Project design document form
(Version 11.0)

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

BASIC INFORMATION	
Title of the project activity	CTR Rosario Landfill Gas Project
Scale of the project activity	☒☒ Large-scale ☐ Small-scale
Version number of the PDD	208
Completion date of the PDD	06/07/201229/04/2020
Project participants	Vital Engenharia Ambiental S.A.
Host Party	Brazil
Applied methodologies and standardized baselines	Methodology: ACM0001 – : Flaring or use of landfill gas, version 1319.0.0;
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	63,98173,221 tCO2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>

The proposed project activity has the objective to capture, flare and generate electricity through the use of landfill gas (LFG)[1] produced in anaerobic conditions into the landfill called "C*entral de Tratamento de Resíduos Rosario*" (hereinafter referred to as *CTR Rosario*) located in the municipality of Rosario in the state of Maranhão, Brazil.

The project activity will result in greenhouse gas (GHG) emission reduction from the CTR Rosario through two ways:

- Burning CH_4 in flares and/or group generators;
- The amount of electricity generated in the project activity will be dispatched to the Brazilian national grid, avoiding the dispatch of an equal amount of energy produced by fossil-fuelled thermal plants to that grid. The initiative avoids CO_2 emissions and contributes to the regional and national sustainable development.

The Project Activity is the same as the one before proposed PRC:

- It is the same Project Participant (Vital Engenharia Ambiental S.A.);
- It is located in the same physical/geographical location;

Prior to the implementation of the project activity, the scenario for LFG destruction ~~will be~~was the partial released to atmosphere through the exiting LFG passive capture system and partial LFG combustion in ~~open flares~~gas wells. Regarding the electricity generation, the baseline scenario is the generation in existing and/or new grid-connected power plants.

The baseline scenario is the scenario existing prior to the implementation of the project activity.

The estimate of:

- Annual average is ~~63,981~~73,221 tCO_2e;
- Total GHG emission reduction is ~~447,867~~512,549 tCO_2e.

The project activity will be to capture and to flare the LFG and to generate electricity through the implementation of a power generation plant using LFG. The generation installed capacity during the first crediting period will be expected to be ~~around 4.3 MW with 3 installed group-generators and the forecast for the end of project lifetime will be 5.7 MW.~~3.000 MW (3 x 1.000 MW).

The project ~~will be to construct~~constructed an efficient capture, collection and flaring system to burn CH_4 (a greenhouse gas), and this ~~will reduce~~reduced odours and adverse environmental impacts. Moreover, it ~~will install~~installs generators that ~~will combust~~combusts the LFG to produce electricity, using part of the electricity for self-consumption and the other part ~~will be~~is exported to the grid. The flares ~~will be~~are kept in operation due to LFG excess, periods when electricity will not be produced or other operational considerations. The LFG power plant ~~will be expected to install approximately 5.7 MW upon project completion. However, the final equipments that will be chosen (as well as the final installed capacity) may vary depending on the availability of the generation equipments on the market at the time of actual implementation.~~[2]is expected to install 3.000 MW (3 x 1.000 MW).

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[1] The gas is generated by the decomposition of waste in a solid waste disposal sites (SWDS). LFG is mainly composed of methane, carbon dioxide and small fractions of ammonia and hydrogen sulphide.

~~[2] The installed capacity by generator group may vary between 1.426 to 1.5 MW. This range has been considered based on technical specifications of main manufacturers in the market. The project activity considered 1.426 MW the installed capacity per generator group.~~

The LFG capture and collection systems and flaring station will consistconsists on a LFG pipeline grid and a flaring station, equipped with flares, centrifugal blowers, and all other supporting mechanical and electrical subsystems and appurtenances necessary to run the system. The power generation facility will be comprisedcomprises of LFG engine generator sets of high- -performance standards. The engine-generator sets will beare the primary equipment to combust the collected LFG once they are installed. A fraction of the collected LFG will beis diverted to flares, which will beis used to combust any gas in excess of the fuel demand for the engines, as well as a contingency backup.

The landfill will beginstarted the operation in August 2013, receiving solid waste (type Class II-A Inert and Class II-B Non-inert)[3], according to InstallationOperation License nº 225/2011,1049272/2018 process number nº 2815/2011171800/2017- *Secretaria de Estado do Meio Ambiente e Recursos Naturais – SEMA* (responsible agency to issue environmental licences in Maranhão State) dated of 11/10/2011 valid up to 11/10/2012. The Project Participant (PP) has already requested the extension of the Installation License along with the environmental agency. According to Brazilian laws after the issuance of the Installation License, the Operational License will be issued06/04/2018 valid up to 06/04/2022.

Contribution of the Project Activity to Sustainable Development:

The project will make a strong contribution to sustainable development in Brazil. In addition to reducing emissions of GHGs and generating clean electricity, the Project will provide other sustainable development benefits as follows:

a) Contribution to the environment:

Electrical generation in the project will displace electricity generated by fossil fuel-fired power plants.

b) Contribution to the improvement of working conditions and employment creation:

During the operational phase, which will take place 24 hours/day, 7 days/week, there will be new jobs created locally for duties related to construction, operations and maintenance, landscaping, plumbing, monitoring and security personnel. These people will be fully trained by CTR Rosario on their duties and tasks. Local manpower will be used in the project implementation, which entails installation of vertical wells, horizontal collection system and assembly and operation of equipment such as blowers, flares, and group-generators.

c) Contribution to income generation:

In addition to the local jobs created during its implementation and operation, the project will pay taxes to the municipality.

A.2. Location of project activity

>>

Host Party(ies): :Brazil
- Brazil

Region/State/Province etc.: :
- Maranhão

City/Town/Community etc.: :
- Rosario

[3] According to definition of the Brazilian Association of Technical Norms (ABNT NBR 10004) http://www.aslaa.com.br/legislacoes/NBR%20n%2010004-2004.pdf

Physical/Geographical location:

CTR Rosario is located at Fazenda Arapixi - zona industrial, Buenos aires, Rosario (city), Maranhão (State), Brazil.

Formatado: Inglês (Reino Unido)

Geo-coordinates: Latitude: 02° 54' 53.64" S and Longitude: 44° 16' 26.50" W
Decimal coordinates: Latitude: -2.914900° Longitude: -44.274028°

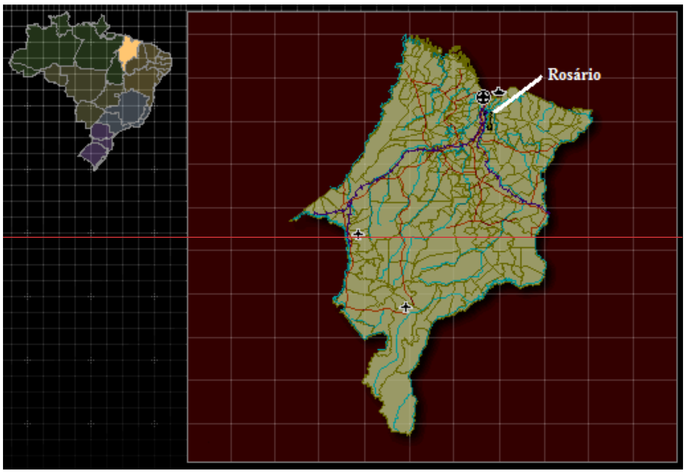


Figure 1 - Geographical position of Rosario city, inside of Maranhão State in Brazil

Source: IBGE Cidades (http://www.ibge.gov.br/cidadesat/topwindow.htm?1)

Figure 2 – Implementation phase at CTR Rosario

A.3. Technologies/measures

>>

According to the executive project, the landfill will be operated under anaerobic conditions adopting the following conditions:

- Landfill surface every day covered;
- Mechanical compacting;
- Leveling of the waste.

In the proposed project activity, the used technology will be the improvement of biogas collection and flare produced in the landfill, through the installation of an active recovery system composed for:

- Collection system;
- Biogas transport pipe system;
- Gas suction and flare system (located in the Biogas Station).
- A power generation plant will also be installed.

Collection system

The biogas collection infrastructure of landfill is based in vertical drains. Those elements will be connected to a collection pipe that will accomplish the transport of gas to control stations (manifolds), used to control the drains loss of load.

Células Inseridas

Figure 3 – Example of collection system (manifolds)

Source: Cenbio, 2006

Figure 3 - Example of installation of the LFG capturing system

(Source: CTR Rosario)

CTR Rosario intends to install and improve drains directly in the landfill. A covering layer will be installed around the drains to avoid the exhaust gases.

The top of the existing and new vertical drains will be equipped with headstocks. This element is important because it makes the connection between the drain and pipe collection. The headstocks are made of HDPE or similar ø 200 mm to 1 m in length. In the body of the head, a derivation of HDPE or similar ø 50 to 200 mm will be installed and attached to a butterfly valve which is connected to a hose ø 70 mm to 300 mm of HDPE or similar, which is finally connected to the tubing of collection.

Figure 5 - Transmission pipelines

(Source: CTR Rosario)

Figure 4 - ~~Example of collection system (well head)~~Vertical wells/drains.

(Source: ~~Landfill Methane Outreach Program - EPA~~ CTR Rosario)

Células Inseridas

The collection pipe will be built using HDPE or similar. The sizing of the piping was done considering the maximum production of landfill gas that can reach. Activities will be intense welding tubing to connect each station of the adjustment. The pipe will be covered with materials that do not pose any possibility of damage to the material.

Removers of condensate will be provided to drain humidity from the LFG. These removers are constructed at points of lower elevation of the tubing and collection stations, located before the adjustment. The condensate removed will be returned to the landfill, through pumps installed at the base of the removers.

All drains will be connected to the adjustment of station located around the landfill, through the collection pipes. The basic functions of the stations will promote the systematic control and monitoring of the characteristics of biogas extracted. Each station will have an adjustment of additional condensate remover, valves and regulating valves-drawer.

Transport System

The transmission pipeline is the last step of the collecting system. It transports the collected LFG to the flare. The transmission pipeline might be connected to all gas regulation stations around the landfill.

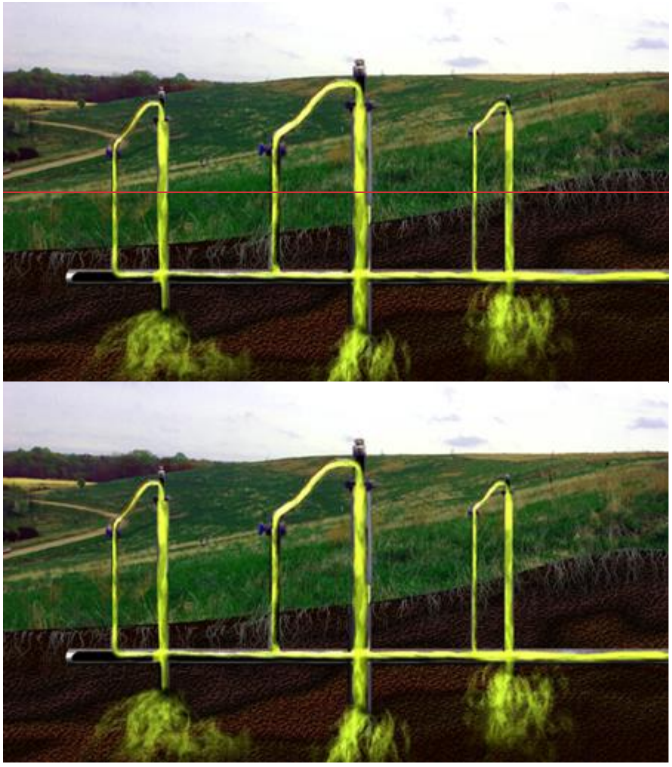


Figure 65 - Illustrative of transport system

(Source: Landfill Methane Outreach Program -– EPA)

Blowering System

The blowering system is responsible to give negative pressure to the landfill, blowing the gas to the pipeline. The dimensioning of the blowers will depend on flow of the landfill gas which may range between 1,000 to 3,000 Nm^3/h per each blower and the installed capacity around 37 kW for each equipment.

In order to preserve the operation of the blowers, a dewatering system is installed to remove the condensate. This equipment is a single knock-out dewatering component.

Figure ~~7~~6 - Example of blower system
(Source: John Zink)

Flare System

The destruction of the methane content in the LFG collected will be made via ~~enclosed~~open flares~~, in order to assure higher~~.

The Flaring Station, responsible for methane destruction ~~(enclosed flare).~~by combustion usually has:

~~The flare operational flow may range between 1,000 to 3,000 Nm³/h depending on the manufacturer and design that will be chosen in the purchasing moment. The standard combustion temperature is around 850º C and efficiency combustion around 99.8%.~~

~~Basically, the flare is constructed using refractory material, a gas inlet, dampers to control the air inlet, an ignition spark, flame viewer and points to sample collection, as presented in the pictures below:~~

- Open flare(s);
- Blower(s);
- Safety valve(s) on/off;
- Remover(s) of condensate;
- Gas Analyzer(s);
- Meter(s) for pressure;
- Meter(s) for flow;
- Meter(s) for temperature.

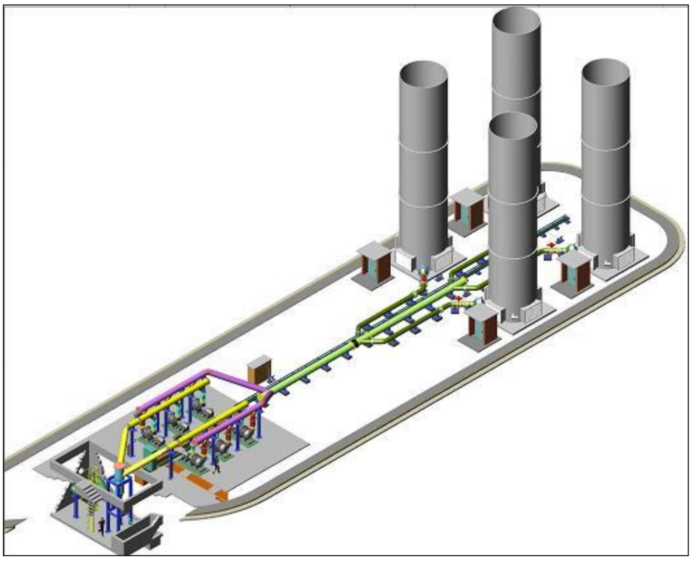


Figure ~~8~~7 - Detail of Enclosed Flare

Source:– Example of a Flaring station for a Landfill Methane Outreach Program - EPAGas Project.

Biogas Station

The collection of gas within the landfill will be made by applying a pressure differential in each drain. The depressurization system shall be composed of a group of centrifugal multi-stage blowers, connected in parallel with the central collector. The depressurization of the system will depend on the pressure of operation of flares. In addition, the biogas station will have the following:

- Safety valve on/off;
- Remover of condensate;
- Gas analyzer;
- Meter flow.

Figure ~~8~~9 - Example of ~~a biogas station~~LFG plant

(Source: Santo Filho, 2013[4])

The biogas station will have, even a system of destruction of methane through flares. This system will be composed initially by 1 ~~enclosure~~open flare and can get ~~others~~other units, according to the generation of gas. The flare is constructed in a vertical cylindrical combustion chamber, where the biogas is flared at a constant temperature, controlled by the admission of air, and with a minimum residence time.

Power generation

The power generation system will be comprised of around ~~5.7~~3.0 MW. The electricity generated by the project will be supplied to the grid.

[4] Master dissertation: "*Potential for energy recovery from landfill gas through MSW in Brazil*". Available at: http://www.teses.usp.br/teses/disponiveis/86/86131/tde-16022014-170905/pt-br.php

This kind of technology is still not widely applied in Brazil. The publication named "Reducing the uncertainty of methane recovered (R) in greenhouse gas inventories from waste sector and of adjustment factor (AF) in landfill gas projects under the Clean Development Mechanism[5]" states that:

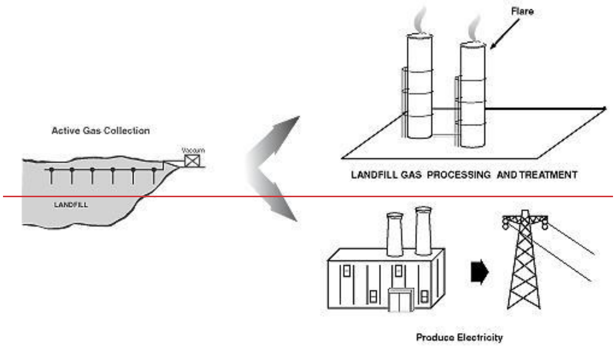
> *"…all of Brazilian landfills with collection and destruction system (active system) are implemented projects under the CDM…".*

Additionally, the PP carried out a survey in order to verify the existence of any landfill with LFG collection and destruction active system not register as a CDM Project. The result of this survey concludes that there is no similar project activities developed without CDM benefits.

