, versions 8 and 9 mention Eq (3) because of a reference to earlier versions.
[18] ACM0001 version 10 (and earlier versions) refers to the total quantity of methane generated, it is not possible to monitor methane generation. Moreover, the quantities of methane captured will be fed to the flare(s), power plant(s) and thermal plant(s), thus methane destroyed in project will be related to methane captured.

w_{CH4} = Average methane fraction of the landfill gas as measured[19] during the year and expressed as a fraction (in m3 CH4 / m3 LFG)

D_{CH4} = Methane density expressed in tonnes of methane per cubic meter of methane (tCH4/m3CH4)[20]

$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year y (tCO2e) 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 PEflare,y shall be determined for each flare using the tool.

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

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

Here the mass of methane sent to the flare is determined hourly, with hourly values added over the year.

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

Not all the methane that reaches the flare is destroyed, and the "*Tool to determine project emissions from flaring gases containing methane*" (ver. 1) is meant to take this into account.

The tool differentiates between open and enclosed flares. The project proposed here will use an enclosed flare, since these 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*

[19] Methane fraction of the landfill gas and LFG flow have to be measured on same basis (either wet or dry). In case the "Tool to determine project emissions from flaring gases containing Methane" is used, follow the standard approaches to convert the flow on wet basis to dry basis. For example, refer to the procedures provided in the book "Fundamentals of Classical Thermodynamics"; Gordon J. Van Wylen, Richard E. Sonntag and Claus Borgnakke; 4º Edition, 1994, John Wiley & Sons, Inc.

[20] At standard temperature and pressure (0 degree Celsius and 1.013 bar) the density of methane is 0.0007168 tCH4/m3CH4.

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."

The project will use continuous monitoring of the methane destruction efficiency of the flare (flare efficiency), and the Tool procedures for continuous monitoring will be applied.

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[21] of the residual gas is determined based on the volumetric fraction of all components in the gas."

$$FM_{RG,h} = \rho_{RG,n,h} * FV_{RG,h} \qquad \textbf{(T.1)}^{13}$$

Where:

$FM_{RG,h}$	kg/h	Mass flow rate of the residual gas in hour h
$\rho_{RG,n,h}$	kg/m3	Density of the residual gas at normal conditions in hour h
$FV_{RG,h}$	m3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h

And:

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

Where:

$\rho_{RG,n,h}$	kg/m3	Density of the residual gas at normal conditions in hour h
P_n	Pa	Atmospheric pressure at normal conditions (101,325)
R_u	Pa.m3/kmol.K	Universal ideal gas constant (8,314)
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
T_n	K	Temperature at normal conditions (273.15)

And:

$$MM_{RG,h} = \sum_i \left(fv_{i,h} * MM_i \right) \qquad \textbf{(T.3)}$$

$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
$fv_{i,h}$	-	Volumetric fraction of component i in the residual gas in the hour h
MM_i	kg/kmol	Molecular mass of residual gas component i
I		The components CH4, CO, CO2, O2, H2, N2

The Tool states that *"As a simplified approach, project participants may only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N2)"*.

Note that the Tool is applicable to a wide variety of residual gases to be flared, while landfill gas is the product of anaerobic decomposition, which does not produce hydrogen or carbon monoxide, so these two gases can be eliminated from the calculations, without any assumptions. The simplification proposed in

[21] Equation numbers from the Flare Tool are prefixed with the letter "T" to distinguish them from equations from the methodology.

the tool involves considering CO2 and O2 as N2. While this leads to minor errors, we use this simplified approach, since it greatly simplifies measurements, and does not significantly affect the estimate of flare efficiency.

With this simplification, Eq. (T.3) becomes:

$$MM_{RG,h} = \sum_i \left(fv_{i,h} * MM_i \right) \quad \textbf{(T.3a)}$$

Where:

$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
$fv_{i,h}$	-	Volumetric fraction of component i in the residual gas in the hour h
MM_i	kg/kmol	Molecular mass of residual gas component i
I		The components CH4, N2 (Note that only CH4 would be measured and N2 determined as the balance)

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

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

Step 2 states:

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

$$fm_{j,h} = \frac{\sum_i fv_{i,h} * AM_j * NA_{j,i}}{MM_{RG,h}} \quad \textbf{(T.4)}$$

Where:

$fm_{i,h}$	-	Mass fraction of element j in the residual gas in hour h
$fv_{i,h}$	-	Volumetric fraction of component i in the residual gas in the hour h
AM_j	kg/kmol	Atomic mass of element j
$NA_{j,i}$	-	Number of atoms of element j in component i
$MM_{RG,h}$	kg/kmol	Molecular mass of the residual gas in hour h
J		The elements carbon, hydrogen, oxygen and nitrogen. Note that the simplified approach, involving measurement of methane and assuming the balance to be nitrogen, implies that there is no elemental oxygen in the gas, and that all the carbon is in the form of methane. The only hydrogen is also in methane, but this does not involve any simplification, since there is no H2 in the other components that might be present in landfill gas: CO2 and O2.
I		The components CH4 and N2 (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:

$$TV_{n,FG,h} = V_{n,FG,h} * FM_{RG,h} \quad \textbf{(T.5)}$$

Where:

$TV_{n,FG,h}$	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

$$V_{n,FG,h} = V_{n,CO_2,h} + V_{n,O_2,h} + V_{n,N_2,h} \quad \textbf{(T.6)}$$

Where:

$V_{n,FG,h}$	m3/kg residual gas	Volume of the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in the hour h
$V_{n,CO2,h}$	m3/kg residual gas	Quantity of CO2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h
$V_{n,N2,}h$	m3/kg residual gas	Quantity of N2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h
$V_{n,O2,h}$	m3/kg residual gas	Quantity of O2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour h

$$V_{n,O_2,h} = n_{O_2,h} \times MV_n \quad \textbf{(T.7)}$$

Where:

$V_{n,\ O2,}\ h$	m3/kg residual gas	Quantity of O2 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 O2 in the exhaust gas of the flare per kg residual gas flared in hour h
MV_n	m3/kmol	Volume of one mole of any ideal gas at normal temperature and pressure (22.4 litres/mol)

The Tool states:

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

Where:

$V_{n,\ N2,\ h}$	m3/kg residual gas	Quantity of N2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in hour h
$fm_{N,\ h}$	-	Mass fraction of nitrogen in the residual gas in the hour h
AM_N	kg/kmol	Atomic mass of nitrogen
MF_{O2}	-	O2 volumetric fraction of air (0.21)
F_h	kmol/kg residual gas	Stoichiometric quantity of moles of O2 required for a complete oxidation of one kg residual gas in hour h

and other variables are as defined earlier.

Note that if the mass fraction is expressed as a fraction, as the definition above implies, and not as a %, the number in the first denominator of Eq. T.8 should be 2 and not 200, so that the correct equation would be:

$$V_{n,N_2,h} = MV_n \times \left\{ \frac{fm_{N,h}}{2AM_N} + \left(\frac{1 - MF_{O_2}}{MF_{O_2}} \right) \times \left[F_h + n_{O_2,h} \right] \right\} \quad \textbf{(T.8a)}$$

Next we have:

$$V_{n,CO_2,h} = \frac{fm_{C,h}}{AM_C} \times MV_n \quad \textbf{(T.9)}$$

Where:

$V_{n,\ CO2,\ h}$	m3/kg residual gas	Quantity of CO2 volume free in the flare exhaust gas 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

and other variables are as defined earlier.

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

Where:

$t_{O2,\ h}$	-	Volumetric fraction of O2 in the exhaust gas in hour h

and other variables are as defined earlier.

Note that the second term in the large brackets [..] is

$$\frac{fm_{N,h}}{2AM_N}$$

, with 2 in the denominator, not 200, confirming our observation of Eq. (8) above.

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

Where:

F_h	kmol O2 / kg residual gas	Stoichiometric quantity of moles of O2 required for a complete oxidation of one kg residual gas in hour h
$fm_{H,\ h}$	-	Mass fraction of hydrogen in the residual gas in hour h
$fm_{O,\ h}$	-	Mass fraction of oxygen in the residual gas in hour h
AM_H	kg/kmol	Atomic mass of hydrogen
AM_O	kg/kmol	Atomic mass of oxygen

and other variables are as defined earlier.

Step 4: Determination of methane mass flow rate in the exhaust gas on a dry basis

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:

$$TM_{FG,h} = \frac{TV_{n,FG,h} * fv_{CH_4,FG,h}}{1{,}000{,}000} \quad \textbf{(T.12)}$$

Where:

$TM_{FG,h}$	kg/h	Mass flow rate of methane in the exhaust gas of the flare in dry basis at normal conditions in hour h
$TV_{n,FG,h}$	m3/h exhaust gas	Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour h
$fv_{CH4,FG,h}$	mg/m3	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 (fvCH4,RG,h) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis)."

Note that this is identical to the first part of our reformulation Eq. (9a) of Eq. (9) of ACM0001.

The Tool further elaborates:

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

$$TM_{RG,h} = FV_{RG,h} * fv_{CH_4,RG,h} * \rho_{CH_4,n} \quad \textbf{(T.13)}$$

Where:

$TM_{RG,h}$	kg/h	Mass flow rate of methane in the residual gas in the hour h
$FV_{RG,h}$	m3/h	Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h[22]
$fv_{CH4,RG,h}$	-	Volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to fvi,RG,h where i refers to methane).
$\rho_{CH4,n}$	kg/m3	Density of methane at normal conditions (0.716)[23]

[22] Note that the Tool uses terms of the type fvCH4,FG,h in Eq. (T.12) expressed as mg/m3 and similar terms fvCH4,RG,h in Eq. (T.13) expressed as a dimensionless quantity. While it would have been better if Equation (T.12) had used a different letter (other than "fv") to designate concentration, the equations are correct as long they are applied noting that there are two types of "fv".

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 (η flare,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.*
- *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 :*

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

Where:

$\eta_{flare,h}$	-	Flare efficiency in hour h
$TM_{FG,h}$	kg/h	Methane mass flow rate in exhaust gas averaged in hour h[24]
$TM_{RG,h}$	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 (h flare,h), as follows:"

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH_4}}{1000} \quad \textbf{(8)}$$

Where:

$PE_{flare\ y}$	tCO2e	Project emissions from flaring of the residual gas stream in year
$TM_{RG,\ h}$	kg/h	Mass flow rate of methane in the residual gas in the hour h
$\eta_{flare,\ h}$	-	Flare efficiency in hour h
GWP_{CH4}	tCO2e/tCH4	Global Warming Potential of methane

$$MD_{electricity,\ y} = LFG_{electricity,\ y} \times w_{CH_4,y} \times D_{CH_4} \quad \textbf{(10)}$$

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

[24] Note that the first version of the Tool (EB28 Annex 13) defines TMFG, h as "Methane mass flow rate in exhaust gas averaged over a period of time t (hour, two months or year)". We believe this is a misprint. For hourly flare efficiency to be meaningfully determined, the definition should be as stated here in the PDD.

Where:

MDelectricity,y	= quantity of methane destroyed by generation of electricity (tCH4/yr)
LFGelectricity,y	= quantity of landfill gas fed into electricity generator (m3/yr)

Considering hourly variations in methane density and methane concentration in LFG, a more precise form of Eq. (10) is:

$$MD_{electricity,\,y} = \sum_{h=1}^{8760} (LFG_{electricity,\,h} \times w_{CH_4,\,h} \times D_{CH_4}) \qquad \textbf{(10a)}$$

Note that electricity generation using LFG is a possible energy application of LFG being considered in the proposed project, and Eq. (10a) would only apply in case there is electricity generation.

Since LFG will not be used for thermal uses neither injected into a pipeline in the proposed project, Eq. (11) nor Eq. (12) of ACM0001, Ver. 10 are not applicable here.

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

Further, ACM0001 version 10 requires that:

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

$$MD_{project,\,y} = \frac{BE_{CH_4,SWDS,y}}{GWP_{CH_4}} \qquad \textbf{(13)}$$

Where:

$BE_{CH4,SWDS,y}$	= Methane generation from the landfill in the absence of the project activity at year y (tCO2e), calculated as per the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site". The tool estimates methane generation adjusted for, using adjustment factor (f) any landfill gas in the baseline that would have been captured and destroyed to comply with relevant regulations or contractual requirements, or to address safety and odor concerns. As this is already accounted for in equation 2, "f" in the tool shall be assigned a value 0.

ACM0001, version 10 further states:

"Furthermore the following guidance should be taken into account:

• *In the tool x will refer to the 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)];*

• *Sampling to determine the different waste types is not necessary, the waste composition can be obtained from previous studies.*

"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."

We use version 4 of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site".

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

The tool provides a procedure to determine $BE_{CH4,SWDS,y}$, given by[25]:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k(y-x)} \cdot (1-e^{-kj}) \qquad \textbf{(TW.1}^{17}\textbf{)}$$

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 (tCO2e)[26]
φ	= Model correction factor to account for model uncertanties (0.9)
F	= Fraction of methane captured at the SWDS and flared, combusted or used in another maner
GWP_{CH4}	= Global Warming Potential (GWP) of methane, valid for the relevant commitment period
OX	= Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering 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 (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. 10.
Y	= Year for which methane emissions are calculated

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

Important Note: the same term $MD_{project,y}$ is used for the ex-post measurement of methane destruction as in Eqs. (8) and (8a) as well as for the ex-ante estimation of methane destruction using Eq. (13). In fact, Eq. (13) refers to the ex-ante estimation of methane captured without taking into account the methane destruction efficiency of the flare. Since the amount of methane flared depends on other uses of methane, the ex-ante estimation for this project starts from an estimate of methane captured using Eq. (13), then estimates how much is used for power generation, with the remainder going to the flare. Finally, the methane destruction efficiency of the flare is taken into consideration in determining the methane

[25] Equation numbers from the Waste Emission Tool are prefixed with the letter "TW" to distinguish them from equations from the methodology.
[26] Note that "methane emissions avoided" in this project case means methane emissions generated by the landfill. So, the period in consideration here will be since the landfill opening to the landfill closure.

destruction in the project scenario. The details of the calculations are provided in the workbook "CER Calculation El Verde 18Dec09.xls", and the results are shown in tabular form in Section B.6.3.

