Project design document form
(Version 12.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the project activity	Uberlândia landfills I and II
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	07
Completion date of the PDD	07/02/2022
Project participants	Energas Geracao de Energia Ltda. (Private Entity) Limpebrás Resíduos Ltda. (Private Entity) Asja Brasil Serviços para o Meio Ambiente Ltda. (Private Entity) Numerco Limited (Private Entity)
Host Party	Brazil
Applied methodologies and standardized baselines	ACM0001: Flaring or use of landfill gas, version 18.1;
Sectoral scopes	Sectoral Scope: 1 - Energy industries (renewable - / non-renewable sources) Sectoral Scope: 13 – Waste handling and disposal
Estimated amount of annual average GHG emission reductions	184,133 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>

The objective of the Uberlândia landfills I and II is to collect the landfill gas produced in the Uberlândia Landfill and use it to generate electricity. A total capacity of 4.278 MW will be installed, composed by 3 engines with individual capacity of 1.426 MW each. The CDM project activity is expected to export 196,599 MWh during the crediting period[1].

The Project will start operating its LFG collection, flaring and electricity generation in March 2012, and the production of emission reductions is estimated to start in September 2012, when the Project is expected to be registered as a CDM project activity.

Uberlândia Landfill comprises two adjoining solid waste disposal sites (SWDS), named Landfill I and Landfill II, both owned and operated by Limpebrás Resíduos Ltda. (Project Participant). The Landfill I started operating in July of 1995 and stopped receiving waste in September 2010. During the 15 years of lifetime, Landfill I received around 2,100,000 tonnes of domestic waste, disposed in 150,000 m^2 of a total area of 300,000 m^2, being operated under the most strict environmental care, for which the landfill was awarded with the Borboleta de Ouro prize, given by the state environment entity, Fundação Estadual do Meio Ambiente – FEAM, as the best landfill of Minas Gerais state.

The Landfill II started operating in October 2010 with the same environmental care applied to the previous disposal site and counts on a qualified and multidisciplinary team of technicians. The landfill has a total area of 300,000 m^2, with 200,000 m^2 dedicated to disposal of waste, being able to receive till 4,500,000 m^3 of solid waste for an approximately 18 years of lifetime. All the area was sealed with a membrane of High Density Polyethylene (HDPE) and compacted clay in order to protect the phreatic layer from contamination.

The leachate generated in each landfill is given a different treatment. For Landfill I the leachate is treated at an ascendant flow anaerobic reactor followed by an anaerobic filter and then sent to the Uberabinha's sewage treatment station (ETE Uberabinha) through municipal canalization. The leachate from Landfill II, after being analysed by the Municipal Department of Water and Sewage (Departamento Municipal de Água e Esgoto – DMAE), was authorized to be directly sent to the ETE Uberabinha without previous treatment.

In this Project the Landfill I and the Landfill II were considered as a sole SDWS, since the area surrounding the two sites, including them, is owned and operated by Limpebrás Resíduos Ltda. and they are physically near enough to permit the joint operation. In fact, only a 27 m width road used exclusively for the landfilling operation separates the two sites, and the gas station and power plant of the proposed project activity are planned to be installed on the roadside between the Landfill I and Landfill II. Therefore, the estimative of emissions of methane from SWDS considered the two sites as one single SWDS.

The scenario existing prior to the implementation of the Uberlândia landfills I and II project activity at the Uberlândia Landfill is the operation of the landfill with uncontrolled emission of the LFG (landfill gas) generated to the atmosphere, i.e. the LFG generated due to the decomposition of the organic matter is vented through the vertical wells installed at the landfill's area. At the top of some wells, the LFG is partially burned to address safety and odour issues. As will be demonstrated ahead, the existing scenario and the baseline scenario are the same.

Emissions associated with the baseline scenario are the CH_4 emissions due to the atmospheric release of the LFG and CO_2 emissions due to the power generation from fossil-fuel power-plants. With the implementation of the project, the LFG previously released will be collected through the

[1] According to para 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased installed capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC).

installation of pipelines and emission reduction will be achieved through the destruction of the gas collected in a flaring system and in the power plant. Additionally, the project will export renewable electricity to the grid, avoiding the dispatch of the same amount of electricity from fossil-fuel based power plants in the Brazilian National Grid.

For this crediting period, estimates of GHG emission reductions are:

- Annual average GHG emission reduction: 184,133 tCO2e
- Total estimated GHG emission reductions: 1,288,931 tCO2e

The project will bring benefits to sustainable development, as follows:

- *Increase of local environmental quality:* the project will contribute not only through the avoidance of GHG emissions to the atmosphere, but also by displacing the fossil fuel consumption from power plants connected to the Brazilian Electric Grid. The project might also be seen as a good practice of correct solid waste final disposal;

- *Labour capaciting / Income generation:* the project will need qualified operators to maintain the gas collection wells and pipeline and to operate the degassing station and the power plant. A team composed by engineers and technicians will be created and trained by international consultants and manufacturers. The revenues of these personnel will be above the market, as the technology employed is new in the Uberlândia region;

- *Integration with different sectors:* using LFG to generate electricity is relatively new in Brazil – some projects were developed only under the CDM and only a few of them are indeed generating electricity (like the Bandeirantes Landfill Gas to Energy Project, São João Landfill Gas to Energy Project and Exploitation of the biogas from Controlled Landfill in Solid Waste Management Central – CTRS / BR.040). Therefore, the project will have an enormous contribution over the integration with the electric sectors.

A.2. Location of project activity

>>

Host Party:

- Brazil

Region/State/Province:

- State of Minas Gerais.

City/Town/Community:

- Uberlândia

Physical/Geographical location:

The geographical coordinates of the Uberlândia Landfill are:

- S 18.878361°
- W 48.318583°

The picture below presents the detailed location of the landfill:

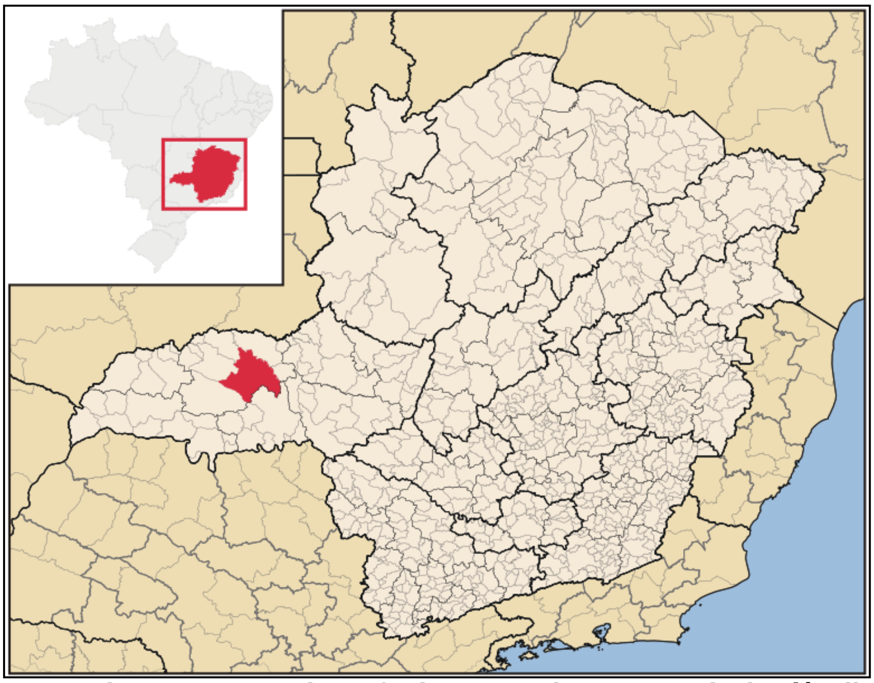

Figure 1 - Location of Minas Gerais State and Uberlândia

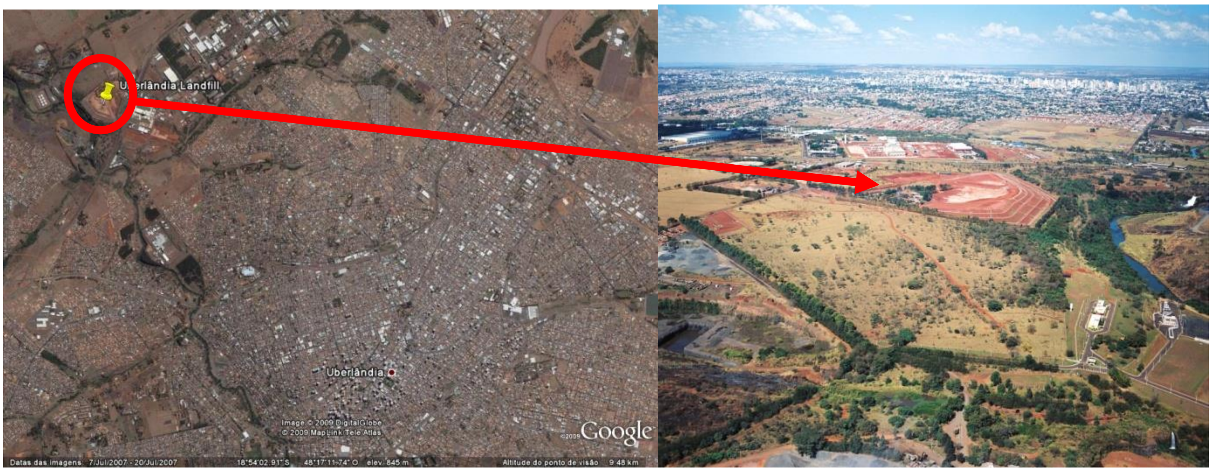

Figure 2 - Location of the Landfill inside Uberlândia

A.3. Technologies/measures

>>

As described in section A.1., the scenario existing prior to the implementation of the Uberlândia landfills I and II at the Uberlândia Landfill is the operation of the landfill with uncontrolled emission of the LFG generated to the atmosphere, i.e. the LFG generated due to the decomposition of the organic matter is vented through the vertical wells installed at the landfill's area. At the top of some wells the LFG is partially burned to address safety and odour issues.

Emissions associated with the baseline scenario are the CH_4 emissions due to the atmospheric release of the LFG and CO_2 emissions due to the power generation from fossil-fuel power-plants. With the implementation of the project, the LFG previously released will be collected through the installation of pipelines and emission reductions will be achieved through the destruction of the gas collected in a flaring system and in the power plant. Additionally, the project will export renewable electricity to the grid, avoiding the dispatch of the same amount of electricity from fossil-fuel based power plants in the Brazilian National Grid. Therefore, none of the equipment installed in the project activity exist in the baseline scenario.

The technology to be employed will be the improvement of landfill gas collection and flaring, through the installation of an active recovery system composed by:

- a collection system;
- a transmission pipeline network;
- a gas station, composed by condensate separators, pipe bundle heat exchanger, chiller, blowers and flaring system; and
- a dry filter (moisture and contaminant removal) and a power plant.

Figure 3 presents a lay-out of such kind of installation.

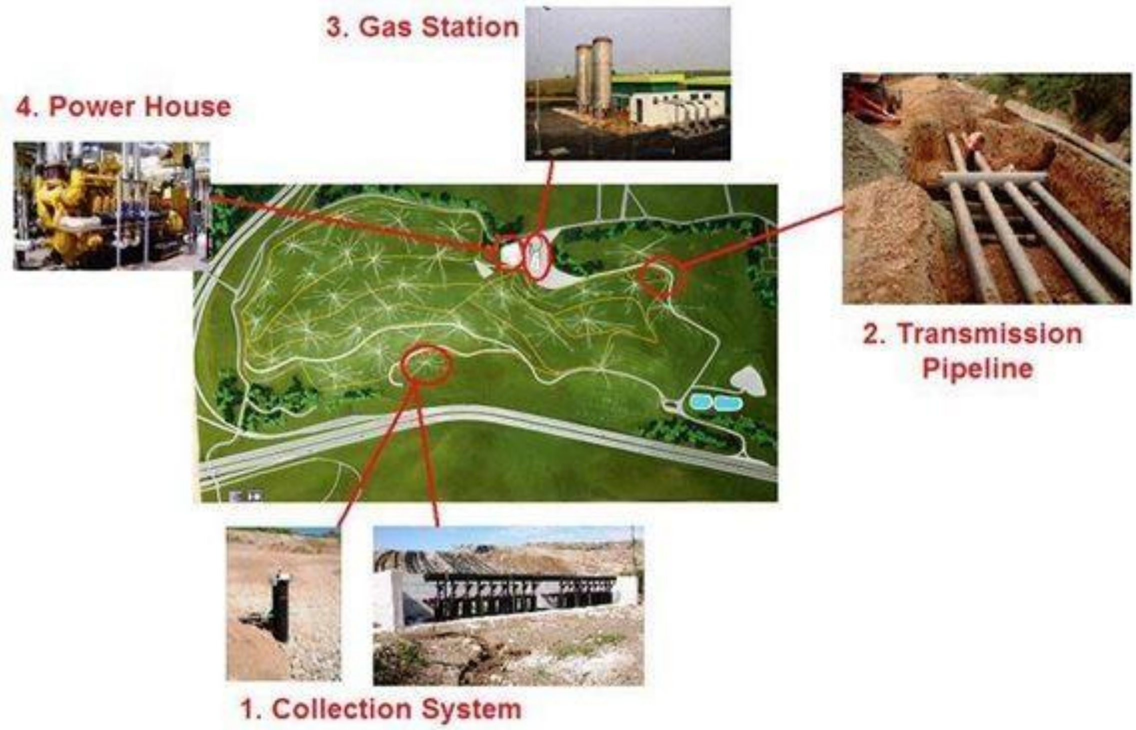

Figure 3 - Schematic situation of a landfill with active gas recovery

The proposed system will be installed to absorb a maximum of 3,000 Nm^3/h of landfill gas, based on estimative of biogas generation.

1. Collection System

Having in mind the dimensions of the Uberlândia Landfill, when considering the LFG collection the infra-structure was defined based on vertical wells. These elements will be connected to a collection pipeline which will transport the gas to the regulation stations – used to control the load loss in the wells. Some horizontal wells might also be constructed, if necessary.

Project Proponents will install vertical wells all over the landfill in an approximately 25 meter grid. Each well will be equipped with wellheads consisting of a carbon steel pipe, complete with a flanged side section bearing a butterfly type valve that enables the well to be connected or cut out from the vacuum system. This is an important element because it will connect the well with the collection pipeline, avoiding directly emission of LFG to the atmosphere.

The wellhead is equipped with threaded pipe unions to allow the installation of a submersible pump for leachate removal from the well and fitted with wiring and control float; in this case, the leachate accumulated within the well can be easily extracted without removing the well head. One of the threaded pipe unions will be used for gas sampling and physical and chemical measuring of gas characteristics. The wellhead mounting and the connection between all well devices must be performed with particular care to avoid air insertion through waste body that could bring bacteria working under aerobic condition within landfill, therefore inhibiting methane production.

These pipelines will consist on HDPE (High Density Polyethylene) pipes and will transport the LFG collected from the wells to the gas regulation stations, which role is to control and monitor the characteristics of the LFG extracted. Each regulation station will be done in carbon steel pipe equipped with an additional condensate knock-out and regulation valves and will be able to receive the connection of many wells, beyond transferring the LFG collected to the transmission network.

2. Transmission pipeline network
From the regulation stations the LFG will be transferred to lines manifolds constructed in carbon steel and then to the gas station through a HDPE transmission pipeline. Lines manifolds are responsible for receiving the LFG from many regulation stations and grouping then into a single line towards the gas station.

3. Gas Station
The gas station comprises the LFG pre-treatment system, the suction system and the flares.

The pre-treatment system consists in a series gas/water & glycol tube nest heat exchangers that can cool down the LFG to a temperature lower than 10 °C, by means of a set of chillers through which the biogas passes as it arrives at the gas station. Such cooling aims to force the moisture in the LFG to condensate, so it can be easily removed from the flow through a coalescer filter situated just after the heat exchangers. This considerably reduces impurities that would damage the equipment.

Following the coalescer filters, LFG flows to the suction system responsible for applying the appropriate pressure to the each well, guaranteeing the effectiveness of gas collection. The system will be composed by two centrifugal multi-stage blowers in parallel (one in standby) connected with the LFG collection and conveying system. The pressuring of the system will depend on the pressure needed by the flares and generators.

The dimensioning of the components is straight connected to the gas production from Uberlândia Landfill; Project Proponents foresee the installation of 2 blowers with 3,000 Nm^3/h capacity each – one main and another standby unit. However, the capacity of standby blower can be reviewed in order to better suit the project.

The gas station will also count with a gas flaring system, which will be equipped with enough high temperature enclosed flares to ensure the total LFG captured to be completely and safely destroyed. Each flare installed will be assembled with all equipment needed to continuously monitor of flare's compliance with manufacturer's specifications, according to the "*Tool to determine project emissions from flaring gases containing methane*", i.e. flow meter on the inlet pipeline and a thermocouple installed at 80% of flare's height.

4. Power Plant
A power plant will also be installed in order to generate electricity with the LFG captured. It will be composed by dry filters which consist in barrels made in carbon steel fitted with polyester filters designed to remove solid impurities from the stream (as well as a share of the micro-contaminants that would be harmful to the electric energy generating sets) and internal combustion engine generating sets.

This is a well known and high reliable technology for biogas utilization. Furthermore, internal combustion engine generating sets have modular design and are available in many different sizes permitting the installation of power plant step by step as the LFG flow increases. High performance and reliability are guaranteed for the equipment.

The number of engines to be installed will depend on the amount of LFG collected, but Project Proponents foresee to install in two phases a total capacity of 4.278 MW.

Real Implemented due to PRC					PDD registered before PRC	PDD registered before PRC with increased capacity by 20 per cent
Year*	**PRC Applied**	**Net capacity (MWe)[1]**	**Number of group generators**	**Net electricity generated in the plant (MWh)[2]**	**Net electricity generated in the plant (MWh)**	**Net electricity generated in the plant (MWh)[3]**
2019	No	2.852	2	7,738	7,911	7,738
2020	Yes	4.278	3	35,602	23,734	27,469[4]
2021	Yes	4.278	3	35,602	23,734	28,481
2022	Yes	4.278	3	35,602	23,734	28,481
2023	Yes	4.278	3	35,602	23,734	28,481
2024	Yes	4.278	3	35,602	23,734	28,481
2025	Yes	4.278	3	35,602	23,734	28,481
2026	Yes	4.278	3	23,994	15,823	18,987

[1] Definition of Net capacity: is the maximum capacity at the plant minus the amount of electricity that is consumed by the plant;
* From 04/09/2019 to 03/09/2026

The LFG stream will be preferably sent to the power plant and the LFG amount exceeding its assimilation capacity will be diverged to the enclosed flares, guaranteeing the destruction of all methane captured. Therefore, flares will be used to combust the LFG exceeding the power plant capacity or to burn all the LFG captured, in case of generation sets maintenance.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	• Energas Geracao de Energia Ltda. (Brazilian Private Entity) • Limpebrás Resíduos Ltda. (Brazilian Private Entity) • Asja Brasil Serviços para o Meio Ambiente Ltda. (Brazilian Private Entity)	No
Switzerland	• Energas Geracao de Energia Ltda. (Private entity)	No
United Kingdom of Great Britain and Northern Ireland	• Numerco Limited (Private entity)	No

A.5. Public funding of project activity

>>

[2] Real implemented but not used in CERs calculation, due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC)

[3] Values from PDD registered before PRC with increased capacity by 20 per cent, due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC)

[4] 3rd Group Generator became operational only on 19/03/2020, thus net electricity generated in the plant has been calculated proportionally considering days in the year in order to be conservative.