Very few landfills have already installed equipment for flaring and combustion LFG. Therefore, the company will need engineers and other specialists with experience in this area to advice the company while implementing the project. These professionals will also train local operators and engineers on operations and maintenance of the facilities.

~~The installed capacity by generator group may vary between 1.426 to 1.5 MW. This range has been considered based on technical specifications of main manufacturers in the market.~~ The project activity considered 1.~~426~~000 MW the installed capacity per generator group.

[5] Source: MAGALHÃES, G.HC.; ALVES, J.W.S.; SANTO FILHO. F.; COSTA, R.M.; KELSON. M. Reducing the uncertainty of methane recovered (R) in greenhouse gas inventories from waste sector and of adjustment factor (AF) in landfill gas projects under the clean development mechanism (2010). Page 174. (http://ghg.org.ua/fileadmin/user_upload/book/Proceedengs_UncWork.pdf), accessed on 25/06/2012.



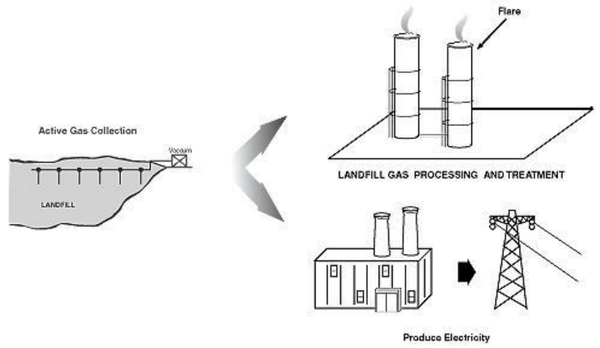


Figure 109 – Power generation diagram

It is important to clarify that the authorization to generate electricity to Brazilian Electricity Regulatory Agency (ANEEL) has not been request yet.

The estimated number of group generators and the expected output is shown on the table below:

Table 1 - Electricity generation

Year	Number of flares (unit)	Number of engines installed (unit)	Installed capacity (MW)*	Net electricity generated in the plant (MWh)	
2014	1	0.0	0.0	0	
2015		10	2.0	2.90	10,076
2016		10	2.0	2.90	10,076
2017		10	2.0	2.90	10,076
2018		10	3.0	4.30	15,642
2019		12	3.02.000	4.315,768	18,496
2020		13	3.0000	4.323,652	18,496

*[1] Definition of net capacity is the maximum capacity at the plant minus the amount of electricity that is consumed by the group generators;
[2] The totalplant load factor is 90%.

Células Excluídas

Células Excluídas

Note: The final equipment that will be chosen (as well as the final installed capacity ~~will be expected since 2027 with 5.7 MW and 4 installed group-generators~~) may vary depending on the availability of the generation equipment on the market at the time of actual implementation.

The lifetime of the equipments is 25 years and it was based on "Tool to determine the remaining lifetime of equipment Version 01 – Option (c) Default Values" (Electric Generators, air cooled)[6]. The equipments that will be installed in the project site will be all new.

The only equipments in operation under the existing scenario prior to the implementation of the project activity are the vertical drains which venting the LFG through passive LFG capture system. For active capture system, these exiting vertical drains will be improved to increase the LFG capture efficiency, according to described above.

The baseline scenario is the same scenario of the scenario exiting prior to the implementation of the project activity.

The load factor is 90% based on manufacturer's specification[7].

Technology will have to come from the Europe and USA. Hence, technology transfer will occur from countries with strict environmental legislative requirements and environmentally sound technologies.

The technology for biogas collection, flaring and power generation can be considered state of art in the Brazilian sanitation context, because all equipment involved has the highest level of development, and the technology used to combust LFG to produce electricity is not a usual business practice in Brazil, as demonstrated in Section B.5.

The monitoring equipments and their location in the systems along with the balance of the system are presented below:

[6] The lifetime of the equipments is also supported by the International Energy Agency (IEA) World energy model – Methodology and assumptions, page 13.

[7] The document will be available to DOE in validation visit.

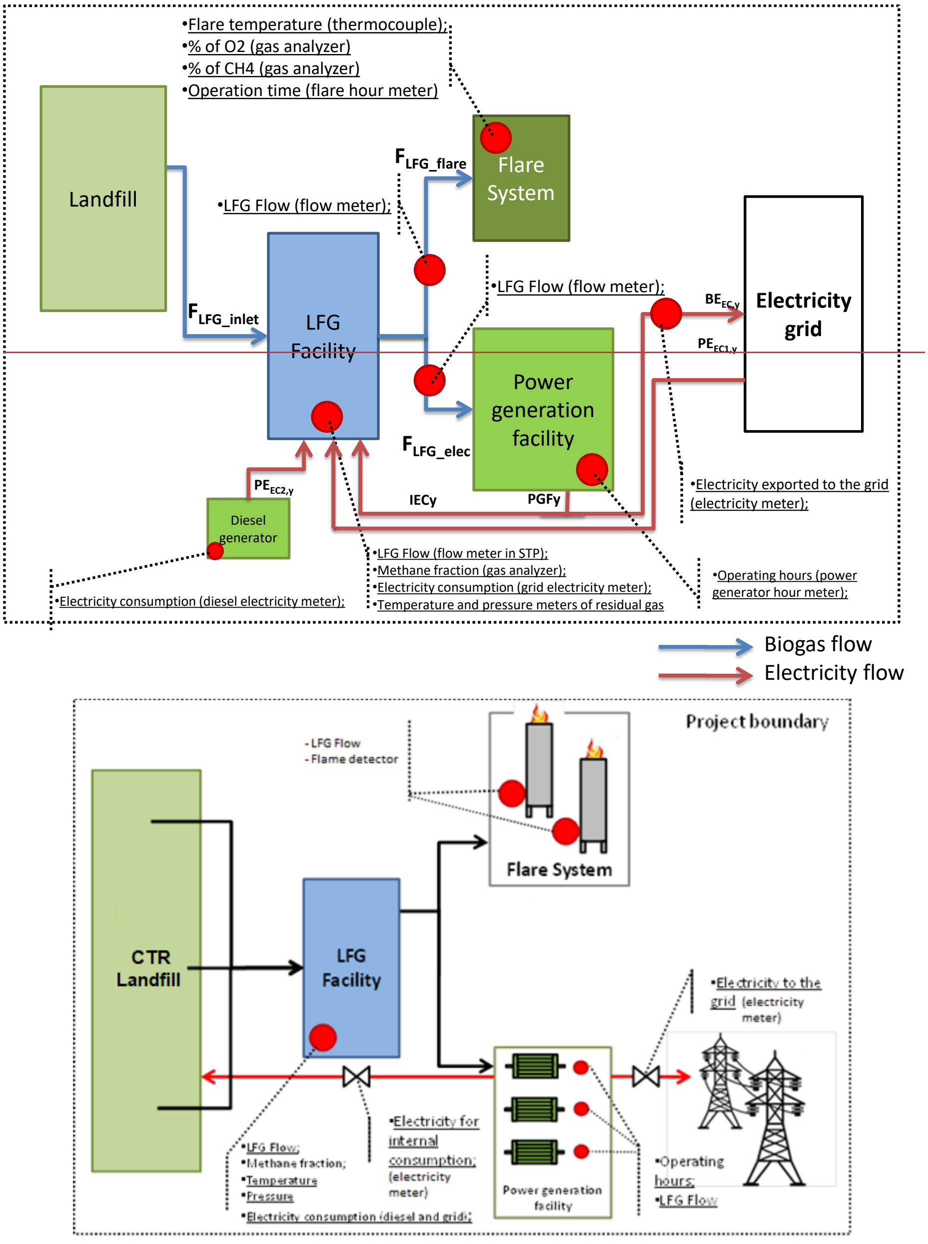


Figure 1110 - Technologies and measures of the project activity

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)	Vital Engenharia Ambiental S.A. (private entity)	Brazil (host)No

CTR Rosario belongs to Vital Engenharia Ambiental S.A[8] and URCD Ilha Grande Ltda[9]. Both companies are specialized in waste treatment and disposal.

A.7.A.5. Public funding of project activity

>>

There is no public funding involved in the project activity.

A.8.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.9.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 1319.0.0);)[10];
- TOOL02 Methodological tool: "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 0407.0.0);)[11];
- TOOL03 Methodological tool: "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 02);03.0)[12].
- TOOL04 Methodological tool: "Emissions from solid waste disposal sites" (Version 0608.0.1);)[13];
- Tool to calculate TOOL05 Methodological tool: "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 01);03.0)[14];
- Tool to determine TOOL06 Methodological tool: "Project emissions from flaring gases containing methane" (Version 01), EB 28, Annex 1303.0)[15];
- TOOL07 Methodological tool: "Tool to calculate the emission factor for an electricity system" (Version 07.0)[16];

[8] http://www.vitalambiental.com.br/main_empresa.html

[9] http://www.limpel.com.br/

[10] https://cdm.unfccc.int/methodologies/DB/JPYB4DYQUXQPZLBDVPHA87479EMY9M

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

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

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

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

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

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

- TOOL08 Methodological tool: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 0203.0.0);)[17];
- Tool to determineTOOL09 Methodological tool: "Determining the baseline efficiency of thermal or electric energy generation systems" (Version 01);02.0)[18];
- TOOL10 Methodological Tool: "Tool to determine the remaining lifetime of equipment" (Version 01).)[19];
- TOOL12 Methodological tool: "Project and leakage emissions from transportation of freight" (Version 01.1.0)[20];
- TOOL32 Methodological tool: "Positive lists of technologies" (Version 02.0)[21].

B.2. Applicability of methodologies and standardized baselines

>>

The methodology ACM0001 is applicable tofor project activities whichthat 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 a new oran 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 can notcannot 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;[22] and/or*

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

(iv) *Supplying compressed/liquefied LFG to consumers using trucks;[23]*

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

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

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

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

[21] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-32-v2.0.pdf

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

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

(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 ~~burn LFG in enclosed flares~~be flared and will generate electricity ~~through LFG~~.

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.

"...

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) Release of the LFG from the SWDS; and~~

(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 ~~on-site~~ equipment~~.~~ located within the project boundary;

This methodology is not applicable:

(c) 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 ~~the~~a kiln or glass melting furnace;

(d) 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 ~~release~~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 ~~generation~~Correction Factor).

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.

The tool "Project emissions from flaring" 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.

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

The "Tool to 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 "Tool to determine the remaining lifetime of equipment" 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.

The "Project and leakage emissions from transportation of freight" 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 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 **not applicable** since demonstration of additionality is not applicable/required for the registered CDM project activity. Simplified procedure to identify the baseline scenario and demonstrate additionality of ACM0001 has been used.

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	~~GHG~~**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~~.~~

	Source	GHGGas	Included?	Justification/Explanation
		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.
		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	There is noMajor emission source if heat generation. is included in the project activity
		CH_4	No	There is no heat generation.Excluded for simplification. This is conservative
		N_2O	No	There is no heat generation.Excluded for simplification. This is conservative
	Emissions from the use of natural gas	CO_2	No	There is no use of natural gas.Excluded for simplification. This is conservative

	Source	GHGGas	Included?	Justification/Explanation
		CH_4	No	There is no use of natural gas.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	There is no use of natural gas.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	There is no fossil fuel consumption for purposes other than electricity generation or transportation due to the project activityMay be an important emission source
		CH_4	No	There is no fossil fuel consumption for purposes other than electricity generation or transportation due to the project activityExcluded for simplification. This emission source is assumed to be very small

	Source	GHGGas	Included?	Justification/Explanation
		N_2O	No	There is no fossil fuel consumption for purposes other than electricity generation or transportation due to the project activityExcluded 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)

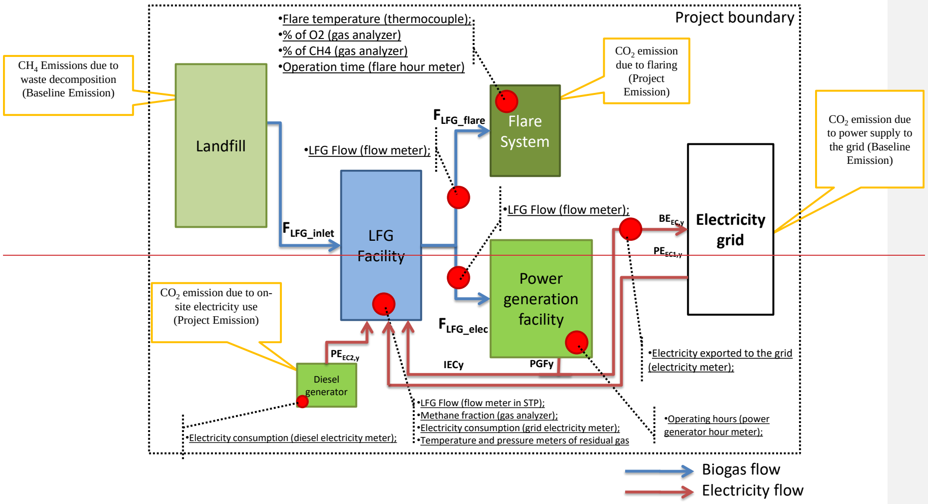
(b) Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity to the project activity; (not applicable)

(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:



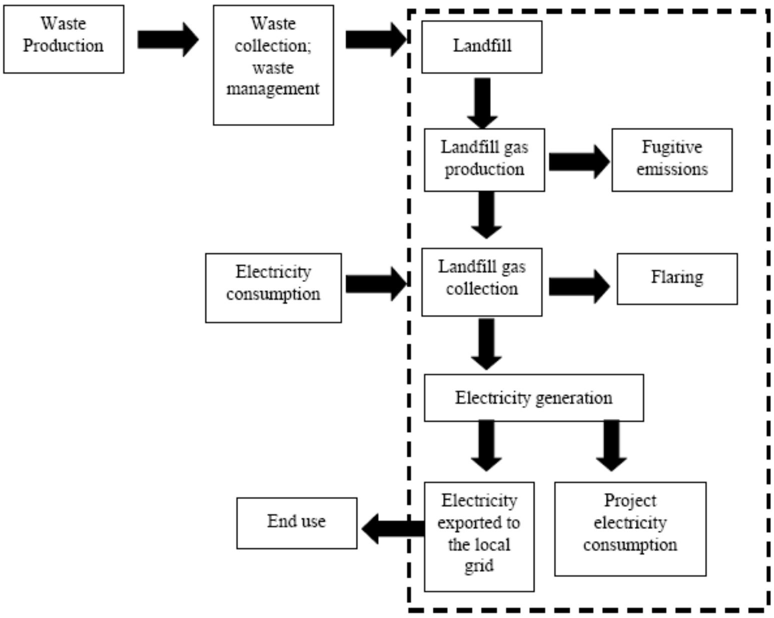


Figure 12~~11~~ – Flow diagram project boundary

~~B.5.~~B.4. Establishment and description of baseline scenario

>>

The baseline scenario for the project activity is identified using step 1 of the 'Combined tool to identify the baseline scenario and demonstrate additionality", as agreed in ACM0001 "Flaring or use of landfill gas".

Realistic and credible alternatives to the project activity that can be part of the baseline scenario are defined through the following sub-steps:

STEP 0: Demonstration that a proposed project activity is the First-of-its-kind.

This step is not applied because the proposed project activity is not the First-of-its-kind.

Outcome of Step 0: The proposed project activity is not the First-of-its-kind.

Step 1: Identification of alternative scenarios

This Step serves to identify all alternative scenarios to the proposed CDM project activity(s) which can be the baseline scenario.

The project participants will monitor all relevant policies and circumstances at the beginning of each crediting period and adjust the baseline accordingly.