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

ACM0001, Ver. 10 states: "*In case the baseline is electricity generated by plants connected to the grid the emission factor should be calculated according to "Tool for calculation of emission factor for electricity systems*"

The calculation of the emission factor for the electricity system is demonstrated in Annex 3 using the tool recommended.

While there is no thermal use of LFG in the baseline and there is no thermal use in the project, no CO2 emissions reductions for fossil fuel savings as a result of LFG use are being claimed. Hence the following section of ACM0001 may be skipped: "Determination of $CEF_{ther,BL,y}$".

We next determine emissions associated with the project activity.

Project Emissions:

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

Where:

$PE_{EC,y}$ = Emissions from consumption of electricity in the project case. The project emissions from electricity consumption (PEEC,y) will be calculated following the latest version of "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". We used Version 1 of the Tool. 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 (PEFC,j,y) will be calculated following the latest version of "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion". We use Version 2 of the Tool. 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.

$PE_{EC,y}$ will be calculated using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

The tool presents three different possibilities, and the El Verde Landfill Project is inserted in Scenario A: Electricity consumption from the grid.

We use the Tool to determine project emissions from electricity consumption. There are no baseline emissions for this case, since project electricity consumption is associated with landfill gas capture and flaring, and there is no active capture of LFG prior to project implementation. .

According to ACM0001, Ver. 10, "*No leakage effects need to be accounted under this methodology*". Hence we do not consider any leakage electricity consumption either.

The "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1) declares:

"In the generic approach, project, baseline and leakage emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses…"

Specifically for project emissions we have[27]:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \qquad \textbf{(TE.1}^{19}\textbf{)}$$

Where:

$PE_{EC,y}$	= Project emissions from electricity consumption by the project activity during the year y (tCO_2/yr)
$EC_{PJ,j,y}$	= Quantity of electricity consumed by the project electricity consumption source j in year y (MWh)
$EF_{EL,j,y}$	= Emission factor for electricity generation for source j in year y (tCO_2/MWh)
$TDL_{j,y}$	= Average technical transmission and distribution losses for providing electricity to source j in year y
j	= Sources of electricity consumption in the project

There is some confusion with the terminology used in this new tool on electricity consumption. It is not clear what is meant by "sources of electricity consumption". In normal terminology, energy sources provide energy to end uses. The most reasonable interpretation involves the assumption that by "sources", the Tool means end uses. Since all electricity end uses at the proposed project site would be supplied by the same power grid, $EF_{EL,j,y}$ and $TDL_{j,y}$ are independent of j. This interpretation is confirmed by the Option A1 for determining $EF_{EL,j,,y.}$ We use this option which requires us to:

"Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the "Tool to calculate the emission factor for an electricity system" ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$)."

Hence we have a single emission factor given by EFgrid,CM,y. Moreover, following the "Tool to calculate the emission factor for an electricity system" (version 1.1), we choose the option of determining a single fixed value of this emission factor, valid for the first crediting period, so that we are reduced to the determination of a single $EF_{grid,CM}$ valid for the first crediting period. The determination of this value is shown in Annex 3, and reported in Section B.6.2 and B.6.3 below.

Further down in the Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 1) (p.12), there is mention of $TDL_{j,y}$. For Scenario A, applicable here, we are given the following choices to determine its value:

- *Use recent, accurate and reliable data available within the host country;*
- *Use as default values of 20% for*

  (a) project or leakage electricity consumption sources;

Other default values are suggested, but are not applicable to this project, since there is no baseline electricity consumption.

[27] Equation numbers from the Electricity Consumption Tool are prefixed with the letter "TE" to distinguish them from equations from the methodology.

Again, since all electricity consumed on site is supplied from the grid, there is a single value of $TDL_{j,y}$ independent of the electricity end use, j. The value used is reported in Section B.6.2 and B.6.3.

Regarding project electricity consumption: despite the fact that electricity can be supplied by on-site generation using LFG, in order to be more conservative during the emissions reduction estimation, i.e. higher project emissions, we have assumed that all project electricity consumption (for blowers) come from the power grid in all years. However, please note that Project Participant will implement the monitoring plan as described in sections B.7.1 and B.7.2, including the monitoring of the real electricity consumption from the grid once the project is operational by using an electricity meter.

$PE_{FC,j,y}$ will be calculated according to the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (version 2) and is given by the formula[28]:

$$PE_{FC,j,y} = \sum_i FC_{i,j,y} \times COEF_{i,y} \qquad \textbf{(TF.1}^{20}\textbf{)}$$

Where:

$PE_{FC,j,y}$	= CO2 emissions from fossil fuel combustion in process j during the year y (tCO2/yr)
$FC_{i,j,y}$	= Quantity of fuel type i combusted in process j during the year y (mass or volume unit /yr)
$COEF_{i,y}$	= CO2 emission coefficient of fuel type i in year y (tCO2/mass or volume unit)
i	= Fuel types combusted in process j during the year y

In order to calculate COEFi,y, we chose the Option B of the tool, that is:

"The CO2 emission coefficient COEFi,y is calculated based on net calorific value and CO2 emission factor of the fuel type i, as follows:"

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO_2,i,y} \qquad \textbf{(TF.4)}$$

Where:

$COEF_{i,y}$	= CO2 emission coefficient of fuel type i in year y
$NCV_{i,y}$	= Weighted average net calorific value of the fuel type i in year y (GJ/mass or volume unit)
$EF_{CO2,i,y}$	= Weighted average CO2 emission factor of fuel type i in year y (tCO2/GJ)
I	= Fuel types combusted in process j during the year y.

Finally, according to ACM0001 Ver. 10, emission reductions can be calculated as follows:

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

Where:

ER_y	= Emission reductions in year y (tCO_2e/yr)
BE_y	= Baseline emissions in year y (tCO_2e/yr)
PE_y	= Project emissions in year y (tCO_2e/yr)

[28] Equation numbers from the Fossil Fuel Consumption Tool are prefixed with the letter "TF" to distinguish them from equations from the methodology.

B.6.2. Data and parameters fixed ex ante

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

Table 4. Data and parameters available at validation

Parameter	SI Unit	Description	Value
MM_{CH4}	kg/kmol	Molecular mass of methane	16.04
MM_{CO}	kg/kmol	Molecular mass of carbon monoxide	28.01
MM_{CO2}	kg/kmol	Molecular mass of carbon dioxide	44.01
MM_{O2}	kg/kmol	Molecular mass of oxygen	32.00
MM_{H2}	kg/kmol	Molecular mass of hydrogen	2.02
MM_{N2}	kg/kmol	Molecular mass of nitrogen	28.02
AM_C	kg/kmol (g/mol)	Atomic mass of carbon	12.00
AM_H	kg/kmol (g/mol)	Atomic mass of hydrogen	1.01
AM_O	kg/kmol (g/mol)	Atomic mass of oxygen	16.00
AM_N	kg/kmol (g/mol)	Atomic mass of nitrogen	14.01
P_n	Pa	Atmospheric pressure at normal conditions	101,325
R_u	Pa m3/kmol K	Universal ideal gas constant	8,314.472
Tn	K	Temperature at normal conditions	273.15
MF_{O2}	Dimensionless	O2 volumetric fraction of air	0.21
GWP_{CH4}	tCO2/tCH4	Global warming potential of methane	21
MV_n	m3/Kmol	Volume of one mole of any ideal gas at normal temperature and pressure	22.414
$\rho_{CH4,n}$ / DC_{H4}	kg/m3	Density of methane gas at normal conditions	0.7168
$NA_{i,j}$	Dimensionless	Number of atoms of element *j* in component *i*, depending on molecular structure	

Data and parameters not measured for the **"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"**, version 4, are presented in Annex 3 where they are used to make ex-ante estimates.

The remaining parameters and data that are available at the time of validation, and are not monitored, are listed in individual data tables below.

Data / Parameter	Regulatory requirements relating to landfill gas projects
Unit	Dimensionless
Description	Regulatory requirements relating to landfill gas projects
Source of data	Publicly available information of the host country's regulatory requirements relating to landfill gas.
Value(s) applied	0%
Choice of data or Measurement methods and procedures	In the absence of the proposed project, all the landfill gas will be released to the atmosphere. As explained in B.4, the current configuration is passive venting and **no** burning at El Verde landfill.
Purpose of data	
Additional comment	The information though recorded annually, is used for changes to the adjustment factor (AF) or directly MDBL,y at renewal of the credit period. Relevant regulations for LFG project activities shall be updated at renewal of each credit period. Hence, because this value may change at the end of each crediting period, in case of changes in regulatory requirements, it will be monitored as shown in B.7.1 below.

Data / Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
Description	Global Warming Potential of CH_4
Source of data	IPCC
Value(s) applied	21
Choice of data or Measurement methods and procedures	For the first commitment period. Shall be updated according to any future COP/MOP decisions.
Purpose of data	
Additional comment	

Data / Parameter	D_{CH4}
Unit	tCH_4/m^3CH_4
Description	Methane density
Source of data	
Value(s) applied	0.0007168
Choice of data or Measurement methods and procedures	At standard temperature and pressure (0°C and 1.013 bar).
Purpose of data	
Additional comment	

Data / Parameter	$BE_{CH4, SWDS,y}$
Unit	tCO_2e
Description	Methane generation from the landfill in the absence of the project activity at year y
Source of data	Calculated as per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site", version 4.
Value(s) applied	See details in Annex 3, results shown in B.6.3.
Choice of data or Measurement methods and procedures	As per "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site", version 4.
Purpose of data	
Additional comment	Used for ex-ante estimation of the amount of methane that would have been destroyed/combusted during the year.

Data / Parameter	$CEF_{elec,BL,y} = EF_{grid,CM,y}$
Unit	tCO_2e/MWh
Description	CO_2 emissions intensity of the grid connected to the project site. It is used both to determine emissions due to project electricity consumption (**$EF_{grid,CM,y}$**) as well as baseline emissions as a result of electricity displaced from the grid because of generation using landfill gas (**$CEF_{elec,BL,y}$**).
Source of data	Official data for power plants in the Mexican grid connected to the project site. Calculation details are provided in Annex 3.
Value(s) applied	0.5126 (Combined Margin)
Choice of data or Measurement methods and procedures	The emissions factor was calculated using the *"Tool to calculate the emission factor for an electricity system"*, recommended by ACM0001 Ver. 10. We used version 1.1 of the Tool.
Purpose of data	A single, fixed value is used for each crediting period.
Additional 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 is made using the 'Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site", version 4. 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 65%, which is a conservative value compared to typical values considered in Mexican and others landfills. The amount of methane collected would represent $MD_{project,y}$.

As discussed in section B.4, in the absence of the proposed project activity, the configuration at El Verde landfill is passive venting and no burning of LFG, therefore, AF value assumed is equal to zero.

Project proponent (PP) expects to collect and flare landfill gas initially. Subsequently, PP may decide to generate electricity using the LFG. However, at present the landfill operator does not have permits to generate electricity. Therefore, electricity generation would be subject to obtaining the appropriate authorisation. The maximum electricity generation potential (MW) can be estimated from the flow rate of landfill gas collected (m3/h). We assumed that a dedicated LFG engine-generator will need a flow of 509 m3/h of landfill gas (@50% methane) to generate 0.8 MWe (one electric megawatt). This assumption was based on information provided in the website http://www.lfgtech.com/catech.htm. This allows us to calculate the maximum power generation potential if all the LFG were converted to electricity. While LFG generation may vary continuously over time, power generation equipment is only available at specific power output capacities. Based on the amount of landfill gas available, we assume that initial power generation in 2012 would be 2.4 MW, reaching up to 5.6 MW in 2014 and keeping this installed capacity until the end of the project activity. All these calculations are presented in the tables within this section.

For conservativeness, the ex-ante estimations assume a default flare efficiency of 90%, as recommended in the Methodological "*Tool to determine project emissions from flaring gases containing methane*" (Version: EB28, Annex 13). However, please note that project participant will use continuous monitoring to determine ex-post flare efficiency as described in the tool.

The project activity involves LFG recovery, which requires a blower for gas pumping, and electricity is needed for this purpose. If the project does not generate electricity, or until the power plant is operational, this electricity will be purchased from the grid and will constitute PEEC,y in Eq. (16). In case of electricity generation using the methane collected in the project, emissions reductions would be determined by the sum of the amount of electricity exported from the project site to the grid and the amount of electricity used on-site unrelated to the project activity —as it would have been imported in the absence of the project activity. This will constitute $EL_{LFG,y}$.

Other assumptions made for the ex-ante estimations, are as follows:

- **Operation of the power plant:** If installed, it is expected that the electricity generation facility will operate 8,000 h/yr (91.3% of the year).

- **Operation of the flare station:** It was assumed that the flare station will operate 8,760 h/yr.

- **Blower electricity consumption:** Based on manufacturer's information, it is assumed that a blower will use 25 HP or about 18 kW to pump 1,869 m3/h of LFG (@ 50% methane).

Emissions from this power consumption from the grid in the project activity will also depend on the emissions 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 0.5126 tCO2/MWh (combined margin) was used in this project for imported (grid) electricity. This CO2 emissions factor for power generation was determined using the same procedure indicated in the tool which allows for $EF_{grid,y}$ to remain fixed for each crediting period.