There is no public funding involved in the development of the Project Uberlândia landfills I and II.

A.6. History of project activity

>>

The proposed CDM project activity is not a project activity that has been deregistered, nor included as a component project activity (CPA) in a registered CDM programme of activities (PoA).

A.7. Debundling

>>

Not applicable.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

>>

- Large-scale Consolidated Methodology ACM0001: “Flaring or use of landfill gas” (Version 18.1)[5];
- TOOL04 Methodological tool: “Emissions from solid waste disposal sites” (Version 08.0)[6];
- TOOL05 Methodological tool: “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0)[7];
- TOOL06 Methodological tool: “Project emissions from flaring” (Version 03.0)[8];
- TOOL08 Methodological tool: “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0)[9];
- TOOL09 Methodological tool: “Determining the baseline efficiency of thermal or electric energy generation systems” (Version 02.0)[10];
- TOOL10 Methodological Tool: “Tool to determine the remaining lifetime of equipment” (Version 01)[11];
- TOOL12 Methodological tool: “Project and leakage emissions from transportation of freight” (Version 01.1.0)[12];
- TOOL07 Methodological tool: “Tool to calculate the emission factor for an electricity system” (Version 07.0)[13];
- TOOL11 Methodological Tool: “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” (Version 03.0.1)[14];
- TOOL02 Methodological tool: “Combined tool to identify the baseline scenario and demonstrate additionality” (Version 07.0)[15];
- TOOL03 Methodological tool: “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 03.0)[16].

---

[5] https://cdm.unfccc.int/methodologies/DB/Y88077XT5O83TZ2PYEZ36LFIAMAODR

[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf

[7] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf

[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v3.0.pdf

[9] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf

[10] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-09-v2.0.pdf

[11] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-10-v1.pdf

[12] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-12-v1.1.0.pdf

[13] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

[14] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf

[15] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf

[16] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v3.pdf

B.2. Applicability of methodologies and standardized baselines

>>

The methodology ACM0001 is applicable for project activities that comprise one of the following scenarios:

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

The methodology ACM0001: "Flaring or use of landfill gas" is applicable to project activities which:

"...

(a) *Install a new LFG capture system in an existing or new (Greenfield) SWDS where no LFG capture system was or would have been installed prior to the implementation of the project activity; or*

(b) *Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:*

(i) *The captured LFG was vented or flared and not used prior to the implementation of the project activity; and*

(ii) *In the case of an existing active LFG capture system for which the amount of LFG cannot be collected separately from the project system after the implementation of the project activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available;*

(c) *Flare the LFG and/or use the captured LFG in any (combination) of the following ways:*

(i) *Generating electricity;*

(ii) *Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace;*[17] *and/or*

(iii) *Supplying the LFG to consumers through a natural gas distribution network;*

(iv) *Supplying compressed/liquefied LFG to consumers using trucks;*[18]

(v) *Supplying the LFG to consumers through a dedicated pipeline;*

(d) *Do not reduce the amount of organic waste that would be recycled in the absence of the project activity.*

Justification: - Part 1

The methodology **is applicable** because it will be made an investment into an existing LFG capture system to increase the recovery rate (collection efficiency) and change the use of the captured LFG (also electricity generation). The captured LFG was only vented and partially flared in open flares and not used prior to the implementation of the project activity.

In the project activity, the LFG will be flared and will generate electricity.

Moreover, the amount of organic waste will be the same in the project activity as well as in the absence of the project activity. A declaration letter issued by the PP has been made available to the DOE.

---

[17] For claiming emission reductions for other heat generation equipment (including other products in kilns), project participants may submit a revision to this methodology.

[18] In case other means of transportation are used a revision to this methodology may be requested.

"...
The methodology is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is:

(a) Atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons; and

(b) In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln:

(i) For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or

(ii) For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary;

(c) In the case of LFG supplied to the end-user(s) through natural gas distribution network, trucks or the dedicated pipeline, the baseline scenario is assumed to be displacement of natural gas.

(d) In the case of LFG from a Greenfield SWDS, the identified baseline scenario is atmospheric release of the LFG or capture of LFG in a managed SWDS and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.

This methodology is not applicable:

(a) In combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln or glass melting furnace, where the purpose of the CDM project activity is to implement energy efficiency measures at a kiln or glass melting furnace;

(b) If the management of the SWDS in the project activity is deliberately changed during the crediting in order to increase methane generation compared to the situation prior to the implementation of the project activity.

..."

Justification: - Part 2
According to Section B.4 and B.5, the methodology is applicable because:

- The most plausible baseline scenario is released the LFG to atmosphere from the SWDS, and;
- The electricity would be generated in the grid.

Moreover, there is neither a combination with other approved methodologies nor change in management of the landfill due to the project activity (e.g. addition of liquids, pre-treating waste or changing the shape of the landfill to increase the Methane Correction Factor).

The applicable scenarios are (a) and (b). Scenarios (c) and (d) are not applicable for the project activity.

The tool "Emissions from solid waste disposal sites" is **applicable** to the project activity because the CDM project activity mitigates methane emissions from a specific existing SWDS (Application A).

The tool to calculate "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" is **applicable** to the project activity following one out of the three scenarios below applied to the sources of electricity consumption:

- Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either no captive power plant(s) is/are installed at the site of electricity consumption or, if any captive power plant exists on site, it is either not operating or it is not physically able to provide electricity to the electricity consumer;
- Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid; or
- Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power plant(s) and the grid.

As for the monitoring of the amount of electricity generated in the project scenario, only if one out of the following three project scenarios applies to the recipient of the electricity generated:

a) Scenario I: Electricity is supplied to the grid;
b) Scenario II: Electricity is supplied to consumers/electricity consuming facilities; or
c) Scenario III: Electricity is supplied to the grid and consumers/electricity consuming facilities.

Justification:
The tool is applicable according to Scenario A and Scenario B stated above since the project activity includes electricity consumption from the grid when electricity generated by the LFG power plant is not operational.

Also, Scenario I is applicable since the project activity includes electricity generation to the grid.

<u>The tool “Project emissions from flaring”</u> is **applicable** to the project activity since the project activity uses enclosed and/or open flares and project participant documents the same in the PDD including the type of flare used in the project activity. Tool is applicable to the flaring of flammable greenhouse gases where:

- Methane is the component with the highest concentration in the flammable residual gas; and
- The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g. biogas, landfill gas or wastewater treatment gas).
- The flares used in the project site operate according to the specifications provided by the manufacturer.

Justification:
Since methane is the component with the highest concentration in the flammable residual gas from waste anaerobic degradation generating LFG and flares used in the project site operate according to the specifications provided by the manufacturer, the tool is available.

<u>The “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”</u> is **applicable** to the project activity because the applicable methodology (ACM0001) demands measuring flow and composition of residual and exhaust gases for the determination of baseline and project emissions.

<u>The “Tool to determine the remaining lifetime of equipment”</u> is **not applicable** since the project activity do not involve the replacement of existing equipment with new equipment or retrofit of existing equipment as part of energy efficiency improvement activities.

LFG use equipment was not in operation prior to the implementation of the project activity.

<u>The “Project and leakage emissions from transportation of freight”</u> is **not applicable** since the project activity do not involve the transportation of freight.

The "Tool to calculate the emission factor for an electricity system" is **applicable** since the project activity demands electricity that is provided by the grid. This tool is also referred to in the "Tool to calculate project and/or leakage emissions from electricity consumption and monitoring of electricity generation" 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.

The "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" is **applicable** to the project activity since it is required to assess the continued validity of the baseline at the renewal of a crediting period.

The methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems" is **not applicable** to the project activity since there is no thermal or electric energy generation in the baseline scenario. Also, the project activity does not involve the improvement of the energy efficiency through retrofits or replacement of the existing system by a new system.

The methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality" is **applicable** since demonstration of additionality using investment analysis was used at the time of the project registration. Also, simplified procedure to identify the baseline scenario and demonstrate additionality of ACM0001 has been used. Please refer to Section B.5.

The methodological tool "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" is **not applicable** due to the absence of fossil fuel consumption by the project activity.

B.3. Project boundary, sources and greenhouse gases (GHGs)

>>

Source		Gas	Included	Justification/Explanation
Baseline	Emissions from decomposition of waste at the SWDS site	CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from SWDS. This is conservative
		CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted since the CO_2 is also released under the project activity
	Emissions from electricity generation	CO_2	Yes	Major emission source if power generation is included in the project activity

Source		Gas	Included	Justification/Explanation
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from heat generation	CO_2	No	Major emission source if heat generation is included in the project activity
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from the use of natural gas	CO_2	No	Excluded for simplification. This is conservative
		CH_4	No	Major emission source if supply of LFG through a natural gas distribution network, dedicated pipeline or using trucks is included in the project activity
		N_2O	No	Excluded for simplification. This is conservative
Project activity	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	No	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small

Source		Gas	Included	Justification/Explanation
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Emissions from electricity consumption due to the project activity	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 flaring	CO_2	No	Emissions are considered negligible
		CH_4	Yes	May be an important emission source
		N_2O	No	Emissions are considered negligible
	Emissions from distribution of LFG using trucks and dedicated pipelines	CO_2	No	May be an important emission source
		CH_4	No	May be an important emission source
		N_2O	No	Emissions are considered negligible

The project boundary of the project activity shall include the site where the LFG is captured and, as applicable:

(a) Sites where the LFG is flared or used (e.g. flare, power plant, boiler, air heater, glass melting furnace, kiln, natural gas distribution network, dedicated pipeline or biogas processing facility); (applicable)

(b) Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity to the project activity; (not applicable)

(c) Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity in the baseline that is displaced by electricity generated by captured LFG in the project activity; (applicable)

(d) Heat generation equipment or sources which are supplying heat in the baseline that is displaced by heat generated by captured LFG in the project activity; and (not applicable)

(e) The transportation of the compressed/liquefied LFG from the biogas processing facility to consumers. (not applicable)

The flow diagram is presented below:

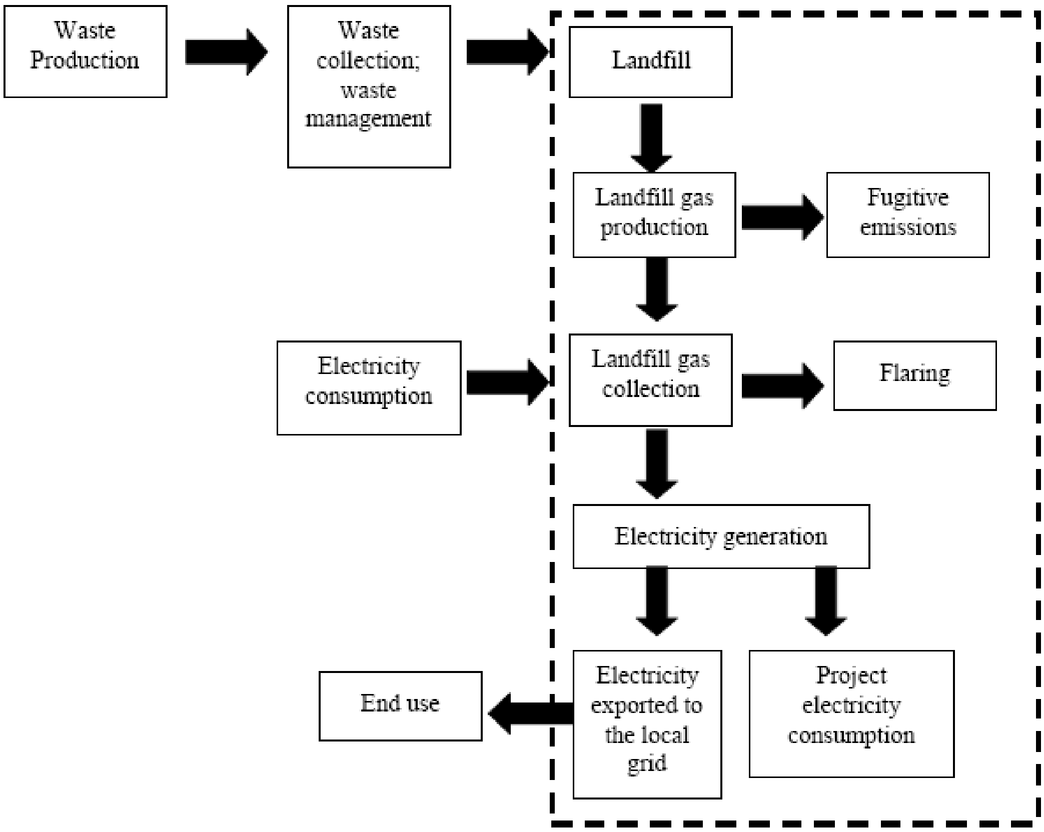

Figure 4 – Flow diagram project boundary

B.4. Establishment and description of baseline scenario

>>

The baseline scenario for LFG is assumed to be the atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.

Since LFG is also used in the project activity for generating electricity, the baseline scenario is assumed to be that the electricity would be generated in the grid or in captive fossil fuel fired power plants.

The methodological tool “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period”, has been used to assess the continued validity of the baseline considering the renewal of the crediting period.

It is important to clarify that the baseline scenario for LFG defined for the 1st crediting period is maintained valid.

The stepwise procedure of the "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period are as follows:

Step 1: Assess the validity of the current baseline for the next crediting period

In order to assess the continued validity of the baseline, changes in the relevant national and/or sectorial regulations between two crediting periods has to be examined at the renewal of the crediting period. If at the start of the project activity, the project activity was not mandated by regulations, but at the time of renewal of the crediting period regulations are in place that enforce the practice or norms or technologies that are used by the project activity, the new regulation (formulated after the registration of the project activity) has to be examined to determine if it applies to existing project or not.

The baseline scenario does not have to be updated for the second crediting period as no new regulations requiring capture and combustion or use of LFG are in place.

The "Procedures for the renewal of the crediting period of a registered CDM project activity" approved by the CDM Executive Board require assessing the impact of new relevant national and/or sectorial policies and circumstances on the baseline.

The validity of the current baseline is assessed using the following Sub-steps:

Step 1.1: Assess compliance of the current baseline with relevant mandatory national and/or sectorial policies

At the start of the project activity, the Brazilian legislation did not require landfills to capture and/or flare and/or use the LFG. After the registration of the project activity, the project participant in order to assess if the current baseline complies with all relevant mandatory national and/or sectorial policies which have come into effect after the submission of the project activity for validation (there were new national and/or sectorial policies related to requirements of LFG capture and/or flare and/or use) has verified that the current baseline complies with all applicable laws and regulations, as the Brazilian legislation does not require landfills to capture and/or flare and/or use the LFG.

Brazil's New National Solid Waste Policy (NSWP),[19] ratified by the President on 02/08/2010 after 19 years under discussion. The NSWP does not request the LFG capture and/or flare and there is not forecast to approve any regulation or policy in the next years with this requirement. The laws and regulations applicable for the electricity generation component are law 8987/95 and law 9074/95[20].

By analysing the LFG electricity generation plant operational license N° 00899/2018, issued in 31/01/2018 and valid up to 08/12/2021 it is possible to notice that LFG use is permitted by legislation. Also, there is an authorization issued by the National Electricity Agency (ANEEL[21]) permitting the electricity generation at the landfill.

Since in the baseline scenario the collection system was not implemented, there was no electricity consumption from the grid or fossil fuel sources.

Step 1.2: Assess the impact of circumstances

There is no impact of circumstances existing at the time of requesting renewal of the crediting period on the current baseline emissions.

---

[19] http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm

[20] http://www.aneel.gov.br/area.cfm?idArea=43

[21] http://www2.aneel.gov.br/cedoc/ofc2012841scg.pdf

Step 1.3: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which renewal is requested.

This sub-step is not applicable since the baseline scenario of the project activity is the business as usual (BAU) scenario (passive venting system).

Step 1.4: Assessment of the validity of the data and parameters

Considering the applied methodology at the project activity registration ACM0001 version 12 has changed to consolidated methodology ACM0001 version 18 and all related applicable tools some ex-ante parameters published by IPCC have been updated accordingly.
According to the "Tool to assess the validity of the original/current baseline and to update the baseline at the renewal of a crediting period", where any data and parameter used and not monitored during the crediting period are not valid anymore they should be updated following the Step 2 as follows:

Step 2: Update the current baseline and the data and parameters

Step 2.1: Update the current baseline

The baseline emissions for the second crediting period have been updated, without reassessing the baseline scenario, based on the latest approved version of the methodology ACM0001. This update was applied in the context of the sectorial policies and circumstances that are applicable at the time of requesting for renewal of the crediting period, which has not changed as to affect the project.

Step 2.2: Update the data and parameters

All fixed parameters were updated in accordance with the updated methodology ACM0001 version 18, applicable tools and supporting documentation.

The baseline scenario for LFG is assumed to be the atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.

Since LFG is also used in the project activity for generating electricity, the baseline scenario is assumed to be that the electricity would be generated in the grid or in captive fossil fuel fired power plants.

B.5. Demonstration of additionality

>>
According to the methodology, the additionality is demonstrated and assessed following the *"Combined tool to identify the baseline scenario and demonstrate additionality".*

Application of the "Combined tool to identify the baseline scenario and demonstrate additionality".
Step 1. Identification of alternative scenarios
As shown in the section B.4, the realistic and credible alternative scenarios to the project activity which are consistent with mandatory laws and regulations are:

LFG1. The project activity implemented without being registered as a CDM project activity (i.e. capture and flaring or use of LFG);

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; and electricity generation in existing and/or new grid-connected power plants.

Step 2. Barrier Analysis
As per the *"Combined tool to identify the baseline scenario and demonstrate additionality"*:

Step 2a. Identify barriers that would prevent the implementation of alternative scenarios:
None of the alternative scenarios face barriers that would prevent their implementation.

Step 2b. Eliminate alternative scenarios which are prevented by the identified barriers
According to the tool, those alternative scenarios which are prevented by at least one of the barriers listed in *Step 2a* shall be eliminated from further consideration.
For this Project, none of the alternative scenarios would be prevented by any barrier.