Step 1a: Define alternative scenarios to the proposed CDM project activity

The identified alternatives for the destruction of LFG in the absence of the project activity are:

LFG1	The project activity implemented without being registered as a CDM project activity (capture, flaring and use of LFG);
LFG2	~~Release of the LFG to atmosphere~~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;

~~As the EIA (Environmental Impact Assessment) does not cover recycling, treatment or incineration of waste, alternatives LFG3, LFG4 and LFG5 should not be considered.~~

Thus, the remaining real alternatives for the destruction of LFG are LFG1, LFG2.

The EIA (Environmental Impact Assessment) does not cover recycling, treatment or incineration of organic waste, alternatives LFG3, LFG4, LFG5 and LFG6 should not be considered.

Alternative (a): For electricity generation, the realistic and credible alternatives are:

E1	Electricity generation from LFG, undertaken without being registered as CDM project activity;
E3	Electricity generation in existing and/or new grid-connected power plants.

In the absence of project activity, no captive electricity consumption would be necessary. Thus, the alternative scenario E2 should not be considered.

According to the project activity ~~does not aim~~configuration, there will be no heat generation. Therefore, all alternative scenarios ~~(from H1 to H7) considering heat generation~~addressing these possibilities should not be considered.

Thus, the remaining real alternatives ~~for electricity generation~~to the project activity are E1 and E3.

The combinations of the project activity compose the following scenarios:

Scenarios	Combination	Comments

1	LFG1 + E1	Possible
2	LFG1 + E3	Possible
3	LFG2 + E1	This alternative is not plausible because to generate electricity in the project activity, it is necessary to implement the capture, flaring and use of LFG.
4	LFG2 + E3	Possible

Outcome of Step 1a:

Three realistic and credible alternative scenarios to the project activity were identified:

- Scenario 1 (LFG1 + E1);
- Scenario 2 (LFG1 + E3);
- Scenario 4 (LFG2 + E3).);

Outcome of Step 1a: Three realistic and credible alternative scenarios to the project activity were identified. The alternatives are LFG1, LFG2 and E3.

Step 1b: Consistency with mandatory applicable laws and regulations

All alternative scenarios identified in Step *1a* comply with all applicable laws and regulations. Brazil's New National Solid Waste Policy (NSWP),[24] 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[25].

The scenario 4 which is, a continuation of the current situation of the landfill (baseline scenario) represents the business as usual practice for the project site as well as for most of the landfills in Brazil.

The project participant will monitor all relevant policies and circumstances at the beginning of each crediting period and adjust the baseline accordingly.

Outcome of Step 1b: Three realistic and credible alternative scenarios to the project activity are in compliance with mandatory legislation and regulations. The alternatives scenarios remain the same:.

- Scenario 1 (LFG1 + E1);
- Scenario 2 (LFG1 + E3);
- Scenario 4 (LFG2 + E3).);

B.6.B.5. Demonstration of additionality

>>

The following table shows the timeline of the project activity showingIt is crucial to consider that the CDM benefits were taken into account to implement it.

[24] http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm., accessed on 16/07/2019.

[25] http://www.aneel.gov.br, accessed on 16/07/2019.

Table 2 - Implementation timeline of the Project

Key Events	Date
Prior Consideration of the CDM to UNFCCC and Brazilian DNA	25/05/2012
Submit the PDD for Global Stakeholder Consultation (GSC)	June/2012
Initial operation of the landfill (CTR Rosario)	August/2013
The starting date of the project activity will be the purchase of the main equipment (flare).*	August/2013
Initial operation of the project activity (capture and flare of LFG)*	January/2014
Initial operation of the project activity (electricity generation)*	January/2015

*Estimated

simplified

The project participants notified on 25/05/2012 the Brazilian DNA and UNFCCC of their intention to seek CDM status, according to "Clean development mechanism project cycle procedure" version 02.0.

The additionality of the project activity will be demonstrated and assessed using the "Combined tool to identify the baseline scenario and demonstrate additionality".

The Step *0*, *1a* and *1b* are described above.

Step 2: Barrier analysis

This step serves to identify barriers and to assess which alternative scenarios are prevented by these barriers as per the latest approved version of the "Guidelines for objective demonstration and assessment of barriers". The following Sub-steps are applied:

Sub-step 2a: Identify barriers that would prevent the implementation of alternative scenarios

It was made an assessment to identify barriers that would prevent the implementation of alternative scenarios and only one barrier has been identified:

Investment barrier:

This barrier would prevent the implementation of scenario 2 (collection and destruction of LFG in enclosed flare + electricity generation in existing and/or new grid-connected power plants), because this scenario would have lack of access to capital to be developed due to this scenario does not met the requirements of the main financial entity in Brazil BNDES (Brazilian Development Bank) to obtain a loan.
BNDES requires to finance any project: *"Item b -The expected cash flows of the project should be sufficient to pay off loans"*[26].

Outcome of Step 2a: the identified barrier (investment barrier) as described above may prevent one of the alternatives to occur.

Step 2b: Eliminate alternative scenarios which are prevented by the identified barriers

[26] http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/Project_Finance/index.html

As the investment in Scenario 2 does not generate any revenues for the PP and there is not a mandatory requirement legislation and/or regulations to collection and destruction of LFG in enclosed flare (active system), this scenario is not plausible.

Outcome of Step 2b: The two realistic and credible alternative scenarios to the project activity are:

- Scenario 1 (LFG1 + E1);
- Scenario 4 (LFG2 + E3).

Step 3: Investment analysis

of ACM0001

For the purpose of assessing the financial/economic attractiveness, the indicator used was the Net Present Value (NPV).

The discount rate used for this analysis was the value pointed out in Appendix A (Group 1 - Brazil) of the "Guidelines on the assessment of investment analysis" - version 05. The value was 11.75%.

The following assumptions were taken for the purpose of the calculation of the financial indicator in all alternatives:

Table 3 - Financial parameters of the cash flow

Assumptions			
Parameter	**Value**	**Unit**	Reference
Discount rate	11.75%	%	Guidelines on the assessment of investment analysis - version 05, Group 1 (Brazil).
Asset's Life time	25	Years	International Energy Agency (IEA) World energy model – Methodology and assumptions, page 13.
Installed capacity for each engine	1.4	MW	Based on the manufacturer proposal
Number of generators groups	4	unit	Based on the manufacturer proposal
Total installed capacity	5.7	MW	Based on the manufacturer proposal
Price per MW installed	2,394.36	kR$/MWe	Power plant proposal from the engineer company
Investment in biogas plant	2,743.59	kR$	Calculated in cash flow
Investment in power electricity plant	13,657.43	kR$	Calculated in cash flow
Total investment in the CDM project	16,401.02	kR$	Calculated in cash flow
Load factor	90.00%	%	Based on the manufacturer proposal
O&M costs	46.93	R$/MWh	Calculated as the average from the whole period.
Electricity price	102.18	R$/MWh	The highest value from the last auctions held in Brazil 3 years prior to the PDD submission for validation. (Source: Electric Power Commercialization Chamber - CCEE)
Tax - IRPJ (income tax)	25%	%	Incomex tax (http://www.receita.fazenda.gov.br/legislacao/ins/Ant2001/Ant1997/1995/insrf05195.htm), accessed on 23/05/2012.
Tax - CSLL (social contribution)	9%	%	Social contribution (http://www.planalto.gov.br/ccivil_03/LEIS/L7689.htm), accessed on 23/05/2012.
Tax (PIS)	1.65%	%	Contribution to the Social Integration Program and Civil Service Asset Formation Program – PIS/PASEP (http://www.receita.fazenda.gov.br/principal/Ingles/SistemaTributarioBR/Taxes.htm), accessed on 23/05/2012.
Tax (Cofins)	7.60%	%	COFINS - Contribution to Social Security Financing (http://www.receita.fazenda.gov.br/principal/Ingles/SistemaTributarioBR/Taxes.htm), accessed on 23/05/2012.
Depreciation	5	years	Secretary of the Federal Revenue of Brazil. Available on http://www.receita.fazenda.gov.br/legislacao/ins/ant2001/1998/in16298ane1.htm, accessed on 23/05/2012. Item: 8502. As the group generators will work in 3 shift of operation, a coefieciént of 2 was considered for accelerated depreciation, according to Federal Revenue of Brazil (RIR/99, art. 313). Available on http://www.receita.fazenda.gov.br/pessoajuridica/dipj/2002/pergresp2002/pr371a375.htm, accessed on 23/05/2012.
Commercial Lending rate	10.97%	%	Available on http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/energias_alternativas.html, accessed on 23/05/2012.
Debt term	16	years	Available on http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Institucional/Apoio_Financeiro/Produtos/FINEM/energias_alternativas.html, accessed on 23/05/2012.
Salvage value	0	R$	Cash flow spreadsheet

Note: All numbers are in Brazilian Real (R$).

Scenario 1 (LFG1 + E1)

The scenario 1 (capture and flare of LFG and power generation) undertaken without being registered as a CDM project activity, the estimated project cash flow has been made available to DOE in the validation visit is presented below:

~~**Table 4 – Scenario 1**~~

Biogas flaring and Electricity generation		Year 0	1	2	3	4	5	6	7	8	9	10
		YEARLY INVESTIMENT ANALYSIS										
		2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
INCOME x COSTS ANALYSIS												
Dispatched electricity (MWh/year)		0	-1,167	10,076	10,076	10,076	15,642	18,496	18,496	21,318	21,318	21,318
Electricity Price (R$/MWh)		0	102	102	102	102	102	102	102	102	102	102
Electricity reveneus (kR$)		0	-119	1,030	1,030	1,030	1,598	1,890	1,890	2,178	2,178	2,178
Gross Reveneus (kR$)		0	-119	1,030	1,030	1,030	1,598	1,890	1,890	2,178	2,178	2,178
Tax (PIS/Cofins)	9.25%	0	0	-95	-95	-95	-148	-175	-175	-201	-201	-201
Net reveneus		0	-119	934	934	934	1,450	1,715	1,715	1,977	1,977	1,977
O&M Total Costs		0	-444	-945	-945	-945	-1,196	-1,196	-1,196	-1,196	-2,773	-1,196
Operational Results - EBITDA		0	-564	-11	-11	-11	254	519	519	781	-796	781
Depreciation		0	-549	-1,914	-1,914	-1,914	-2,597	-2,049	-683	-683	-683	0
EBIT		0	-1,112	-1,926	-1,926	-1,926	-2,343	-1,530	-164	98	-1,479	781
Interests		0	-141	-483	-450	-417	-560	-515	-471	-426	-382	-337
~~EBT~~		~~0~~	~~-1,253~~	~~-2,408~~	~~-2,376~~	~~-2,343~~	~~-2,903~~	~~-2,045~~	~~-635~~	~~-328~~	~~-1,861~~	~~443~~
IRPJ/ CSLL taxes (Real Profit Regime)	34%	0	0	0	0	0	0	0	0	0	0	-151
Depreciation		0	549	1,914	1,914	1,914	2,597	2,049	683	683	683	0
Net operational profit		0	-705	-494	-461	-428	-306	4	48	354	-1,178	293
CapEx												
CapEx - Biogas plant		-2,744	0	0	0	0	0	0	0	0	0	0
CapEx - Electricity Generation		0	-6,829	0	0	-3,414	0	0	0	0	0	0
Drawdown of debt		1,372	3,414	0	0	1,707	0	0	0	0	0	0
Debt Repayment		0	-86	-299	-299	-299	-406	-406	-406	-406	-406	-406
Net Cash Flow Equity		-1,372	-4,205	-793	-760	-2,435	-711	-402	-358	-51	-1,584	-113

Note: All numbers are in Brazilian Real (k BRL)

Benchmark	11.75%
NPV (25 years)	-9,461.43

Year	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Dispatched electricity (MWh/year)	21,318	21,318	21,318	26,884	26,884	26,884	29,738	29,738	29,738	29,738	26,884	21,318	21,318	18,496	15,642
Electricity Price (R$/MWh)	102	102	102	102	102	102	102	102	102	102	102	102	102	102	102
Electricity reveneus (kR$)	2,178	2,178	2,178	2,747	2,747	2,747	3,039	3,039	3,039	3,039	2,747	2,178	2,178	1,890	1,598
Gross Reveneus (kR$)	2,178	2,178	2,178	2,747	2,747	2,747	3,039	3,039	3,039	3,039	2,747	2,178	2,178	1,890	1,598
Tax (PIS/Cofins)	-201	-201	-201	-254	-254	-254	-281	-281	-281	-281	-254	-201	-201	-175	-148
Net reveneus	1,977	1,977	1,977	2,493	2,493	2,493	2,758	2,758	2,758	2,758	2,493	1,977	1,977	1,715	1,450
O&M Total Costs	-1,196	-1,984	-1,196	-1,447	-1,447	-1,447	-1,447	-1,447	-1,447	-1,447	-2,235	-1,447	-1,447	-1,447	-1,447
Operational Results - EBITDA	781	-8	781	1,046	1,046	1,046	1,311	1,311	1,311	1,311	258	530	530	269	4
Depreciation	0	0	0	-683	-683	-683	-683	-683	0	0	0	0	0	0	0
EBIT	781	-8	781	364	364	364	628	628	1,311	1,311	258	530	530	269	4
Interests	-293	-248	-204	-331	-271	-211	-160	-133	-105	-78	-62	-47	-31	-16	0
EBT	488	-256	577	33	93	153	468	496	1,206	1,233	196	483	499	253	4
IRPJ/ CSLL taxes (Real Profit Regime)	-166	0	-196	-11	-32	-52	-159	-168	-410	-419	-66	-164	-170	-86	-1
Depreciation	0	0	0	683	683	683	683	683	0	0	0	0	0	0	0
Net operational profit	322	-256	381	704	744	784	992	1,010	796	814	129	319	329	167	3
CapEx															
CapEx - Biogas plant	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CapEx - Electricity Generation	0	0	-3,414	0	0	0	0	0	0	0	0	0	0	0	0
Drawdown of debt	0	0	1,707	0	0	0	0	0	0	0	0	0	0	0	0
Debt Repayment	-406	-406	-406	-548	-548	-548	-462	-249	-249	-249	-142	-142	-142	-142	-142
Net Cash Flow Equity	-84	-662	-1,732	156	196	236	530	761	547	565	-13	177	187	25	-140

~~According to the cash flow, the NPV of scenario 1 is kR$ -9,461.43. Consequently, this scenario is not deemed attractive by the project participants.~~

~~**Scenario 4 (LFG2 + E3)**~~

~~The scenario is the continuation of the current practice, which is in compliance with all applicable regulations and policies.~~

~~According to "Combined tool to identify the baseline scenario and demonstrate additionality", if the alternative scenario does not involve any investment costs, operational costs or revenues for the Project Participant, the NPV will be equal to zero.~~

~~Therefore, NPV = 0.~~

~~A short list showing the scenarios of the project activity is presented below according to the NPV (financial indicator).~~

Table 5 - Financial indicator comparison

Scenarios	NPV @ 11.75% (k R$)
Scenario 1	-9,461.43
Scenario 4	0

Sensitivity analysis

The sensitivity analysis was performed varying the electricity tariff (revenues), the capital expenses (CapEx) and operational and maintenance costs (O&M) for the scenarios. All parameters ranging from -10% to +10%, as the result presented below:

Table 6 - Sensitivity analysis

-	Variation	NPV (k R$)	
-		Scenario 1	Scenario 4
CapEx	-10%	-8,343.61	0
	10%	-10,579.28	0
Revenues	-10%	-10,506.25	0
	10%	-8,452.51	0
O&M	-10%	-8,614.99	0
	10%	-10,323.14	0

As presented above, the project Net Present Values are always below zero in all sensitivity analyses.

The figures below show the sensitivity analysis for scenarios 1 and 4, respectively.