The El Verde landfill project does not claim CO2 emissions reductions associated with fossil fuel combustion avoided as a result of the thermal use of LFG. Moreover, there is no fossil fuel consumption in the baseline scenario. Thus, the thermal parameters ($CEF_{therm,BL,y}$ and $ET_{LFG,y}$) are not relevant to the proposed project. See explanation preceding Eq (1a) above.

Any fossil fuel consumption, e.g. for flare startup, will be accounted. $PE_{FC,j,y}$ will depend on the fossil fuel consumed and its value will be take from IPCC default emission factors, in case no other data is available. For ex ante estimates, very conservative (i.e. high) estimates of fuel consumption for flare

startup are considered. According to the flare manufacturer, the flare would need to be lit 12 times per year. The manufacturer also informed us that a 5-gallon cylinder of LPG was adequate for 196 turn-ons. To be very conservative we consider that an entire cylinder is used each year, i.e. allowing for 196 turn ons per year.

Because ACM0001 covers a broad spectrum of methane utilization options, there are several calculation details and assumptions which can be better expressed in a spreadsheet. See CER Calculation El Verde 18Dec09.xls. All the equations and main assumptions were presented above and are used to estimate project emissions reductions. The results are shown in the next page.

$BE_y = (MD_{project,y} - MD_{BL,y}) * GWP_{CH4} + EL_{LFG,y} * CEF_{elec,BL,y}$ (1a)		2010	2011	2012	2013	2014	2015	2016
BE_y	*Baseline emissions (tCO_2e).*	131,271	140,301	166,271	174,839	204,725	214,421	222,590
$MD_{project,y}$	*Amount of methane that would be destroyed/combusted during the year, in project scenario (tCH_4)*	6,251	6,681	7,449	7,857	8,694	9,117	9,506
$MD_{BL,y}$	*Amount of methane that would have been destroyed/combusted during the year y in the absence of the project due to regulatory and/or contractual requirement (tCH_4)*	0	0	0	0	0	0	0
GWP_{CH4}	*Global Warming Potential value for methane for the first commitment period (tCO_2e/tCH_4)*	21	21	21	21	21	21	21
$EL_{LFG,y}$	*Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year y (MWh)*	0	0	19,200	19,200	43,212	44,800	44,800
$CEF_{elec,BL}$	*CO_2 emissions intensity of the baseline source of electricity displaced (tCO_2e/MWh).*	0.5126	0.5126	0.5126	0.5126	0.5126	0.5126	0.5126

$MD_{BL,y} = MD_{project,y} * AF$ (2)		2010	2011	2012	2013	2014	2015	2016
$MD_{BL,y}$	*Amount of methane that would have been destroyed/combusted during the year y in the absence of the project (tCH_4)*	0	0	0	0	0	0	0
$MD_{project,y}$	*Amount of methane that would be destroyed/combusted during the year y (tCH_4)*	6,251	6,681	7,449	7,857	8,694	9,117	9,506
AF	*Adjustment factor*	0%	0%	0%	0%	0%	0%	0%

$MD_{project,y} = MD_{flared,y} + MD_{electricity,y}$ (8a)		2010	2011	2012	2013	2014	2015	2016
$MD_{project,y}$	*Quantity of methane that would be destroyed/combusted during the year y (tCH_4)*	6,170	6,600	7,368	7,776	8,642	9,036	9,425
$MD_{flared,y}$	*Quantity of methane destroyed by flaring (tCH_4)*	6,170	6,600	3,866	4,273	469	863	1,252

MD electricity,y	*Quantity of methane destroyed by generation of electricity (tCH_4)*	0	0	3,503	3,503	8,173	8,173	8,173
$MD_{thermal,y}$	*Quantity of methane destroyed by thermal generation*	0	0	0	0	0	0	0

$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y}/GWP_{CH4})$ (9)		2010	2011	2012	2013	2014	2015	2016
$LFG_{flare,y}$	*Quantity of landfill gas fed to the flare during the year (m3)*	19,128,818	20,462,455	11,984,163	13,247,300	1,455,394	2,675,108	3,881,178
$w_{CH4,y}$	*Average methane fraction of the landfill gas as measured during the year y and expressed as a fraction (m^3 CH_4 / m^3 LFG)*	50%	50%	50%	50%	50%	50%	50%
D_{CH4}	*Methane density (tCH_4/m^3CH_4)*	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168
$PE_{flare,y}$	*Project emissions from flaring of the residual gas stream (tCO_2e) determined following the procedure described in the "Tool to determine project emissions from flaring gases containing methane"*	14,397	15,401	9,020	9,970	1,095	2,013	2,921
GWP_{CH4}	*Global Warming Potential value for methane for the first commitment period (tCO_2e/tCH_4)*	21	21	21	21	21	21	21

$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4} * D_{CH4}$ (10)		2010	2011	2012	2013	2014	2015	2016
$MD_{electricity,y}$	*Quantity of methane destroyed by generation of electricity (tCH_4)*	0	0	3,503	3,503	7,883	8,173	8,173
$LFG_{electricity,y}$	*Quantity of landfill gas fed into the electricity generator (m^3)*	0	0	9,772,800	9,772,800	21,995,103	22,803,200	22,803,200
$w_{CH4,y}$	*Average methane fraction of the landfill gas as measured during the year y and expressed as a fraction (m^3 CH_4 / m^3 LFG)*	50%	50%	50%	50%	50%	50%	50%
D_{CH4}	*Methane density (tCH_4/m^3CH_4)*	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168

$MD_{thermal,y} = LFG_{thermal,y} * w_{CH4} * D_{CH4}$ (11)		2010	2011	2012	2013	2014	2015	2016
$MD_{thermal,y}$	*Methane destroyed by thermal generation (tCH_4)*	0	0	0	0	0	0	0

$LFG_{thermal,y}$	*Quantity of landfill gas fed into thermal generator (m^3)*	0	0	0	0	0	0	0
$w_{CH4,y}$	*Average methane fraction of the landfill gas as measured during the year y and expressed as a fraction (m^3 CH_4 / m^3 LFG)*	50%	50%	50%	50%	50%	50%	50%
D_{CH4}	*Methane density (tCH_4/m^3CH_4)*	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168	0.0007168

$PE_{flare,y} = \sum TM_{RG,h} * (1 - \eta_{flare,h}) * GWP_{CH4} / 1000$ *(T.15)*		2010	2011	2012	2013	2014	2015	2016
$PE_{flare,y}$	*Project emissions from flaring of the residual gas stream (tCO_2e) determined following the procedure described in the "Tool to determine project emissions from flaring gases containing methane"*	14,397	15,401	9,020	9,970	1,095	2,013	2,921
$\sum TM_{RG,h}$	*Total mass flow rate in the residual gas (kg)*	6,855,768	7,333,744	4,295,124	4,747,832	521,613	958,759	1,391,014
$\eta_{flare,h}$	*Flare combustion efficiency*	90%	90%	90%	90%	90%	90%	90%
GWP_{CH4}	*Global Warming Potential value for methane for the first commitment period (tCO_2e/tCH_4)*	21	21	21	21	21	21	21

$CEF_{elec,BL,y}$ *determined by "Tool for calculation of emission factor for electricity system" (see details in Annex 3)*		2010	2011	2012	2013	2014	2015	2016
$CEF_{elec,BL,y}$	*CO_2 emissions intensity of the baseline source of electricity displaced (tCO_2e/MWh)*	0.5126	0.5126	0.5126	0.5126	0.5126	0.5126	0.5126
$EL_{LFG,y}$	*Net electricity produced using LFG (MWh)*	0	0	19,200	19,200	43,212	44,800	44,800
-	*CO_2 emission reductions attributable to the displacement of electricity from the grid (tCO_2e)*	0	0	9,842	9,842	22,150	22,964	22,964

$PE_y = PE_{EC,y} + PE_{FC,j,y}$ *(16)*		2010	2011	2012	2013	2014	2015	2016
PE_y	*Project emissions in year y (tCO_2e/yr)*	144	153	161	168	176	183	191
$PE_{EC,y}$	*Emissions from consumption of electricity in the project case (tCO_2e/yr)*	117	126	133	141	149	156	164
$PE_{FC,j,y}$	*Emissions from consumption of heat in the project case (tCO_2e/yr)*	27	27	27	27	27	27	27

$PE_{EC,y} = EC_{PJ,y} * EF_{grid} * (1+TDL_y)$ (TE.1)		2010	2011	2012	2013	2014	2015	2016
$PE_{EC,y}$	*Project emissions from electricity consumption by the project activity during the year y (tCO2 / yr)*	117	126	133	141	149	156	164
$EC_{PJ,y}$	*Quantity of electricity consumed by the project activity during the year y (MWh)*	191	204	217	230	242	254	266
EF_{grid}	*Emission factor for the grid in year y (tCO2/MWh)*	0.5126	0.5126	0.5126	0.5126	0.5126	0.5126	0.5126
TDL_y	*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.*	20%	20%	20%	20%	20%	20%	20%

$PE_{FC,j,y} = \Sigma FC_{i,j,y} * COEF_{i,y}$ (TF.1)		2010	2011	2012	2013	2014	2015	2016
$PE_{FC,j,y}$	*Emissions from consumption of heat in the project case (tCO_2e/yr)*	27	27	27	27	27	27	27
$FC_{i,j,y}$	*Quantity of fuel type i combusted in process j during the year y (mass or volume unit / yr) (LPG)*	0.43	0.43	0.43	0.43	0.43	0.43	0.43
$COEF_{i,y}$	*CO_2 emission coefficient of fuel type i in year y (tCO_2/mass or volume unit)*	63.1	63.1	63.1	63.1	63.1	63.1	63.1

$ER_y = BE_y - PE_y$ (17)		2010	2011	2012	2013	2014	2015	2016
ER_y	*Emission reductions in year y (tCO_2e/yr)*	129,426	138,447	164,409	172,970	204,270	212,537	220,698
BE_y	*Baseline emissions in year y (tCO_2e/yr)*	129,570	138,600	164,570	173,138	204,446	212,720	220,889
PE_y	*Project emissions in year y (tCO_2e/yr)*	144	153	161	168	176	183	191

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2010	129,570	144	0	129,426
2011	138,600	153	0	138,447
2012	164,570	161	0	164,409
2013	173,138	168	0	172,970
2014	204,446	176	0	204,270
2015	212,720	183	0	212,537
2016	220,889	191	0	220,698
Total	**1,243,933**	**1,176**	**0**	**1,242,757**
Total number of crediting years	**7 years**			
Annual average over the crediting period	**177,705**	**168**	**0**	**177,537**

B.7. Monitoring plan
B.7.1. Data and parameters to be monitored

Data / Parameter	**$LFG_{total,y}$**
Unit	Nm3
Description	Total amount of landfill gas captured at normal temperature and pressure
Source of data	Measured by a flow meter
Value(s) applied	Details of assumptions, calculations and resulting data are presented in sections B.6.3 and B.6.4.
Measurement methods and procedures	Continuous mass flow meters will be used to measure flow rates. Data will be recorded at least each two minutes, recorded electronically, and data will be kept during the crediting period and two years after. Data will also be aggregated monthly/yearly.
Monitoring frequency	
QA/QC procedures	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy
Purpose of data	
Additional comment	No separate monitoring of temperature and pressure is necessary when using flow meters that automatically compensate for temperature and pressure, expressing LFG volumes in normalized cubic meters (Nm3). Otherwise, biogas temperature and pressure shall be monitored as described in the tables below for each parameter in order to express LFG volumes in normalized cubic meters (Nm3).

Data / Parameter	$LFG_{flare,y}$
Unit	Nm3
Description	Amount of landfill gas flared at normal temperature and pressure
Source of data	Measured by a flow meter
Value(s) applied	Details of assumptions, calculations and resulting data are presented in sections B.6.3 and B.6.4.
Measurement methods and procedures	Data will be recorded at least each two minutes, recorded electronically, and data will be kept during the crediting period and two years after. Data will also be aggregated monthly/yearly.
Monitoring frequency	
QA/QC procedures	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.
Purpose of data	
Additional comment	No separate monitoring of temperature and pressure is necessary when using flow meters that automatically compensate for temperature and pressure, expressing LFG volumes in normalized cubic meters (Nm3). Otherwise, biogas temperature and pressure shall be monitored as described in the tables below for each parameter in order to express LFG volumes in normalized cubic meters (Nm3).

Data / Parameter	$LFG_{electricity,y}$
Unit	Nm3
Description	Amount of landfill gas combusted in power plant at normal temperature and pressure
Source of data	Measured by a flow meter
Value(s) applied	Details of assumptions, calculations and resulting data are presented in sections B.6.3 and B.6.4
Measurement methods and procedures	Continuous mass flow meters will be used to measure flow rates. Data will be recorded for each power plant at least each two minutes, recorded electronically, and data will be kept during the crediting period and two years after. Data will also be aggregated monthly/yearly.
Monitoring frequency	
QA/QC procedures	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy
Purpose of data	
Additional comment	No separate monitoring of temperature and pressure is necessary when using flow meters that automatically compensate for temperature and pressure, expressing LFG volumes in normalized cubic meters (Nm3). Otherwise, biogas temperature and pressure shall be monitored as described in the tables below for each parameter in order to express LFG volumes in normalized cubic meters (Nm3).

Data / Parameter	$PE_{flare,y}$
Unit	tCO2e
Description	Project emissions from flaring of the residual gas stream in year *y*
Source of data	On-site measurements / calculations
Value(s) applied	10% of CH4 in gas stream
Measurement methods and procedures	The parameters used for determining the project emissions from flaring of the residual gas stream in year y (PEflare,y) will be monitored as per the "Tool to determine project emissions from flaring gases containing methane". The parameters used for the determination of PEflare,y are LFGflare,y, wCH4,y, fvi,h, fvCH4,FG,h and tO2 ,h, Tflare
Monitoring frequency	
QA/QC procedures	Regular maintenance will ensure optimal operation of the flare. Analysers will be calibrated according to manufacturer's recommendations.
Purpose of data	
Additional comment	Note: A determination of PEflare,y using the flaring tool requires the measurements of a number of additional parameters. These are listed and described following the variables specifically mentioned in ACM0001.