Outcome of Step 2: As both alternative scenarios LFG1 and LFG2 a not prevented by any barrier and the proposed project activity is not the First-of-its-kind, according to the *"Combined tool to identify the baseline scenario and demonstrate additionality"* there is a need to explain how the registration of the CDM project activity will alleviate the barriers that prevent the proposed project activity from occurring in the absence of the CDM. This explanation can be seen through the investment analysis, in the *Step 3* below.

Step 3: Investment analysis
The objective of this step is to compare the economic or financial attractiveness of the alternative scenarios of the Step 2 by conducting an investment analysis, and to confirm the choice of the most plausible baseline scenario.

Selection of financial benchmark
According to the tool, the financial indicator most suitable for the project type and decision-making context needs to be identified. If one of the alternative scenarios corresponds to the situation that does not involve any investment costs, either NPV or IRR can be used as the financial indicator. Project participants do not undertake an investment, IRR will be used as the financial indicator.

For the alternative LFG2, since it does not involve investment cost, the IRR to be used shall be the financial benchmark, as stated in the "*Combined tool to identify the baseline scenario and demonstrate additionality*", and determined through the options (a) to (e). In the case of LFG2, the financial benchmark is derived from:

(b) Estimates of the cost of financing and required return on capital (e.g. commercial lending rates and guarantees required for the country and the type of project activity concerned), based on banker's views and private equity investor/fund's required return on comparable projects.

The reference rate for investments in Brazil is the SELIC (Sistema Especial de Liquidação e de Custódia) rate, which is the market indicator for the government securities of Tesouro Nacional and of Banco Central do Brasil. Therefore, the benchmark value considered for the alternative LFG2 is **11.55%**, which corresponds to the average of SELIC rates fixed in COPOM (Comitê de Política Monetária do Banco Central do Brasil) meetings held in the last 5 years, from April 19th 2006 to April 20th 2011.

For the calculation of the IRR for the LFG1 alternative scenario (The project activity undertaken without being registered as a CDM project activity), some assumptions were made:

- The operational lifetime of this Project is considered to be 21 years, as the operational lifetime of the Landfill II is estimated to finish in 2028 and the landfill gas production is expected to quickly decrease after the stop in receiving waste, according to the experience of Asja Group with similar projects located in tropical areas. Therefore the Project Proponents estimate the lifetime of this Project to end in December of 2032.
  For this Project the period of assessment considered in the investment analysis is the project lifetime, then 21 years.
- For IRR calculation the input number are the revenue, variable costs, depreciation, income tax and investment.

Project revenues considered are the ones from electricity sale: "*Annual average output (MWh)*" is calculated as the simple average of the estimated annual electricity production and "*Total Electricity delivered to the grid (MWh)*" is calculated as the sum of the quantities of electricity estimated to be sold during the lifetime of the project.

Total investment and project costs, "*Total investment (Euro)*", "*Annual operation cost on flaring production (Euro/year)*", "*Annual operation cost on energy generation (Euro/year)*" and "*General and administrative expenses (Euro/year)*", are estimated from previous similar projects implemented by Asja Group around the world.

Investment costs include the construction of a new LFG collection, conveying, suction, treatment, analysis, flare combustion and electricity generation systems, all civil works to build the infrastructure necessary to the equipment and personnel, connection of power plant to the power grid, the revamping cost of the engines, etc.; such costs are based on commercial proposals and detail on the main values is described in the Table 1 below. Those cost values, when necessary, included an inflation value, according to the time interval between the time of the investment decision (May 3rd 2011, when Energas Geração de Energia Ltda. was created) and the time when the budget was made by the producer. Operational costs and general expenses are estimated based on Asja's experience in similar projects already built. The forecast is realistic and conservative; from a market survey it can be gathered that real cost will actually be higher than the ones foreseen.

No expense related to the baseline systems is considered in this analysis, neither related to the implementation costs of LFG passive venting system and leachate collection and treatment system, nor to their operation, as it is exclusive responsibility of landfill's manager. Only the costs from the additional LFG and leachate collection systems (active LFG collection and leachate removal through pumps) are considered in the input costs being analyzed.

The depreciation rate considers the amortization of equipment by the end of a 10 years period, which is an internal company depreciation period; it means that in ten years we should have an amortization of 100% of investment. For this Project it is foreseen an investment in the year 2027 due to the revamping of the engines which will not be able to be totally amortized until the end of the project lifetime (December of 2032), so the remaining value not depreciated was considered to be the fair value of the equipment. Therefore the average depreciation of project is 4.38%.

The operation cost on flaring production is estimated from real and recent (from 2011 January to July) costs of a similar project implemented by Asja Group in Brazil, and include maintenance expenses with acquisition of materials and payment of employees, costs with electricity and water consumption and telecommunication services, as internet connection and telephone, besides private security, consultancy services from external entities, travels of personnel and other minor operational costs.

The operation cost on energy generation is estimated from real cost of a similar project implemented by Asja Group in the year 2008. Such cost was considered to remain constant through that year to the time of investment decision; therefore no inflation rate was applied. This is considered to be conservative.

General and administrative expenses refer to expenditure with financial, controlling, administrative, legal, information technology, communication, technical and commercial departments which, although not being directly involved with the operation of flaring and/or electricity generation systems, are necessary to the correct and organized management of the operational plant. The cost considered for this Project is based in real expenses of a similar project implemented by Asja Group in the country and includes expenses with payment of employees, acquisition of services and materials and consumption of electricity and water and use of internet and telephone connections by the mentioned departments.

Table 1: Description of main values of the total investment cost

Description of cost		Cost without inflation (EUR/y)							Source of cost
		2011	2012	2014	2016	2018	2019	2027	
LFG Collection System	Drilling of wells	149,565.22	82,608.70	132,173.91	132,173.91	132,173.91	-	-	Signed contract
	HDPE piping for the wells	35,349.81	24,678.88	37,018.32	37,018.32	37,018.32	-	-	Commercial invoice
	Well heads	31,801.02	15,221.00	22,831.50	22,831.50	22,831.50	-	-	Commercial offer
LFG Conveying System	HDPE piping for LFG transport	48,079.11	35,644.46	43,194.74	43,194.74	43,194.74	-	-	Commercial offer
	Substation of regulation	40,291.09	40,291.09	40,291.09	40,291.09	40,291.09	-	-	Commercial offer
Gas Station	Heat exchangers	40,058.74	-	-	-	-	-	-	Commercial offer
	Chillers	54,347.83	-	-	-	-	-	-	Commercial offer
	Blowers	114,482.61	-	-	-	-	-	-	Commercial offer
	PLC controlling panel	224,151.75	-	-	-	-	-	-	Commercial offer
	Enclosed flare	134,834.73	-	-	-	-	-	-	Commercial offer
Power plant	Generation engines	1,394,219.49	1,394,219.49	-	-	-	-	-	Commercial offer
	Revamping of engines	-	-	-	-	-	2,171,363.36	2,171,363.36	Supplier statement
	Electrical substations	156,754.35	156,754.35	-	-	-	-	-	Commercial offer
Civil Works	Foundation of electrical substations	19,316.70	-	-	-	-	-	-	Commercial offer
	Other foundations and administrative office	75,789.13	15,877.44	-	-	-	-	-	Commercial offer
Others	Connection to the local grid	22,956.52	-	-	-	-	-	-	Commercial offer
	Incidental expenses (5% of total cost)	147,114.19	95,473.39	19,637.78	19,637.78	19,637.78	-	-	N/A

The Brazilian taxes applied in the financial analysis, based on presumed profit, were COFINS (Contribuição para o Financiamento da Seguridade Social - *Contribution to the Financing of Social Security*)[22], PIS (Programa de Integração Social - *Social Integration Program*)[23], IRPJ (Imposto de Renda para Pessoa Jurídica - *Income Tax for Corporations*)[24] and CSLL (Contribuição Social sobre o Lucro Líquido - *Social Contribution on Net Income*)[25], in accordance with local regulations.

The electricity price chosen for this project has been taken from the results of the 2º Leilão de Fontes Alternativas (Second Renewable Sources Auction) held in 2010, exclusive for auctioning small hydro power plant and other renewable sources' energies (source: http://www.ccee.org.br/cceeinterdsm/v/index.jsp?contentType=RESULTADO_LEILAO&vgnextoid=ed7c645eb56ba210VgnVCM1000005e01010aRCRD&qryRESULTADO-LEILAO-CD-RESULTADO-LEILAO=5710645eb56ba210VgnVCM1000005e01010a &x=11&y=5, accessed in 09/06/2011).

The financial analysis inputs and results, for the alternative LFG1, are provided in the following tables. It is important to highlight that initially, the project design counted with 2 x 1.426 MW (2.852 total) installed capacity group generators. In 2020 there was an inclusion of one more group generator with 1.426 MW, totalizing 4.278 MW installed capacity. As a conservative approach, project participant changed only the key parameters related to projects revenues only (electricity sales), and kept CAPEX and OPEX unchanged. By doing so, PP established the best investment analysis scenario possible for the project activity in terms of Internal Rate of Return (IRR).

Table 2: Main financial data in the project scenario LFG1.

Financial parameters	
Annual average output (CERs)	184,133
Annual average output (MWh)	35,602
Total CERs to trade during project crediting period (CERs)	3,247,805
Total electricity delivered to the grid (MWh)	625,000
Expected electricity sale (Euro/MWh)	64.76
Average installed capacity (MW)	4.278
Annual Engines' working hours (h)	8,322
Total investment (Euro)	10,843,903
Life time of this project (years)	21 years of production + 1 year for construction
Crediting period (years)	21
Depreciation rate (average)	4.38%
Annual operation cost on flaring production (Euro/year)	177,600
Annual operation cost on energy generation (Euro/MWh)	25
General and administrative expenses (Euro/year)	100,000

Table 3: Financial analysis result.

Revenue Analysis	**Project Activity without CDM**	**Business As Usual**
Total investment IRR	6.9%	11.5%

[22] http://www.receita.fazenda.gov.br/pessoajuridica/pispasepcofins/regincidencia.htm (accessed in 10/04/2012).

[23] http://www.receita.fazenda.gov.br/pessoajuridica/pispasepcofins/regincidencia.htm (accessed in 10/04/2012).

[24] http://www.receita.fazenda.gov.br/legislacao/rir/L2Parte3.htm (accessed in 10/04/2012) and http://www.planalto.gov.br/ccivil_03/leis/L9249.htm (accessed in 10/04/2012).

[25] http://www.planalto.gov.br/ccivil_03/leis/L7689.htm (accessed in 10/04/2012).

The project IRR in the scenario LFG 1 (the project undertaken without carbon credits revenues) results quite lower than the benchmark, and the NPV by the end of project lifetime is negative. Therefore, comparing both alternative scenarios, it is clear that the scenario LFG2 (Business As Usual) is the most attractive scenario.

Sensitivity analysis

Sensitivity analysis is conducted in order to assess whether the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions. The calculated project IRR will be used to be comparable with the benchmark.

The most suitable financial indicators in the LFG1 alternative scenario are the total investment, the electricity revenue and the operation costs, included general expenses; total investment and operation costs represent, respectively, 32% and 49% of overall cost of the project, and the electricity selling is the only revenue of the project excepting CDM benefits, as shown at the table below. To maintain a conservative approach, these parameters are supposed to increase and decrease about 5% - 20%.

Table 4: Financial indicators for scenario LFG1.

Representativeness of financial indicators	**Without CERs**
Total costs of the project	€ 33,448,621
O&M on Total costs (>= 20%)	49%
Total investment on Total costs (>= 20%)	32%
Electricity revenues on Total revenues (>= 20%)	100%

The table below shows how these parameters should vary in order to reach the benchmark.

Table 5: Sensitivity analysis.

Total investment IRR sensitivity analysis								
	-20%	**-10%**	**-5%**	**0%**	**5%**	**10%**	**20%**	**on benchmark = 11.55%**
Floating total investment	10.4%	8.5%	7.7%	6.9%	6.2%	5.5%	4.3%	**-43.0%**
Electricity price	-0.3%	3.6%	5.3%	6.9%	8.5%	9.9%	12.6%	**33.7%**
Operation cost (O&M)	9.7%	8.3%	7.6%	6.9%	6.2%	5.4%	3.8%	**-72.0%**

As it can be seen, the LFG1 project IRR remains lower than the benchmark (scenario LFG2) even in the case where these parameters change in favor of the project.

Another analysis was made in the column “on benchmark = 11.55%”, considering how much the electricity price of the MWh would have to increase and how much the operational costs and investments would have to decrease to achieve an 11.55% IRR in the alternative scenario LFG1. The results show that the project investment needs to decrease by 43% and the O&M costs by 72% in order to achieve the expected IRR. Based on the experience of Project Proponents such variations are not likely to happen due to the maintenance regime required on the generation equipment and the qualified personnel required to ensure the adequate gas field balancing and operation of the project. Moreover, the cap inflation rate applied to the investment forecasts is 2.5%, too conservative when compared to the historic of the IGP-M (Índice Geral de Preços do Mercado) inflation rate, which accumulated value from 2006 May to 2011 May (investment decision date) is 38.53% (https://www3.bcb.gov.br/CALCIDADAO/publico/corrigirPorIndice.do?method=corrigirPorIndice, consulted in 18/01/2012), with an annual average of 7.71%.

The IGP-M rate is monthly calculated based on the price variation of different activities as Industry, Construction, Agriculture, Retailer Commerce and Services and their many distinct stages of production, and is largely used in Brazil as a reference of a macroeconomic index (http://portalibre.fgv.br/main.jsp?lumChannelId=402880811D8E34B9011D92B6B6420E96, accessed in 18/01/2012).

It's also unlikely that renewable energy price would increase 33.7% from its current value. Considering the Brazilian hydroelectric energy descending trend of prices, which respond for more than half of national energetic matrix, and the abundance of renewable sources in Brazil, we can expect the same trend to be the one for the price of every kind of renewable energy. Therefore such an electricity price variation is not realistic and it can be actually demonstrated that the scenario LFG1 (project activity without extra revenue from CDM) is not financially attractive.

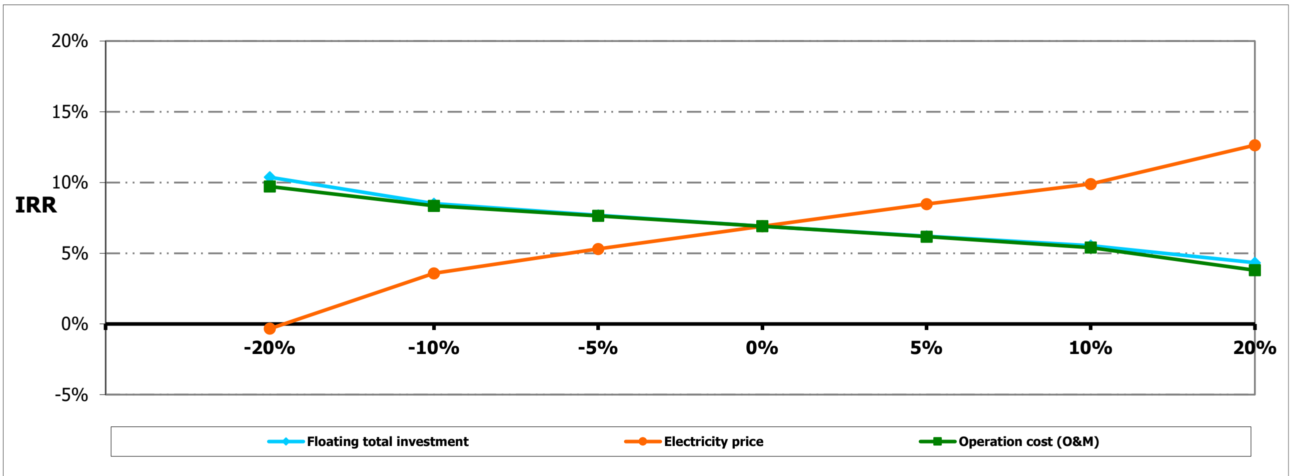

Figure 5: The impact from changes of floating total investment, electricity revenue and operation cost on IRR of the LFG1 alternative scenario.

Outcome of Step 3:
The variations obtained for the alternative scenario LFG1 are not realistic scenarios. Only in the situations of very favorable scenarios (but hardly realistic) it would be possible to reach an 11.55% benchmark. The IRR is quite lower than the benchmark (stated as the IRR of the alternative scenario LFG2) based on realistic assumptions, therefore alternative LFG1 cannot be considered as financially feasible without the support of the CDM benefits.

Scenario LFG1 is not likely to happen in the absence of a CDM project being developed at the landfill site since it has been clearly demonstrated that LFG revenues (electricity) are not enough to recover the project investments and operational costs of the project. The investment analysis above shows that it is not possible to develop the project without CDM benefits.

According to the "*Combined tool to identify the baseline scenario and demonstrate additionality*", if the sensitivity analysis confirms the result of the investment analysis comparison, then the most economically or financially attractive alternative scenario is considered as baseline scenario. Therefore, **the identified baseline scenario is the alternative 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; and electricity generation in existing and/or new grid-connected power plants*), confirming the choice from the Step 2.

STEP 4. Common practice analysis
According to the *"Combined tool to identify the baseline scenario and demonstrate additionality"* and the "*Guidelines on common practice*", as the project activity is not the First-of-its-kind, the previous Steps shall be complemented with an analysis of the extent to which the proposed project type has already diffused in the relevant sector and applicable geographical area.

According to the latest official statistics on urban solid waste in Brazil the "*Pesquisa Nacional de Saneamento Básico 2008*"[26] (National Research of Basic Sanitation), from a total of 5,562 districts with waste management service only 1,540 or 27.69% of them are attended by sanitary landfills, as presented in the Figure 6 below, also presented in the original form in Table 18 in Appendix 3 - Baseline Information. Most part of waste produced in the country is sent to open dumps which are generally areas without any sort of proper infrastructure to avoid environmental hazards. Therefore, even the disposal of waste in landfills is not a common practice in the country yet.