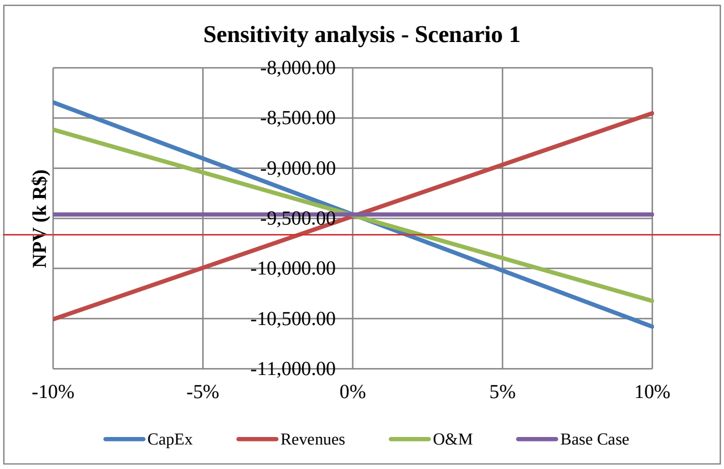


Figure 12 - Sensitivity analysis – Scenario 1 (in Brazilian Reais - k R$)

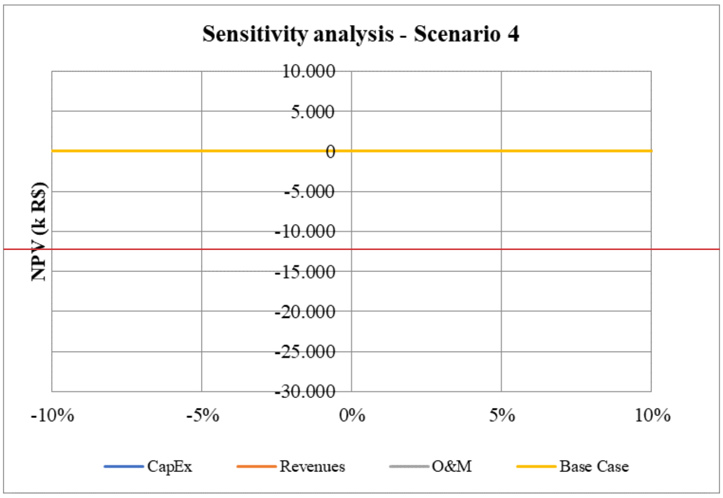


Figure 13 - Sensitivity analysis – Scenario 4 (in Brazilian Reais - k R$)

Breakeven point

To ensure the additionality of this project activity, the project proponents varied the three identified parameters (CapEx, Revenues and O&M) until each of them reached the benchmark (i.e. NPV=0). The results are presented below for each scenario (1 and 4) and the spreadsheet was provided to the audit team:

- **Scenario 1 (LFG1 + E1)**

Capital Expenditures (CapEx) – To reach the benchmark, the Capital Expenditures should be reduced in 84.7%. This result is extremely unlikely to happen in the future, as this reduction is too large for any kind of project which has a reliable investment estimate and as usually the CapEx increases during the project implementation.

Revenues – This value should be increased in 99.3% to reach the benchmark. This means that the electricity tariff should reach R$ 203.69 or the maximum annual electricity generated reaches 53,593 MWh[27], deemed unrealistic as this value is far superior to the average values from the latest electricity sale auctions in Brazil.

The table below shows the electricity price for the alternatives auctions held in Brazil 3 years prior to the starting date of the project activity. The maximum electricity price in auctions was 102.18 R$/MWh. In addition, in Brazil the energy auctions are reverse auctions, therefore power is acquired at the lowest prices.

[27] Note: It is important to notice that for the revenues to reach 99.3% the LFG production should increase 152.8%, since the collection efficiency of the biogas plant is 65%.

Table 7 - Results of the alternatives sources auctions held in Brazil

Date	Name of the Auction	Electricity price (R$/MWh)
17/08/2011	12th New Energy Auction	102.07
20/12/2011	13th New Energy Auction	102.18[28]

Source: Electric Power Commercialization Chamber – CCEE (http://www.ccee.org.br), accessed on 02/04/2012.

O&M – Also, to reach the benchmark, the O&M shall be reduced in 119.4%. This means that PPs should reduce all O&M costs, practically. Consequently, this scenario is unreal. Thus, the PPs deemed this situation to be unlikely to happen in the future.

Outcome of Step 3

A short list raking the alternatives of the project activity is presented below according to the best NPV (financial indicator), taking into account the results of the sensitivity analysis.

Table 8 – Rank of the alternatives scenarios

Scenarios	NPV @ 11.75% (k R$)	Rank
Scenario 1	-9,461.43	Worst scenario
Scenario 4	0	Best scenario

As a result the sensitivity analysis was conclusive and the most financially attractive alternative scenario is considered to befor the scenario 4.

Therefore, it seems reasonable to conclude thatcrediting period for the project activity (Scenario 1) is unlikely to be the most financially attractive scenario.

Step 4. Common practice analysis

. According to "CombinedTOOL32 Methodological tool to identify the baseline scenario and demonstrate additionality", the common practice analysis establishes the following items below:

- **Applicable geographical area:** Brazil is the largest country in South America and the world's fifth largest country in the world. Therefore, the entire host country (Brazil) is considered suitable for this analysis;
- **Measure:** The project activity covers methane destruction;
- **Output:** the service delivered by the project is electricity (MWh)[29];
- **Technology:** the technology used in the project is electricity generation through biogas combustion in group generators.

[28] This value was considered in the financial analysis for the electricity tariff.

[29] It was considered only electricity as the output of the project electricity because the higher investment in the project is in the LFG power plant (83%). Moreover, this analysis is conservative because includes all electricity generation projects instead of only electricity generation projects burning methane).

As the project activity applies measure that are listed in the definitions section: “Positive lists of the “Combined tool to identify the baseline scenario and demonstrate additionality”, the Step 4 a was applied.

Step 4a:technologies”, as the proposed ***CDM project activity(s) applies measure(s) that are listed in the definitions section above***

The common practice analysis consists of the following steps:

Sub-step 4a (1): *Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.*

The installed capacity of the project activity is 5.73 MW. Then, the output range of the project activity is from 2.85 to 8.55 MWautomatically additional.

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 and projects activities undergoing validation shall not be included in this step.*

It was carried out a survey through ANEEL website and the list with all plants was given to the DOE[30]. The total of the plants is 107. Then, N_{all} = 107.

Sub-step 4a (3): Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N_{diff}.

The technology of the project activity is electricity generation through biogas. All projects in Brazil which generates electricity through biogas are registered CDM project activities or projects activities undergoing validation. Therefore, there is no project with the same technologies as the project activity.

Then, N_{diff} = 107 or N_{all} = N_{diff}.

Sub-step 4a (4): Calculate factor F=1 - 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.

$$F = 1 - \left(\frac{N_{diff}}{N_{all}}\right)$$

$$F = 1 - \left(\frac{107}{107}\right)$$

Therefore, F = 0 and N_{all} - N_{diff} = 0.

The “Combined tool to identify the baseline scenario and demonstrate additionality” states:

> *The proposed project activity is regarded as “common practice” within a sector in the applicable geographical area if both the following conditions are fulfilled:*

(a) The additionality of the project activities and PoAs is demonstrated as follows:

[30] The website at ANEEL was accessed on 09/05/2012 (http://www.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.asp) and the name of the electronic spreadsheet is “*5.7 MW CTR Rosario common practice.xlsx*”

"The project activities and PoAs at new or existing landfills (greenfield or brownfield) are deemed automatically additional, if it is demonstrated that prior to the implementation of the project activities and PoAs the landfill gas (LFG) was only vented and/or flared (in the case of brownfield projects) or would have been only vented and/or flared (in the case of greenfield projects) but not utilized for energy generation, and that under the project activities and PoAs any of the following conditions are met:

(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;
The *factor F is greater than 0.2; and*
(b)(c) *(b) N_{all} - N_{diff}*LFG is *greater than 3*flared.

Outcome of common practice analysis.

The project activity is not a common practice because the factor F = 0 and the N_{all} - N_{diff} = 0.

B.12.B.6. Estimation of emission reductions

B.12.1.B.6.1. Explanation of methodological choices

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Baseline emission calculation

The baseline emission was calculated according to the following formula-s from the methodology ACM0001:

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

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 only aims flare 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 ($BE_{CH4,y}$)

The formula below was extracted from the methodology ACM0001:

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

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

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

The formulas below were extracted from the methodology ACM0001:

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

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

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_4tCH_4/yr)

As the project only aims flare LFG and generate electricity, the$F_{CH4,EL,y}$, $F_{CH4,HG,y}$ = 0 and $F_{CH4,NG,y}$ = 0.Thus, the equation is:
are

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

$F_{CH4,EL,y}$ 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:

- The gaseous stream the tool shall be applied to is the LFG delivery pipeline to each item of electricity generation.
- $F_{CH4,EL,y}$ is then calculated as the sum of mass flows to each item of electricity generation;

(e) 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;

(h)(f) CH_4 is the greenhouse gasesgas for which the mass flow should be determined;

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

- (equations 3 or 17 in the tool); and

(k)(h) The mass flow should be calculated on an hourly basis for each hour *h* in year *y*;

(l)(i) 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:

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

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

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 above where the gaseous stream below. The tool shall be applied to isthe gaseous stream flowing in the LFG delivery pipeline to theeach flare(s)..

According to "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" the following options will be considered for the determination of the absolute humiditypresent project activity:

- Option A (Volume flow in dry basis and volumetric fraction in dry basis) when the temperature of the gaseous stream will be used the Option 2: simplified calculation withoutis less than 60ºC (333.15 K) at the flow measurement point

  And

- of the moisture content and the measurement option in Table 1 will be 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.

When**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 60ºC60ºC (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 (8,314 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:

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

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[31].

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 "Tool to determine methodological tool "Project emissions from flaring gases" containing methane.". If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

[31] 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).

Open flareEnclosed flare(s) will bebeen installed in the project activity to increase the destruction efficiency. Those flares reach 99.8%[32] of methane destruction efficiency.

To determine the project emissions from flaring gases was used the "Tool to determine tool "Project emissions from flaring gases containing methane". According to this tool,". The project emissions should be calculated calculation procedure is given in 7the following steps.:

STEP 1.: Determination of the methane mass flow rate of the residual gas that is flared;

The density of the residual gas is determined based on the volumetric fraction of all components in the gas:

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

$FM_{RG,h}$ = Mass flow rate of the residual gas in *hour* h (kg/h);
$\rho_{RG,n,h}$ = Density of the residual gas at normal conditions in hour h (kg/m^3);
$FV_{RG,h}$ = Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h;

And

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

P_n = Atmospheric pressure at normal conditions (101,325Pa);
R_u = Universal ideal gas constant (8.314 Pa.m^3/kmol.K);
$MM_{RG,h}$ = Molecular mass of the residual gas in hour *h* (kg/kmol);
T_n = Temperature at normal conditions (273.15K);

And,

$$MM_{RG,h} = \sum_i (fv_{i,h} \cdot MM_i)$$

$fv_{i,h}$ = Volumetric fraction of component *i* in the residual gas in the hour *h*;
MM_i = Molecular mass of residual gas component *i* (kg/kmol/);
i = Gas components CH_4 and N_2 (according to the simplification used).

As permitted by the tool, the project participants will only measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2).

STEP 2.: Determination of the **mass fraction of carbon, hydrogen, oxygen and nitrogen in the residual gas**flare efficiency;

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

$fm_{j,h}$ = Mass fraction of element *j* in the residual gas in hour *h*;
AM_j = Atomic mass of element *j* (kg/kmol);
$NA_{j,i}$ = Number of atoms of element *j* in component *i*;

[32] The document about the specification of the flare efficiencies was provided to DOE (*flare efficiency.pdf*).

$MM_{RG,h}$ = Molecular mass of the residual gas in hour *h (kg/kmol)*;
j = The elements carbon, hydrogen, oxygen and nitrogen;
i = The components CH_4 and N_2 (according to the simplification used);

STEP 3.: Calculation of project emissions from flaring.

***Step 1:* Determination of the volumetricmethane mass flow rate ofin the exhaustresidual gas on a dry basis**

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

Where:

$TV_{n,FG,h}$ = Volumetric The "Tool to determine the mass flow rate of the exhausta greenhouse gas in dry basis at normal conditions in hour h (m^3/h);
$V_{n,FG,h}$ = Volume ofa gaseous stream" shall be used to determine the exhaust gas of the flare in dry basis at normal conditions per kg of residual gas in hour *h* (m^3/kg residual gas);following parameter:
$FM_{RG,h}$ = Mass flow rate of

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 in the hour *h* (kg residual gas/h);;

$$V_{n,FG,h} = V_{n,CO2,h} + V_{n,O2,h} + V_{n,N2,h}$$

Where:

- $V_{n,N2,h}$ = QuantityThe flow of N_2 volume freethe 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

$F_{CH4,}$ exhaust gas of$_{m}$, 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 at normal conditions per kg of residualin 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 the hour *h* (m³/ kg residual gas);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.

$V_{n,O2,h}$ = Quantity of O_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m³/ kg residual gas);

$V_{n,CO2,h}$ = Quantity of CO_2 volume free in the exhaust gas of the flare at normal conditions per kg of residual gas in the hour *h* (m³/ kg residual gas);

$$V_{n,O2,h} = n_{O2,h} \times MV_n$$

$n_{O2,h}$ = Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour *h* (kmol/$kg_{residual\_gas}$);

MV_n = Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol) (in m³/kmol);

$$V_{n,CO2,h} = \frac{fm_{C,h}}{AM_C} \times MV_n$$

$fm_{C,h}$ = Mass fraction of carbon in the residual gas in the hour h;

AM_C = Atomic mass of carbon (kg/kmol);

MV_n = Volume of one mole of any ideal gas at normal temperature and pressure (22.4 L/mol) (in m³/kmol);

And

$$V_{n,N2,h} = MV_n \cdot \left\{ \frac{fm_{N,h}}{200AM_n} + \left(\frac{1 - MF_{O_2}}{MF_{O_2}} \right) \cdot \left(F_h + n_{O_2,h} \right) \right\}$$

Where:

$fm_{N,h}$ = Mass fraction of nitrogen in the residual gas in the hour h
AM_n = Atomic mass of nitrogen (kg/kmol);
MF_{O2} = O_2 volumetric fraction of air (0.21);
F_h = Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas flared in hour h (kmol/kg residual gas);
$n_{O2,h}$ = Quantity of moles O_2 in the exhaust gas of the flare per kg residual gas flared in hour h (kmol/kg residual gas);

$$n_{O_2,h} = \frac{t_{O_2,h}}{(1-(\frac{t_{O_2,h}}{MF_{O_2}}))} \times \left[\frac{fm_{C,h}}{AM_C} + \frac{fm_{N,h}}{2AM_N} + \left(\frac{1-MF_{O2}}{MF_{O2}} \right) \times F_h \right]$$

$t_{O2,h}$ = Volumetric fraction of O_2 in the exhaust gas in the hour *h*;
MF_{O2} = O_2 volumetric fraction of air (0.21);
F_h = Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in hour *h* (kmol/kg residual gas);
AM_j = Atomic mass of element *j* (kg/kmol);
j = The elements carbon, hydrogen, oxygen and nitrogen;

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

Where:

$fm_{j,h}$ = Mass fraction of element *j* in the residual gas in hour *h;*

STEP 4.
Step 2: **Determination of methane mass flow rate in the exhaust gas on a dry basis**

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

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

Where:

$TV_{n,FG,h}$ = Volumetric flow rate of the exhaust gas in dry basis at normal conditions in hour *h* (m^3/h exhaust gas);
$fv_{CH4,FG,h}$ = Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in hour *h* (mg/m^3).

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

The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{CH4,RG,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference conditions (normal conditions and dry or wet basis).

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

$FV_{RG,h}$ = Volume flow rate of the residual gas in dry basis at normal conditions in hour h (m^3/h);
$fv_{CH4,RG,h}$ = Volumetric fraction of methane in the residual gas on dry basis in hour h (NB: this corresponds to fvi,RG,h where i refers to methane).

$\rho_{CH4,n}$ = Density of methane at normal conditions (0.716 kg/m³);

STEP 6. Determination of the hourly flare efficiency

The determination of the hourlyOpen flare

In the case of open flares, the flare efficiency depends on the operation of flare (through temperature),in the type of flare used (enclosed) andminute *m* ($\eta_{flare,m}$) is 50% when the approach selected (continuous).flame is detected in the minute *m* ($Flame_m$), otherwise $\eta_{flare,m}$ is 0%.

Enclosed flare For the project activity,
In the case of enclosed flares and continuous monitoring of the flare , project participants may choose between the following two options to determine the flare efficiency for minute *m* ($\eta_{flare,m}$).

Option A: Apply a default value for flare efficiency,.

Option B: Measure the flare efficiency in the hour h is:.
0% if
Option A: Default value

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

(1) The temperature of the exhaustflare ($T_{EG,m}$) and the flow rate of the residual gas ofto the flare ($T_{flare}F_{RG,m}$) is below 500°C during more than 20 minutes duringwithin the hour *h*;manufacturer's specification for the flare ($SPEC_{flare}$) in minute m; and

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

Otherwise $\eta_{flare,m}$ is 0%.