Data / Parameter	$w_{CH4,y}$
Unit	m3 CH4 / m3 LFG
Description	Methane fraction in the landfill gas
Source of data	Measured by a gas analyzer
Value(s) applied	50%
Measurement methods and procedures	Methane content will be measured using a continuous gas analyzer. Data will be measured at least once per hour, recorded electronically, and data will be kept during the crediting period and two years after. Data will also be aggregated monthly/yearly.
Monitoring frequency	
QA/QC procedures	Gas analyzers should be subject to a regular calibration, maintenance and testing regime to ensure accuracy.
Purpose of data	
Additional comment	Paired values of the methane fraction of the landfill gas and LFG flow which are averaged for the same time interval will be used in the calculation of emission reductions

Data / Parameter	**T**
Unit	ºC
Description	Temperature of the landfill gas
Source of data	Measured.
Value(s) applied	0
Measurement methods and procedures	Data will be measured at least once per hour, recorded electronically. Data will also be aggregated monthly/yearly. Records will be kept during the crediting period and two years after.
Monitoring frequency	
QA/QC procedures	Measuring instruments should be subject to a regular maintenance and testing regime to ensure accuracy.
Purpose of data	
Additional comment	No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (Nm3).

Data / Parameter	**P**
Unit	Pa
Description	Pressure of the landfill gas
Source of data	Measured.
Value(s) applied	101,325 (1 atm at STP conditions)
Measurement methods and procedures	Data will be measured with pressure analyser at least once per hour, recorded electronically. Data will also be aggregated monthly/yearly. Records will be kept during the crediting period and two years after.
Monitoring frequency	
QA/QC procedures	Measuring instruments should be subject to a regular maintenance and testing regime to ensure accuracy.
Purpose of data	
Additional comment	No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (Nm3).

Data / Parameter	EL_{LFG}
Unit	MWh
Description	Net amount of electricity generated using LFG.
Source of data	Measured.
Value(s) applied	Details of assumptions, calculations and resulting data are presented in sections B.6.3 and B.6.4
Measurement methods and procedures	The quantities will be measured with electricity meters. The readings will be made at least once per hour and electronically stored in a spreadsheet. Data will be recorded during crediting period and two years after.
Monitoring frequency	
QA/QC procedures	Electric meters are quite accurate. Moreover, the meter will be calibrated periodically according to manufacturer's specification.
Purpose of data	
Additional comment	Required to estimate the emission reductions from electricity generation from LFG, if credits are claimed.

Data / Parameter	**Operation of the energy plant**
Unit	Hours
Description	Operation of the power plant
Source of data	Measured with run meter connected to the power plant.
Value(s) applied	8,000
Measurement methods and procedures	Records will be kept during the crediting period and two years after.
Monitoring frequency	
QA/QC procedures	Meters are quite accurate. But it will be calibrated according to manufacturer specifications.
Purpose of data	
Additional comment	This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational.

Data / Parameter	$PE_{EC,y}$
Unit	tCO_2
Description	Project emissions from electricity consumption by the project activity during the year y
Source of data	Calculated as per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 1)
Value(s) applied	Details of assumptions, calculations and resulting data are presented in section B.6.3
Measurement methods and procedures	As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 1)
Monitoring frequency	
QA/QC procedures	As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (Version 1)
Purpose of data	
Additional comment	-

Data / Parameter	$PE_{FC,j,y}$
Unit	tCO_2e
Description	Project emissions from fossil fuel combustion in process j during the year y
Source of data	Calculated as per the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"
Value(s) applied	27
Measurement methods and procedures	As per the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"
Monitoring frequency	
QA/QC procedures	As per the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"
Purpose of data	
Additional comment	

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

Data / Parameter	**$FV_{RG,h}$**
Unit	m3/h
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*.
Source of data	On-site measurements.
Value(s) applied	Not used in ex-ante estimates.
Measurement methods and procedures	Measured at least one per hour and electronically using a flow meter, and will be kept during the crediting period and two years after.
Monitoring frequency	
QA/QC procedures	Flow meters will be periodically calibrated according to the manufacturer's recommendation.
Purpose of data	
Additional comment	The same basis (dry or wet) is considered for this measurement when the residual gas temperature exceeds 60ºC.

Data / Parameter	**$fv_{i,h}$**
Unit	**-**
Description	Volumetric fraction of component i in the residual gas in the hour h
Source of data	On-site measurements using a continuous gas analyser.
Value(s) applied	Not used in ex-ante estimates.
Measurement methods and procedures	As a simplified approach (see Eq. 3a), only methane content of the residual gas will be measured and the remaining part will be considered as N2. Methane concentration would be measured at least once per hour using a continuous gas analyser, and data records will be kept during the crediting period and two years after.
Monitoring frequency	
QA/QC procedures	Analysers will be periodically calibrated according to the manufacturer's recommendation. A zero check and typical value check to be performed by comparison with a standard certified gas.
Purpose of data	
Additional comment	The same basis (dry or wet) is considered for this measurement when the residual gas temperature exceeds 60ºC.

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

Data / Parameter	**$fv_{CH4,FG,h}$**
Unit	mg/m3
Description	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour *h*
Source of data	Measurements by project participants using a continuous gas analyser
Value(s) applied	Not used in ex-ante estimates.
Measurement methods and procedures	Extractive sampling analysers with water and particulates removal devices or in situ analyser for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height). Sampling shall be conducted with appropriate 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. Monitoring frequency: Continuously. Values to be averaged hourly or at a shorter time interval.
Monitoring frequency	
QA/QC procedures	Analysers will be periodically calibrated according to manufacturer's recommendation. A zero check and a typical value check will be performed by comparison with a standard gas.
Purpose of data	
Additional comment	Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. Measurement instruments may read ppmv or % values. To convert from ppmv to mg/m3 simply multiply by 0.716. 1% equals 10 000 ppmv.

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

The following variables are required to determine the electricity consumption from the grid using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”, version 1.

Data / Parameter	**$EC_{PJ,y}$**
Unit	MWh
Description	On-site consumption of electricity provided by the grid and/or LFG-based power plant(s) and attributable to the project activity during the year y
Source of data	On-site measurements
Value(s) applied	Details of assumptions, calculations and resulting data are presented in section B.6.3
Measurement methods and procedures	Measured continuously, aggregated at least annually.
Monitoring frequency	
QA/QC procedures	Meters will be calibrated according to manufacturer’s speficications. Cross check measurements results with invoices for purchased electricity if relevant.
Purpose of data	
Additional comment	Note that the project electricity consumption is the sum of electricity consumption by the LFG blower and any other electrical equipment used in the project activity (i.e offices). Each has the same emissions factor for electricity generation and the same transmission and distribution losses. Therefore we need only measure the total electricity consumption here. See discussion in section B.6.1 around Eqs. (TE.1), (TE.1a) and (TE.1b).

Data / Parameter	**TDL_y**
Unit	**-**
Description	Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site
Source of data	One of the following options will be used: a) Recent, accurate and reliable data available within the host country. b) A default value of 20%. As per “Tool to calculate project, baseline and leakage emissions from electricity consumption” (version 1)
Value(s) applied	The default value is chosen, i.e., 20% for each year of the first crediting period.
Measurement methods and procedures	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.
Monitoring frequency	
QA/QC procedures	In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
Purpose of data	
Additional comment	Technical distribution losses do not take into account other types of grid losses (e.g. commercial losses/theft). In case there are no official data available, the default value of 20% will be used.

The following variables are required to determine the CO2 emissions from fossil fuel combustion using the “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”.

Data / Parameter	**$FC_{i,j,y}$**
Unit	Mass or volume unit per year (tonne/yr or m3/yr)
Description	Quantity of fuel type i combusted in process j during the year y
Source of data	Onsite measurements
Value(s) applied	Details of assumptions, calculations and resulting data are presented in section B.6.3.
Measurement methods and procedures	Use mass or volume meters
Monitoring frequency	
QA/QC procedures	The consistency of metered fuel consumption quantities should be crosschecked by an annual energy balance that is based on purchased quantities and stock changes Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Purpose of data	
Additional comment	For ex-ante calculation purposes, there will be no fossil fuel consumption at project scenario, but any eventual fossil fuel consumption will be accounted.

Data / Parameter	**$NCV_{i,y}$**
Unit	GJ per mass or volume unit (GJ/m3 or GJ/tonne)
Description	Weighted average net calorific value of fuel type i in year y
Source of data	The following data sources may be used if the relevant conditions apply:

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 Vol. 2 (energy) of the 2006 IPCC Guidelines on National GHG Inventories.	If a) is not available.

Value(s) applied	Details of assumptions, calculations and resulting data are presented in section B.6.3.
Measurement methods and procedures	As per “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”
Monitoring frequency	
QA/QC procedures	As per “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”
Purpose of data	
Additional comment	For ex-ante calculation purposes, there will be no fossil fuel consumption at project scenario, but any eventual fossil fuel consumption will be accounted.

Data / Parameter	**$EF_{CO2,i,y}$**
Unit	tCO2/GJ
Description	Weighted average CO2 emission factor of fuel type i in year y
Source of data	The following data sources may be used if the relevant conditions apply: **Data source** — **Conditions for using the data source** a) Values provided by the fuel supplier in invoices — This is the preferred source. 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 1.4 of Chapter 1 Vol. 2 (energy) of the 2006 IPCC Guidelines on National GHG Inventories. — If a) is not available.
Value(s) applied	Details of assumptions, calculations and resulting data are presented in section B.6.3.
Measurement methods and procedures	As per “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”
Monitoring frequency	
QA/QC procedures	As per “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion”
Purpose of data	
Additional comment	

B.7.2. Sampling plan

>>

Not applicable

B.7.3. Other elements of monitoring plan

>>

Unlike most methodologies that determine baseline and project emissions separately, and calculate emissions reductions as the difference between the two, the methodology ACM0001 determines emissions reductions directly. ACM0001 version 10 states:

"The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform(s) and the electricity generating/thermal energy unit(s) to determine the quantities as shown in Figure 1 [of ACM0001, Ver. 10] The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared. The main variables that need to be determined are the quantity of methane actually captured $MD_{project,y}$, quantity of methane flared ($MD_{flared,y}$), the quantity of methane used to generate electricity ($MD_{electricity,y}$)/thermal energy ($MD_{thermal,y}$), the quantity of methane sent to the pipeline to the natural gas distribution network ($MD_{PL,y}$) and the quantity of methane generated ($MD_{total,y}$).The methodology also measures the energy generated by use of LFG ($EL_{LFG,y}$, $ET_{LFG,y}$) and energy consumed by the project activity that is produced using fossil fuels".

An adjusted Figure 1 of ACM0001, Ver. 10 is shown as Figure 5 below.

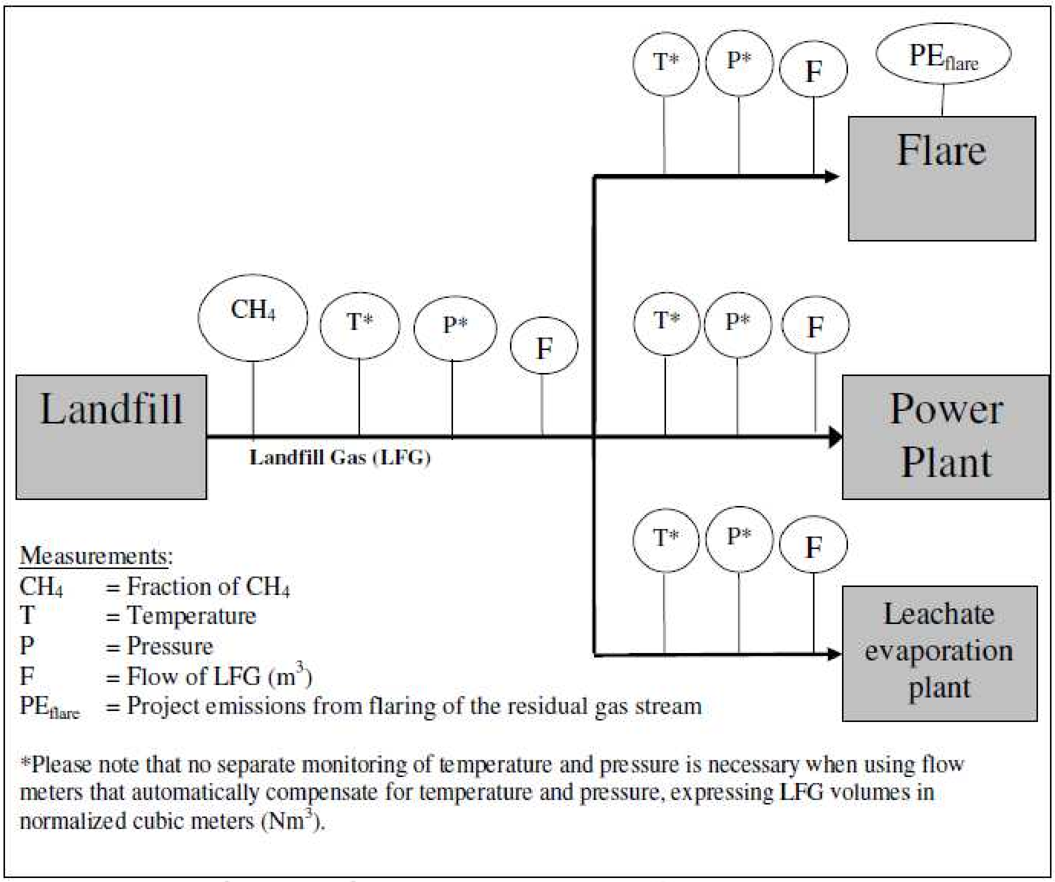

Figure 3. Schematic of the monitoring system, according to ACM0001 version 10.