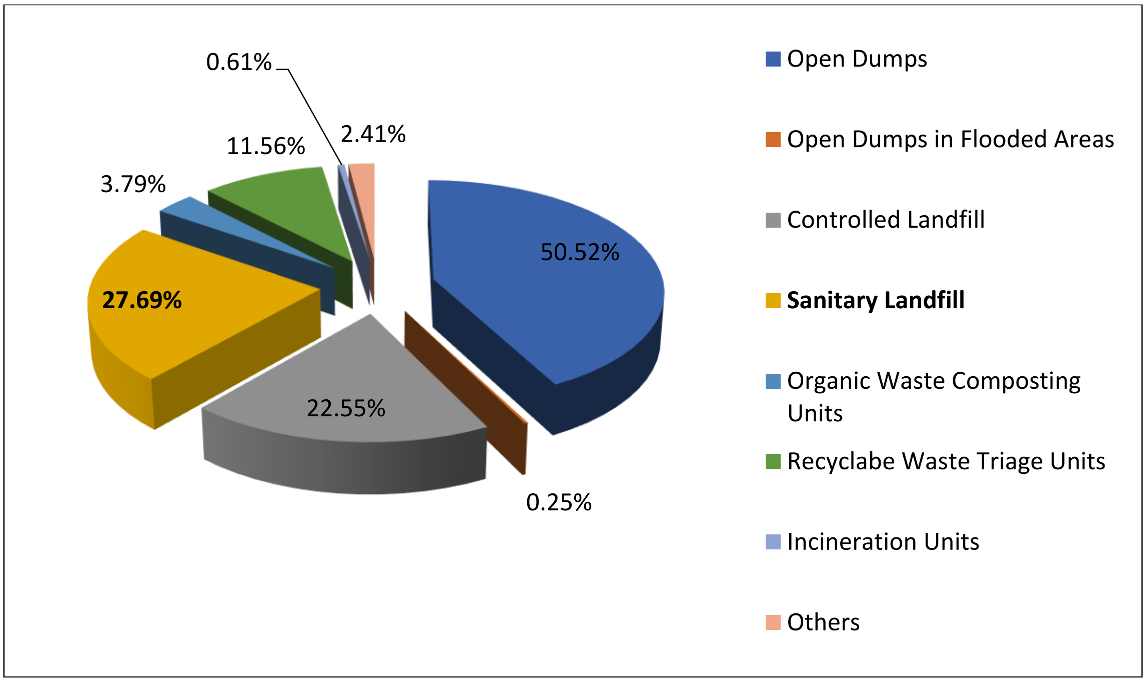

Figure 6: Districts with waste management service (total of 5,562), by final waste destination - 2008.

Other research, published by "*Sistema Nacional de Informações sobre Saneamento*" (National System of Information about Sanitation) for the year 2006[27], shows that from a total of 211 solid waste disposal sites (SWDS) in Brazil, only 17 affirm to have installed a "Gas Final Use" project. The majority release the gas directly in the atmosphere, without any previous treatment, since it is not a regulatory requirement in Brazil.

From the 17 SWDS presented in the study which have a project for the landfill gas, 10 are registered as CDM project, according to the information available at Brazilian DNA website[28]. They are located at (city/state): Cariacica/ES, Nova Iguaçu/RJ, Paulínia/SP, Salvador/BA (2 landfills), Santos/SP, São José dos Campos/SP, São Paulo/SP (2 landfills) and Tremembé/SP. Therefore, from the total, only 7 landfills affirm to have a gas final use without being CDM projects.

These landfills are the following:

Name and Location	Type and discussion about of project implemented
Sanitary Landfill of Cuiabá (MT)	*Actual status:* LFG utilization system not implemented. The landfill drains the gas and destroys part in the top of the wells (phone call confirmation).

[26] Brazilian National Research of Basic Sanitation 2008, Table 92; Available at http://www.ibge.gov.br/home/estatistica/populacao/condicaodevida/pnsb2008/defaulttabzip_man_res_sol.shtm; accessed in 09/06/2011.

[27] 2006 SNIS, Table Up03; Available at http://www.snis.gov.br/PaginaCarrega.php?EWRErterterTERTer=16; acessed in 10/06/2011.

[28] www.mct.gov.br; accessed in 12/03/2012.

Controlled Landfills of Juína (MT)	*Actual status:* LFG utilization system not implemented. The landfill does not even have a gas draining system (phone call confirmation).
a. CTR – Rio de Janeiro (RJ)	*Actual status:* LFG utilization system not implemented. The landfill does not exist and the project was never approved to receive the Environmental Permission[29]. However, the project encompasses the installation of a degassing unit, with a LFG flaring system.
Sanitary Landfill of Santa Bárbara d'Oeste (SP)	*Actual status:* LFG utilization system not implemented. The landfill drains the gas and destroys part in the top of the wells (internet search confirmation[30]).
Sanitary Landfill of São Leopoldo (RS)	*Actual status:* LFG utilization system not implemented. The landfill has leachate evaporation and incineration system, only (phone call confirmation).
Sanitary Landfill of Goiânia (GO)	*Actual status:* LFG utilization system implemented, but not operating. Enclosed flare voluntarily not operating (phone call confirmation).
Sanitary Landfill of Cascavel (PR)	*Actual status:* Power generation for lightning – pilot-scale (phone call confirmation).

Regarding the above described landfills and the definition in the *"Combined tool to identify the baseline scenario and demonstrate additionality",* similar activities to the proposed project activity are not observed and commonly carried out, since the project activity involves the landfill gas flaring and electricity generation to the grid. Although, according to the tool, if the proposed CDM project activity applies a measure that is listed in the definitions section and for further conduct the common practice analysis, it is needed to follow the *Step 4a.*

Sub-step 4a(1): Calculate the applicable output range as +/- 50% of the design output or capacity of the proposed project activity.
The proposed project activity is foreseen to have an installed electricity capacity of 4.278 MW. Therefore, the applicable output range is 2.139 MW – 6.417 MW.

Sub-step 4a(2): In the applicable geographical area, identify all plants that deliver the same output or capacity, within the applicable output range calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project. Note their number N_{all}. Registered CDM project activities shall not be included in this step.
According to a list published by ANEEL (*Agência Nacional de Energia Elétrica*[31]), informing the projects in Brazil which generate electricity, there are 87 with an installed capacity of 1.426 MW – 4.278 MW currently in operation.

Among these, 4 are registered as CDM projects, as per data published by CD4CDM – *Capacity Development for the Clean Development Mechanism*[32], and should not be included in this analysis, according to the tool.

Therefore, the identified plants that deliver the same output or capacity, within the applicable output range calculated in the *Step 4a(1),* represent N_{all} = 87.

[29] http://www.inea.rj.gov.br/downloads/ata_audit_public_ctr.pdf; accessed in 10/06/2011.

[30] http://www.santabarbara.sp.gov.br/v3/index.php?pag=pag_noticia&dir=noticias&id=27715; accessed in 10/06/2011.

[31] https://app.powerbi.com/view?r=eyJrIjoiNjc4OGYyYjQtYWM2ZC00YjllLWJlYmEtYzdkNTQ1MTc1NjM2IiwidCI6IjQwZDZmOWI4LWVjYTctNDZhMi05MmQ0LWVhNGU5YzAxNzBlMSIsImMiOjR9 ; accessed in 01/02/2022.

[32] http://www.cd4cdm.org/CDMJIpipeline.htm (accessed in 10/04/2012).

Sub-step 4a(3): Within the plants identified in Step 2, identify those that apply technologies different than the technology applied in the proposed project activity. Note their number N_{diff}.
According to the tool, different technologies, in the context of common practice, are defined as technologies that deliver the same output and differ by at least one: energy source/fuel; feed stock; size of installation; investment climate in the date of the investment decision; other features.

Among the 87 plants identified, all of them are identified to use "different technologies" to deliver the same output as the proposed project activity, because they utilize different energy source/fuel as hydroelectric, fossil fuels etc. The LFG to electricity generation is a strictly use, nowadays, for projects under the CDM.

Therefore, $N_{diff} = 87$.

Sub-step 4a(4): Calculate factor $F = 1\text{-}N_{diff}/N_{all}$ representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity.
Regarding $N_{all} = N_{diff} = 87$, therefore:

$F = 1 - N_{diff}/N_{all} = 1 – 87/87 =$ **0**

According to the *"Combined tool to identify the baseline scenario and demonstrate additionality"*, the proposed project activity is regarded as a "common practice" within a sector in the applicable geographical area if both of the following conditions are fulfilled:

(a) The factor F is greater than 0.2; and
(b) $N_{all} – N_{diff}$ is greater than 3.

As shown in the calculation above, the proposed project activity has F = 0 (not greater than 0.2) and $N_{all} - N_{diff} = 0$ (not greater than 3). Therefore, it is clear that electricity generation using LFG is not a common practice in the host country.

<u>Outcome of Step 4:</u> This project is one of the fewest proposed to use the LFG to generate electricity, and other LFG capturing projects were developed strictly only under the CDM; similar activities are not observed or commonly carried out, being restricted into pilot-scale systems.
Thus, the proposed project activity is not regarded as "common practice" and **it is additional.**

Timeline and starting date of the project:
CDM revenues were seriously considered in the decision to proceed with the project activity as the following timeline of events demonstrates:

1. In April 12th 2010, Limpebrás Resíduos Ltda. communicated to Brazilian DNA the intention to develop a project activity and to seek CDM status.
2. In April 13th 2010, Limpebrás Resíduos Ltda. communicated to UNFCCC the intention to develop a project activity and to seek CDM status.
3. In June 10th 2010, Limpebrás Resíduos Ltda. sent letters inviting all local stakeholders of the project activity to know and comment about the proposed project activity.
4. In May 3rd 2011, Limpebrás Resíduos Ltda. and Asja Brasil Serviços para o Meio Ambiente Ltda. signed contract to create Energas Geração de Energia Ltda. (the three are Project Participants of the Project), compromising themselves to invest money and efforts to implement a CDM project activity based on LFG collection, flare combustion and electricity generation, therefore the Project; this has been assumed to be the Project's starting date hereinafter in section C.1.1.
5. In June 23rd 2011, the PDD was published in the UNFCCC website for global stakeholder consultation. This is considered the start of validation process.

From the last event on, real action of a program of activities began aiming to obtain the CDM status and implement the Project. Implementation timeline foreseen is:

1. May to June 2011: earth-moving activities;

2. July to December 2011: constructions works;
3. July to December 2011: wells drilling and LFG collection system assembly;
4. August to December 2011: gas station's equipment installation works and power plant assembling;
5. 26 January 2012: start of flaring;
6. 19 February 2012: power plant commissioning (1 engine of 1.426 MW);
7. 01 March 2012: start of electricity production;
8. 09 October 2012: installation of the second engine (1.426 MW) for electricity generation; and
9. October to December 2013: wells drilling in the landfill II.
10. 3rd Group Generator became operational on March 2020.

Also, it is crucial to consider that the simplified procedure to identify the baseline scenario and demonstrate additionality of ACM0001 remains being considered for the 2nd 7-year crediting period for the project activity. As per such simplified procedure, the additionality of the project activity is demonstrated as follows:

"The following types of project activities at new or existing landfills (greenfield or brownfield) are deemed automatically additional, if prior to the implementation of the project activity the LFG was or would have been only vented and/or flared but not utilized for energy generation:

(a) The LFG is used to generate electricity in one or several power plants with a total nameplate capacity that equals or is below 10 MW;
(b) The LFG is used to generate heat for internal or external consumption;
(c) The LFG is flared."

In summary, regardless the demonstration of additionality is not applicable/required for the renewal of the crediting period of a registered CDM project activity, just by taking into account the continuation of the simplified procedure to identify the baseline scenario and demonstrate additionality of ACM0001 in the context of the demonstration of the validity of the previously derived baseline scenario, the project activity is thus automatically/directly assumed as additional since types a) and c) mentioned above applies for this project activity.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

>>
The baseline emission was calculated according to the following formula:

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (t CO_2e/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year *y* (t CO_2/yr)
$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (t CO_2/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (t CO_2/yr)

As the project flares LFG and generate electricity, the $BE_{HG,y} = 0$ and $BE_{NG,y} = 0$.

Therefore, $BE_y = BE_{CH4,y} + BE_{EC,y}$

Step (A): Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

$$BE_{CH4} = \left(\left(1 - OX_{top\_layer}\right) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$$

Where:

$BE_{CH4,y}$	=	Baseline emissions of LFG from the SWDS in year *y* (t CO_2e/yr)
OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

Step A.1: *Ex-post* determination of $F_{CH4,PJ,y}$

During the crediting period, the **$F_{CH4,PJ,y}$** will be determined as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}$$

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)
$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year y (t CH_4/yr)
$F_{CH4,EL,y}$	=	Amount of methane in the LFG which is used for electricity generation in year y (t CH_4/yr)
$F_{CH4,HG,y}$		Amount of methane in the LFG which is used for heat generation in year y (t CH_4/yr)
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year y (t CH_4/yr)

As the project flares LFG, generate electricity, the $F_{CH4,HG,y} = 0$ and $F_{CH4,NG,y.} = 0$. Thus, the equation is:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$$

$F_{CH4,EL,y}$ is determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” and monitoring the working hours of the power plant(s), boiler(s), air heater(s), glass melting furnace(s) and kiln(s), so that no emission reduction are claimed for methane destruction during non-working hours. This is taken into account by monitoring the hours that the equipment utilizing the LFG is operating in year *y* ($Op_{j,h,y}$).

The following requirements apply:

a. As per the gaseous stream tool, if the LFG is used for multiple purposes (e.g. flaring or energy generation), and all methane destruction devices are verified to be operational (e.g. by means of flame detectors records, energy generated), a single flow meter may be used to record the flow into multiple destruction devices. The destruction efficiency of the least efficient among the destruction devices shall be used as the destruction efficiency for all destruction devices monitored by this flow meter. If there are any periods for which one or more destruction devices are not operational, paragraph 5 (a) and (b) of the Appendix of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" tool shall be followed;

b. CH_4 is the greenhouse gas for which the mass flow should be determined;

c. The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations (3) or (17) in the tool);

d. The mass flow should be calculated on an hourly basis for each hour *h* in year *y*;

e. The mass flow calculated for hour *h* is 0 if the equipment is not working in hour *h* ($Op_{j,h}$=not working), the hourly values are then summed to a yearly unit basis.

The amount of methane destroyed by flaring ($F_{CH4,flared,y}$) will be determined as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$$

Where:

$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year y (t CH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year y (t CH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year y (t CO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

$F_{CH4,sent\_flare,y}$ will be determined directly using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, applying the requirements described below. The tool shall be applied to the gaseous stream flowing in the LFG delivery pipeline to each flare.

According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” the following options will be considered for the present project activity:

- Option A (Volume flow in dry basis and volumetric fraction in dry basis) when the temperature of the gaseous stream is less than 60ºC (333.15 K) at the flow measurement point

  And

- Option B (Volume flow in wet basis and volumetric fraction in dry basis) when the temperature of the gaseous stream is higher than 60ºC (333.15 K) at the flow measurement point.

Option A

Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. The demonstration will be made as following:

- Demonstrate that the temperature of the gaseous stream (T_t) is less than 60ºC (333.15 K) at the flow measurement point.

The mass flow of greenhouse gas i ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t}$$

With

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t}$$

Where:

$F_{i,t}$ = Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)

$v_{i,t,db}$ = Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m^3 gas *i*/m^3 dry gas)
$\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval *t* (kg gas *i*/m^3 gas *i*)
P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i = Molecular mass of greenhouse gas *i* (kg/kmol)
R_u = Universal ideal gases constant (Pa.m^3/kmol.K)
T_t = Temperature of the gaseous stream in time interval *t* (K)

If it cannot be demonstrated that the gaseous stream is dry, then the flow measurement should be assumed to be on a wet basis and the option B should be applied instead.

Option B

The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined using equations used to Option A. The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t\,db} = V_{t,wb} / (1 + v_{H2O,t,db})$$

Where:
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$V_{t,wb}$ = Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m^3 wet gas/h)
$v_{H2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m^3 H_2O/m^3 dry gas)

The volumetric fraction of H_2O in time interval *t* on a dry basis ($v_{H2O,t,db}$) is estimated according to following equation.

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}}$$

Where:
$v_{H2O,t,db}$ = Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m^3 H_2O/m^3 dry gas)
$m_{H2O,t,db}$ = Absolute humidity in the gaseous stream in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$MM_{t,db}$ = Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
MM_{H2O} = Molecular mass of H_2O (kg H_2O/kmol H_2O)

The absolute humidity of the gaseous stream (mH_2O,t,db) will be determined using Option 2 (simplified calculation without measurement of the moisture content):

Option 2: Simplified calculation without measurement of the moisture content

This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation[33].

[33] An assumption that the gaseous stream is saturated is conservative for the situation that the mass flow of greenhouse gas *i* is underestimated (applicable for calculating baseline emissions). Conversely, an assumption that the gas stream is dry is conservative for the situation that the greenhouse gas *i* is overestimated (applicable for calculating project emissions).

Concerning the project activity, the conservative situation will be to assume that the gaseous stream is saturated, then $m_{H2O,t,db}$ is assumed to equal the saturation absolute humidity ($m_{H2O,t,db,sat}$) and calculated using the following equation.

$$m_{H2O,t,db,Sat} = \frac{p_{H2O,t,Sat} * MM_{H2O}}{(P_t - p_{H2O,t,Sat}) * MM_{t,db}}$$

Where:

$m_{H2O,t,db,sat}$	= Saturation absolute humidity in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$p_{H20,t,Sat}$	= Saturation pressure of H_2O at temperature Tt in time interval t (Pa)
T_t	= Temperature of the gaseous stream in time interval *t* (K)
P_t	= Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{H2O}	= Molecular mass of H_2O (kg H_2O/kmol H_2O)
$MM_{t,db}$	= Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas)

Parameter $MM_{t,db}$ is estimated using the following equation.

$$MM_{t,db} = \sum_k (v_{k,t,db} * MM_k)$$

Where:

$MM_{t,db}$	= Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
$v_{k,t,db}$	= Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (m^3 gas k/m^3 dry gas)
MM_k	= Molecular mass of gas *k* (kg/kmol)
k	= All gases, except H_2O, contained in the gaseous stream (e.g. N_2 and CH_4,). See available simplification below

The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (*k*) in the gaseous stream. However as a simplification, in the case of the project activity, the volumetric fraction of the methane that is a greenhouse gas and considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. The simplification is not acceptable if it is differently specified in the underlying methodology.

$PE_{flare,y}$ shall be determined using the methodological tool "Project emissions from flaring – version 02.0.0". If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

To determine the project emissions from flaring gases was used the tool "Project emissions from flaring – version 02.0.0". The project emissions calculation procedure is given in the following steps:

STEP 1: Determination of the methane mass flow of the residual gas;
STEP 2: Determination of the flare efficiency;
STEP 3: Calculation of project emissions from flaring.

Step 1: Determination of the methane mass flow in the residual gas

The "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" shall be used to determine the following parameter:

Parameter	SI Unit	Description
$F_{CH4,m}$	kg	Mass flow of methane in the residual gaseous stream in the minute m

The following requirements apply:

- The gaseous stream tool shall be applied to the residual gas;
- The flow of the gaseous stream shall be measured continuously;
- CH4 is the greenhouse gas i for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and
- The time interval t for which mass flow should be calculated is every minute m

$F_{CH4,m}$, which is measured as the mass flow during minute m, shall then be used to determine the mass of methane in kilograms fed to the flare in minute m ($F_{CH4,RG,m}$). $F_{CH4,m}$ shall be determined on a dry basis.