For Determined as follows in cases where the enclosed flares that are defined as low height flares, the flare efficiency shall be adjusted, as a conservative approach, by subtracting 10 percentile points. For example, the default value applied shall be 80%, rather than 90%.

Option B: Measured flare efficiency

The flare efficiency in the minute *m* is a measured value ($\eta_{flare,m} = \eta_{flare,calc,m}$) when the following three conditions are met to demonstrate that the flare is operating:

a. The temperature of the exhaust gas flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($T_{flare}F_{RG,m}$) is above 500°Cwithin the manufacturer's specification for more than 40 minutes during the hour *h*;the flare ($SPEC_{flare}$) in minute *m*;

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

b. The flame is detected in minute *m* ($Flame_m$); and
c. Otherwise $\eta_{flare,m}$ is 0%.

Option B.1: Biannual measurement of the flare efficiency

The calculated flare efficiency $\eta_{flare,calc,m}$ is determined as the average of two measurements of the flare efficiency made in year *y* ($\eta_{flare,calc,y}$), adjusted by an uncertainty factor of 5 percentile points as follows:

$$\eta_{flare,calc,y} = 1 - \frac{1}{n}\sum_{t=1}^{n}\left(\frac{F_{CH4,EG,t}}{F_{CH4,RG,t}}\right) - 0.05$$

Where:

$\eta_{flare,calc,y}$	=	Flare efficiency in the year y
$F_{CH4,EG,t}$	=	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period t (kg)
$F_{CH4,RG,t}$	=	Mass flow of methane in the residual gas on a dry basis at reference conditions in the time period t (kg)
t	=	The two time periods in year y during which the flare efficiency is measured, each a minimum of one hour and separated by at least six months

$F_{CH4,}$

$TM_{FG,h}$ = Methane mass flow rate in exhaust gas averaged in a period of time *t* (kg/h);

$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour *h* (kg/h);

STEP 7. $F_{CH4,EG,t}$ is measured according to an appropriate national or international standard. $F_{CH4,RG,t}$ is calculated according to Step 1, and consists of the sum of methane flow in the minutes *m* that make up the time period *t*.

For enclosed flares that are defined as low height flares, the flare efficiency in the minute m($\eta_{flare,m}$) shall be adjusted, as a conservative approach, by subtracting 10 percentile points from the efficiency. For example, if the measured value was 99%, then the value to be used shall correspond to 89%.

Step 3: Calculation of annual project emissions from flaring

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

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

Where:

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times (1 - \eta_{flare,h}) \times \frac{GWP_{CH4}}{1000}$$

$TM_{RG,h}$ = Mass flow rate of methane in the residual gas in the hour *h* (kg/h);

$\eta_{flare,h}$ = Flare efficiency in hour *h*;

$PE_{flare,y}$	=	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 2 - Parameters 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[33]	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. The formula below was extracted from the methodology ACM0001It is determined as follows:

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

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

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:

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

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

Where:

$BE_{CH4,SWDS,y}$	=	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

[33] Default value of 25 from IPCC. Shall be updated according to any future COP/MOP decisions.

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. For this reason, the parameter f_y and *X* will not be monitored.

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

In the baseline there are no regulatory or contractual requirements, or to address safety and odour concerns to capture and destroy LFG. Thus, the case of the project activity for determining methane captured and destroyed in the baseline is **Case 3*: No requirement to destroy methane exists and LFG capture system exists*** according to methodology ACM0001, because there is existing LFG capture system (passive system), however there is no requirement to destroy methane. In this case:

$$F_{CH4,BL,y} = F_{CH4,BL,sys,y} = F_{CH4,sent\_flare,y}$$

Where:

$F_{CH4,BL,sys,y}$	=	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 (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)

The amount of methane captured with the existing system will be monitored along with the amount captured under the project activity and there is no historic data on the amount of methane that was captured in the year prior to the implementation of the project activity. Thus, the situation to determine $F_{CH4,BL,y}$ is:

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

$F_{CH4,BL,sys,y} = 20\% \times F_{CH4,PJ,y}$; or

$F_{CH4,BL,y} = 20\% \times F_{CH4,PJ,y}$

The 20% is a default factor according to methodology ACM0001.

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

It was used the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" to calculate the baseline emissions associated with electricity generation.

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

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

Where:

$BE_{EC,y}$	Baseline emissions associated with electricity generation in year y (tCO_2/yr)
$EC_{BL,k,y} = EG_{PJ,y}$	Amount of electricity generated using LFG by the project activity in year (MWh)
$EF_{grid,CM,y}$	Combined margin emission factor of the applicable electricity system (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 (dimensionless).

Project emissions

The formula below was extracted from the methodology ACM0001:

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

Where:

$BE_{EC,y}$ PE_y	=	ProjectBaseline emissions from electricity generation in year *y* (tCO_2/yr)
PE_{EC} $EC_{BL,k,y}$ = $EG_{PJ,y}$	=	Emissions from consumptionNet amount of electricity due to the project activitygenerated using LFG in year y (tCO_2(MWh/yr)
PE_{FC} $EF_{EL,k,y}$[34]	=	Emissions from consumption of fossil fuels due to the project activity,Emission factor for purpose other than electricity generation, for source *k* in year *y* (tCO_2/yrMWh)
$TDL_{k,y}$	=	Average technical transmission and distribution losses for providing electricity to source *k* in year *y*.

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

Thus,

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

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

According to "*Tool to calculate*) shall be calculated using the "Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".

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". 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

[34] According to the "*Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*", $EF_{EL,k,y} = EF_{grid,CM,y}$

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.[35]

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 $EF_{grid,OM-DD,y}$.

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)

[35] DNA Resolution n.°8 was published on 26/05/2008 on http://www.mct.gov.br/index.php/content/view/14797.htmlhttp://www.mctic.gov.br/mctic/export/sites/institucional/ciencia/SEPED/clima/arquivos/legislacao_cimgc/Resolucao-n-8-de-26-de-maio-de-2008.pdf, accessed on 04/04/201216/07/2019.

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

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:

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

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: $w_{OM} = 0.5$ and $w_{BM} = 0.5$, fixed for the first crediting period. That gives:

The build margin CO_2 emission factor 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 CO2/yr)
$PE_{SP,y}$	=	Emissions from the supply of LFG to consumers through a dedicated pipeline, in year *y* (t CO_2/yr)

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*", the project emission from consumption of electricity will be from two sources:

- $PE_{EC1,y}$ - Grid (Brazilian interconnected electric system);
- $PE_{EC2,y}$ - Diesel generator(s) (off-grid captive power plant)

Thus,

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

$PE_{EC1,y}$ - 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:

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

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

Where:

$EC_{PJ1,y}$ ~~$EC_{EC1,y}$~~	=	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.

$PE_{EC2,y}$ - Project emission from electricity consumption from an off-grid captive power plant (diesel generator(s~~)~~))

As electricity will be consumed from diesel generators (off-grid captive power plant), a conservative approach was adopted and the option B2 of the scenario B was chosen because: "The electricity consumption source is a project or leakage electricity consumption source". Therefore, the value used will be 1.3[36] tCO_2/MWh for project emission from diesel generator(s).

[36] According to the default value of the tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".

$$\sout{PE_{EC2,y} = EC_{PJ2,y} \times EF_{diesel\_generator,y}}$$

$$PE_{EC2,y} = EC_{PJ2,y} \times EF_{diesel\_generator,y} \times (1 + TDL_y)$$

Where:

$EC_{PJ2,y}$ = ~~$EG_{EC2,y}$~~	= quantity of electricity consumed from diesel generator by the project activity during the year y (MWh);
$EF_{diesel\_generator,y}$	= the emission factor for the diesel generator 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 $PE_{FC,y}$ – project emission from consumption of heat**~~

~~There is no 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, 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);

Open flare(s) will been installed in the project activity.

~~B.12.2.~~B.6.2. Data and parameters fixed ex-ante

~~*(Copy this table for each piece of data or parameter.)*~~

The following ex ante parameters, listed in the registered project activity, will not be used in this project activity and thus not presented in the tables below since have been not used in the calculation of emission reductions:

- Manufacturer's flare specifications for temperature, flow rate and maintenance schedule ($SPEC_{flare}$)

Data / Parameter	OX_{top_layer}
~~Data~~ **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	GWP_{CH4}
Data Unit	t CO_2e/t CH_4
Description	Global warming potential of CH_4
Source of data	IPCC
Value(s) applied	2125. Updated for the first2nd commitment period. Shall be updated according to any future COP/MOP decisions[37]
Choice of data or Measurement methods and procedures	Default value used, according to ACM0001IPCC 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	-In opposite of the PDD registered on 26 Feb 13 using GWP of 21, it has been updated to 25.

Data/ / Parameter	$NCV_{CH4}$$R_u$
Data Unit	TJ/t CH4Pa.m³/kmol.K
Description	Net calorific value of methane at reference conditionsUniversal ideal gas constant
Source of data	Technical literatureMethodological tool "Project emissions from flaring"
Value(s) applied	0.05048,314
Choice of data or Measurement methods and procedures	Default value used, according to ACM0001Methodological tool "Project emissions from flaring", 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

[37] 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.

Value(s) applied	(see Composition of waste 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	29.40%
B) Pulp, paper and cardboard (other than sludge)	6.40%
C) Food, food waste, beverages and tobacco (other than sludge)	29.40%
D) Textiles	0.00%
E) Garden, yard and park waste	0.00%
F) Glass, plastic, metal, other inert waste	34.80%
TOTAL	**100.00%**

Data / Parameter	η_{PJ}
Unit	Dimensionless
Description	Efficiency of the LFG capture system installed in the project activity
~~**Purpose of data**~~	~~Calculation of baseline emission~~
~~**Additional comment**~~	~~-~~

~~**Data/Parameter**~~	~~η_{PJ}~~
~~Data unit~~	~~Dimensionless~~
~~Description~~	~~Efficiency of the LFG capture system that will be installed in the project activity~~
Source of data	Equipments manufacturer of biogas capture system
Value(s) applied	65%
Choice of data or Measurement methods and procedures	Based on the active LFG capture system ~~to be~~ installed, according to technical specifications from the equipments provider~~.~~
Purpose of data	Calculation of baseline emission
Additional comment	-

Data~~/~~ / Parameter	$\varphi_{default}$
~~Data~~ **Unit**	-
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 ~~mitigates~~the methane emissions ~~from the landfill and the default value was applied for~~are being mitigated by capturing and flaring the ~~wet climatic condition.~~methane (ACM0001).

Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	OX
Unit	-
Purpose of data	Calculation of baseline emission
Additional comment	-

Data/Parameter	OX
Data unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	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
Data **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	$DOC_{f,default}$
Data **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	$MCF_{default}$
Data **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 sitessite 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) levellingleveling of the waste;
Purpose of data	Calculation of baseline emission
Additional comment	-

Data/Parameter	DOC_j
Data unit	-
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	DOC_j
Unit	-
Description	Fraction of degradable organic carbon in the waste type j (weight fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)
Value(s) applied	see table below

Waste type j	DOCj (% wet waste)
Wood and wood products	43%
Pulp, paper and cardboard (other than sludge)	40%
Food, food waste, beverages and tobacco (other than sludge)	15%
Textiles	24%
Garden, yard and park waste	20%
Glass, plastic, metal, other inert waste	0%

Choice of data or Measurement methods and procedures	IPCC default value for anaerobic managedmunicipal solid waste (MSW) disposal site is applied.
Purpose of data	Calculation of baseline emission
Additional comment	-

Data/Parameter	k_j
Data unit	1/yr
Description	Decay rate for the waste type j
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)
Value(s) applied	see table below
Choice of data or measurement methods and procedures	IPCC default value for anaerobic managed solid waste disposal site is applied.

Value(s) applied:

Waste type j		Tropical (MAT > 20 °C) Wet (MAP > 1,000 mm)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.07
	Wood, wood products and straw	0.035
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.17
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.40

Purpose of data	Calculation of baseline emission
Additional comment	-The mean annual temperature (MAT) is 26.3ºC and the mean annual precipitation (MAP) 2,326 mm. Source: INMET – Instituto Nacional de Meteorologia[38]

Data/ / Parameter	$EF_{diesel\_generator}$ k_j
Data Unit	tCO_2/MWh-
Description	Emission factor for the diesel generatorDecay rate for waste type j

[38] http://www.bdclima.cnpm.embrapa.br/resultados/balanco.php?UF=&COD=72 https://www.cnpm.embrapa.br/projetos/bdclima/balanco/resultados/ma/72/balanco.html, accessed on 16/07/2019.

<table>
<tr><td>Source of data</td><td>Tool to calculate baseline, project and/or leakage emissions from electricity consumption2006 IPCC Guidelines for National Greenhouse Gas Inventories</td></tr>
<tr><td>Value(s) applied</td><td>1.3
<table>
<tr><td colspan="2" rowspan="2">Waste type j</td><td>Tropical (MAT > 20 °C)</td></tr>
<tr><td>Wet (MAP>1000mm)</td></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>The diesel generator is an off-grid fossil fuel fired captive power plant. Thus, theIPCC default value of the Scenario B2 was for anaerobic managed solid waste disposal site is applied.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissionbaseline emissions</td></tr>
<tr><td>Additional comment</td><td>The mean annual temperature (MAT) is 26.3ºC and the mean annual precipitation (MAP) 2,326 mm. Source: INMET - Instituto Nacional de Meteorologia[39].</td></tr>
</table>

Data/ / Parameter	MM_i
Data 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

[39] http://www.bdclima.cnpm.embrapa.br/resultados/balanco.php?UF=&COD=72 https://www.cnpm.embrapa.br/projetos/bdclima/balanco/resultados/ma/72/balanco.html, accessed on 16/07/2019.

Value(s) applied	Compound / Structure / Molecular mass (kg/kmol): Carbon dioxide, CO_2, 44.01; Methane, CH_4, 16.04; Nitrous oxide, N_2O, 44.02; Sulfur hexafluoride, SF_6, 146.06; Perfluoromethane, CF_4, 88.00; Perfluoroethane, C_2F_6, 138.01; Perfluoropropane, C_3F_8, 188.02; Perfluorobutane, C_4F_{10}, 238.03; Perfluorocyclobutane, c-$C4F_8$, 200.03; Perfluoropentane, C_5F_{12}, 288.03; Perfluorohexane, C_6F_{14}, 338.04
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	-

Compound	Structure	Molecular mass (kg/kmol)
Carbon dioxide	CO_2	44.01
Methane	CH_4	16.04
Nitrous oxide	N_2O	44.02
Sulfur hexafluoride	SF_6	146.06
Perfluoromethane	CF_4	88.00
Perfluoroethane	C_2F_6	138.01
Perfluoropropane	C_3F_8	188.02
Perfluorobutane	C_4F_{10}	238.03
Perfluorocyclobutane	c-$C4F_8$	200.03
Perfluoropentane	C_5F_{12}	288.03
Perfluorohexane	C_6F_{14}	338.04

Data/ / Parameter	MM_k
Data 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	(see table below)

Compound	Structure	Molecular mass (kg/kmol)
Nitrogen	N_2	28.01
Oxygen	O_2	32.00
Carbon monoxide	CO	28.01
Hydrogen	H_2	2.02
Nitric oxide	NO	30.01
Nitrogen dioxide	NO_2	46.01
Sulphur dioxide	SO_2	64.06

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}
Data 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	-

Data/ / Parameter	Constants used in equations of tool to determine project emissions from flaring gases containing methaneMM_{H2O}
Data **Unit**	-kg/kmol
Description	Constants used in equations of Tool to determine project emissions from flaring gases containing methaneMolecular mass of water
Source of data	Tool to determine project emissions from flaring gases containing methanethe mass flow of a greenhouse gas in a gaseous stream

<table>
<tr><td>Value(s) applied</td><td>

Parameter	SI Unit	Description	Value
MM_{CH4}	kg/kmol	Molecular mass of methane	16.04
MM_{CO}	kg/kmol	Molecular mass of carbon monoxide	28.01
MM_{CO2}	kg/kmol	Molecular mass of carbon dioxide	44.01
MM_{O2}	kg/kmol	Molecular mass of oxygen	32
MM_{H2}	kg/kmol	Molecular mass of hydrogen	2.02
MM_{N2}	kg/kmol	Molecular mass of nitrogen	28.02
AM_c	kg/kmol (g/mol)	Atomic mass of carbon	12
AM_h	kg/kmol (g/mol)	Atomic mass of hydrogen	1.01
AM_o	kg/kmol (g/mol)	Atomic mass of oxygen	16
AM_n	kg/kmol (g/mol)	Atomic mass of nitrogen	14.01
P_n	Pa	Atmospheric pressure at normal conditions	101 325
R_u	$Pa.m^3/kmol.K$	Universal ideal gas constant	8 314.472
T_n	K	Temperature at normal conditions	273.15
MF_{O2}	Dimensionless	O_2 volumetric fraction of air	0.21
GWP_{CH4}	tCO_2/tCH_4	Global warming potential of methane	21
MV_n	$m^3/Kmol$	Volume of one mole of any ideal gas at normal temperature and pressure	22.414
$\rho_{CH4,n}$	kg/m^3	Density of methane gas at normal conditions	0.716
$NA_{i,j}$	Dimensionless	Number of atoms of element j in component i, depending on molecular structure	$NA_{i,j}$

18.0152</td></tr>
<tr><td>Choice of data or Measurement methods and procedures</td><td>According to “Tool to determine project emissions from flaring gases containing methanethe mass flow of a greenhouse gas in a gaseous stream”</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

B.12.4.B.6.3. Ex--ante calculation of emission reductions

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The emission reductions derived from the displacement of fossil fuels used for electricity generation from other sources are estimated for the Brazilian Interconnected System and guided by “Tool to calculate baseline, project and/or leakage emissions from electricity consumption. The combined margin emission factor” was calculated by the “Tool to calculate the emission factor for an electricity system” – version 02.2.1, 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.[40]

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

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
-)a) Simple adjusted OM, or
-)a) Dispatch data analysis OM, or
-)a) 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 $EF_{grid,OM-DD,y}$.