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

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

PASA is the landfill operator and the investor of the proposed CDM project which involves investments for gas collection, flare equipment and possibly power generation, as well as additional operation, maintenance and monitoring costs.

The Technical Team of PASA will be responsible for the day-to-day operation of the landfill gas collection, flaring and use system. This Technical Team would also be responsible for monitoring key variables required for meeting the CDM monitoring requirements. PASA's Technical Team structure for monitoring the CDM project is shown in Figure 6.

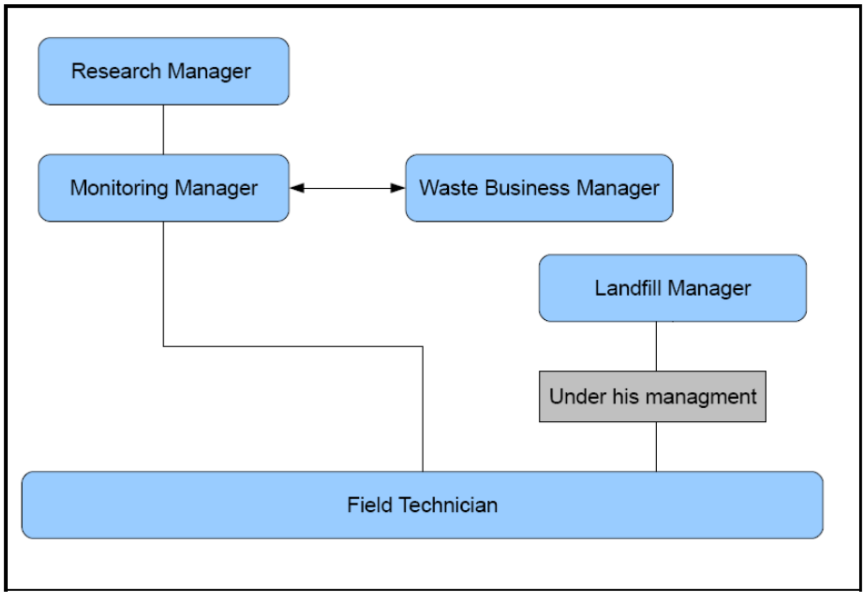

Figure 4. Operational Management Structure for El Verde Project Monitoring

Data monitoring will be conducted by Field Technicians supervised by the the Monitoring Manager.. Other staff persons will be assigned by the Landfill Manager to assist in the monitoring tasks, as needed (i.e., Research Manager and the Waste Business Manager)

Certain activities (such us calibration of flow meters, gas analyser and electric meters) would be conducted by independent, outside laboratories, with the data archived by the Monitoring Manager.

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

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

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

Note that the project proponent initially expects to collect LFG and flare it. This PDD leaves open the option of using some or all of the LFG to generate electricity, and supply excess electricity to the power grid. In such case, LFG used for generating electricity and total electricity generated would need to be measured. Therefore, in keeping with this eventuality, the monitoring plan includes procedures that would only be needed in the case for electricity generation. It is of course recognized that no power generation activities would be initiated until all necessary permits and authorizations are available.

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

Table 5. Operational Management Structure for El Verde Project Monitoring

#	Task name	Responsible	Frequency	Internal procedures of Quality Control	Documentation
1	Reading of landfill gas capture and gas flared/used	PASA Technical Team	Weekly. Data will be entered into a spreadsheet on a weekly basis, permitting continuous monitoring.	Yes	The data will be monitored and filed by PASA Technical Team.
2	Calibration of the flow meters	External calibration	Every 2 years, o according to manufacture's specifications	Yes	Calibration certificate will be issued by the Calibration Laboratory. This certificate will be filed by PASA Technical Team.
3	Measurements related to the determination of flare efficiency	PASA Technical Team	Continuous.	Yes	The data will be monitored and filed by PASA Technical Team.
4	Measurement of methane fraction in the landfill gas	PASA Technical Team	Continuous measurement, recording on a weekly basis.	Yes	Measured value will be used, together with corresponding measurements of pressure, temperature and flow rate of landfill gas, and other parameters that are periodically upgraded. Measurement of methane fraction would be recorded in an appropriate computer file, which would indicate start and end time of measurements corresponding to each data file. The data records will be filed by the person responsible for data filing and the Head of PASA Technical Team.
5	Other environmental indicators	PASA Technical Team	Annual	Yes	This data file will be completed and filed by the person responsible for data filing at PASA Project and by its Technical Team.
6	Monitoring of regulatory requirements relating to landfill gas projects	PASA Technical Team	Annual	No	PASA Technical Team will prepare the report on the current situation with respect to legal requirements.

#	Task name	Responsible	Frequency	Internal procedures of Quality Control	Documentation
7	Electricity generation and consumption from the grid	PASA Technical Team	Monthly	Yes	Data tables showing date, hour, and meter reading to be recorded in a spreadsheet file, and filed by the person responsible for data filing and by PASA Technical Team
8	Fossil fuel use (diesel, propane, etc)	PASA Technical Team	Fossil fuel purchase will be recorded on delivery, with totals recorded monthly	Yes	Data tables showing date and amount of fossil fuel (diesel) purchased (data obtained from invoices) to be recorded in a spreadsheet file by the person responsible and checked by PASA Technical Team,.
9	Operation of the flare(s) and possibly the power plant(s)	PASA Technical Team	Continuous measurement recording on a annual basis	Yes	The data will the monitored and filed by PASA Technical Team.
10	Electric meter calibration	PASA Technical Team	As per manufacturer's specifications	Yes	Calibration certificate will be issued by the Calibration Laboratory. This certificate will be filed by PASA Technical Team.
11	Gas analyzer calibration	External calibration/PASA	Every year, or according to manufacture specifications	Yes	Calibration certificate will be issued by the Calibration Laboratory/entity. This certificate will be filed by PASA Technical Team.

SECTION C. Duration and crediting period
C.1. Duration of project activity
C.1.1. Start date of project activity
>>
26/10/2007

This is the date on which project proponent has commited to expenditures related to the implementation and construction of the project activity (contract with SCS Engineers for engineering services related to landfill gas capture and use). See key dates and explanations at the start of Section B.5.

C.1.2. Expected operational lifetime of project activity
>>
23 years from start of operation, expected in January 2010. 25 years from the start date as defined above

C.2. Crediting period of project activity
C.2.1. Type of crediting period
>>
Renewable.

C.2.2. Start date of crediting period
>>
01/01/2010 or the registration date, if this is after 01/01/2010.

C.2.3. Length of crediting period

7 years

SECTION D. Environmental impacts
D.1. Analysis of environmental impacts
>>
Landfill gas collection, treatment and flaring are measured to improve the environmental management of waste in landfills. The detailed design and engineering of the proposed project will be conducted by PASA and a leading consulting company on landfill gas management.

- The project implementation would provide a number of local environmental benefits in addition to climate change mitigation:

- Destruction of non-methane hydrocarbons (NMHC) that contribute to photochemical smog in the local area. Moreover, volatile organic compounds are burnt in high-temperature flare, specially designed for this purpose;

- Destruction of air pollutants, such as hydrogen sulphide, that are sometimes present in landfill gas in trace quantities;

- Reduced fire and explosion risk through improved management of landfill gas.

- Reduced odour as landfill gas is captured and flared;

- Avoidance of methane leaking through the landfill cover. LFG displaces oxygen in the soil, thereby harming the roots of plants. Plants on the landfill surface protect the cover soil from erosion.

Erosion can lead to rainwater intrusion into the landfill and a consequent increase in leachate quantities. Erosion of the surface soil makes it more difficult for plants to grow. Plants promote transpiration of water, thereby minimizing both leachate and rainwater runoff.

Note that LFG combustion would produce small amounts of nitrogen oxides (NOx), particulate matter and carbon monoxide (CO), as would be the case in the kitchen stove or any other device burning natural gas.

The emissions of such gases are not regulated in Mexico. Nevertheless, the project would use an enclosed flare specially designed to reduce these emissions to levels below that of an open flame. Note, however, that since the main fuel is methane, the emissions of particulate matter would be minimal. On the other hand a LFG flare is specially designed to operate at high temperature in order to burn the volatile organic compounds.

The landfill already has the permit necessary to operate the landfill as well as the proposed project activity, insofar as landfill gas collection and flaring:

- Authorization MIA-026-3357/2000 of December 10th, 2000. Guanajuato State Environment, Authority - Institute of Ecology (Instituto de Ecología del Gobierno del Estado de Guanajuato). This Authorization also states that the Environmental Impact Assessment presented during the landfill conception and construction complies with the laws in force for LFG capture and use.

- Concession contract SPM/CRS/01/2000 between PASA the Public Service of Cleaning, Use and Final Disposal of Municipal Waste of León, Guanajuato (Servicio Público y de Limpia, Aprovechamiento y Disposición Final de los Residuos Municipales de León, Guanajuato).

The proposed project would not require a modification of the current Enviromental Impact Assessment (issued on December 20, 2000 by the Guanajuato Ecology Institute, MIA-026-3357/2000), as is stated in the document no. PAYDS-DS-902-2007 emited by the Sustainable Development Ministry of Leon Government.

At present, the project operator (PASA) expects to initially flare the LFG. The project proponent recognizes that the current permits do not include power generation. ***If at some point PASA decides to generate electricity, it will solicit all necessary permits prior to electricity generation.***

D.2. Environmental impact assessment
>>
No significant negative impacts are expected, as discussed in section D.1.

SECTION E. Local stakeholder consultation
E.1. Solicitation of comments from local stakeholders
>>
On October 3, 2007, letters were sent by José Eleazar López Araiza Alday, General Director or Environmetal Protección of Guanajuato with return receipt in order to invite persons to attend the 1st stakeholders presentation meeting. A total of 58 people were invited to attend the meeting from different sectors.

On January 23, 2009, letters were sent by Eleazar López Araiza Alday, General Director or Environmetal Protection of Guanajuato with return receipt in order to invite persons to attend the 2nd stakeholders presentation meeting. A total of 39 people were invited to attend the meeting from different sectors.

The sectors are listed below:

(14) Non-governmental organizations and/or consultancies and academic sector
(25) Local and Federal government

(3) Private sector
(15) Additional persons, representing the surrounding communities

The 1st public event was held on October 16th at the Guanajuato Room in Hotel La Nueva Estancia in León, Guanajuato State, Mexico. This event was also open to the public in general, permitting an opportunity for all persons and institutions that feel affected by the project to provide their input to the proposed project activity.

The 2nd public event was held on January 30th at the events room of the greenhouse of the Park "Los Cárcamos" León, Guanajuato State, Mexico. This event was also open to the public in general, permitting an opportunity for all persons and institutions to provide their input.

The following table lists all the people that attended the 1st meeting and /or submitted any comment (not including PASA's personnel):

Table 6. People that attended the 1st stakeholder meeting of El Verde Landfill Project

Name	Charge	Company/Institution
Laura Maldonado Chavez	Chief of Environmental Management Unit	SEMARNAT
Blanca E. Moreno Valles	Director	Control and Management of Solid Waste
Dora Alicia Garcia Cruz	President of Settler Committee	Paseo De Los Laureles Committee
Angelica Ramirez Estrada	General Secretary	Paseo De Los Laureles Committee
Hector Reyes O		UMVALEON
Ivonne Marquez	General Attendant	Invited
Yinyer Bastidas	Housewife	Invited
Carlos Aaron Avila Plascencia	Fixed Sources Department	Institute of Ecology
Belen Ramirez Hernandez		Environmental Education
Jose Refugio Rocha Elias	Area Chief	Paydes, Environmental Education
Sergio Moreno T		León Town Hall
Gabriela Torral Vivero	General Director	La Palabra Magazine
Luz Adriana Rocha Gomez	Promoter	Environmental Education
Monica Aspeitia Gonzalez		Environmental Education
Cinthya G		A.M.
Cecilia Pimentel		Education and Environmental Management
Raul Tapia		Hermanos Tapia Ecologist Group
Alejandro Perez	Press Coordinator	Secretary of Sustainable Development
Luz Cristina Moreno	Coordinator of Control and Administration	Environment Protection and Solid Waste
Alicia Zuñiga	Technical Coordinator	PA Y DS
Maria Eugenia Gonzalez		PA Y DS
Ivan Jose M		S.E.C Y D
Iris Bañuelos		Televisa-Carpeta Information
Juan Carlos Samarrina Perez	Coordinator of Environmental Fulfillment	Control and Management of Solid Waste

Name	Charge	Company/Institution
Teresa Gonzalez Rodriguez	Environmental Director	Improvement and Environmental Assessment
J. Refugio	Information Chief	El Heraldo
Lorena Perez		Televisa
Noe Garcia		A.M.