The option chosen for the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" by the project participant is option A. However, during the project operational monitoring, If not demonstrated that the temperature of the gaseous stream (T_t) is less than 60ºC (dry basis), then the flow measurement should be assumed to be on a wet basis and the option B should be applied instead.

Step 2: Determination of flare efficiency

According to "Project emissions from flaring", the flare efficiency will be calculated as follows:

<u>Open flare</u>

In the case of open flares, the flare efficiency in the minute *m* ($\eta_{flare,m}$) is 50% when the flame is detected in the minute *m* ($Flame_m$), otherwise $\eta_{flare,m}$ is 0%.

<u>Enclosed flares</u>

In the case of enclosed flares, project participants may choose between the following two options to determine the flare efficiency for minute *m* ($n_{flare,m}$).

Option A: Apply a default value for flare efficiency

Option B: Measure the flare efficiency.

The project participant has chosen Option A.

For enclosed flares that are defined as low height flares, which is the case of the project activity, the flare efficiency in the minute m ($n_{flare,m}$) shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency as determined in Option A. For example, the default value applied should be 80%, rather than 90%.

Option A: Default value

The flare efficiency for the minute m ($n_{flare,m}$) is 90% when the following two conditions are met to demonstrate that the flare is operating:

(1) The temperature of the flare ($T_{EG.m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m; and

(2) The flame is detected in minute m ($Flame_m$).

Otherwise $n_{flare,m}$ is 0%.

Step 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute *m* in year *y*, based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare\,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times \left(1 - \eta_{flare\,m}\right) \times 10^{-3}$$

Where:

$PE_{flare,y}$	=	Project emissions from flaring of the residual gas in year *y* (tCO_2e)
GWP_{CH4}	=	Global warming potential of methane valid for the commitment period (tCO_2e/tCH_4)
$F_{CH4,RG,m}$	=	Mass flow of methane in the residual gas in the minute *m* (kg)
$\eta_{flare,m}$	=	Flare efficiency in minute m

Table 1 – Parameters[34] used in the Tool "Project emissions from flaring"

Parameter	Description	Value	Unit
P_{ref}	Atmospheric pressure at reference conditions	101,325	Pa
R_u	Universal ideal gas constant	8,314	$Pa.m^3/kmol.K$
T_{ref}	Temperature at reference conditions	273.15	K
GWP_{CH4}	Global warming potential of methane valid for the commitment period	25[35]	tCO_2/tCH_4
$\rho_{CH4,n}$	Density of methane at reference conditions	0.716	kg/m^3

Step A.1.1: *Ex-ante* estimation of $F_{CH4,PJ,y}$

An *ex ante* estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane from the SWDS in order to estimate the emission reductions of the proposed project activity in the CDM-PDD. It is determined as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} \times BE_{CH4,SWDS,y} / GWP_{CH4}$$

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/yr)
$BE_{CH4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (tCO_2e/yr)
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH4}	=	Global warming potential of CH_4 (tCO_2e/tCH_4)

$BE_{CH4,SWDS,y}$ is determined using the methodological tool "Emissions from solid waste disposal sites". The calculation of $BE_{CH4,SWDS,y}$ according the tool is:

$$BE_{CH4,SWDS,} = \varphi_y \cdot \left(1 - f_y\right) \cdot GWP_{CH4} \cdot (1 - OX) \cdot \frac{16}{12} \cdot F \cdot DOC_{f,y} \cdot MCF_y \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot \left(1 - e^{-k_j}\right)$$

Where:

[34] As the Option B.1 of the tool "*Project emissions from flaring (Version 02.0.0)*" has been adopted to calculate the flare efficiency, the molecular mass parameters are not mentioned.

[35] Value for the 2nd commitment period updated according to COP/MOP decisions

$BE_{CH4,SWDS,y}$	=	Baseline, project or leakage methane emissions occurring in year y generated from waste disposal at a SWDS during a time period ending in year y (t CO_2e / yr)
X	=	Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year y (x = y).
Y	=	Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)
$DOC_{f,y}$	=	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction)
$W_{j,x}$	=	Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (t)
φ_y	=	Model correction factor to account for model uncertainties for year y
f_y	=	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
GWP_{CH4}	=	Global Warming Potential of methane
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)
MCF_y		Methane correction factor for year *y*
DOC_j	=	Fraction of degradable organic carbon in the waste type *j* (weight fraction)
k_j	=	Decay rate for the waste type *j* (1 / yr)
J	=	Type of residual waste or types of waste in the MSW

According to ACM0001 methodology, the parameter f_y in the methodological tool “Emissions from solid waste disposal sites” shall be assigned a value of 0 (zero) because the amount of LFG that would have been captured and destroyed is already accounted for in equation 2 of this methodology. Also, according to ACM0001 methodology, the parameter *X* begins with the year that the SWDS started receiving wastes (2010). For this reason, the parameter f_y and *X* will not be monitored.

Step A.2: Determination of $F_{CH4,BL,y}$

According to the methodology *ACM0001*, to determine the amount of methane that would have been captured and destroyed (by flaring) in the baseline due to regulatory or contractual requirements, or to address safety and odour concerns (collectively referred to as *requirement* in this step), the appropriate case should be identified and the corresponding instruction followed.

Table 2 - Cases for determining methane captured and destroyed in the baseline

Situation at the start of the project activity	**Requirement to destroy methane**	**Existing LFG Capture system**
Case 1	No	No
Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

In the Uberlândia Landfills I and II methane is partially destroyed through lighting the top of some wells of passive venting system exclusively to address safety and odour concerns. There are no regulatory or contractual requirements related to the capture and/or destruction of methane generated in the landfill.

However, *ACM0001* establishes that, when applying the *Step A.2*, the capture and destruction of methane in the baseline “*due to regulatory or contractual requirements, or to address safety and odour concerns*” should be “*collectively referred to as requirement*”. Therefore, according to the methodology the purpose of the passive venting system used in the Project (addressing safety and odour concerns) is referred to as a requirement, for what the Case 3 is not applicable.

So, as the Uberlândia Landfills I and II has a LFG capture system (passive system) and partially destroy methane through lighting the top of some wells of the passive venting system to address safety and odour concerns, the **Case 4** is identified as the appropriate case and will be followed.

Case 4: Requirement to destroy methane exists and LFG capture system exists

$F_{CH4,BL,y} = \max \{F_{CH4,BL,R,y} \, ; \, F_{CH4,BL,sys,y}\}$

Where:

$F_{CH4,BL,R,y}$	=	Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y* (tCH_4/yr)
$F_{CH4,BL,sys,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* for the case of an existing LFG capture system (tCH_4/yr)

According to the methodology, for the Case 4, $F_{CH4,BL,R,y}$ and $F_{CH4,BL,sys,y}$ shall be determined according to the respective procedures for Case 2 and Case 3.

According to Case 2 procedures:

- If the requirement does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared then:

$F_{CH4,BL,R,y} = 0$

According to Case 3 procedures:

- If there is no monitored data available, but there is historic data on the amount of methane that was captured in the year prior to the implementation of the project situation, then:

$F_{CH4,BL,sys,y} = F_{CH4,hist,y}$

In determining $F_{CH4,hist,y}$ it is assumed that the fraction of LFG that was recovered in the year prior to the implementation of the project activity will be the same fraction recovered under the project activity:

$$F_{CH4,hist,y} = \frac{F_{CH4,BL,x-1}}{F_{CH4,x-1}} \cdot F_{CH4,PJ,y}$$

Where:

$F_{CH4,hist,y}$	=	Historical amount of methane in the LFG which is captured and destroyed (tCH_4/yr)
$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)
$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (tCH_4/yr)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is captured in the project activity in year y (tCH_4/yr)

$F_{CH4,BL,x-1}$ can be evaluated as a fraction of $F_{CH4,x-1}$, therefore:

$F_{CH4,BL,x-1} = MD_{BL} \cdot F_{CH4,x-1}$

Where:

$F_{CH4,BL,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (tCH_4/yr)
MD_{BL}	=	Methane destruction efficiency in the baseline (-)

$F_{CH4,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (tCH_4/yr)

According to the study "*Reducing the uncertainty of methane recovered (R) in GHG inventories from waste sector and of adjustment factor (AF) in landfill gas projects under CDM*", 154 Brazilian municipal solid waste landfills were analyzed, and those which have available historic data (from reliable sources, as Brazilian Ministry of Cities, Brazilian Ministry of Environment and from landfill managers) had their methane destruction efficiency in the baseline (MD_{BL}) calculated, following the methodology *ACM0001*. Then, an average of this value was found among those landfills, in order to contribute for better estimating MD_{BL} in landfill gas destruction projects in Brazil, under the CDM. Project participants decided to use this study in order to contribute for better calculation of the $F_{CH4,hist,y}$ parameter.

As per the studies, a collection efficiency of 85% was attributed to the passive systems, what the authors acknowledge to be a conservative approach, not reflecting the reality of existent passive systems commonly used in Brazil, and the sampled average MD_{BL} for those projects was 0.0176 and weighted average MD_{BL} was 0.0040 or, respectively, 1.76% and 0.40%. Regarding that the use of the sampled average MD_{BL} from the cited study is more conservative, for Uberlândia landfills I and II a methane destruction efficiency of 1.76% will be used for estimating the $F_{CH4,BL,x-1}$.

Therefore, the equation is updated to:

$$F_{CH4,BL,x-1} = 1.76\% \,.\, F_{CH4,x-1}$$

The equation is then updated to:

$$F_{CH4,hist,y} = \frac{1.76\% \,.\, F_{CH4,x-1}}{F_{CH4,x-1}} \,.\, F_{CH4,PJ,y}$$

Or

$$F_{CH4,hist,y} = 1.76\% \,.\, F_{CH4,PJ,y}$$

Since the amount of methane in the LFG which is flared in the baseline ($F_{CH4,BL,y}$) shall be the major value, between those given in equations above and it is then determined that:

$$F_{CH4,BL,y} = 1.76\% \,.\, F_{CH4,PJ,y}$$

Step (B): Baseline emissions associated with electricity generation ($BE_{EC,y}$)

The baseline emissions associated with electricity generation in year y ($BE_{EC,y}$) shall be calculated using the "Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".

$$BE_{EC,y} = \sum_{k} EC_{BL,k,y} \times EF_{EL,k,y} \times (1 + TDL_{k,y})$$

Where:

$BE_{EC,y}$	=	Baseline emissions from electricity generation in year *y* (tCO2/yr)
$EC_{BL,k,y} = EG_{PJ,y}$	=	Net amount of electricity generated using LFG in year y (MWh/yr)
$EF_{EL,k,y}$[36]	=	Emission factor for electricity generation for source *k* in year *y* (tCO2/MWh)

[36] According to the "*Tool to calculate project or leakage CO2 emissions from fossil fuel combustion*", $EF_{EL,k,y} = EF_{grid,CM,y}$

$TDL_{k,y}$ = Average technical transmission and distribution losses for providing electricity to source *k* in year *y*.

Emission Factor calculation

The project emissions derived from fossil fuels used for electricity consumption from grid connected power plants are estimated and guided using the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”. For the determination of the emission factor for electricity generation ($EF_{EL,j/k/l,y}$), the scenario A “Electricity consumption from the grid” was used. The combined margin emission factor was calculated by the “Tool to calculate the emission factor for an electricity system”, as follows:

Step 1. Identify the relevant electric power system

For the purpose of determining the electricity emission factors, 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 (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without signification transmission constraints.

The Brazilian DNA published an official delineation of the project electricity system in Brazil, considering a national interconnected system.[37]

Step 2. Choose whether to include off-grid power plants in the project electricity system (optional)

Option I: Only grid power plants are included in the calculation.

The Brazilian DNA is responsible for calculating the emission factors and it is not included in calculation the off-grid power plants.

Step 3. Select a method to determined the operating margin (OM)

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

a) Simple OM, or
b) Simple adjusted OM, or
c) Dispatch data analysis OM, or
d) Average OM.

The Brazilian DNA is responsible for calculating the OM emission factor in Brazil. It uses the method c) Dispatch data analysis OM.

For the dispatch data analysis OM, it is necessary to use the year in which the project activity displaces grid electricity and to update the emission factor annually during monitoring.

Step 4. Calculate the operating margin emission factor according to the selected method

The dispatch data analysis OM emission factor ($EF_{grid,OM-DD,y}$) is determined based on the power units that are actually dispatched at the margin during each hour h where the project is displacing electricity. This approach is not applicable to historical data and, thus, requires annual monitoring of $EF_{grid,OM-DD,y}$.

Method chosen c) Dispatch data analysis OM.

[37]According to Brazilian DNA Resolution n.8 published on 26/05/2008.

The emission factor is calculated as follows:

$$EF_{grid,OM-DD,y} = \frac{\sum_{h} EG_{PJ,h} \cdot EF_{EL,DD,h}}{EG_{PJ,y}}$$

Where:

$EF_{grid,OM-DD,y}$	=	Dispatch data analysis operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EG_{PJ,h}$	=	Electricity displaced by the project activity in hour *h* m of year *y* (MWh)
$EF_{EL,DD,h}$	=	CO_2 emission factor for power units in the top of the dispatch order in hour *h* in year *y* (tCO_2/MWh)
$EG_{PJ,y}$	=	Total electricity displaced by the project activity in year *y* (MWh)
h	=	hours in year y in which the project activity is displacing grid electricity
y	=	Year in which the project activity is displacing grid electricity

The $EF_{grid,OM,}$ is displayed on the Brazilian DNA website, for the year 2018

$EF_{grid,OM,2018}$ = 0.5390 tCO_2/MWh

Step 5. Calculate the build margin (BM) emission factor

The Brazilian DNA is responsible for calculating the BM emission factor in Brazil.

In terms of vintage of data, project participants can choose between one of the following two 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 request 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 emission factor during the crediting period.

Option 2: For the first crediting period, the build margin emission factor should 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 yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin 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.

The *Option 2* was chosen for the proposed project.

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

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

Where:

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (t CO_2/MWh)

$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit m in year y (t CO_2/MWh)
m	=	Power units included in the build margin
y	=	Most recent historical year for which electricity generation data is available

The $EF_{grid,BM}$ is displayed on the Brazilian DNA website, for the year 2018.

$EF_{grid,BM,2018}$ = 0.1370 tCO_2/MWh

Step 6. Calculate the combined margin emissions factor

The option a) weighted average CM was used to calculate the combined margin (CM).

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

The default weights are as follows: w_{OM} = 0.25 and w_{BM} = 0.75, fixed for the second crediting period. That gives:

$$EF_{2018} = (0.5390 \times 0.25) + (0.1370 \times 0.75) = 0.2375\ tCO_2/MWh$$ [38]

The build margin CO_2 emission factors will be ex-ante.

The operating margin CO_2 emission factors will be ex-post.

Therefore, the combined margin CO_2 emission factor will be ex-post.

Project emissions:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} + PE_{SP,y}$$

Where:

PE_y	=	Project emissions in year *y* (t CO_2/yr)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year *y* (t CO_2/yr)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (t CO_2/yr)
$PE_{DT,y}$	=	Emissions from the distribution of compressed/liquefied LFG using trucks, in year y (t CO_2/yr)
$PE_{SP,y}$	=	Emissions from the supply of LFG to consumers through a dedicated pipeline, in year y (t CO_2/yr)

[38] The source of the data is from Brazilian DNA. The link is http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html, accessed on 23/03/2018.

The parameter $PE_{DT,y}$, $PE_{FC,y}$ and $PE_{SP,y}$ are not used in the calculation of project emissions since there is no distribution of compressed/liquefied LFG using trucks, no supply of LFG to consumers through a dedicated pipeline as well as no project emission from consumption of fossil fuels due to the project activity, for purpose other than electricity generation in the project activity. Then, $PE_{DT,y}$, $PE_{FC,y}$ and $PE_{SP,y}$ = 0.

Calculation of $PE_{EC,y}$ – project emission from consumption of electricity

According to "*Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"*, version 03.0 the project emission from consumption of electricity will be from one source:

- $PE_{EC1,y}$ - Grid (Brazilian interconnected electric system);

Thus,

$$PE_{EC,y} = PE_{EC1,y}$$

$PE_{EC1,y}$ - Project emission from electricity consumption from the grid

As electricity will be consumed from the grid, the option A1 of the scenario A was chosen, as follows:

> *Option A1: 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" ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$).*

Thus, the project emission is calculated as following:

$$PE_{EC1,y} = EC_{PJ1,y} \times EF_{grid,CM,y} \times (1 + TDL_y)$$

Where:

$EC_{PJ1,y}$	= quantity of electricity consumed from the grid by the project activity during the year y (MWh);
$EF_{grid,CM,y}$	= the emission factor for the grid in year y (tCO_2/MWh);
TDL_y	= average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.

Calculation of $PE_{FC,y}$ – Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation

There is no project emission from consumption of fossil fuels due to the project activity, for purpose other than electricity generation.

Therefore, $PE_{FC,y}$ = 0

Leakage:

In accordance with the ACM0001 version 18, no leakage effects need to be accounted.

Emission Reduction

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y,$$

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

B.6.2. Data and parameters fixed ex ante

Data / Parameter	OX_{top_layer}
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool "Emissions from solid waste disposal sites"
Value(s) applied	0.1
Choice of data or Measurement methods and procedures	Default value used, according to ACM0001
Purpose of data	Calculation of baseline emission
Additional comment	Applicable to Step A

Data / Parameter	$EF_{grid,BM,y}$
Unit	tCO_2 /MWh
Description	Build margin emission factor of the Brazilian grid
Source of data	Calculations based on parameters described above.
Value(s) applied	0.1370
Measurement methods and procedures	The emission factor is calculated ex-ante, as described in B.6.3.
Monitoring frequency	Annual
QA/QC procedures	Apply procedures in the "Tool to calculate the emission factor for an electricity system"
Purpose of data	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comment	All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system", were included in the monitoring plan. For more details, see Annex 3.

Data / Parameter	GWP_{CH4}
Unit	$t\ CO_2e/t\ CH_4$
Description	Global warming potential of CH_4
Source of data	IPCC

Value(s) applied	25. Updated for the 2nd commitment period according to COP/MOP decisions[39]
Choice of data or Measurement methods and procedures	Default value used, according to IPCC Fourth Assessment Report: Climate Change 2007, item 2.10.2: Direct Global Warming Potentials, Table 2.14
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	R_u
Unit	$Pa.m^3/kmol.K$
Description	Universal ideal gas constant
Source of data	Methodological tool “Project emissions from flaring” version 02.0.0
Value(s) applied	8,314
Choice of data or Measurement methods and procedures	Default value used, according to Methodological tool “Project emissions from flaring” version 02.0.0, table 1: Constants used in equations
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	Waste composition
Unit	%
Description	Waste composition
Source of data	landfill internal studies
Value(s) applied	(see table below)
Choice of data or Measurement methods and procedures	Internal Report
Purpose of data	Calculation of baseline emission
Additional comment	Used for projection of methane avoidance

Composition of waste	
A) Wood and wood products	8.42%
B) Pulp, paper and cardboard (other than sludge)	9.39%
C) Food, food waste, beverages and tobacco (other than sludge)	64.46%
D) Textiles	3.35%
E) Garden, yard and park waste	9.09%
F) Glass, plastic, metal, other inert waste	5.29%
TOTAL	**100.00%**

Data / Parameter	$SPEC_{flare}$

[39] IPCC Fourth Assessment Report: Climate Change 2007, item 2.10.2: Direct Global Warming Potentials, Table 2.14, available at: http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html , accessed on 11/01/2018 and in accordance with EB69, Annex 3 and decision 4/CMP.7, available at: http://cdm.unfccc.int/Reference/Standards/meth/reg_stan02.pdf , accessed on 11/01/2018.