The emission factor is calculated as follows:

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

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

[40] DNA Resolution n.°8 was published on 26/05/2008 on http://www.mct.gov.br/index.php/content/view/14797.htmlhttp://www.mctic.gov.br/mctic/export/sites/institucional/ciencia/SEPED/clima/arquivos/legislacao_cimgc/Resolucao-n-8-de-26-de-maio-de-2008.pdf, accessed on 04/04/201216/07/2019.

y = Year in which the project activity is displacing grid electricity

The $EF_{EL,DD,h}$, $EF_{EL,DD,d}$ and $EF_{EL,DD,m}$ are displayed on the Brazilian DNA website[41], for the year 2011. However only the $EF_{EL,DD,m}$ will be used in order to calculate the emission reductions.

In order to estimate the emission reductions for the first crediting period the $EF_{EL,DD,2011}$ was calculated as a mean average of the $EF_{EL,DD,m}$. Then,

$EF_{grid,OM-DD,2011}$ = 0.2920 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:

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

$$EF_{grid,BM,2011} = 0.1056 \ tCO_2/MWh$$

Step 6. Calculate the combined margin emissions factor

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

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

The default weights are as follows: w_{OM} = 0.5 and w_{BM} = 0.5, fixed for the first crediting period. That gives:

$$EF_{2011} = 0.2920 \times 0.5 + 0.1056 \times 0.5 = 0.1988 \ tCO_2/MWh$$

[41] Source: http://www.mct.gov.br/index.php/content/view/333605.html#ancora, accessed on 06/07/2012.

~~The build margin CO_2 emission factor and operating margin CO_2 emission factor will be ex-post.~~

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

Emission reduction

Baseline emission calculation

The total of methane generation at the site has been estimated based on the waste tonnage of the landfill ~~and the waste composition (Appendix 4)~~ 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 = 65~~%: (Based on technical specifications from the equipments provider for the active LFG capture system);~~%
- Density of methane = 0.716 kg/m³ (as per ~~"*Tool to determine*~~ tool "Project emissions from flaring ~~*gases containing methane*~~*")*.

The landfill gas collection and utilization system will capture only a portion of the generated landfill gas. Thus, an estimate of 65% LFG collection efficiency 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:

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

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

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.

~~$F_{CH4,PJ,y}$~~

Table ~~9~~3 - Ex-ante estimation of $F_{CH4,PJ,y}$

Year	$F_{CH4,PJ,y}$ (tCH_4/yr)
2014	2,311
2015	3,083
2016	3,703
2017	4,215
2018	4,652
2019	5,034
2020	5,376

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

$F_{CH4,BL,y} = 20\% \times F_{CH4,PJ,y}$

Table 4~~10~~ - Ex-ante estimation of $F_{CH4,BL,y}$

Year	$F_{CH4,BL,y}$ (tCH_4/yr)
2014	462
2015	617
2016	741
2017	843
2018	930
2019	1,007
2020	1,075

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

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

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

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

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~~11~~ - Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Year	$BE_{CH4,y}$ (tCO_2/year)
2014	~~34,942~~40,442
2015	~~46,621~~53,959
2016	~~55,987~~64,800
2017	~~63,737~~73,769
2018	~~70,341~~81,413
2019	~~76,118~~88,099
2020	~~81,283~~94,077

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

~~The ex-ante calculation is based in the electricity generation produced by 3 group generators (one stand by) with a total installed capacity of 4.3 MW during the first credit period:~~

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 $EF_{grid,CM,y}$ = 0.19883380 tCO_2/MWh

Table 612 - Baseline emissions associated with electricity generation ($BE_{EC,y}$)

Year	$EC_{BL,k,y}$ (MWh/yr)	$BE_{EC,y}$ (tCO_2/yr)
2014	0	0
2015	10,0760	2,3230
2016	10,0760	2,3230
2017	10,0760	2,3230
2018	15,6420	3,6070
2019	18,49615,768	4,2656,396
2020	18,49623,652	4,2659,594

The forecast installed capacity and electricity generated ($EC_{BL,k,y}$) by the project activity are present below:

Year	Number of engines	Installed capacity (MWe)	Electricity generated in the plant (MWh)
2014	0	0.000	0
2015	0	0.000	0
2016	0	0.000	0
2017	0	0.000	0
2018	0	0.000	0
2019	2	2.000	15,768
2020	3	3.000	23,652

[1] The plant load factor is 90%.

The equation of the baseline emission calculation is:

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

The result is:

Table 713 - Baseline emission calculation

Year	$BE_{CH4,y}$ (tCO_2/year)	$BE_{EC,y}$ (tCO_2/yr)	BE_y (tCO_2/yr)
2014	34,94240,442	0	34,94240,442
2015	46,62153,959	2,3230	48,94553,959
2016	55,98764,800	2,3230	58,31164,800
2017	63,73773,769	2,3230	66,06073,769
2018	70,34181,413	3,6070	73,94881,413
2019	76,11888,099	4,2656,396	80,38394,495
2020	81,28394,077	4,2659,594	85,548103,671

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

1. Project emissionsemission

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

Where:

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

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)

$PE_{EC,y}$ = 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

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

There are two The project emission project sourcesfrom consumption of electricity is:

- $PE_{EC1,y}$ - Grid (Brazilian interconnected electric system);
- $PE_{EC2,y}$ - Diesel generator(s) (off-grid captive power plant)

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

Where:

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

In the project activity, the electricity consumption from the grid is estimated around 1,167 MWh/year. it was assumed for ex-ante calculations that the internal consumption of diesel generator is 0% and all internal consumption will be from the Brazilian grid. However, both parameters will be continuously monitored and measured.

In the option A1 of the "*Tool to calculate*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 0.19883380 tCO_2/MWh will be used.

Finally, the technical transmission and distribution losses ($TDL_{j,y}$) value has been assumed to be 1620%, according to technical articleOption 2: default value from researcher at Brazilian (UTFPR).[42]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.

[42] The article was made available to DOE during the validation process (*Perdas de transmissão e distribuição de energia elétrica - Brasil.pdf*).

Table 814 - Electricity consumption from the grid resulting due to project activity

Year	Electricity consumption from the grid – $EC_{PJ1,y}$ (MWh/yr year)	$PE_{EC1,y}$ $PE_{el,grid}$ (tCO_2/year)
2014	1,1670	2690
2015	0	0
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0

$PE_{EC2,y}$ – Project emission from diesel generator(s)

According to information above (Project emission from the grid), the ex-ante estimation was not considered. However, this parameter will be continuously monitored and measured ex-post.

The emission factor that will be used for diesel generator(s) is 1.3 tCO_2/MWh. The following table represents the project emissions from the use of the standby generator over the crediting period. Table below presents the project emissions associated with fossil fuel combustion at the project site.

Table 15 - Project emissions from diesel generator

Year	$PE_{el,diesel}$ – $EC_{PJ2,}$ (MWh/year)	$PE_{EC2,y}$ (tCO_2/year)
2014	0	0
2015	0	0
2016	0	0
2017	0	0
2018	0	0
2019	0	0
2020	0	0

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:

In accordance with the ACM0001, No leakage effects need to be accounted under methodology ACM0001.

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);

$$ER_y = BE_y - PE_y$$

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/year)	PEy (tCO_2/year)	ERy (tCO_2/year)
2014	34,94240,442	2690	34,67340,442
2015	48,94553,959	0	48,94553,959
2016	58,31164,800	0	58,31164,800
2017	66,06073,769	0	66,06073,769
2018	73,94881,413	0	73,94881,413
2019	80,38394,495	0	80,38394,495
2020	85,548103,671	0	85,548103,671

It is important to notice that, even with a lower electricity plant installed capacity proposed in this Post-Registration Changes, the ex-ante estimates of emission reductions are higher than in the PDD prior to the changes. This is due to the update of parameter GWP_{CH4} "Global warming potential of methane valid for the commitment period" to 25 $tCO_2e/t\ CH_4$ and update of paramenter $EF_{grid,CM,y}$ from 2011 to 2018 values.

B.12.5.B.6.4. Summary of ex ante estimates of emission reductions

B.13.B.7. Monitoring plan

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions (t CO_2e)
2014	34,94240,442	2690	0	34,67340,442
2015	48,94553,959	0	0	48,94553,959
2016	58,31164,800	0	0	58,31164,800
2017	66,06073,769	0	0	66,06073,769
2018	73,94881,413	0	0	73,94881,413
2019	80,38394,495	0	0	80,38394,495
2020	85,548103,671	0	0	85,548103,671
Total	**448,136512,549**	**2690**	**0**	**447,867512,549**
Total number of crediting years	**7**			
Annual average over the crediting period	**64,01973,221**	**380**	**0**	**63,98173,221**

B.13.1.B.7.1. Data and parameters to be monitored

(Copy this table for each piece of data or parameter.)

Flaring or use of landfill gas

The following ex ante parameters, listed in the registered project activity, will not be used in this project activity and thus not presented in the tables below since have been not used in the calculation of emission reductions:

- Quantity of LPG combusted in pilot flames of flares during year y ($FC_{i,j,y}$)
- Weighted average CO2 emission factor of LPG in year y ($EF_{CO2,LPG,y}$)
- Weighted average net calorific value of fossil fuel i in year y ($NCV_{fuel,y}$)
- Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period t ($F_{CH4,EG,t}$)
- Maintenance events completed in year y ($Maintenance_y$)
- Temperature in the exhaust gas of the flare in minute m ($T_{EG,m}$)

Data/ / Parameter	Management of SWDS $EF_{grid,CM,y}$
Data 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	0.3380 (year 2018)
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 (year 2018)
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	$EF_{grid,BM,y}$
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 (year 2018)
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	$TDL_{j,y}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j, in year y
Source of data	Default value from TOOL05
Value(s) applied	20%
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	The technical transmission and distribution losses (TDLj,y) value has been assumed to be 20%, default value from TOOL05.

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>2014</td><td>0</td></tr><tr><td>2015</td><td>0</td></tr><tr><td>2016</td><td>0</td></tr><tr><td>2017</td><td>0</td></tr><tr><td>2018</td><td>0</td></tr><tr><td>2019</td><td>0</td></tr><tr><td>2020</td><td>0</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” and methodology ACM0001.
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”
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	~~$O_{pj,h}$~~ $EG_{PJ,y}$ = $EC_{BL,k,y}$
~~Data~~ **Unit**	MWh
Description	~~Operation of the equipment that consumes the LFG~~Amount of electricity generated using LFG by the project activity in year y
Source of data	~~Project participants~~Electricity meter
Value(s) applied	~~n/a~~ <table><tr><th>Year</th><th>$EG_{PJ,y}$ (MWh/year)</th></tr><tr><td>2014</td><td>0</td></tr><tr><td>2015</td><td>0</td></tr><tr><td>2016</td><td>0</td></tr><tr><td>2017</td><td>0</td></tr><tr><td>2018</td><td>0</td></tr><tr><td>2019</td><td>15,768</td></tr><tr><td>2020</td><td>23,652</td></tr></table>
Measurement methods and procedures	Monitor net electricity generation by the project activity using LFG
Monitoring frequency	Continuous

Measurement methods andQA/QC **procedures**	For each equipment unit j using the LFG monitor that the plant is operating in hour h by the only monitoring parameter below: • 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; $O_{pj,h}$=0 when: • One of more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute); 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. Otherwise, Opj,h=1 The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.
Monitoring frequency**Purpose of data**	Hourly(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"

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	1 or 0
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 furnaces. 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	$V_{t,}$~~$_{wb}$~~$_{db}$
~~Data~~ **Unit**	m³ ~~wet gas~~/h
Description	Volumetric flow of the gaseous stream in time interval t on a ~~wet~~dry basis
Source of data	Measurements by ~~the~~ Project participants using a flow meter(s)
Value(s) applied	n/a
Measurement methods and procedures	The volumetric flow ~~measurement should always refer~~rate of the residual gas which is sent to ~~the actual pressure and temperature. Instruments~~each individual flare, LFG engines in the hour h will be measured by the installed flow meters with digital recordable electronic signal ~~(analogical or digital) are required.~~, 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: ~~The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.~~ • 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 ~~and good practices in the market, ranging between 3 to 7 years.~~.
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	~~According to~~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~~”,~~” is applied for the ~~measurement option in the project activity will be Option B when the temperature of gaseous stream is higher than 60ºC (333.15 K) at the flow measurement point~~ determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$

Data/ / Parameter	$V_{t,dbwb}$
Data Unit	m³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a drywet 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 should always refer to the actual pressure andoption in the project activity will be: • Option (A) dry basis: when the temperature. Calculated based on the wet basis of gaseous stream is lower than 60ºC (333.15 K) at the flow measurement plus water concentrationpoint; • Option (B) wet basis: when the temperature of gaseous stream is higher than 60o C (333.15 K) at the flow measurement. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%. 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" 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" 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	m^3 gas i/m^3 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 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" is applied for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$

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 ~~in accordance with~~ according to the manufacturer's specifications ~~and good practices in the market, ranging between 3 to 7 years.~~
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	~~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 when the temperature of gaseous stream is lower than 60ºC (333.15 K) at the flow measurement point~~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	$v_{i,t,db}$ = $fv_{i,,h}$ P_t
Data **Unit**	-Pa
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* on a dry basis
Source of data	Measurements by project participants
Value(s) applied	n/a
Measurement methods and procedures	Continuous gas analyzer operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature Data will be monitored continuously and values will be averaged hourly or a shorter time interval. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.
Monitoring frequency	Continuously
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). The calibration frequency of this monitoring equipment should be every year according to the manufacturer's specifications and good practices in the market.
Purpose of data	Calculation of baseline emissions
Additional comment	As a simplified approach, project participants may only measure the methane content of the gaseous stream and consider the remaining part as N_2, therefore i = CH_4 and N_2 This parameter will be monitored to option A e B

Data/Parameter	T_t
Data unit	K
Description	Temperature of the gaseous stream in time interval *t*
Source of data	Measurements by project participants
Value(s) applied	n/a
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required. Examples include thermocouples, thermo resistance, etc. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.
Monitoring frequency	Continuous unless differently specified in the underlying methodology
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 every year according to the manufacturer's specifications and good practices in the market.
Purpose of data	Calculation of baseline emissions.
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
Data unit	Pa

Description	Pressure of the gaseous stream in time interval t
Source of data	Measurements by Project participantsparticipant using a pressure meter
Value(s) applied	n/a
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are requiredwill be used. Examples include pressure transducers, etc. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.instrument will be in accordance with manufacturer specifications.
Monitoring frequency	Continuous unless differently specified in the underlying methodology
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 every two years according to the manufacturer's specifications and good practices in the market.
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	$P_{H2O,t,Sat}$Status of biogas destruction device
Data **Unit**	Pa-
Description	Saturation pressure of H_2O at temperature Tt in time interval tOperational status of biogas destruction devices
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 PaMonitoring 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.