Fernando Avila Gonzalez	Advisor	H. Town Hall
Luis Efren Ramos		Tv4
Estefania Flores		Tv4
Maria Elena Duran Padilla	General Coordinator	Public Security of Civil Protection
Andres Contreras S	Director of the Industrial Engineering Faculty	Leon University
Karla Gonzalez De La Mora		PA Y DS
Martha Alicia Perez	Coordinator	UNIVA
J. Jesus Gaytan F	Director of Civil Engineering	Leon University
Juan Antonio R		Monterrey Technician
Santiago Vargas	Director of Environmental Regulation and Verification	PA Y DS
Valeria Vivero	Support of Technical Direction	SEDESU
Jose De Jesus Vazquez G	Representative of Lagunillas Community	
Jose Alejandro Martinez P		PA Y DS
Ricardo Froylan Garcia B	Enlace De La Juventud	Angel A. C. Group
Fabiola Moreno Villegas		Environmental Education
Ivonne Garcia Lira	Coordinator of Sustainable Education Institutions	Environmental Education, Environmental Secretariat
Jesus Montoya		A.M.
Ricardo Ramirez H	Promoter	Environmental Education
Angelica Ramos		
Federico Pimentel	General Coordinator of Environemtal Management	PA, León Guanajuato Municipality
Hector Nava M	Projects Coordinator	S.O.P
Simon Pablo Gonzalez	Technical Secretary	General Director of Environmental Protection
R. Barrera		Televisa
Elba Valdivia	Chief of Environmental Assessment	Improvement and Environmental Impact, Environmental Protection
Salvador Lara Garcia	Coordinator of Emissions to Atmosphere	Improvement and Environmental Impact
Luis Miguel Lopez		Newspaper A.M.
Carlos Magdaleno	Director	NAFINSA
Fernando Araiza M	Public Coordinator	Angel A.C., Clase Ciudadana AC
Paulina Ramirez	Reporter	Multimedios TV
Alberto Gonzalez	Camera Man of Newscast	Multimedios
Gabriel Villagrana Garcia	Advisor	H. Town Hall
Jose Eleazar Lopez	General Director	Sedesu
Sergio Navarro	Advisor	H. Town Hall
Juan Jose Medina	Director of Municipal Education Development	Secretary of Education, Culture and Sports
Monserrat Castañeda	Reporter	AM newspaper

The following table lists all the people that attended the 1st meeting and /or submitted any comment (not including PASA's personnel):

Table 7. People that attended the 2nd stakeholder meeting of El Verde Landfill Project

Name	**Company/Institution**
Belen Ramirez Hernandez	Environmental Protection
Edgar Villanueva	Univa
Gustavo Arguello	Environmental Protection

Simon Pablo Gonzalez	Environmental Protection
Fabiola Moreno Villegas	Environmental Protection
Cecilia Pimentel	Environmental Protection
Teresa Gonzalez Rodriguez	Environmental Protection
Angeles Abracon	Gen Industrial
Raul Osuna	Gen Industrial
Martha Fuentes	Gen Ambiental
Marcos Llamas	Social Comunication, Municpality President
Jose Refugio Rocha Elias	Environmental Protection
Dagaberto Paez	Lic. Sergio Navarro Representation
Juan Gerardo Morales	Gen Landfill
Lilia Veronica Ramirez	Environmental Protection
Juan Macias Contreras	Environmental Protection
Carla Gonzales De La Mora	Environmental Protection
Veronica Cornejo	Gen Industrial
Alicia Zuñiga	Rda Environmental Protection
Jorge Lopez	Environmental Protection
Ivonne Garcia Lira	Environmental Protection
Elba Valdivia	Environmental Protection
Panfilo Santos Martinez	Coordinatior Of Education, Culture And Recreation Of Municipality
Alfonso Martinez	Pasa
Lourdes Fernandez	Mgm International
Jose De Jesus Vazquez	Member Of Lagunillas Municipality
Maria De La Luz Martinez Martinez	Financial Of The Municipality
Jose Alejandro Martinez	Environmental Education Municipality
Laura Maldonado Chavez	Environmental Protection
Angelica Ramirez Estrada	General Secretariat, Municipality
Monica Aspeitia Gonzalez	Consultant
Federico Pimentel	Environmental Protection
Blanca E. Moreno Valles	Waste Sustainable Management, Municipality
Maria Eugenia Hernandez	Environmental Protection
Jose Santiago Vargas	Environmental Protection
Juliana Banda	Environmental Protection
Raul Tapia Flores	Advisor
J. Carlos Samarriego	Environmental Protection
Miguel Gastelun	Pasa
Hector Nava Muguiro	Public Construction Local Municipality
Julio Rodriguez	Gen Landfill
Fernando Aranza	Case Ciudadano Ac
Ignacio Aviña Franco	Environmental Education Municipality
Renata Perez	Environmental Protection
Jose Lopez Araiza	Environmental Protection

Support material of the 1st meeting:

- PowerPoint presentation of the project
- Brochure with the Executive Summary of the project
- Invitations

Support material of the 2nd meeting:

- PowerPoint presentation of the project
- Invitations

During the meeting, questionnaires were distributed to the people in order to stimulate comments on the project.

PROMOTORA AMBIENTAL	El Verde Landfill Gas Recovery Project	mgm INTERNATIONAL

YOUR OPINION IS IMPORTANT TO US

Please, answer the following questions and include all the pertinent comments in the columns on the right.

Question	Answer/Comment/Opinion
With reference to climate change, the Kyoto Protocol and the Clean Development Mechanism, briefly express your opinion on the "El Verde Landfill Gas Recovery Project".	
Would you recommend private companies, government authorities and other organizations to develop projects of this nature: the capture and flaring and/or use of landfill gas as a contribution to the sustainable development?	
Do you believe "El Verde Landfill Gas Recovery Project" will contribute to the social, economic and environmental development (Sustainable Development) of the region and Mexico?	
Are there any additional comments you would like to make?	

Please, write your personal data:

- Name and Last name:
- Institution/Organization that you represent:
- Position:
- E-mail:
- Telephone:

Signature:

Please, return this survey at the end of the meeting or send it back to the following addresses. Do not hesitate to consult us if you have any doubts. Thank you very much.

PROMOTORA AMBIENTAL S.A.
Julio César Martínez (1st meeting), Alfonso Martínez (2nd meeting)
jrodriguez@gen.tv, amartinezmu@gen.tv
Fax:

MGM INTERNATIONAL
Casiopea Ramírez (1st meeting) Lourdes Fernández (2nd meeting)
cramirez@mgminter.com, lfernandez@mgminter.com
Fax: (55) 2454.9139

PASA
Blvd. Antonio L. Rodríguez
1884 Torre 1 Piso 8 y 9
Col. Santa María
Monterrey, N.L.
Tel. (81) 8122-7600
www.gen.tv

MGM INTERNATIONAL
Ometusco 7, piso 6,
Col. Hipódromo-Condesa.
México D.F.
Tel: (55) 2454.9136 al 38
E-mail: cramirez@mgminter.com
www.mgminter.com

E.2. Summary of comments received

>>

In general, the comments obtained regarding to the project presentation were positive. Some remarkable aspects mentioned were the contribution of this type of projects for improving waste management and reducing odours, benefiting the surrounding communities. Most of the participants expressed their interest in replicating these greenhouse gas emission reduction projects in Mexico and to receive more information about projects that reduce GHG emissions. The project contribution to greenhouse gases mitigations was clearly understood.

During the second meeting, the comments obtained regarding to the project presentation were positive. The stakeholders were interested in the price of the CERs and how the CERs are estimated and which factors affects the estimations.

E.3. Report on consideration of comments received
>>

During the questions and answers session in the event held, participants expressed concern about several issues. Below we provide a list of the questions raised and answers given by PASA's representatives:

Q.- For how long will the landfill continue to produce gas using the waste that already exists?

A.- Maximum gas production is reached during the first 3 or 4 years after a cell is closed. Since this landfill is currently operating, it is estimated that it will continue to produce good levels for 15 to 20 years.

Q.- What will happen as a result of the law that obliges the administration of the León Municipality to manage separated wastes?

A.- The specific conditions for this type of projects do not exist here, due to the education level of people and the lack of infrastructure. The important thing about this project is that no gases will be released as in the current scenario; however, the Municipality needs private funds to finance this initiative.

Q.- Is it worth to spend millions to flare the gas or is it better to focus economic efforts on generating a model for the management of organic waste?

A.- The project focuses on the existing scenario; the problem is that the management of organic waste costs about 5-10 times more. In Mexico, the organizations do not have an incentive to pay this cost right now to not pay it in the future; the simplest thing to do, in the next 5 years, is to continue with the current method to collect waste and to maintain it in the landfill. The conversion of the system is good from the environmental point of view, but it involves a risk for PASA's business. The Kyoto Protocol will remain valid for another 5 years, so the project will be covered for that period.

Q.- If there exist previous studies, why not invest in electric generation from the beginning?

A.- Although there are studies, it is necessary to analyze wells and monitor the gas to be sure about the measurements; generally, the EPA models are used, but the Protocol says that measurements must be carried out.

Q.- If Mexico is obliged to reduce emissions in 2012, how will the market be managed?

A.- This issue is being currently discussed since Mexico contributes with very low emissions. The United Nations program related to Latin America and the Caribbean is focused on stopping deforestation and involves a voluntary carbon market. Probably, a similar mechanism will continue to operate.

Q.- What do gas flares generate?

A.- They do not generate electricity, only Carbon Credits. It is just a very efficient monitored flaring.

Q.- Does PASA have agreements with universities for the investigation of Bioenergy generation?

A.- Yes, PASA has an agreement with the Universidad de Nuevo León and the Fundación Mundo Sustentable (Sustainable World Foundation) will develop a course on climate change with an area of investigation.

Q.- Can a pilot compost project be implemented per colony in order to not spend so much money?

A.- A compost project per colony (neighborhood) is not recommended, it is better to transport the already separated waste to a single location. Currently, León already has separation programs and education is being provided in schools and colonies. Leon is now interested in making the most of waste. In the Mochis, PASA has an integral service where it collects municipal waste and transports it to a separation plant, where compost is produced and commercialized.

Q.- Which are the local environmental benefits that the project will generate?

A.- The odur will be reduce as the same as fire risk. The lecheate evaporation will reduce the risk of underwater contamination. PASA is inviting to the engineering students to make their professional practices in the Landfill to get experience to develop future Mexican projects.

Q.- Does the validator will be agreed with the current emissions estimations?

A.- The CERs estimations of the PDD are theorical based in a approved CDM methodology, the PDD complies with this methodology and the validator will review it, and give his expert opinion.

Q.- How you estimate the price of the CERs?

A.- The CERs price has been changing during the last year, it depends on the offer and demand. There are some web pages as Point Carbon web page that gives an idea of the current price of the CERs.

SECTION F. Approval and authorization

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Appendix 1: Contact information of project participants

Organization name	Promotora Ambiental S.A.B. de C.V.
Street/P.O. Box	Blvd. Antonio L. Rdz. N. 1884 Pte. Col. Santa Maria
Building	Parque Torre I, piso 8
City	Monterrey
State/Region	Nuevo León
Postcode	64650
Country	Mexico
Telephone	52 81 8122 7600
Fax	52 81 8122 7600 ext. 194
E-mail	
Website	http://www.gen.tv/
Contact person	
Title	Manager of Research and Development
Salutation	Dr.
Last name	Muñoz
Middle name	Martínez
First name	Alfonso
Department	R&D
Mobile	8116112509
Direct fax	52 8181 227600 ext. 194
Direct tel.	52 8181 227600 ext. 316
Personal e-mail	amartinezmu@gen.tv

Appendix 2: Affirmation regarding public funding

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

Appendix 3: Applicability of selected methodology

Not applicable. See Section B.2.

Appendix 4: Further background information on ex ante calculation of emission reductions

BASELINE INFORMATION

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

The Annex contains two items:

1. A derivation of the parameters used to estimate landfill gas generation from solid waste using the "Tool to determine methane emissions from disposal of waste at a solid waste disposal site", version 4, from Executive Board 41st Meeting Report, Annex 10. These parameters are only used in the ex-ante estimation of emissions reductions; and
2. A calculation of the emissions factor for power generation in the interconnected power grid in Mexico, using the "tool to calculate the emission factor for an electricity system", from Executive Board 35th Meeting Report, Annex 12. Version 1.1 of the Tool was used here.

Methane emissions reductions from landfill gas capture

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

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

The k-parameters needed as input in the "tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site", ver. 4, are based on IPCC recommendations (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 5). The tool is described in detail below.

The tool states:

"The amount of methane that would in the absence of the project activity be generated from disposal of waste at the solid waste disposal site (BECH4,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 until end of year y, for which baseline emissions are calculated (years x with x=1 to x=y)."

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

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

Where:

$BE_{CH4,SWDS,y}$	= Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO2e)
φ	= Model correction factor to account for model uncertainties (0.9)
f	= Fraction of methane captured at the SWDS and flared, combusted or used in another manner

GWP_{CH4}	= Global Warming Potential (GWP) of methane, valid for the relevant commitment period
OX	= Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering waste)
F	= Fraction of methane in the SWDS gas (volume fraction) (0.5)
DOC_f	= Fraction of degradable organic carbon (DOC) that can decompose
MCF	= Methane correction factor
$W_{j,x}$	= Amount or organic waste 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. 10.
y	= Year for which methane emissions are calculated

The tool used is usually for project activities that would avoid methane avoiding waste disposal at landfills. But in the same way, the methane generation can be estimated for landfills, only taking into account different years: the first year is the year of landfill opening and the last year is the last year of the project activity.

Hence, the above equation is used to estimate methane generation for a given year from all waste disposed up through that year. Multi-year projections are developed by varying the projection year and re-applying the equations. The year of maximum LFG generation normally occurs in the closure year or the year following closure (depending on the final year's disposal rate).