<table>
<tr><td>Unit</td><td>Temperature - °C
Flow rate - Nm^3/h
Maintenance schedule - number of days</td></tr>
<tr><td>Description</td><td>Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule</td></tr>
<tr><td>Source of data</td><td>Flare Manufacturer</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>Enclosed flares

There is no control of minimum and maximum temperatures, only the detection of the flame. The methods and procedures will be manufacturer manual/recommendation.

According to manufacturer manual/recommendation.

<table>
<tr><td>Flare model</td><td>2500 HT</td></tr>
<tr><td>Minimum flare temperature</td><td>850 ºC</td></tr>
<tr><td>Maximum flare temperature</td><td>1200 ºC</td></tr>
<tr><td>Minimum and maximum inlet flow rate</td><td>Minimum flow: 500 Nm^3/h *

Maximum flow: 2,500 Nm^3/h</td></tr>
<tr><td>Maximum duration in days between maintenance events</td><td>7 days[40]</td></tr>
</table>
</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td></td></tr>
</table>

Data / Parameter	η_{PJ}
Unit	Dimensionless
Description	Efficiency of the LFG capture system installed in the project activity
Source of data	Collection efficiency 0.85 - USEPA Handbook EPA-LFG.pdf - Item 2.2.2. page 2-8.
Value(s) applied	85%
Choice of data or Measurement methods and procedures	Based on Collection efficiency 0.85 - USEPA Handbook EPA-LFG.pdf - Item 2.2.2. page 2-8.
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	$\varphi_{default}$
Unit	-

40 The maximum duration in days between maintenance events has been chosen considering preventive maintenance program which defines the frequency for checking flare equipment situation every week.

Description	Default value for the model correction factor to account for model uncertainties
Source of data	Tool "Emissions from solid waste disposal sites"
Value(s) applied	0.75
Choice of data or Measurement methods and procedures	According to "Emissions from solid waste disposal sites", the *Application A* was used because the landfill is an existing solid waste disposal site and in the project activity the methane emissions are being mitigated by capturing and flaring the methane (ACM0001).
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	OX
Unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.1
Choice of data or Measurement methods and procedures	Default value used according to "Emissions from solid waste disposal sites"
Purpose of data	Calculation of baseline emission
Additional comment	When methane passes through the top-layer, part of it is oxidized by methanotrophic bacteria to produce CO_2. The oxidation factor represents the proportion of methane that is oxidized to CO_2.This should be distinguished from the methane correction factor (MCF) which is to account for the situation that ambient air might intrude into the SWDS and prevent methane from being formed in the upper layer of SWDS.

Data / Parameter	F
Unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	Default value used according to "Emissions from solid waste disposal sites"
Purpose of data	Calculation of baseline emission
Additional comment	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide

Data / Parameter	$DOC_{f,default}$
Unit	Weight fraction

Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or Measurement methods and procedures	The default value was used for type Application A). according to "Emissions from solid waste disposal sites"
Purpose of data	Calculation of baseline emission
Additional comment	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. This default value can be used for Application A.

Data / Parameter	f_y
Unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
Source of data	Select the maximum value from the following: (a) contract or regulation requirements specifying the amount of methane that must be destroyed/used (if available) and (b) historic data on the amount captured
Value(s) applied	0
Choice of data or Measurement methods and procedures	-
Purpose of data	Calculation of baseline emission
Additional comment	According to ACM0001 methodology, the parameter f_y in the methodological tool "Emissions from solid waste disposal sites" shall be assigned a value of 0 (zero) because the amount of LFG that would have been captured and destroyed is already accounted for in equation 2 of this methodology. Also, according to ACM0001 methodology, the parameter *X* begins with the year that the SWDS started receiving wastes (2010). For this reason, the parameter f_y and *X* will not be monitored.

Data / Parameter	$MCF_{default}$
Unit	-
Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	1.0
Choice of data or Measurement methods and procedures	The project activity is an anaerobic managed solid waste disposal site with 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 is include: (i) cover material; (ii) mechanical compacting and (iii) leveling of the waste;
Purpose of data	Calculation of baseline emission
Additional comment	-

<table>
<tr><td>Data / Parameter</td><td>DOC_j</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Fraction of degradable organic carbon in the waste type j (weight fraction)</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Waste type j</th><th>DOCj
(% wet waste)</th></tr>
<tr><td>Wood and wood products</td><td>43%</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40%</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15%</td></tr>
<tr><td>Textiles</td><td>24%</td></tr>
<tr><td>Garden, yard and park waste</td><td>20%</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0%</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>IPCC default value for municipal solid waste (MSW) disposal site is applied.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emission</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data / Parameter</td><td>k_j</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Decay rate for waste type j</td></tr>
<tr><td>Source of data</td><td>2006 IPCC Guidelines for National Greenhouse Gas Inventories</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th colspan="2" rowspan="2">Waste type j</th><th>Tropical (MAT > 20 °C)</th></tr>
<tr><th>Wet
(MAP>1000mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.4</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>IPCC default value for anaerobic managed solid waste disposal site is applied.</td></tr>
</table>

Purpose of data	Calculation of baseline emissions
Additional comment	Used for projection of methane avoidance. The climate data was provided to Rainfall index database from Uberlandia city - (http://www.ciiagro.sp.gov.br/ciiagroonline/Quadros/QTmedPeriodo.asp). And the temperature data was provided to CIIAGRO (http://www.ciiagro.sp.gov.br/ciiagroonline/Quadros/QChuvaPeriodo.asp) • MAT = 22.8 °C • MAP = 1,283 mm

Data / Parameter	MM_i
Unit	kg/kmol
Description	Molecular mass of greenhouse gas i
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	Compound / Structure / Molecular mass (kg/kmol): Methane / CH_4 / 16.04
Choice of data or Measurement methods and procedures	According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	MM_k
Unit	kg/kmol
Description	Molecular mass of gas *k*
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	Compound / Structure / Molecular mass (kg/kmol): Nitrogen / N_2 / 28.01
Choice of data or Measurement methods and procedures	According to “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”
Purpose of data	Calculation of baseline emissions
Additional comment	-

Data / Parameter	MM_{H2O}
Unit	kg/kmol
Description	Molecular mass of water
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream
Value(s) applied	18.0152

Choice of data or Measurement methods and procedures	According to "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"
Purpose of data	Calculation of baseline emissions
Additional comment	-

B.6.3. Ex-ante calculation of emission reductions

>>

Emission reduction

Baseline emission calculation

The total of methane generation at the site has been estimated based on the waste tonnage of the landfill using the first order decay model presented in the *"Emissions from solid waste disposal sites"* and considering the following equation as mentioned previously.

Ex-ante estimation of $F_{CH4,PJ,y}$

The assumptions used to calculate **$F_{CH4,PJ,y}$** are:

- Methane content in LFG = 50% (default value);
- LFG collection efficiency = 85%: (Based on Collection efficiency 0.85 & Load Factor 0.95 - USEPA 1996 Handbook EPA-LFG.pdf - Item 2.2.2. page 2-8.);
- Density of methane = 0.716 kg/m^3 (as per tool "Project emissions from flaring*").*

The landfill gas collection and utilization system will capture only a portion of the generated landfill gas. Thus, an estimate of 85% LFG collection was applied to the estimate of LFG produced, under assumption that generated LFG is composed of 50% methane.

The ex ante estimation of the $F_{CH4,PJ,y}$ is presented below:

$$F_{CH4,PJ,y} = \eta_{PJ} \times \frac{BE_{CH4,SWDS,y}}{GWP_{CH4}}$$

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr)
$BE_{CH4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y (tCO_2e/yr)
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH4}	=	Global warming potential of CH_4 (tCO_2e/tCH_4)

The table below illustrates the ex-ante estimation of $F_{CH4,PJ,y}$ by the project activity during the crediting period.

Table 3 - Ex-ante estimation of $F_{CH4,PJ,y}$

Year	$F_{CH4,PJ,y}$ (tCH_4/yr)
From 04/09/2019	2,227
2020	7,126
2021	7,434
2022	7,753
2023	8,086
2024	8,432
2025	8,792
Until 03/09/2026	6,178

Values extracted from ER spreadsheet

Determination of $F_{CH4,BL,y}$

$F_{CH4,BL,y}$ = 1.76% × $F_{CH4,PJ,y}$

Table 4 - Ex-ante estimation of $F_{CH4,BL,y}$

Year	$F_{CH4,BL,y}$ (tCH_4/yr)
From 04/09/2019	39
2020	125
2021	131
2022	136
2023	142
2024	148
2025	155
Until 03/09/2026	109

Values extracted from ER spreadsheet

Step (A): Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

The equation of the $BE_{CH4,y}$ is:

$$BE_{CH4} = \left(\left(1 - OX_{top\_layer}\right) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$$

Where the OX_{top_layer} = 0.1 (default value) and $F_{CH4,PJ,y}$ and $F_{CH4,BL,y}$ are calculated above. The results are presented below:

Table 5 - Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Year	$BE_{CH4,y}$ (tCO_2/year)
From 04/09/2019	49,131
2020	157,206
2021	163,985
2022	171,040
2023	178,378
2024	186,010
2025	193,949
Until 03/09/2026	136,281

Values extracted from ER spreadsheet

Step (B): Baseline emissions associated with electricity generation ($BE_{EC,y}$)

The ex-ante calculation is:

$$BE_{EC,y} = EC_{BL,k,y} \times EF_{grid,CM,y} \times (1+TDL_y)$$

As explained above, the $EF_{grid,CM,y}$ = 0.2375 tCO_2/MWh

Table 6 - Baseline emissions associated with electricity generation ($BE_{EC,y}$)

Year	$EC_{BL,k,y}$ (MWh/yr) [41]	$BE_{EC,y}$ (tCO_2/yr)
From 04/09/2019	7,738	2,205
2020	27,469[42]	7,829
2021	28,481	8,117
2022	28,481	8,117
2023	28,481	8,117
2024	28,481	8,117
2025	28,481	8,117
Until 03/09/2026	18,987	5,412

Values extracted from ER spreadsheet

[41] Values from PDD registered before PRC with increased capacity by 20 per cent, due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC)

[42] 3rd Group Generator became operational only on 19/03/2020, thus net electricity generated in the plant has been calculated proportionally considering days in the year in order to be conservative.

The forecast installed capacity and electricity generated by the project activity are present below:

Real Implemented due to PRC					PDD registered before PRC	PDD registered before PRC with increased capacity by 20 per cent
Year*	**PRC Applied**	**Net capacity (MWe)[1]**	**Number of group generators**	**Net electricity generated in the plant (MWh)[43]**	**Net electricity generated in the plant (MWh)**	**Net electricity generated in the plant (MWh)[44]**
2019	No	2.852	2	7,738	7,911	7,738
2020	Yes	4.278	3	35,602	23,734	27,469[45]
2021	Yes	4.278	3	35,602	23,734	28,481
2022	Yes	4.278	3	35,602	23,734	28,481
2023	Yes	4.278	3	35,602	23,734	28,481
2024	Yes	4.278	3	35,602	23,734	28,481
2025	Yes	4.278	3	35,602	23,734	28,481
2026	Yes	4.278	3	23,994	15,823	18,987

[1] Definition of Net capacity: is the maximum capacity at the plant minus the amount of electricity that is consumed by the plant;
* From 04/09/2019 to 03/09/2026

The equation of the baseline emission calculation is:

$$BE_y = BE_{CH4,y} + BE_{EC,y}$$

The result is:

Table 7 - Baseline emission calculation

Year	$BE_{CH4,y}$ (tCO_2/year)	$BE_{EC,y}$ (tCO_2/yr)	BE_y (tCO_2/yr)
From 04/09/2019	49,131	2,205	51,336
2020	157,206	7,829	165,035
2021	163,985	8,117	172,103
2022	171,040	8,117	179,157
2023	178,378	8,117	186,495
2024	186,010	8,117	194,128
2025	193,949	8,117	202,066
Until 03/09/2026	136,281	5,412	141,692

Values extracted from ER spreadsheet

[43] Real implemented but not used in CERs calculation, due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC)

[44] Values from PDD registered before PRC with increased capacity by 20 per cent, due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC)

[45] 3rd Group Generator became operational only on 19/03/2020, thus net electricity generated in the plant has been calculated proportionally considering days in the year in order to be conservative.

Therefore, the combined margin CO_2 emission factor will be ex-ante.

1. Project emission

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

Where:

PE_y	=	Project emissions in year y (tCO_2/yr)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year y (tCO_2/yr)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year y (tCO_2/yr)

There is no consumption of fossil fuels due to the project activity for purpose other than electricity generation, in year y (tCO_2/yr), therefore $PE_{FC,y} = 0$

Thus,

$$PEy = PE_{EC,y}$$

Calculation of $PE_{EC,y}$ – project emission from consumption of electricity

The project emission from consumption of electricity is:

$$PE_{EC,y} = PE_{EC1,y} + PE_{EC2,y}$$

Where:

$PE_{EC1,y}$ - Project emission from the grid

In the option A1 of the "Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation", states that a value of the combined margin emission factor ($EF_{grid,CM,y}$) may be used as the emission factor ($EF_{ELj/k/l,y}$) Therefore a value of 0.2375 tCO_2/MWh will be used.

Finally the technical transmission and distribution losses ($TDL_{j,y}$) value has been assumed to be 20%, according to Option 2: default value from TOOL05 - Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation. Table below summarizes the project emissions resulting from electrical consumption in the plant.

Table 8 - Electricity consumption from the grid resulting due to project activity

Year	Electricity consumption from the grid (MWh/year)	$PE_{el,grid}$ (tCO_2/year)
From 04/09/2019	502	144
2020	1,541	440
2021	1,541	440
2022	1,541	440
2023	1,541	440
2024	1,541	440
2025	1,541	440
Until 03/09/2026	1,039	297

Values extracted from ER spreadsheet

Calculation of $PE_{FC,y}$ – Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation

For ex-ante calculation, this factor was considered zero because there is no estimation from LPG consumption in pilot flames of flares.

$PE_{FC,y} = 0$

2. Leakage:

No leakage effects need to be accounted under methodology ACM0001 ver. 18.

3. Emission reduction

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$

Where:

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

Year	BEy (tCO_2)	PEy (tCO_2)	ERy (tCO_2)
From 04/09/2019	51,336	144	51,192
2020	165,035	440	164,595
2021	172,103	440	171,663
2022	179,157	440	178,717
2023	186,495	440	186,055
2024	194,128	440	193,688
2025	202,066	440	201,626
Until 03/09/2026	141,692	297	141,395

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)
From 04/09/2019	51,336	144	0	51,192
2020	165,035	440	0	164,595
2021	172,103	440	0	171,663
2022	179,157	440	0	178,717
2023	186,495	440	0	186,055
2024	194,128	440	0	193,688
2025	202,066	440	0	201,626
Until 03/09/2026	141,692	297	0	141,395
Total	1,292,012	3,081	0	1,288,931
Total number of crediting years	**7**			
Annual average over the crediting period	**184,573**	**440**	**0**	**184,133**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data / Parameter	$EF_{grid,CM,y}$
Unit	tCO_2/MWh
Description	CO_2 emission factor of the Brazilian grid electricity during the year y
Source of data	Calculations based on parameters described above.
Value(s) applied	0.2375
Measurement methods and procedures	The emission factor is calculated ex-post, as the weighted average of the dispatch data analysis OM (Operating Margin) and the BM (Build margin), as described in B.6.3.
Monitoring frequency	Annual
QA/QC procedures	Apply procedures in the “Tool to calculate the emission factor for an electricity system”.

Purpose of data	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comment	All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system", were included in the monitoring plan. For more details, see Annex 3.

Data / Parameter	$EF_{grid,OM,y}$
Unit	tCO_2 /MWh
Description	Operating margin emission factor of the Brazilian grid
Source of data	Calculations based on parameters described above.
Value(s) applied	0.5390
Measurement methods and procedures	The operating margin emission factor is calculated ex-post, as described in B.6.3.
Monitoring frequency	Annual
QA/QC procedures	Apply procedures in the "Tool to calculate the emission factor for an electricity system".
Purpose of data	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comment	All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system", were included in the monitoring plan. For more details, see Annex 3.

Data / Parameter	$TDL_{j,y}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j, in year y
Source of data	TOOL05 - Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation
Value(s) applied	20%[46]
Measurement methods and procedures	For (a): *TDLj/k/l,y* 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 contain 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	Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years
QA/QC procedures	-
Purpose of data	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comment	According to Option 2: default value as 20% from TOOL05 - Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation

[46] According to Option 2: default value from TOOL05 - Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation

Data / Parameter	$EC_{PJ1,y} = EG_{EC1,y}$
Unit	MWh/y
Description	Quantity of electricity consumed from the grid by the project activity during the year y;
Source of data	Measurement from Project participants.
Value(s) applied	<table><tr><th>Year</th><th>$EC_{PJ1,y}$ (MWh/year)</th></tr><tr><td>From 04/09/2019</td><td>502</td></tr><tr><td>2020</td><td>1,541</td></tr><tr><td>2021</td><td>1,541</td></tr><tr><td>2022</td><td>1,541</td></tr><tr><td>2023</td><td>1,541</td></tr><tr><td>2024</td><td>1,541</td></tr><tr><td>2025</td><td>1,541</td></tr><tr><td>Until 03/09/2026</td><td>1,039</td></tr></table>
Measurement methods and procedures	Continuously measured by electricity meters for the grid electricity consumption as per the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” version 03.0 and methodology ACM0001 version 18.
Monitoring frequency	Continuously
QA/QC procedures	As per the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” version 03.0
Purpose of data	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comment	The data will be archived throughout the crediting period and two years thereafter.