Tool to calculate baseline, project and/or leakage*Methodological tool "Project* emissions *from* electricity consumption*flaring"*

Data/ / Parameter	$EF_{grid,CM,y}$ $Flame_m$
Data **Unit**	tCO_2/MWh Flame on or Flame off
Description	CO_2 emission factor of the Brazilian grid electricity during the year y
Source of data	Brazilian DNA
Value(s) applied	0.1988
Measurement methods and procedures **Description**	Flame detection of flare in the minute m 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. According to the "Tool to calculate the emission factor for an electricity system", the chosen monitoring option is *ex-post.*
Monitoring frequency	Annual
QA/QC procedures	Apply procedures in the "Tool to calculate the emission factor for an electricity system".
Purpose **Source of data**	Project Participant Calculation of baseline emissions and; Calculation of project emissions.
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 appendix 4.

Data/Parameter	$EF_{grid,BM,y}$
Data unit	tCO_2/MWh
Description	Build margin emission factor of the Brazilian grid
Source of data	Brazilian DNA
Value(s) applied	0.1056

Measurement methods and procedures	According to the "Tool to calculate the emission factor for an electricity system", the chosen monitoring option is *ex-post*.
Monitoring frequency	Annual
QA/QC procedures	Apply procedures in the "Tool to calculate the emission factor for an electricity system".
Purpose of data	Calculation of baseline emissions and; Calculation of project emissions.
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 appendix 4.

Data/Parameter	$EF_{grid,OM,y}$
Data unit	tCO_2/MWh
Description	Operating margin emission factor of the Brazilian grid
Source of data	Brazilian DNA
Value(s) applied	0.2920
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	Calculation of baseline emissions and; Calculation of project emissions.
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 appendix 4.

Data/Parameter	TDL_y
Data unit	-
Description	Average technical transmission and distribution losses in the grid in year y for the voltage level at which electricity is obtained from the grid at the project site.
Source of data	Regional or national technical literature
Value(s) applied	16%
Measurement methods and procedures	The technical distribution losses do not contain grid losses other than technical transmission and distribution.

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	Calculation of project emissions.
Additional comment	The technical transmission and distribution losses ($TDL_{j,y}$) value has been assumed to be 16%, according to technical article from researcher at Brazilian (UTFPR).

Data/Parameter	$EG_{PJ,y} = EC_{BL,k,y}$
Data unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year y
Source of data	Measured by the project participant
Value(s) applied	-
Measurement methods and procedures	Monitor net electricity generation by the project activity using LFG The data will be collected continuously using an electricity meter. The net amount of electricity will be directly measured. The data will be archived throughout the crediting period and two years thereafter. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.
Monitoring frequency	Continuously
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. Periodical calibration as per manufacturer specifications to ensure validity of data measured. The calibration frequency of this monitoring equipment should be every year according to the manufacturer's specifications and good practices in the market.
Purpose of data	Calculation of baseline emissions.
Additional comment	This parameter is required for calculating baseline emissions associated with electricity generation ($BE_{EC,y}$) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"

Data/Parameter	$EG_{EC1,y} = EC_{PJ1,y}$
Data unit	MWh/y
Description	Quantity of electricity consumed from the grid by the project activity during the year y
Source of data	Electricity meter
Value(s) applied	1,167 (for the first year - 2014)
Measurement methods and procedures	The data will be collected continuously using an electricity meter. The data will be archived throughout the crediting period and two years thereafter. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.
Monitoring frequency	Continuously

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. Periodical calibration as per manufacturer specifications to ensure validity of data measured. The calibration frequency of this monitoring equipment should be every year according to the manufacturer's specifications and good practices in the market.
Purpose of data	Calculation of project emissions.
Additional comment	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process ($PE_{EC1,y}$) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

Data/Parameter	$EG_{EC2,y} = EC_{PJ2,y}$
Data unit	MWh/y
Description	Quantity of electricity consumed from diesel generator by the project activity during the year y
Source of data	Measured by project participants
Value(s) applied	-
Measurement methods and procedures	The data will be collected continuously using an electricity meter. The data will be archived throughout the crediting period and two years thereafter. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.
Monitoring frequency	Continuously
QA/QC procedures	Calibration of equipment as per manufacturer specifications to ensure validity of data measured. The calibration frequency of this monitoring equipment should be every year according to the manufacturer's specifications and good practices in the market.
Purpose of data	Calculation of project emissions.
Additional comment	For ex-ante estimations is not being considered electricity consumption. However, this parameter will be continuously monitored and measured. This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process ($PE_{EC2,y}$) using the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption".

Tool to determine project emissions from flaring gases containing methane

Data/Parameter	$t_{O2,h}$
Data unit	-
Description	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour h
Source of data	Measurements by project participants using a continuous gas analyzer
Value(s) applied	-

Measurement methods and procedures	Extractive sampling analyzers with water and particulates removal devices or *in situ* analyzers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flares (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperature level. An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.Measurements by project participants using a continuous Ultra Violet flame detector
Monitoring frequency	ContinuouslyOnce 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	Analyzers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas. The calibration frequency of this monitoring equipment should be every year according to the manufacturer's specifications and good practices in the market.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[43].
Additional comment	The enclosed flares that will be installed in the project activity have a standard temperature higher than 850ºC, according to manufacturer specification[44].-

Data/Parameter	$fv_{CH4,FG,h}$
Data unit	mg/m³
Description	Concentration of methane in the exhaust gas of the flare in dry basis at normal conditions in the hour h
Source of data	Measurements by project participants using a continuous gas analyzer
Value(s) applied	-
Measurement methods and procedures	Extractive sampling analyzers with water and particulates removal devices or *in situ* analyzers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flares (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperature level. An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow. Data will be recorded continuously and values will be averaged hourly or at a shorter time interval. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.
Monitoring frequency	Continuously. Values to be averaged hourly or at a shorter time interval

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

[44] The documentation regarding technical specifications of the flare was made available to DOE in the validation visit.

QA/QC procedures	Analyzers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas. The calibration frequency of this monitoring equipment should be every year according to the manufacturer's specifications and good practices in the market.
Purpose of data	Calculation of baseline emissions.
Additional comment	The enclosed flares that will be installed in the project activity have a standard temperature higher than 850ºC, according to manufacturer specification. Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. Measurement instruments will be read ppmv values or % values. To convert from ppmv to mg/m3 simply multiply by 0.716. 1% equals 10,000 ppmv.

Data/Parameter	T_{flare}
Data unit	º C
Description	Temperature on the exhaust gas of the flare
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 500 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. The accuracy of the monitoring equipment may range between 0 to 1.5%. Regarding the monitoring equipment uncertainty, it may range between 0 to 2.5%.
Monitoring frequency	Continuously
QA/QC procedures	Thermocouples will be replaced or calibrated every year
Purpose of data	Calculation of baseline emissions.
Additional comment	An excessively high temperature at the sampling point (above 700 ºC) may be an indication that the flare is not being adequately operated or that its capacity is not adequate to the actual flow, however, the enclosed flares that will be installed in the project activity have a standard temperature higher than 850ºC, according to manufacturer specification. The documentation regarding technical specifications of the flare was made available to DOE in the validation visit.

Data/Parameter	$FV_{RG,h}$
Data unit	m^3/h
Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour h
Source of data	Measurements by project participants using a flow meter
Value(s) applied	-

Measurement methods and procedures	Ensure that the same basis (wet or dry) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas gas ($f_{vi,h}$) when the residual gas temperature exceeds 60°C. Data will be monitored continuously and values will be averaged hourly or a shorter time interval. The accuracy and uncertainty of the monitoring equipment may range between 0 to 1.5%.
Monitoring frequency	Continuously
QA/QC procedures	Flow meters must be periodically calibrated according to the manufacturer's recommendation. Periodical calibration.
Purpose of data	Calculation of baseline emissions.
Additional comment	-

B.13.110.B.7.2. Sampling plan

>>

Not applicable.

Not applicable

B.13.111.B.7.3. Other elements of monitoring plan

>>

The monitoring plan will be done according to the methodology ACM0001 and, the applicable tools., as well as per CDM project standard. Details are available in section B.7.1 above. The monitoring equipmentsequipment locations are presented in the picture below:

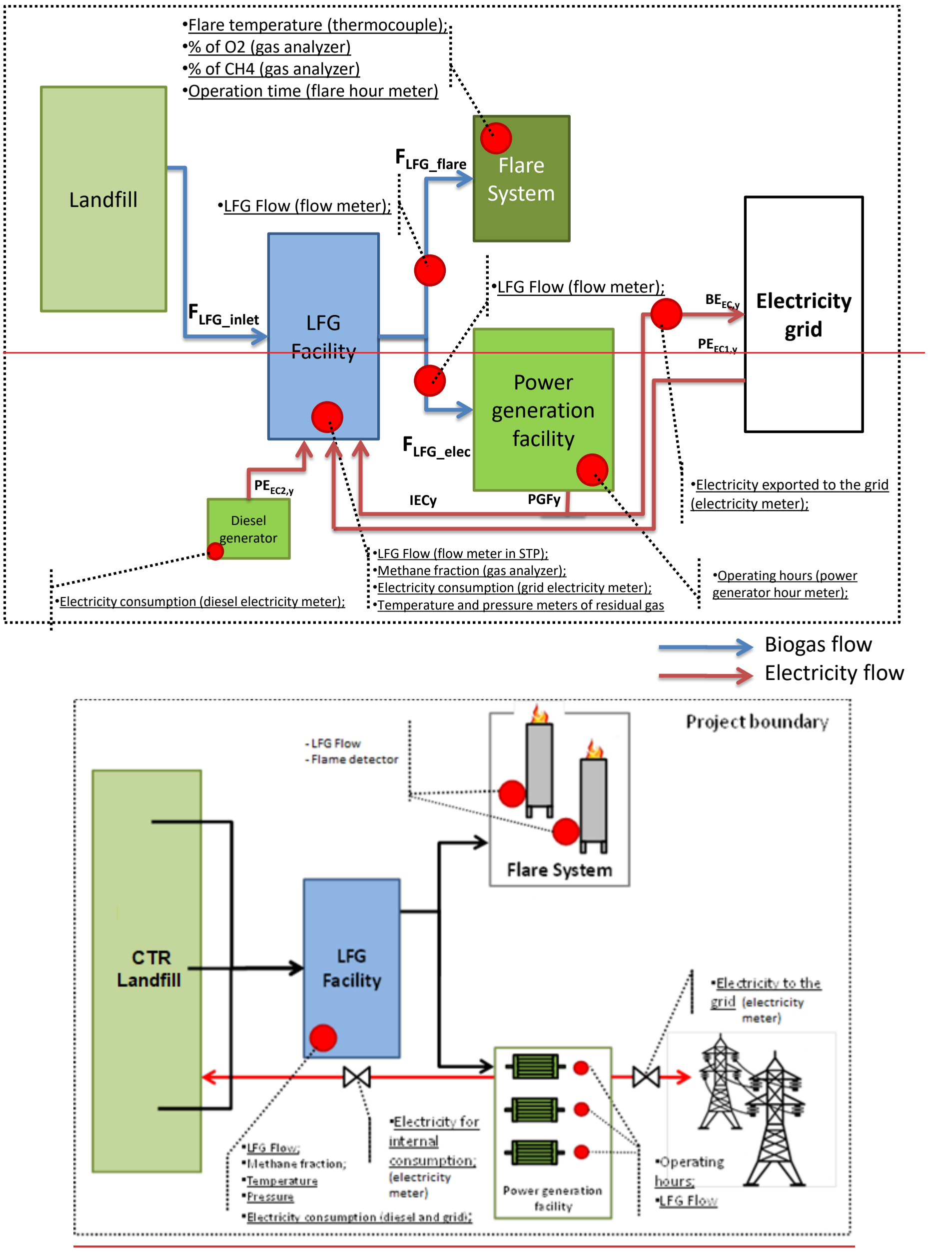

Figure 13~~14~~ - Monitoring ~~equipments~~equipment locations

All continuously measured parameters (LFG flow, ~~LFG~~ CH_4 concentration, flare temperature, flare operating hours, engine operating hours, and engine electrical output) will be recorded electronically via a datalogger, located ~~inside~~within the Site boundary which will have the capability to aggregate and print the collected data ~~in~~at the frequencies ~~range~~as specified above. It will be the ~~Site Operator~~

responsibility of the Site Operator to provide all requested data logs which will be stored duringover the duration of the reporting period at the Site office. The data logs will be summarized into emission reduction calculations prior to each verification. ~~This task will be completed by Project Participant and reported directly to the DOE. These logs will be available to the DOE when requested in order to prove the operational integrity of the Project.~~

~~1. Management Structure~~

1. Introduction and Objectives

The ~~collected~~two primary purposes of the monitoring plan are:

- To collect the necessary system data required for the determination of emissions reductions; and
- To demonstrate successful compliance with established operating and performance criteria to verify the emission reductions and generate the respective CERs.

The operational data that is collected will be used to support the periodic verification report ~~requiring~~that will be required for CER auditing. The ~~herein~~monitoring plan discussed ~~monitoring plan has been~~herein is designed to meet or ~~conservatively~~ exceed the UNFCCC requirements (approved monitoring methodology ACM0001~~ version 13~~).

The ~~monitoring program~~ routine system monitoring program required ~~to determine~~for the determination of the emission reductions is discussed in section 2 below, while the additional system data that is collected to ensure the safe, correct, and efficient operation of the LFG management system is discussed in section 3.

2. ~~The PP will be the operator~~ Training of ~~the~~ monitoring personnel

Before commencement of the O&M phase, project activity will conduct a training and quality control program to ensure that good management practices are carried out and implemented by all project operating personnel in terms of record-keeping, equipment calibration, overall maintenance, and procedures for corrective action. An operation manual will be developed for the operating personnel. The procedures for filing data and calculations to be performed by the LFG utilization operator will be included in a daily log to be placed in the main control room.

~~1.1. Responsibility of the personnel involved~~

~~The personnel involved in the monitoring will be responsible for carrying out the following tasks:~~

- ~~Supervise and verify metering and recording: The staff will internally coordinate with other departments the adequate verification of data metering and recording.~~
- ~~Collection of sales/billing receipts and additional data: The staff will collect sales receipts and additional data such as daily operational reports of project.~~
- ~~Calibration: The staff will internally coordinate to ensure that calibration of the metering instruments will be carried out in accordance with the equipment manufacturers" specifications.~~
- ~~Preparation of monitoring report: The staff will prepare the monitoring report for verification.~~
  ~~- Data Archives: The staff will be responsible for keeping all monitoring data, and making it available to the DOE for the verification of the emission reductions.~~

~~1.2. Installation of meters~~

~~All meters will be installed in order to fulfill the proposed monitoring plan.~~

~~1.~~3. Monitoring Work Program

The LFG monitoring program is a relatively simple, straight forward program designed to collect system operating data required ~~for~~to safely operate the ~~safe~~ system ~~operation~~ and for the verification of CERs. This data ~~is~~will be collected in real time~~,~~ and will provide a continuous ~~recording which can be easily monitored, reviewed~~record that is easy to monitor, review, and ~~validated~~validate.

The following sections will outline and discuss the following key elements of the monitoring program ~~presented below~~:

- ~~LFG~~ Flow measurement;

- LFGGas quality measurements;
- Uncombusted methane;
- ElectricityElectrical Consumption;
- Project electricity output;
- Regulatory requirements;
- Data records; and
- Data assessment and reporting.

1.1.3.1. LFG Flow Measurement

The data will be collected continuously using 3 vortexAccording to ACM0001, depending on necessity, flow meters locatedwill be installed on the piping, straight before the flares.

In order to follow ACM0001, depending on necessity, flow meters will also be installed:

- In the main piping straight after the blowers to measure the total LFG flow extracted from the landfill;
- In the piping before the energy use to measure the LFG flow utilized for energy use.