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

<table>
<tr><th>Variable</th><th>Value</th><th>Justification</th></tr>
<tr><td>φ</td><td>0.9</td><td>Default value recommended in methodology is used here.</td></tr>
<tr><td>f</td><td>50%</td><td>Conservative value according to observation to other landfills with active LFG extraction systems in place.</td></tr>
<tr><td>GWP_{CH4}</td><td>21</td><td>Global Warming Potential (GWP) of methane, valid for the first commitment period of the Kyoto Protocol (up to 2012).</td></tr>
<tr><td>OX</td><td>0</td><td>Oxidation factor in a well managed landfill with a good cover is not considerable and can be estimated as zero.</td></tr>
<tr><td>F</td><td>0.5</td><td>Most waste in SWDS generates a gas with approximately 50 percent of CH_4. Only material including substantial amounts of fat or oil can generate gas with substantially more than 50 percent of CH_4. Taking into account the IPCC default value, MGM estimates future methane content in landfill gas to be 50 percent.</td></tr>
<tr><td>DOC_f</td><td>0.5</td><td>The decomposition of degradable organic carbon does not occur completely and some of the potentially degradable material always remains in the site even over a very long period of time. IPCC recommends that values should vary from 0.5 to 0.77. Default value recommended in methodology is used here.</td></tr>
<tr><td>MCF</td><td>1.0</td><td>El Verde landfill is very well managed, with daily cover with soil, leachate drainage system and waste thickness is higher than 5 meters. The value is chosen according to IPCC table, cited in methodology:
<table>
<tr><th>MCF value</th><th>Type of site</th></tr>
<tr><td>1.0</td><td>For anaerobic managed solid waste disposal sites. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) levelling of the waste.</td></tr>
<tr><td>0.5</td><td>For semi-aerobic managed solid waste disposal sites. These must have controlled placement of waste and will include all of</td></tr>
</table>
</td></tr>
</table>

	the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating poundage; 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.

$W_{j,x}$

Year	Waste input in El Verde Landfill (tonnes)
2001	263,856
2002	457,000
2003	448,379
2004	460,456
2005	474,761
2006	473,499
2007	484,508
2008	456,675
2009	*469,005*
2010	*481,668*
2011	*494,673*
2012	*508,030*
2013	*521,746*
2014	*535,834*
2015	*550,301*
2016	*565,159*
2017	*580,418*

The historical waste disposal data from 2001 to 2008 were provided by landfill operator. See file "Waste quantities 2001-08.xls". Projections from 2009 on are based on historical population growth rate of 2.7% per year. File "Population of Leon.pdf" shows historical population data from the city of Leon whose waste is deposited at this landfill. File "Demographics Leon.xls" shows that population grew at 2.84% from 1980 to 1990, and 2.72% from 1990 to 2000. There might be a further slight decrease in the future. We assume a value of 2.7% for the life of the landfill. We are assuming that waste generation disposal grows at the same rate. The landfill is projected to close in 2017. Using our projections for future waste disposal, and the column "D" of the sheet "Waste" of the file "CER Calculation El Verde 18Dec09.xls" the landfill would have accumulated only 8.2 million tonnes by the end of 2017. Considering a compaction density average value of 0.77 tonnes/m^3 during the years 2001-2009 as shown in file "Waste quantities 2001-08 mod MGM 20Aug08.xls" the estimated 8.2 million tonnes to be disposed until 2017 would use a total volume of 10.6 million m^3, which is less than the 11 million m^3 considered as landfill volume in the Manifiesto de Impacto Ambiental (MIA). Hence, if we apply the same procedure as used in the MIA, based on total landfill volume, it would last several years longer, beyond 2017.

DOC_j

Waste type j	DOC_j (% wet waste)	Fraction of Waste Type *j*
A. Wood and Wood Products	43%	0.67%
B. Pulp, Paper & Cardboard (other than sludge)	40%	18.11%
C. Food, Food Waste, Beverages & Tobacco (other than sludge)	15%	37.44%
D. Textile	24%	2.62%
E. Garden, Yard & Park Waste	20%	7.54%
F. Glass, Plastic, metal, other inert	0%	33.62%
TOTAL		**100%**

Waste composition in El Verde Landfill. Note that the DOC_i values are based on % wet waste, since the waste fraction is also determined on this basis. Waste composition was measured and reported in a study prepared for PASA by "RH Auditoria y Gestion Ambiental". The categories, in original (Spanish), their English translation, and values are shown in the following table:

Waste categories Original, Spanish	Waste categories English	Weighted Average (%)
Carton	Cardboard	3.7316
Finos	(paper)	2.3381
Cartón encerado	waxed cardboard	0.757
Cuero	Leather	0.6113
fibra sintética	Synthetic fiber	1.1469
Hueso	Bone	0.5119
Hule	Rubber	0.0706
Lata	Tin can (iron)	1.0314
Lata aluminio	Aluminum can	0.2205
Loza y ceramic	Ceramic and tile	0.3577
Madera	Wood	0.6706
Material de construcción	Construction material	0.7889
Material ferroso	Ferrous metal	0.6659
Material no ferroso	Non ferrous metal	0.3804
Papel	Paper	11.283
Pañal deshechable	Disposable diapers	8.2055
Plástico rígido	Rigid plastics	7.9233
Plástico de película	Plastic film	7.0737
Poliuretano	Polyurethane	0.0315
Poliestireno	Polystyrene	0.8949
Residuo alimento	Food waste	36.938
Residuo jardín	Garden waste	7.5448
Trapo	Rags (textile)	2.6182

Vidrio color	Color glass	1.1349
Vidrio transparente	Transparent glass	2.9555
Varios	Various	0.1144

In this study, there were many more categories than in the methane avoidance tool. Given that there are many more categories in the study than in tool, we simplify the conversion through an intermediate result, shown in the following table:

#	Waste	%
1	Wood and wood products	0.67
2	Paper and Cardboard	18.11
3	Food waste	37.44
4	Textile	2.62
5	Garden, yard, and park waste	7.54
6	Sludge	0.00
7	Plastics	15.92
8	Leather and Rubber	0.61
9	Metals	2.66
10	Glass	4.20
11	Nappies (disposable diapers)	8.2
12	Other Inorganics – inert	2.0
	TOTAL	100.00%

The first five rows correspond to the first five categories in the tool to determine methane emissions avoided from dumping waste at a solid waste disposal site. Category 6 above is sludge, but there was no sludge in the waste analyzed. The remaining categories above (7 to 12) are all inert, and would fall into the sixth category of methane avoidance tool. Thus, waste composition as shown in the above table can be easily converted to the categories of the tool, as shown in the following table.

Waste type according with the tool to determine methane emissions avoided from dumping waste at a solid waste disposal site	Waste types according to categories shown in the above table	%
A. Wood and Wood Products	1	0.67%
B. Pulp, Paper & Cardboard (other than sludge)	2	18.11%
C. Food, Food Waste, Beverages & Tobacco (other than sludge)	3	37.44%
D. Textile	4	2.62%
E. Garden, Yard & Park Waste	5	7.54%
F. Glass, Plastic, metal, other inert	7 + 8 + 9 + 10 +11 + 12	33.62%
TOTAL		**100.00%**

k_j	(see table below)	Value according to IPCC (2006) Waste section, table 3, copied in the file: CER Calculation El Verde 18Dec09.xls. The annual average temperature at the project site is 19.2°C and the precipitation is 697 mm/year. The default values for each waste category under these weather conditions are presented in the table.
j	According to IPCC recommendations and for the categories in DOC_j	
x	2001	Start of landfill operations
y	2010 - 2016	Year for which methane emissions are calculated for first crediting period.

Type of k	**Temperate (MAT ≤ 20°C) Wet (MAP/PET > 1)**
Slow k1 - Pulp, Paper, Cardboard / Textiles	0.060
Slow k2 - Wood & Straw	0.030
Medium k3 - Garden & Park / Other Organics	0.100
Fast k4 - Food waste/sewage sludge	0.185

Methane Generation Potential [L0]:

The methane generation potential is the total amount of methane that a unit mass of refuse will produce given enough time. The L0 is a function of the organic content of the waste, water content and precipitation data.

The amount of methane released from solid waste, L0, is given by the following formula:

L0 = MCF x DOC x DOCf x F x 16/12 **(Eq. 1)**

Applying these values in Eq. 1, we obtain:

L0 = 0.0550 tonne CH_4/ tonne waste

Or, alternatively,

L0 = 76.76 Nm^3 CH_4/ tonne waste, considering CH_4 density of 0.7168 kg/Nm^3 (P = 1atm, T = 0 C).

For details of calculations, see CER 18Dec09.xls.

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

ACM0001 Ver. 10 recommends calculating the grid emission factor using the “Tool to calculate the emission factor for an electricity system”.

The tool in its version 1.1 states that: *“This methodological tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system, by calculating the “combined margin” (CM). The operating margin refers to a cohort of power plants that reflect the existing power plants whose electricity generation would be affected by the proposed CDM project activity. The building margin refers to a cohort of power units that reflect the type of power units whose construction would be affected by the proposed CDM project activity.”*

Moreover:

‘This tool may be referred to in order to estimate the OM, BM and/or CM for the purpose of calculating baseline emissions for a project activity substitutes electricity from the grid, i.e., where a project activity supplies electricity to a grid or a project activity that results in saving of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects). Note that this tool is also referred (…) for the purpose of calculating project and leakage emissions in case where a project activity consumes electricity from the grid or results in increase of consumption of electricity from the grid outside the project boundary”.

Hence, the combined margin calculated with this tool will be used for two cases: when El Verde Landfill Project is consuming energy from the grid in order to meet project energy demand and/or when the electricity generated with LFG is supplied to the grid and emission reductions will be claimed for energy displacement.

In order to calculate the emission factor so-called “combined margin”, the tool establishes the following six steps:

STEP 1. Identify the relevant electric power system.
STEP 2. Select an operating margin (OM) method.
STEP 3. Calculate the operating margin emission factor according to the selected method.
STEP 4. Identify the cohort of power unites to be included in the build margin (BM).
STEP 5. Calculate the build margin emission factor.
STEP 6. Calculate the combined margin (CM) emission factor.

STEP 1. Identify the relevant electric power system.

The grid emission factor is calculated based on the last version of the "Electricity Sector Prospective" developed by the Mexican Secretary of Energy (SENER)[29].

The relevant power system is the one where the landfill is located, and comprises all of Mexico, except Baja California and Baja California South, each of which has an isolated system, not connected to the rest of Mexico, or to each other.

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

Four different procedures are indicated for determining the operating margin emission factor ($EF_{grid,OM,y}$). These are denominated:

a. Simple Operating Margin.

b. Simple Adjusted Operating Margin.

c. Dispatch Data Analysis Operating Margin.

d. Average Operating Margin.

The tool states that the Simple Operating Margin method can only be used where low-cost/must run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term normals for hydroelectricity production.

In the proposed project activity, the method applied is the simple operating margin method (option A of the Tool), since low-cost/must-run resources of Mexico constitute less than 50% of the total grid generation in average of the five most recent years.

The tool further states that low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear, and solar generation. If coal is obviously used as must-run, it should also be included in this list, i.e. excluded from the set of plants.

Electricity generation in Mexico is dominated by thermal power plants. Thus, for this project activity, in the calculation of the operating margin emission factor, the Simple Operating Margin method has been selected from the four options proposed in the methodology. The following table shows that the low-cost/must run resources in Mexico constitute less than 50% of the total grid generation in average of the five most recent years.

[29] http://www.sener.gob.mx/webSener/portal/index.jsp?id=48#prop2008

Table 3.2 Power generation in Mexico[30]

Type	Low cost or must run	2003	2004	2005	2006	2007
Residual fuel oil and/or gas	no	73,743	66,334	65,077	51,931	49,482
Dual	no	13,859	7,915	14,275	13,875	13,375
Combined cycle	no	55,047	72,267	73,381	91,064	102,674
Gas turbine	no	6,933	2,772	1,358	1,523	2,666
Internal combustion	no	751	610	780	854	1,139
Hydroelectric	yes	19,753	25,076	27,611	30,305	27,042
Coal	no	16,681	17,883	18,380	17,931	18,101
Nuclear	yes	10,502	9,194	10,805	10,866	10,421
Geothermal	yes	6,282	6,577	7,299	6,685	7,404
Wind	yes	5	6	5	45	248

Table 3.3: Low cost/must run generation percentage in the total electricity generation in Mexico

	2003	2004	2005	2006	2007	
Total generation (GWh)	203,556	208,634	218,971	225,079	232,552	
Low cost/must run generation (GWh)	36,542	40,853	45,720	47,901	45,115	
Low cost/must run generation (%)	17.95%	19.58%	20.88%	21.28%	19.40%	**< 50%**

As shown above, the average low-cost/must run generation in the last five years is below 50%. Coal is not included under the low-cost/must run category, but even adding coal generation to it, it would be always lower than 50%.

The tool states that the operating margin emission factor can be calculated using one of the following data vintages:

- *Ex ante option: A 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factors during the crediting period, or*

- *Ex-post option: The year in which project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.*

In this particular PDD, the first, ex-ante option is selected. As a consequence, the operating margin emission factor is calculated ex-ante and it is considered fixed for the first crediting period.

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

As shown in STEP 2, the operating margin calculation method chosen was Simple OM (method a).

For calculating the operating margin emission factor, the generation-weighted average CO2 emissions per unit net electricity generation (tCO2/MWh) of all generating power plants serving the system excluding the low-cost/must run generation units is considered.

[30] Source: Electricity Sector Prospective 2008-2017, Page 85, Table 22.

Also, the tool gives three different options to calculate OM emission factor, as follows:

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

Here we chose Option C, because only net electricity generation and fuel consumption of the electricity system data is available. The OM emission factor is given by the formula:

$$EF_{grid,OMsimple,y} = \frac{\sum_i FC_{i,y} \times NCV_{i,y} \times EF_{CO_2,i,y}}{EG_y}$$

Where:

EFgrid,OMsimple,y	= Simple operating margin CO2 emission factor in year y (tCO2/MWh)
FEi,y	= Amount of fossil fuel type i consumed in the project electricity system in year y (mass or volume unit)
NCVi,y	= Net calorific value (energy content) of fossil fuel type i in year y (GJ / mass or volume unit)
EFCO2,i,y	= CO2 emission factor of fossil fuel type i in year y (tCO2/GJ)
EGy	= Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / unit, in year y (MWh)
i	= All fossil fuel types combusted in power plant / unit m 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) or the applicable year during monitoring (ex-post option), following the guidance on data vintage step 2

For determining the operating margin emission factor, it is necessary to determine the electricity imports. The Mexican electricity imports and exports with other electric systems are the following:

Table 3.4: Electricity exportation and importation[31] (GWh)

Year	**2003**	**2004**	**2005**	**2006**	**2007**
Imports (from USA)	71	47	87	523	277
Exports (to Guatemala, Belize and USA)	953	1,006	1,291	1,299	1,451
Net exchange	**882**	**959**	**1,204**	**776**	**1,174**

Electricity exports are not subtracted from electricity generation data used for calculating the grid emission factor.