ACM0001: Flaring or use of landfill gas

Data / Parameter	Management of SWDS
Unit	-
Description	Management of SWDS
Source of data	Use different sources of data: - Original design of the landfill; - Technical specifications for the management of the SWDS; - Local or national regulations
Value(s) applied	-
Measurement methods and procedures	Project participants should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
Monitoring frequency	Annually

QA/QC procedures	-
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	-

Data / Parameter	$EG_{PJ,y} = EC_{BL,k,y}$
Unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year y
Source of data	Electricity meter
Value(s) applied	<table><tr><th>Year</th><th>$EG_{PJ,y}$ (MWh/year) [47]</th></tr><tr><td>From 04/09/2019</td><td>7,738</td></tr><tr><td>2020</td><td>27,469</td></tr><tr><td>2021</td><td>28,481</td></tr><tr><td>2022</td><td>28,481</td></tr><tr><td>2023</td><td>28,481</td></tr><tr><td>2024</td><td>28,481</td></tr><tr><td>2025</td><td>28,481</td></tr><tr><td>Until 03/09/2026</td><td>18,987</td></tr></table>
Measurement methods and procedures	Monitor net electricity generation by the project activity using LFG
Monitoring frequency	Continuous
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company.
Purpose of data	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comment	This parameter is required for calculating baseline emissions associated with electricity generation ($BE_{EC,y}$) using the “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” version 03.0

[47] Values from PDD registered before PRC with increased capacity by 20 per cent, due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC)

Data / Parameter	$O_{pj,h}$
Unit	-
Description	Operation of the equipment that consumes the LFG
Source of data	Measurements by Project participant using a device integrated with the operational software at the landfill gas plant.
Value(s) applied	n/a
Measurement methods and procedures	For each equipment unit j using the LFG monitor that the plant is operating in hour h by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnances. This option is not applicable to brick kilns. Opj,h=0 when: (a) One of more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); (c) No products are generated in the hour h. Otherwise, Opj,h=1
Monitoring frequency	Once per minute
QA/QC procedures	The calibration of this equipment is not applicable since it is a device integrated with the operational software at the landfill gas plant.
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	-

Tool to determine the mass flow of a greenhouse gas in a gaseous stream

Data / Parameter	$V_{t,db}$
Unit	m^3 /h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Measurements by Project participants using a flow meter(s)
Value(s) applied	n/a
Measurement methods and procedures	The volumetric flow rate of the residual gas which is sent to each individual flare, LFG engines in the hour h will be measured by the installed flow meters with digital recordable electronic signal, according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, the measurement option in the project activity will be: • Option (A) dry basis: when the temperature of gaseous stream is lower than 60ºC (333.15 K) at the flow measurement point; • Option (B) wet basis: when the temperature of gaseous stream is higher than 60o C (333.15 K) at the flow measurement point;
Monitoring frequency	Continuous recorded and hourly aggregated
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be in accordance with manufacturer’s specifications.
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	This parameter will be monitored only in case Option A of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0) is applied for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$

Data / Parameter	$V_{t,wb}$
Unit	m^3 /h
Description	Volumetric flow of the gaseous stream in time interval t on a wet basis
Source of data	Measurements by Project participants using a flow meter
Value(s) applied	n/a
Measurement methods and procedures	The volumetric flow rate of the residual gas which is sent to each individual flare, LFG engines in the hour h will be measured by the installed flow meters with digital recordable electronic signal, according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, the measurement option in the project activity will be: • Option (A) dry basis: when the temperature of gaseous stream is lower than 60ºC (333.15 K) at the flow measurement point; • Option (B) wet basis: when the temperature of gaseous stream is higher than 60o C (333.15 K) at the flow measurement point;
Monitoring frequency	Continuous recorded and hourly aggregated
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be in accordance with manufacturer’s specifications.
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	This parameter will be monitored only in case Options B or C of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0) is applied for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$

Data / Parameter	$v_{i,t,db}$
Unit	m³ gas i/m³ dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Source of data	Measurements by Project participants using gas analyser
Value(s) applied	50%
Measurement methods and procedures	Continuous gas analyser operating in dry basis. Volumetric flow measurement should always refer to the actual pressure and temperature.
Monitoring frequency	Continuous recorded and hourly aggregated
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period.
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	This parameter will be monitored in Options B and E and may be monitored in Options A and D of the tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0) is applied for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$

Data / Parameter	$v_{i,t,wb}$
Unit	m³ gas i/m³ wet gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a wet basis
Source of data	Measurements by Project participants using gas analyser
Value(s) applied	50%
Measurement methods and procedures	Calculated based on the dry basis analysis plus water concentration measurement or continuous in-situ analysers if not specified in the underlying methodology
Monitoring frequency	Continuous recorded and hourly aggregated
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period.
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	This parameter will be monitored in Options C and F and may be monitored in Options A and D

Data / Parameter	T_t
Unit	K
Description	Temperature of the gaseous stream in time interval t
Source of data	Measurements by Project participant using a temperature meter
Value(s) applied	n/a
Measurement methods and procedures	Thermoresistance with digital recordable electronic signal will be used. The accuracy and uncertainty of the monitoring instrument will be in accordance with manufacturer specifications.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be according to the manufacturer’s specifications
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency). However, if the applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted, this parameter must be monitored continuously to assure the applicability condition is met.

Data / Parameter	P_t
Unit	Pa
Description	Pressure of the gaseous stream in time interval t
Source of data	Measurements by Project participant using a pressure meter
Value(s) applied	n/a
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) will be used. Examples include pressure transducers, etc. The accuracy and uncertainty of the monitoring instrument will be in accordance with manufacturer specifications.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device must be performed periodically and records of calibration procedures must be kept available as well as the primary device and its calibration certificate. Pressure transducers (either capacitive or resistive) must be calibrated monthly. In case the pressure meter is not a capacitive or resistive pressure transducer, the calibration frequency of this monitoring equipment should be according to the manufacturer’s specifications.
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency)

Data / Parameter	Status of biogas destruction device
Unit	-
Description	Operational status of biogas destruction devices
Source of data	Provided by project participants
Value(s) applied	n/a
Measurement methods and procedures	Monitoring and documenting may be undertaken by recording the energy production from methane captured or the operation of the flare by means of a flame detector to demonstrate the actual destruction of methane, unless a different method is specified in the underlying methodology/tool. Emission reductions will not accrue for periods in which the destruction device is not operational.
Monitoring frequency	Continuous
QA/QC procedures	-
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	For Flame detector devices refer to the methodological tool “Project emissions from flaring”

Data / Parameter	$P_{H2O,t,Sat}$
Unit	Pa
Description	Saturation pressure of H_2O at temperature Tt in time interval t
Source of data	Provided by project participants
Value(s) applied	n/a
Measurement methods and procedures	This parameter is solely a function of the gaseous stream temperature Tt and can be found at reference [1] for a total pressure equal to 101,325 Pa
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	[1] Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994, John Wiley & Sons, Inc.

Methodological tool “Project emissions from flaring”

Data / Parameter	$Flame_m$
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Source of data	Project Participant
Value(s) applied	-
Measurement methods and procedures	Measurements by project participants using a continuous Ultra Violet flame detector
Monitoring frequency	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer’s recommendations

Purpose of data	Calculation of baseline and project emissions when the flame is on[48].
Additional comment	-

Data / Parameter	$Maintenance_y$
Unit	Calendar dates
Description	Maintenance events completed in year y
Source of data	Project participants
Value(s) applied	-
Measurement methods and procedures	Record the date that maintenance events were completed in year y. Records of maintenance logs must include all aspects of the maintenance including the details of the person(s) undertaking the work, parts replaced, or needing to be replaced, source of replacement parts, serial numbers and calibration certificates
Monitoring frequency	Annual
QA/QC procedures	Records must be kept in a maintenance log for two years beyond the life of the flare
Purpose of data	Calculation of baseline and project emissions when the flame is on[49].
Additional comment	Monitoring of this parameter is required for the case of flares and the project participant selects Option B to determine flare efficiency. These dates are required so that they can be compared to the maintenance schedule to check that maintenance events were completed within the minimum time between maintenance events specified by the manufacturer ($SPEC_{,flare}$).

Data / Parameter	$T_{EG,m}$
Unit	º C
Description	Temperature in the exhaust gas of the enclosed flare in minute m
Source of data	Measurements by project participants
Value(s) applied	-
Measurement methods and procedures	Measure the temperature of the exhaust gas stream in the flare by a Type N thermocouple. A temperature above 850 ºC indicates that a significant amount of gases are still being burnt and that the flare is operating. Data will be recorded continuously and values will be averaged hourly or at a shorter time interval.
Monitoring frequency	Once per minute
QA/QC procedures	Thermocouples will be replaced or calibrated every year
Purpose of data	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comment	-

B.7.2. Sampling plan

>>

Not applicable

B.7.3. Other elements of monitoring plan

>>

[48] When the flame is off, neither baseline nor project emissions occurs since the LFG is not combusted and instead released to the atmosphere.

[49] When the maintenance is being carried out, neither baseline nor project emissions occurs since the LFG is not combusted and released to the atmosphere.

According to *ACM0001*, direct monitoring will be conducted on the LFG destroyed by flare and used for power generation. The monitoring procedures will measure:

- Landfill gas flow into flare
- Landfill gas flow into power plant
- Methane content in the landfill gas
- Temperature of exhaust gas from flaring
- Electricity imported from the power grid
- Electricity exported to the power grid[50]
- Power plant working hours
- Emission Factors
- $TDL_{k/j,y}$ = Average technical transmission and distribution losses for providing electricity to source *k/j* in year *y*
- Information of the host country's regulatory requirement relating to LFG, contractual requirements, or requirements to address safety and odour concerns

The monitoring of the operation parameters during the operation of the plant will be carried out according to the monitoring plan in Appendix 5.

The date of completion the application of the methodology to the project activity study is 30/11/2018.

The person/entity determining the baseline is as follows:
Beng Engenharia Ltda, São Paulo, Brazil
Contact person: Mr. João Sprovieri
Mr. Francisco Santo
Email: joao.sprovieri@beng.eng.br
francisco.santo@beng.eng.br

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
03/05/2011
This is the date of creation of Energas Geração de Energia Ltda., composed by Limpebrás Resíduos Ltda. and Asja Brasil Serviços para o Meio Ambiente Ltda. exclusively for the development of the Project.

C.2. Expected operational lifetime of project activity

>>
21 years and 0 months
The landfill gas production is expected to abruptly decrease once the Landfill II stops receiving waste (2028), so the Project Proponents estimate the lifetime of project in around 4 years after the end of landfill operational lifetime.

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Renewable (3 x 7 years)

[50] Due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased capacity by 20 per cent of the installed capacity specified in the originally registered PDD (before PRC).

C.3.2. Start date of crediting period

>>
The 2nd crediting period started on 04/09/2019.

C.3.3. Duration of crediting period

>>
7 years and 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
According with the Brazilian Legislation, all pollution sources activities must receive an authorization from the competent environmental supervision agency.

In Minas Gerais State the attributions of environmental regularization are performed by the *Conselho Estadual de Política Ambiental* (State Cabinet of Environmental Politics), respected the projects of federal interest, through the *Câmaras Especializadas* (Specialized Councils), the *Unidades Regionais Colegiadas* (Member Regional Units body), the *Superintendências Regionais de Meio Ambiente e Desenvolvimento Sustentável* (Regional Superintendence for Environment and Sustainable Development), the *Fundação Estadual do Meio Ambiente* (State Foundation for Environment), the *Instituto Mineiro de Gestão das Águas* (Minas Gerais Institute for Waters Management) and the *Instituto Estadual de Florestas* (State Institute for Forests), in accordance with Art. 1º of State Decree nº 44.844/08. For this Project the competent environmental agency is the *Superintendência Regional de Meio Ambiente e Desenvolvimento Sustentável*, hereinafter named SUPRAM.

The Uberlândia Landfill, received in 11/08/2015, the environmental licence nº 083/2015 issued by SEMAD, valid until 11/09/2019, for the activities of disposing waste at the solid waste disposal site and collection, transmission and flaring of LFG.

Electricity plant received in 31/01/2018, the environmental license nº 00899/2018 issued by SEMAD, valid until 08/12/2021, for the activities of electricity generation.

The project will not have any transboundary impacts – all potential environmental impacts will occur inside the project boundary, more specifically inside the landfill.

D.2. Environmental impact assessment

>>
The Project does not expect to create any negative environmental impacts. Rather, it will improve the actual destruction of gas from the landfill by installing an efficient burning system which assures a rate of more than 99% of destruction.

Additionally, the Project will avoid the usage of fossil fuel in grid-connected power plants.

Anyway Project Participants will comply with all requirements SUPRAM may identify.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>
The local stakeholder consultation process was carried out according with Resolução nº 7 from the Brazilian DNA.

A copy from the PDD translated to Portuguese and an explanation on how the project will contribute to the promotion of sustainable development, as determined by the Annex III of Resolução nº 1 of Brazilian DNA, was sent, in June 10th 2010, to each of the stakeholders described in the table below.

Table 9 - Local stakeholders consultation.

Resolução nº7	Stakeholder invited
City Hall of the host-city	City Hall of Uberlândia (Mr. Odelmo Leão Carneiro – Mayor)
Legislative Chamber of the host-city	Legislative Chamber of Uberlândia (Mr. Hélio Ferraz – President)
State Environmental Authority	FEAM – Fundação Estadual do Meio Ambiente (*Environmental State Foundation*) (Mr. José Cláudio Junqueira Ribeiro – President)
	Secretaria Estadual de Meio Ambiente e Desenvolvimento Sustentável – SEMAD *(Environmental State Secretariat)* (Mr. José Carlos Carvalho – Secretary)
Municipal Environmental Authority	Municipal Environmental Secretary (Mrs. Raquel Mendes – Secretary)
Fórum Brasileiro de ONG's e Movimentos Sociais para o Meio Ambiente e Desenvolvimento (*Brazilian NGO Forum*)	Fórum Brasileiro de ONG's e Movimentos Sociais para o Meio Ambiente e Desenvolvimento *(Brazilian NGO Forum)*
State Public Attorney	State Public Attorney of Minas Gerais
Federal Public Attorney	Federal Public Attorney (Mr. Roberto Monteiro Gurgel Santos – General Attorney)
Other Stakeholders	Associação dos Recicladores e Catadores Autônomos (Arca) *(NGO)* (Mr. Antônio – President)
	Associação dos Moradores do bairro Guarani *(NGO)* (Mr. Idevaldo José de Souza – President)
	Associação dos Moradores do bairro Tocantins *(NGO)* (Mr. Celson Rosa de Melo – President)

E.2. Summary of comments received

>>

During the public consultation period the following stakeholder made comments about the Project:

- *FEAM – Fundação Estadual do Meio Ambiente (Environmental State Foundation)* – by letter in July 27th 2010

FEAM's comment is positive. The Foundation considers that the project will bring positive environmental benefits both for capturing and destroying methane from landfill gas and for avoiding the use of fossil fuel by adding renewable energy to the grid. The foundation emphasizes the project activity is in tune with Minas Gerais State's directives of supporting projects aiming to mitigate global warming.

- *Federal Public Attorney* – by letter in August 24th 2010

The entity states that it is not allowed to proceed the analysis of the project due to constitutional obligation.

E.3. Consideration of comments received

>>
Project participants appreciated the comments received. No further action was done since no negative comment nor suggestion of change was made.

SECTION F. Approval and authorization

>>
In the proposed project, the project participant is presented below:

Thus, the Party involved is Brazil.

In accordance with the CDM project cycle procedure for project activities (version 01.0)", the project participant has already obtained a letter of approval from the host parties DNAs.

During the 1st CP validation, the registered CDM project activity has been granted with Letter of Acceptance (LoA) by the Designated National Authority (DNA) of the host party Brazil (dated 04/05/2007). Copy of such LoA and related assessment details are made available at the project's page at UNFCCC's CDM website.

Appendix 1. Contact information of project participants

Organization name	Energas Geração de Energia Ltda.
Country	Brazil
Address	Rodovia BR-452, s/n, km 123.8, Anel Viário, Setor A, Distrito Industrial
Telephone	+55 (34) 3291-9000
Fax	+55 (34) 3291-9000
E-mail	eduardosantos@limpebras.com.br
Website	-
Contact person	Mr. Eduardo Lima Santos

Organization name	Limpebrás Resíduos Ltda.
Country	Brazil
Address	Avenida José Andraus Gassani, 1298
Telephone	+55 (34) 3291-9000
Fax	+55 (34) 3291-9000
E-mail	limpebras@limpebras.com.br
Website	http://www.limpebras.com.br
Contact person	Mr. Heitor Eduardo dos Santos

Organization name	Asja Brasil Serviços para o Meio Ambiente Ltda.
Country	Brazil
Address	Ave. Getúlio Vargas, n456, 10th floor.
Telephone	+55 (31) 3286-3311
Fax	+55 (31) 3286-3311
E-mail	m.uchida@asja.energy
Website	http://www.asja.biz
Contact person	Melina Yurie Uchida

Organization name	Numerco Limited
Country	United Kingdom of Great Britain and Northern Ireland
Address	9 Devonshire Square EC2M 4YD London
Telephone	N/A
Fax	N/A
E-mail	N/A
Website	N/A
Contact person	Gareth Turner

Appendix 2. Affirmation regarding public funding

There is no public funding involved in the development of the Project Uberlândia landfills I and II.

Appendix 3. Applicability of methodologies and standardized baselines

The baseline scenario for the project activity is the uncontrolled release of landfill gas to the atmosphere and also the generation of electricity from other sources.

The table below shows the key elements used for estimate the emissions of the baseline scenario.

1. Key Parameters

Year landfilling operations started operator/historical logs	1995
Projected year for landfill closure - estimated based on current filling rate	2028
GWP for methane (UNFCCC and Kyoto Protocol decisions)	25
Methane concentration in LFG (% by volume) typical assumption for baseline scenario	50
LFG collection efficiency (%)	85
Flare efficiencies (%) operational data from flare manufacturer	99 %
Electricity consumption from the grid due to the project activity (MWh/year)	0
Combined margin emission factor for electricity displacement (tCO_2/MWh) calculated based on the Tool to calculate the emission factor for an electricity system.	0.2375
Installed capacity of Power Plant (MW)	4.278
Load factor	95.00
Operational lifetime of the project activity (years)	21
Adjustment Factor (AF)	1.76%

2. Waste disposal

The forecast amount of waste disposal in landfill is presented below:

Year	Waste disposal (tonnes/yr)
1995	35,110
1996	153,305
1997	124,399
1998	120,281
1999	130,675
2000	141,735
2001	140,945

2002	140,388
2003	126,866
2004	125,405
2005	126,931
2006	139,500
2007	143,812
2008	148,895
2009	163,100
2010	166,347
2011	185,079
2012	185,723
2013	191,003
2014	199,592
2015	205,829
2016	214,342
2017	223,207
2018	232,434
2019	242,054
2020	252,066
2021	262,491
2022	273,348
2023	284,654
2024	296,427
2025	308,688
2026	321,456
2027	334,752
2028	87,149

3. Emission factors

The table below shows the Brazilian emission factors according to determination of the Brazilian DNA. More information is available at the Brazilian DNA website[51].

51 http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/arquivos/emissoes_co2/Despacho-2017.xlsx, accessed on 23/07/2018.

Combined Margin Emission Factor 2018 (tCO_2/MWh) [8]		
2nd crediting Period		**0.2375**
Build Margin - 2018		0.1370
Operating Margin 2018	January	0.5652
	February	0.5559
	March	0.5750
	April	0.5058
	May	0.5461
	June	0.6691
	July	0.5989
	August	0.5948
	September	0.5718
	October	0.5782
	November	0.3654
	December	0.3423
	2018	0.5390

Source: Brazilian DNA

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

Historical amount of methane in the LFG which is captured ad destroyed ($F_{CH4,hist,y}$)

Table 10 - Estimated MDBL to Brazilian landfills.

City	MD_{BL}	$MD_{Project}$	AF	AF_{PR}	City	MD_{BL}	$MD_{Project}$	*AF*	AF_{PR}
	a	b	*c=a/b*			a	b	*c=a/b*	
Americana	0.0105	0.7425	0.0142	n.p.	Joinville	0.0084	0.7425	*0.0114*	n.p.
Belo Horizonte	0.0143	0.7425	0.0192	n.p.	Natal	0.0007	0.7425	*0.0009*	n.p.
Betim	0.0340	0.7425	0.0458	n.p.	Niterói	0.0143	0.7425	*0.0193*	n.p.
Blumenau	0.0197	0.7425	0.0265	n.p.	Osasco	0.0501	0.7425	*0.0675*	n.p.
Caieiras	0.0308	0.7425	0.0415	0.20	Palmas	0.0258	0.7425	*0.0348*	n.p.
Camaçari	0.0444	0.7425	0.0598	n.p.	Paulínia	0.0071	0.7425	*0.0095*	0.20
Carapicuíba	0.0000	0.7425	0.0000	n.p.	Ribeirão das Neves	0.0025	0.7425	*0.0034*	n.p.
Contagem	0.0034	0.7425	0.0045	n.p.	Salvador	0.0314	0.7425	*0.0422*	n.ap.
Cuiabá	0.0055	0.7425	0.0074	n.p.	Santos	0.0339	0.7425	*0.0457*	0.20
Curitiba	0.0537	0.7425	0.0724	n.p.	São Francisco do Conde	0.0237	0.7425	*0.0320*	n.p.
Duque de Caxias	0.0030	0.7425	0.0040	0.05	São Leopoldo	0.0190	0.7425	*0.0256*	n.p.
Embu	0.0075	0.7425	0.0101	n.p.	São Paulo - Bandeirantes	0.0225	0.7425	*0.0303*	0.20
Goiânia	0.0138	0.7425	0.0185	n.p.	São Paulo - São João	0.0132	0.7425	*0.0178*	0.20
Gravataí	0.0371	0.7425	0.0500	n.p.	Serra	0.0152	0.7425	*0.0205*	n.p.
Guarujá	0.0246	0.7425	0.0331	n.p.	Valinhos	0.0222	0.7425	*0.0299*	n.p.
Itaquaquecetuba	0.0198	0.7425	0.0266	n.p.	Vera Cruz	0.0019	0.7425	*0.0025*	n.p.
Jaboatão dos Guararapes	0.0023	0.7425	0.0030	n.p.	Vitória	0.0006	0.7425	*0.0008*	n.p.
João Pessoa	0.0005	0.7425	0.0007	0.10					
Brazilian sample average MD_{BL}, $MD_{Project}$ and AF						**0.0176**	**0.7425**	***0.0238***	

Brazilian weighted average MD_{BL}, $MD_{Project}$ and AF	**0.0040**	**0.7425**	**0.0054**	

n.p.: no LFG extracting and destruction CDM project activity is registered and implemented at landfill.
n.ap.: not applicable to this landfill.
Source: Article *Reducing the uncertainty of methane recovered (R) in GHG inventories from waste sector and of adjustment factor (AF) in landfill gas projects under CDM*, presented at the *3rd International Workshop on Uncertainty in Greenhouse Gas Inventories*, available at http://ghg.org.ua/fileadmin/user_upload/book/Proceedengs_UncWork.pdf; accessed in 06/06/2011.

Appendix 5. Further background information on monitoring plan

Introduction

According to ACM0001, direct monitoring will be conducted on the LFG captured, destroyed by flare and used for power generation.

An operative manual of the project will be available. This Management Manual will have the applicative documents of the monitoring plan (description of the project and responsibilities, operative procedures for measurements and handlings of data and details about internal audits, etc.).

Attached to this PDD there's the first Management Manual draft: "Attachment A – Management Manual".

Operators will collect necessary data for the monitoring plan and a Project Manager will verify the correct application of the operative procedures written in the manual.

The monitoring plan is described below:

1 DATA MONITORED

The monitoring procedures will include:

- Landfill gas flow into flare
- Landfill gas flow into power plant
- Methane content in the landfill gas
- Temperature of exhaust gas from flaring
- Electricity imported from the power grid
- Electricity exported to the power grid
- Power plant working hours
- Emissions from flaring
- Emission Factors
- $TDL_{k/j,y}$ = Average technical transmission and distribution losses for providing electricity to source *k/j* in year *y*
- Information of the host country's regulatory requirement relating to LFG, contractual requirements, or requirements to address safety and odour concerns

All equipment of the plant will be connected through a Programmable Logic Control (PLC) that permits the operator quick check of the main working parameters through a user-friendly interface.

2 DATA COLLECTED, FREQUENCY AND QUALITY CONTROL

Landfill gas flow:
- fed to the flares
- fed to the electricity generation devices

Landfill gas flow will be measured by means of a flow meter. One flow meter will be installed for each LFG destroying device. For reporting purposes, this parameter is generally required to be normalized to 0°C and 1.01325bar.

In order to normalize the flow measured by the flow meter to standard temperature and pressure, the temperature and pressure of LFG will be measured by temperature and pressure sensors already included in the flow meter equipment. And to limit the time of operation with no flow signal in case of failure, the flow meter will be exchanged as soon as possible.

Flow meters will be subjected to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications, which recommends this equipment to be calibrated every 10 years. In a conservative way, the equipment will be calibrated at least every 3 years, by a qualified third party.

Methane content in the landfill gas

Methane content in the landfill gas will be measured by a gas analyzer with an infrared ray system analysis (or any measurement system with the same precision and reliability), with a scale range of 0-100%Vol.

The CH_4 analyzer will be calibrated according to its calibration protocol.

To limit the time of operation with no gas analyzer in case of failure, this analyzer will be replaced with another analyzer as soon as possible.

Despite this quick exchange, the plant can operate for a short time without CH_4 signal. To determine the CH_4 content during this time span the average CH_4 content of the last 7 days will be used.

The gas analyzer is subject to regular maintenance and testing regime to ensure accuracy according to manufacturer's specifications and accuracy will be checked at least every six month during the plant normal operation.

Temperature of exhaust gas

Project owners will measure and control the temperature of the exhaust gas with an N-type thermocouple installed in the upper section of the flare, at 80% of the flare's height, in order to determine the efficiency of the flare.

All equipment of monitoring system of the entire plant will be connected through a Programmable Logic Control (PLC) that let the operator quickly check the unit's main variables through a user-friendly interface.

Each enclosed flare will be equipped with an extra thermocouple N-Type at the bottom part of chamber (height of main combustion occurrence). Data from this equipment can be used to assess whether the flare was correctly operating or not in case of failure of thermocouple installed at the top of flare.

Thermocouple will be calibrated every year using a reference thermocouple, in case of failure in calibration the thermocouple will be replaced.

Electricity imported from and exported to power grid

Electricity imported and exported[52] by power grid will be measured by electricity meters owned by the local administrator of the grid, who will be responsible for the maintenance of this equipment. Both amounts of electricity will be taken from official electricity bills emitted by the local administrator of the grid.

---

[52] Due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased capacity by 20 per cent of the installed capacity specified in the originally registered PDD (before PRC).

Emission Factor

Since “ex post” option has been chosen in the Operating Margin calculations applying the “*Tool to calculate the emission factor for an electricity system*”, the emission factor is determined for the year in which the 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) will be used throughout all crediting periods.

TDL

Project emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and TDL, a factor to account for transmission losses.

The Average technical transmission and distribution losses for providing electricity to the Project in year y will be monitored annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.

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 contain 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.

Internal Audits are going to be performed in order to ensure correct monitoring of this parameter.

Information of the host country’s regulatory requirement relating to LFG, contractual requirements, or requirements to address safety and odour concerns

The regulatory requirement relating to LFG valid in the host country, contractual requirements, or requirements to address safety and odour concerns will be monitored annually, in order to define the amount of methane in the LFG that would have been flared in the baseline, as per equation defining parameter $F_{CH4,BL,R,y}$ in the section B.6.1 of the PDD.

Possible failure: No electrical power

When there is no electrical power the blower of the biogas plant cannot operate, so no landfill gas stream is available.

The flow meter detects no landfill gas stream and does not count any CO_2e. No special actions are possible to avoid this.

3 MONITORING EQUIPMENT AND INSTALLATION

All measurements equipment is maintained and managed on general technical standards. The Management Manual will determine the quality control regime for each key that includes regular maintenance and calibration. The measurement and recording will be done in an accurate and transparent manner.

In order to determine the quantity of ERs generated during the project activity the following equipment will be installed. (Figure 5)

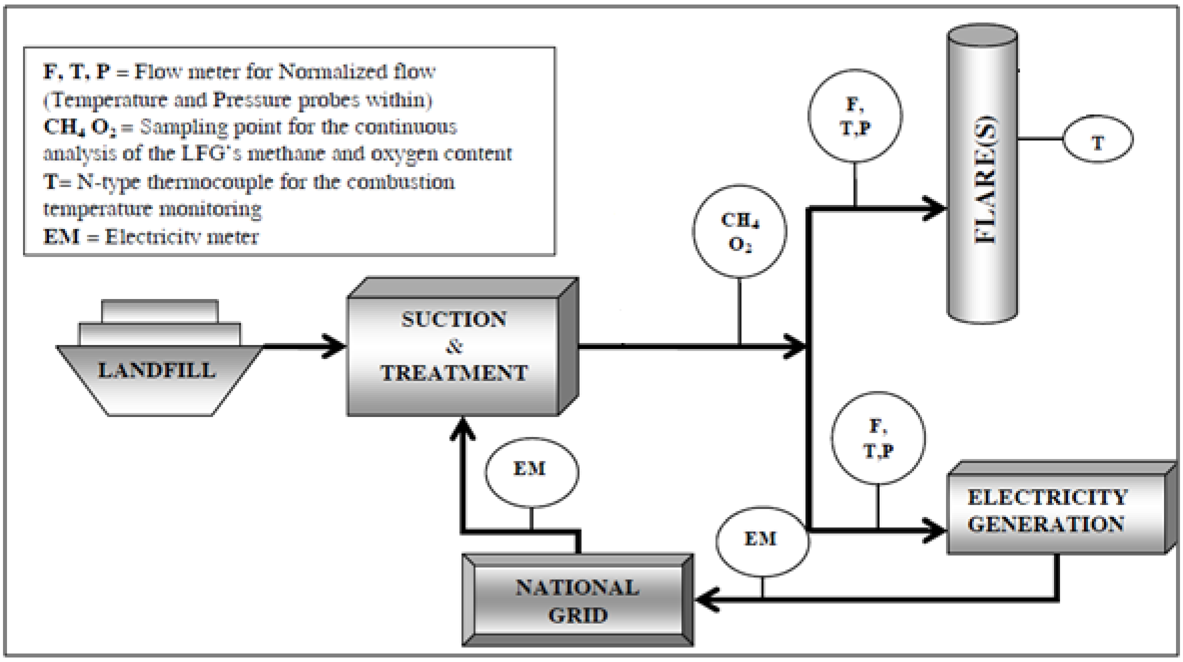

Figure 5 - Monitoring points

4 CALCULATION OF THE AMOUNT OF ERs

The greenhouse gas emission reduction achieved by the project activity during a given year "y" (ERy) is calculated by using the formula as given in methodology *ACM0001* and in the related tools and showed in PDD's Section B.

5 MONITORING ORGANIZATION

To assure a correct monitoring, the personnel will be trained on the following subjects:

- General knowledge about the equipment used in the landfill
- Reading and recording data
- Calibration methodology
- Emergency situation

Chosen trainees will have a good understanding of the processes and installation of the technology for the landfill gas extraction. And the personnel will be trained before the plant enters into operation.

A guidebook about landfill gas extraction and utilization in English and Portuguese will also be available. The guidebook will have:

- Operating manual
- Maintenance instructions
- Description of the main parts of the equipment

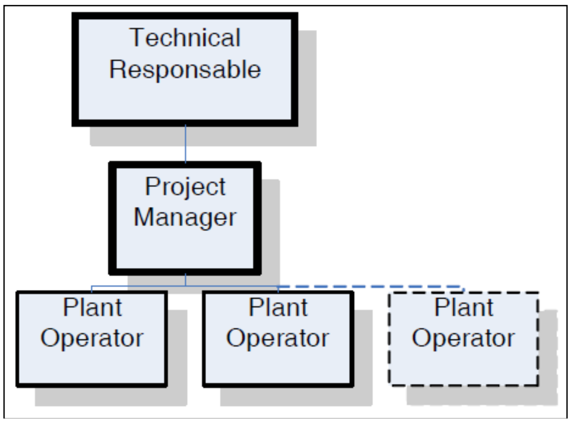

Figure 6 - Organization Chart.

6 CALIBRATION

All measurement instruments will be subject to regular calibration. The calibration procedures in the "Management Manual" define the management, checks and calibration intervals of the equipment used for process control.

PM will be responsible for the management of the pieces of equipment needing regular calibration for the biogas installations.

The regular check and calibration will be entrusted to the operators. The PM will be responsible for checking the equipment's proper working order, as well as checking and storing up the calibration certificates and records. Calibration documents will be kept for all equipment until two years after the end of the crediting period.

7 DATA MANAGEMENT SYSTEM

The PLC will receive continuously the value of the parameters monitored on-site and automatically generate spreadsheets that will be archived. The information archived will be aggregated hourly, monthly and yearly in a standard format for reporting purposes.

The quality control system will ensure that all the necessary documents (such as operation manual, drawings, maintenance and calibration instructions, etc.) are available and stored in a proper manner. Monitored data and monitoring sheets will be copied to magnetic media every 6 months and stored in appropriate archives. All data, including calibration records and Monitoring Reports, will be kept until 2 years after the end of the crediting period.

8 AUDIT REVIEW

Internal audits will be performed by an auditor not involved in the daily operation of the biogas plant in order to assess the implementation of the Monitoring Plan and to prepare the Monitoring Report. All the audit findings, including corrective actions, will be recorded and will be available on-site at the time of verification.

Appendix 6. Summary report of comments received from local stakeholders

Presented in section E.2.

Appendix 7. Summary of post-registration changes

A) History of Post Registration Changes to the project activity that have been approved by the Board after its registration during the project 1st Crediting Period:

1) PRC-7110-001 approved on 19/02/2015. In the registered PDD the indicative output power of the project activity was stated 2.8 MW, planned to be implemented in two phases; the first phase of 1.4 MW to occur in 2012 and the second phase of 1.4 MW in 2014. However, the project has been implemented as follows: on March 2012, one generator of 1.426 MW was installed; and on October 2012, a second generator of 1.426 MW was installed, totalizing 2.852 MW of capacity.
2) PRC-7110-001 approved on 19/02/2015. Starting date of the crediting period revised from 01/08/2012 to 04/09/2012 which reflects the actual registration date of the CDM Project Activity.

B) Post Registration Changes from previous registered PDD (PRC):

1) Change to the project design regarding to electricity generation plant installed capacity increase, from 2.852 MW to 4.278 MW related to the implementation of third generation unit that became operational on 19/03/2020. Due to paragraph 241 from PS for PA´s, CERs may be claimed up to an amount calculated based on the increased installed capacity by 20 per cent of the capacity specified in the originally registered PDD (before PRC).

The correction reflects the actual operational condition of the project and, following the recommendations of paragraph 241 (a) (i) a. of the Project Standard, the increase in emissions reductions related to this revision were capped by 20% from what was previously estimated on the registered PDD.
Also, this post registration changes is applicable for the ISUANCE TRACK as foreseen in paragraph 1 (d) the CDM Project Standard Appendix:

(d) Changes to the project design of a registered CDM project activity that do not adversely impact any of the following:

(i) The applicability and application of the applied methodologies, the applied standardized baselines and the other applied methodological regulatory documents with which the project activity has been registered;

(ii) The additionality of the project activity;

(iii) The scale of the project activity.

The revision does not impact the additionality since the increase in the installed capacity does not exceed the threshold established in paragraph 22 (a) of the applicable methodology. After the inclusion of the third generating unit, the project installed capacity remains below 10 MW.
The CDM Project Activity was registered as large scale and this modification does not alter its scale and applicability conditions of the methodology since the components related to the LFG destruction are not modified.

Due to an incomplete received during the PRC process, the PP reassessed the most recent project cash flow available at the projects website (https://cdm.unfccc.int/PRCContainer/DB/prcp470456806/view) and, as a conservative approach, changed some key parameters related to projects revenues only (electricity sales), and kept CAPEX and OPEX unchanged. By doing so, PP established the best investment analysis scenario possible for the project activity in terms of Internal Rate of Return (IRR). In table below, the changes and results are demonstrated. Because the new IRR changed from 1.0% to 6.9% and the project´s adopted benchmark is 11.55%, it is possible to conclude that the project remains unattractive and thus additional in terms of investment analysis.

2) Correction under parameter "Waste composition[53]": by the time of project activity renewal for the 2nd Crediting Period the composition of waste updated reference used was not reflecting the gravimetric reality at the landfill, a correction of this parameter was proposed in order to correct waste composition to reflect a real situation.

The correction increases consistency with the actual conditions of the project and is in line with the requirement of paragraph 1 (a) the CDM Project Standard Appendix:

(a) Any corrections to project information of a registered clean development mechanism (CDM) project activity that do not affect the design of the project activity;

The design of the project is not affected by the waste composition revision, or rather, there is no modification in the management of the landfill or inclusion of new equipment due to this update.

The rectification of the value increases consistency between the project and the applicable tool and does not significantly impacts the results of the emission reductions calculation and modifies the

[53] The methodology used under the gravimetric study was changed by the local environmental agency in April 2019 and that studies were carried out from June to early July 2019. Such studies were transformed into a new report in August 2019 that confirmed the changes.

design of the project. Therefore, it is in line with the requirement of paragraph 1 (a) the CDM Project Standard Appendix:

> *(a) Any corrections to project information of a registered clean development mechanism (CDM) project activity that do not affect the design of the project activity;*

- - - - -

Document information

Version	*Date*	*Description*
12.0	8 October 2021	Revision to: Improve consistency with version 03.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN).
11.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.

Version	Date	Description
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	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).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: Registration
Keywords: project activities, project design document