There are no imports from other systems inside Mexico. For imports from connected electricity system located in another country, the emission factor is 0 tCO2/MWh.

Thus, the total generation of electricity considered in calculation of the operating margin emission factor results to be:

[31] Source: Electricity Sector Prospective 2008-2017, Page 96, Table 18.

Table 3.5: Electricity generation for OM emission factor calculation (GWh)

Year	2005	2006	2007
Total generation	218,971	225,079	232,552
Low cost/must run generation	45,720	47,901	45,115
Imports	87	523	277
Electricity generation for OM (Σ_j GEN_j)	173,338	177,701	187,714

The consumption of energy from fossil fuel is described in the table below, according to the balance of the Electricity Sector Prospective:

Table 3.6: Fossil fuel consumption for power generation[32]

Fuel	2005		2006		2007	
	% [1]	TJ/day	% [2]	TJ/day	% [3]	TJ/day
Diesel	0.90%	39	1.00%	44	0.50%	23
Coal	20.40%	893	20.00%	881	18.50%	837
Natural gas	39.60%	1,733	47.00%	2,071	52.00%	2,354
Residual fuel oil	39.10%	1,711	32.00%	1,410	28.90%	1,308
Total consumption (TJ / dia)	4,377		4,407		4,522	

The CO_2 emission coefficient of each fuel is obtained as shown in the table below:

Table 3.7: CO2 emission coefficient of each fuel[33]

Fuel	CO_2 emission factor (tCO_2/TJ)
Residual fuel oil	77.40
Natural gas	56.10
Diesel	74.10
Coal	94.60

Thus, total CO2 emissions from fuel combustion by the power plants, excluding low-operating cost andmust-run power plants, are shown in the following table:

Table 3.8: Total CO2 emissions

Year	CO_2 emissions (tCO_2/year)
2007	114,685,575
2006	113,879,260
2005	115,737,376

[32] Source: Electricity Sector Prospective 2006-2015, Page 90, Graphic 31Electricity Sector Prospective 2006-2015, Page 90, Graphic 31. Electricity Sector Prospective 2005-2014, Page 82, Graphic 30. Electricity Sector Prospective 2007-2016, Page 117, Graphic 40, Electricity Sector Prospective 2008 -2017 page 146 graphic 39

[33] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Table 1.4, Pages 1.23 and 1.24.

Thus, the operating margin emission factor results to be:

Table 3.9: Operating margin emission factor

Year	2005	2006	2007
Total CO_2 emissions (tCO_2/year) $\Sigma_i FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}$	115,737,376	113,879,260	114,685,575
Electricity generation for OM (GWh/year) EG_y	173,338	177,701	187,714
OM emission factor (tCO_2/MWh)	0.6677	0.6408	0.6110
Average OM emission factor (tCO_2/MWh)	**0.6398**		

From the above table, the figure for the operating margin emission factor is obtained as 0.6398 tCO2/MWh.

STEP 4. Identify the cohort of power units to be included in the build margin.

For the purpose of determining the build margin emission factor, the spatial extent is limited to the project electricity system, since the plans of transmission line construction for the next years to increase the electricity export capacity are very low and there are no plans to build any transmission line to Belize. For imports from the connected electricity system located in USA, the emission factor is 0 tCO2/MWh.

According to the methodology, the build margin emission factor can be calculated using one of the following options:

- *Option 1: For the first crediting period, calculate the build margin emission factor ex-ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the requested for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emissions factor during the crediting period.*

- *Option 2: for the first crediting period, the build margin emission factor shall be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emission factor shall be calculated ex-ante, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.*

In this particular case, the most recent data available would correspond to one or two years prior to the year in which project generation occurs, thus the Option 1 is selected among the two options proposed by the methodology. As a consequence, the build margin emission factor is calculated ex-ante and it is considered fixed along the first crediting period.

The sample group m consists of either:

a. *The five power plants that have been built most recently, or*

b. *The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.*

According to the methodology, from these two options, the sample group that comprises the larger annual generation should be used. As shown in the table below, the larger annual generation corresponds to the most recently built power plants capacity additions that comprise 20% of the system generation. The 20% of the system generation during 2007 results to be 0.20 × 232,552,000 MWh = 46,510,400 MWh.

Table 3.10: New power plants installed[34]

New power plants installed					
Year	**Central** [1]	**Capacity** [1] **(MW)**	**Technology** [2]	**Power generation** [2] **(MWh/year)**	**Accumulated power generation (MWh/year)**
2007	Ecatepec	32.00	TG		0
	Remedios	32.00	TG		0
	Victoria	32.00	TG		0
	Villa de las flores	32.00	TG		0
	La venta II 98 U	83.30	EOL	80,000	80,000
	Cuautitlan	32.00	TG		80,000
	Coyotepec	32.00	TG		80,000
	Coyotepec 2	32.00	TG		80,000
	El cajon 2	375.00	HYD	989,000	1,069,000
	El cajon 1	375.00	HYD		1,069,000
	Baja Califronia sur I	41.90	IC	430,000	1,499,000
	Tamazunchale	1,135.00	CC	4,117,000	5,616,000
	Holbox 8	0.80	IC		5,616,000
	Holbox 9	0.80	IC		5,616,000
	Vallejo	32.00	TG		5,616,000
	Santa Rosalia 9	1.60	IC		5,616,000
	Santa Rosalia 10	1.60	IC		5,616,000
	Santa Rosalia 11	1.60	IC		5,616,000
	Rio bravo 2	33.00	CC	2,957,000	8,573,000
	Rio bravo 3	33.00	CC	2,063,000	10,636,000
	Rio bravo 4	145.10	CC	2,576,000	13,212,000
2006	Valladolid III	525.00	CC	3,573,000	16,785,000
	Tuxpan V	495.00	CC	3,921,000	20,706,000
	Altamira V	1,121.00	CC	8,391,000	29,097,000
	Los Cabos	27.20	GT		29,097,000
	Chihuahua II (el encino)	65.30	CC	4,301,000	33,398,000
	Atenco	32.00	GT		33,398,000

[34] Source: Electricity Sector Prospective 2008-2017, Page 100, Table 19; Page 203 Table 5, Electricity Sector Prospective 2006 – 2015 Page 57, Table 13, Electricity Sector Prospective 2005 – 2014 Page 51 Table 14.
CC = Combined cycle; GT = Gas turbine; IC= Internal combustion; HYD = Hydroelectric; GEO = Geothermal

New power plants installed					
Year	**Central** [1]	**Capacity** [1] **(MW)**	**Technology** [2]	**Power generation** [2] **(MWh/year)**	**Accumulated power generation (MWh/year)**
	Holbox [3]	0.80	IC		33,398,000
	La Laguna II (PIE)	498.00	CC	3,521,000	36,919,000
	Río Bravo IV (PIE)	500.00	CC		36,919,000
2005	Botello [3]	9.00	HYD		36,919,000
	Yécora [3]	0.70	IC		36,919,000
	Ixtaczoquitlán [3]	1.60	HYD		36,919,000
	Hermosillo	93.30	CC	1,526,000	38,445,000
	Chicoasén (Manuel Moreno Torres)	900.00	HYD	3,378,000	41,823,000
	San Lorenzo Potencia [3] [4]	266.00	GT		41,823,000
2004	Tuxpan (Pdte. Adolfo López Mateos)	163.00	GT	10,189,000	52,012,000
	El Sauz	128.00	CC	2,939,000	54,951,000
	Guerrero Negro II [3] [4]	10.80	IC		54,951,000

In order to determine the fuel consumption of the sample group of power plants, the specific fuel consumption of each plant is estimated considering the most efficient factor of each technology provided in "Electricity Sector Prospective 2008-2017", as a conservative assumption.

STEP 5. Calculate the build margin emission factor

The build margin emission factor is calculated as the generation-weighted average emission factor (tCO2/MWh) of a sample of power plants, calculated in a similar way as the operating margin. The equation is given below:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

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

The CO2 emission factor of each power unit m (FEEL,m,y) is determined according to what the tool recommends, i.e., "*as per guidance in step 3 (a) for the simple OM*".

Finally, in order to calculate total CO2 emissions from fuel combustion by the sample group of power plants, the CO2 emission coefficients determined previously in Table 3.9 are used.

Fuel consumption of the sample group and the corresponding CO2 emissions are calculated as shown below[35].

[35] Source: Electricity Sector Prospective 2006-20015, Page 102, Table 39, Electricity Sector Prospective 2008 – 2017, Table 10 page 100 Table 19, Electricity SectorProspective 2005 – 2014 page 51, Table 14

Table 3.11: CO_2 emissions of the sample group of power plants

Year	**Central** [1]	**Efficiency** [1] **($MWh_{electric}$ / MWh_{fuel})**	**Fuel consumption (TJ/year)**	**CO_2 emission coefficient** [2] **(tCO_2/TJ)**	**CO_2 emissions (tCO)**	**Accumulated CO_2 emissions (tCO_2/year)**
2007	Ecatepec	N.A.	0	0.00	0	0
	Remedios	N.A.	0		0	0
	Victoria	N.A.	0		0	0
	Villa de las flores	N.A.	0		0	0
	La venta II 98 U	N.A.	0		0	0
	Cuautitlan	N.A.	0		0	0
	Coyotepec	N.A.	0		0	0
	Coyotepec 2	N.A.	0		0	0
	El cajon 2	N.A.	0		0	0
	El cajon 1	N.A.	0		0	0
	Baja Califronia sur I	0.378	4,095	74.10	303,457	303,457
	Tamazunchale	0.514	28,835	56.10	1,617,645	1,921,102
	Holbox 8	N.A.	0		0	1,921,102
	Holbox 9	N.A.	0		0	1,921,102
	Vallejo	N.A.	0		0	1,921,102
	Santa Rosalia 9	N.A.	0		0	1,921,102
	Santa Rosalia 10	N.A.	0		0	1,921,102
	Santa Rosalia 11	N.A.	0		0	1,921,102
	Rio bravo 2	0.514	20,711	56.10	1,161,859	3,082,961
	Rio bravo 3	0.514	14,449	56.10	810,590	3,893,552
	Rio bravo 4	0.514	18,042	56.10	1,012,158	4,905,709
2006	Valladolid III	0.514	25,025	56.10	1,403,897	6,309,606
	Tuxpan V	0.514	27,462	56.10	1,540,633	7,850,239
	Altamira V	0.514	58,770	56.10	3,296,977	11,147,216

	Los Cabos	N.A.	0	56.10	0	11,147,216
	Chihuahua II (el encino)	0.514	30,124	56.10	1,689,942	12,837,158
	Atenco	N.A.	0	56.10	0	12,837,158
2005	Holbox [3]	0.378	0	74.10	0	12,837,158
	La Laguna II (PIE)	0.514	24,661	56.10	1,383,465	14,220,623
	Río Bravo IV (PIE)	0.514	0	56.10	0	14,220,623
	Botello [3]	N.A.	0		0	14,220,623
	Yécora [3]	0.4507	0	74.10	0	14,220,623
	Ixtaczoquitlán [3]	N.A.	0		0	14,220,623
	Hermosillo	0.514	10,688	56.10	599,593	14,820,216
2004	Chicoasén (Manuel Moreno Torres)	N.A.	0		0	14,820,216
	San Lorenzo Potencia [3] [4]	0.3942	0	56.10	0	14,820,216
	Tuxpan (Pdte. Adolfo López Mateos)	0.3942	93,050	56.10	5,220,118	20,040,334
	El Sauz	0.514	20,584	56.10	1,154,787	21,195,121
	Guerrero Negro II [3] [4]	0.4507	0	74.10	0	21,195,121

Furthermore, the CO2 emissions were calculated following exactly the same procedure as has been done in estimating operating margin emission factor, as follows:

Table 3.12: Build margin emission factor

Total CO_2 emissions (tCO_2) $\Sigma\, EG_{m,y} \times EF_{EL,m,y}$	20,040,334
Electricity generation for BM (MWh) $\Sigma\, EG_{m,y}$	52,012,000
BM emission factor (tCO_2/MWh)	**0.3853**

Thus, an estimate for the build margin emission factor would be 0.3853 tCO2/MWh.

STEP 6. Calculate the combined margin emissions factor

In order to calculate the Combined Margin emission factor, the tool provides the following formula:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$

The default values indicated to be used for w_{OM} and w_{BM} are:

- *Wind and solar power generation project activities: wOM = 0.75 and wBM = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods, or*

- *All other projects: wOM = 0.5 and wBM = 0.5 for the first crediting period, and : wOM = 0.25 and wBM = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology refers to this tool,*

According to the nature of the proposed project, the combined margin is calculated as follows:

$$EF_{grid,CM,y} = 0.6398 \times 0.5 + 0.3853 \times 0.5 = 0.5126 tCO_2 / MWh$$

Note: The calculations are also shown in detail in “Electric Emission Factor Mexican grid 2009 corr 31oct09.xls”

Appendix 5: Further background information on monitoring plan

Detailed information is in section B.7.

Appendix 6: Summary of post registration changes

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History of the document

Version	Date	Nature of revision
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	EB 66 13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the project design document form for CDM project activities" (EB 66, Annex 8).
03	EB 25, Annex 15 26 July 2006	
02	EB 14, Annex 06b 14 June 2004	
01	EB 05, Paragraph 12 03 August 2002	Initial adoption.
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