In case of LFG is sent to consumer through dedicated pipeline, in order to follow ACM0001, flow meter will also be installed in the piping leading to the flare, to the electricity generation plant and the other on the main piping a consumer through dedicated pipeline.

The flow of LFG collected by the system and subsequently utilized, flared or sent to consumer through dedicated pipeline are measured via individual flow measuring the total collected landfill devices suitable for measuring the velocity and volumetric flow of a gas. One common example is an annubar. The monitoring frequency will be flow measurements are taken within the piping itself, and the flow sensors are connected to transmitters that are capable of collecting and sending continuous. data to a recording device such as a datalogger.

The data will be archived for a minimum of two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs laterflow sensors are calibrated according to a specified temperature and composition of the gas, thus the flow actually measured must be corrected to according to actual temperature, pressure, and composition, thus density, of the gas measured. The equipment selected will allow dynamic compensation for these parameters, normalized to a standard temperature, pressure, and gas composition. For reporting purposes, the flows are generally required to be normalized to 0°C and 1.01325 bar at standard gas composition of 50% methane and carbon dioxide each by volume.

The vortex accuracy of a flow meter will be provided with a normalizer unit which normalizesis dependent on the flow rate at standard temperaturedesign of the equipment, and pressure.

the specific type of sensor used, however equipment is available that will provide a minimum accuracy of +/- 2% by volume. The equipment selected for the project activity will utilizesite utilizes a continuous monitoring system as defined in ACM0001, which measures and aggregates flow data approximately once every minute.

1.2.3.2. LFGGas Quality

The two parameters that are most pertinent to the validation of CERs, as well as the safe and efficient operation of the system are the concentration of methane will be measured via and oxygen in the gas stream delivered for utilization or diverted to flaring. These two parameters are measured via a common sample line that runsis ran to the main collection system piping, and is measured in real time. by two separate sensors, one for methane and the other for oxygen, installed as per ACM0001.

Regular calibration of the equipment is especially important, as the accuracy of the methane and oxygen sensors is greatest within the expected range of the gas stream to be measured. Equipment is readily available that will provide an accuracy of at least +/- 1% by volume. The equipment selected

for the site aggregates gas composition compositions approximately once every 1 minute as per the definition of a continuous monitoring system in ACM0001.

Regular calibrations will be made according to manufacturer specification.

1.3.3.3. Uncombusted Methane

The efficiency of the enclosed flareopen flares will be measured per the methodological "Tool to determine Project emissions from flaring gases containing methane".

1.3. Electricity

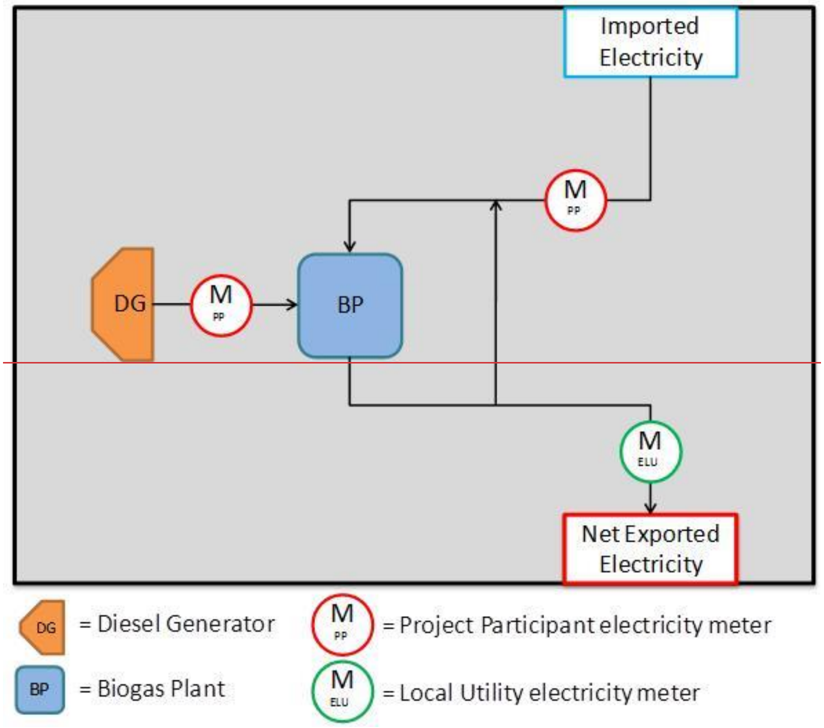

Figure 15 – Electricity Monitoring

~~2.4.1 Electricity for self-consumption~~

3.4. Electrical Consumption

The consumed electricity ~~supplied~~ from the grid by the ~~grid and diesel generators to LFG Plant~~project activity will be continuously measured by electricity meters ~~located in~~for the ~~LFG plant~~grid and diesel generators. The respective data will be electronically recorded.

Monthly electrical bills charged to ~~define~~the project will be monitored and considered as the actual energy consumption for ~~self-consumption due to~~the project ~~activity~~.

~~1.4.~~3.5. Project Electricity Output

The ~~net~~ generated electricity ~~supplied to the grid~~used for the landfill internal consumption (i.e. administration offices, truck garage, recycling plant, leachate pumps), excluding the LFG facility electricity consumption by the project activity[45] will be continuously measured by ~~a Local Electricity Utility (LEU)~~an electricity meter and ~~the~~ respective data will be electronically recorded.

The electricity output crosscheck will be made using monthly electricity invoices. The substation is located into the project activity area. The distance between point of electricity generation and electricity distribution is negligible.

~~1.5.~~3.6. Regulatory Requirements

Regulatory requirements relating to LFG projects will be evaluated annually by investigating municipal, state and national regulations ~~regarding the~~pertaining to LFG. This will be done through consultation with the appropriate regulatory ~~agencies, on-going discussions~~bodies, ongoing discussion with regulators, and monitoring of publications delineating upcoming legislative changes governing landfills and LFG.

~~2.~~4. Data records and storage

Data collected from each of the parameter sensors is transmitted directly to an electronic database~~. Backup of the electronic data will be carried out frequently. Calibration records will be kept for all instrumentation during 2 years after the end of the crediting period.~~ from which the CER volume calculations may be carried out, as described in section 2.1 above. A hard copy backup or reports of the data may be printed as required or recorded in Portable Document Format (PDF). Backup of the electronic data is conducted every minute, as described above.

~~2.1.~~4.1. Data Assessment and Reporting

Assessment of the flow and composition data described above coupled with the operating hours of the engines/flare and engines/flare destruction efficiencies are used to determine the quantity of CERs to be generated. For electricity generation offsets, the appropriate emission factors will be applied.

The destruction efficiency of the flare is a function of the internal combustion temperature and resident holding time, which are generally measured by the flare system controller and recorded for auditing purposes. Extensive technical documentation is available that documents the destructive efficiency of the open flares that will be used, subject to the flow rate and combustion temperature verification. Destruction efficiency will also be assessed periodically through measurement of uncombusted methane emissions.

[45] There will not be claimed CERs for LFG Facility electricity consumption because the electricity consumption is a consequence of the CDM Project.

As The record data will be daily analyzed by the LFG Plant Supervisor. If detected any inconsistency regarding monitoring parameter data, it will be reported in a log-book and the LFG Plant Supervisor along with the LFG Plant Manager will provide corrective actions, according to internal operational procedures.

Daily consolidated data will be sent by the LFG Plant Supervisor to the LFG Plant Manager through electronic reports. The data of the monitored parameters will be storage using internal system network.

discussed in Section 2.1, flow data is normalized to standard temperature, pressure, and composition for reporting purposes. The data will be compiled and assessed to produce the required quantification and validation. The periodic monitoring report will contain the data required for the verification of the CERs. The, and additionally may contain operational data from the collection system and flaring system described below to illustrate that the system is well maintained and operating at peak efficiency. Records of regular maintenance performed will also be a component of the verification reportsannual report.

2 Corrective actions

The staff will log all corrective actions and will report these in the monitoring report. In case when the corrective actions are considered necessary, these actions will be implemented according to internal procedures. The PP will carry out internal audits in order to avoid recording mistakes and to kept the correct operation of the project activity.

3 Procedures for monitoring personnel training

The PP will conduct a training and quality control program to ensure that the good management practices are carried out and implemented by all project operating personnel in terms of record-keeping, equipment calibration, overall maintenance, and procedures for corrective action.

5. Related monitoring and project performance review

Project activity will conduct an additional operational monitoring of the LFG collection system to check the project performance and ensure that the system is being operated both correctly and efficiently. Periodic adjustments to the horizontal trenches and to the extraction wells/drains will be required to optimize the capture and collection systems effectiveness. LFG collection field adjustments will be made based upon a review of the trench and well performance history considered within the context of the overall LFG collection field operation in order to maximize the collection of methane balanced against minimization of any oxygen in the system that could introduce unsafe operating conditions. Monitoring at each trench and extraction well will consist of the following parameters: valve position, individual well/trench flow, individual well/trench vacuum, and composition of the gas collected, i.e., methane, carbon dioxide, and oxygen, using a portable measuring device.

~~3.~~6. Emergency procedures

As a precautionary measure, ~~it will be made regularly backups~~system is plugged to a battery-based uninterruptible power supply (UPS) to avoid data loss due to power ~~outages. The LFG Plant Manager will check daily~~failures. As a backup is produced and stored off-site from the ~~records.~~main recording system, no more than 2 to 3 minutes of data at a time would ever be lost due to a system malfunction.

All data are collected and registered in data log in supervisory system. In addition, ~~an emergency plan~~there will be developed an Emergency Plan including other types of emergencies such as fire and *work accidents.*

~~4.~~7. Calibration

All the measurement instruments will be subject to regular calibration as per manufacturer's specifications~~ or, when applicable, the calibration frequency will be defined by the PP.~~. The regular check and calibration will be made ~~by~~to the operators. The~~ LFG~~ plant Manager will be responsible for checking the equipment's proper working ~~conditions~~order, as well as checking and storing up the calibration certificates and records. Calibration certificates will be kept for all the ~~equipments~~equipment during the crediting period and two years after.

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

>>
~~Project starting date: ~~01/09/2013.

The starting date of the project activity will be the forecast date of purchasing the main equipment (flare) for capture and flare of LFG.

C.2. Expected operational lifetime of project activity

>>
25 years and 0 months

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Renewable (~~first~~3 x 7 years)

C.3.2. Start date of crediting period

>>
The crediting period will start on 01/01/2014 or on the date of the registration of the CDM project activity (whichever is later).

C.3.3. Duration of crediting period

>>
7 years ~~(renewable for two times)~~ and 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
An analysis of the environmental impacts was done for the landfill project aiming:

1. Prevent the pollution of water sources, considering the use of surface and groundwater in region.
2. Provide soil conservation.
3. Minimize air pollution.
4. Ensure welfare of entrepreneurs and neighbourhood.
5. Minimize impacts to flora and fauna of the region.

For the construction and operation of the landfill gas project, the applicable laws were followed:

- Law 6.938/1991 (National Environmental Policy)
- Law 9.605/1998 (Environmental Crimes).
- Law 4.771/1965 (Forestry Code)
- Law 9.985/2000 (National System of Nature Conservation Units - SNUC, criteria and standards for creation, implantation and management of conservation areas, including those ones related to Environmental Protection Areas – EPA, Areas of Ecologic Interests (*Áreas de Relevante Interesse Ecológico -ARIEs*), Private Reserves of Nature Heritage (*Reservas Particulares de Patrimônio Natural - RPPN*).
- CONAMA Resolution 302 and 303/2002 (Permanent Protection Areas – APP).
- CONAMA Resolution 001/86 (Environmental Impact Assessment)
- CONAMA Resolution 396/2008 (Groundwater legislation)

According to Brazilian legislation mentioned above is required an environmental impact assessment to the landfill implementation. As the project boundary includes the landfill, an environmental impact assessment (EIA) of the landfill implementation was carried out and the possible environmental impacts were analysed by the *Secretaria de Estado do Meio Ambiente e Recursos Naturais – SEMA* (responsible agency to issue environmental licences in Maranhão State). The landfill implementation has satisfied all the requirements and the CTR Rosario landfill received from SEMA the ~~Installation~~Operation License nº ~~225/2011~~1049272/2018 process number nº 171800/2017 - dated of ~~11/10/2011~~06/04/2018 valid up to ~~11/10/2012~~06/04/2022. A summary of the environmental impacts and mitigation measures are explained in the section D.2.

There will be no transboundary impacts resulting from this project activity. All the relevant impacts will occur within Brazilian borders and have been mitigated to comply with the environmental requirements for project's implementation.

D.2. Environmental impact assessment

>>
As mentioned previously an environmental impact assessment was developed by the project participant and analysed by SEMA, thus CTR Rosario landfill has obtained ~~Installation~~Operation License.

A summary of the environmental impacts and mitigation measures are explained in the Table 9~~Table 16~~ and in the Table 10~~Table 17~~ are showed the positive impacts due to the implementation of the landfill.

Table ~~9~~16 - Environmental Impacts and mitigation measures

IMPACT	POTENCIAL FACTOR	MITIGATION MEASURES
Atmospheric Pollution	• Dust emission from civil works. • Gas emissions from fossil combustion of vehicles and equipments. • Odour and biogas emissions from landfill.	• Wetting, calculated explosions for lower emissions of dust and vegetation surround. • Maintenance of vehicles and equipments. • Vegetation surround, drainage of leachate, daily coverage of waste, deodorizer, maintenance of ~~waste water~~wastewater treatment plant (WWTP) and biogas drainage and flare using passive capture system.
Superficial and ground water pollution.	• Leachate generation. • Wastewater emissions containing oil and grease. • Ground leachate generation. • Runoff water with particulate material.	• Subsurface drainage and treatment at the WWTP. • Oil/water separator - API and treatment at the WWTP. • Waterproofing with geomembrane and drainage • Sand separator before discharged into the rivers or natural drainage.
Erosion Soil destabilization. Siltation of water bodies Soil impermeabilization.	• Installation of construction site and access roads • Cut and filling of soil. • Leaching of soils. • Pile formation	• Rainwater drainage • Pluvial drainage, reutilization of soil and revegetation. • Preservation of coverage, dike and reutilization of soils. • Specific criteria for operation and infiltration basins.
Noise Pollution	• Noise emissions from civil works, vehicular traffic and equipments.	• Vegetation surround and calculated explosions for lower noise emissions, signalization and planning schedules. • Maintenance of vehicles and equipments.
Sanitary risks	• Vectors (insects, rats) proliferation	• Daily coverage of waste
Traffic alteration and risk of accidents.	• Increase of vehicular traffic. • Waste transport.	• Improvement of access via, signalization and paving. • Construction of alternatives via, maintenance of vehicles and training of drivers.
Suppression of vegetation and loss of natural habitat of fauna Landscape reconfiguration and landscape alteration	• Installation of construction site and access roads •	• Specific criteria in deforestation operations and programs of reforestation and fauna conservation • Planning of vegetation removal, replanting of forest and heterogeneous reforestation
Global environmental collapse	• Destabilization of landfill with rupture.	• Proper design project, rigorous execution and geotechnical monitoring

Table ~~10~~17 - Positive Impacts

IMPACT	POTENCIAL FACTOR	MITIGATION MEASURES
Traffic of vehicles improvement	• Implantation and improvement of access via	• Positive impact
Increase of per capita income and stimulation of economy in the region. Increase of tax revenues	• Generation of direct and indirect jobs using local labor. • Purchase of materials and services in the region.	• Positive impact
Organization of use and occupation of land.	• Regular use and occupation of land, avoiding situations of invasion and disordered occupation.	• Positive impact

Moreover, it was developed a global plan of environmental management to verify and monitor in the proper frequency, the effective implantation of mitigation measures proposed.

The global plan consists of the following specifics monitoring programs:

- Program of environmental control of works.
- Program of environmental management of construction site
- Program of manpower training
- Program of communication and social participation
- Program of environmental education
- Archeological monitoring program
- Program of rescue and preservation of cultural heritage
- Program of environmental compensation
- Program of degraded areas recuperation
- Program of signalization, control and prevention of accidents
- Monitoring program of noise
- Monitoring program of landfill stability (Geotechnical)
- Monitoring program of flora and fauna
- Monitoring program of environmental-society conditions.
- Drainage and erosion control systems
- Emergency plan of CTR Rosario
- Closure plan for the CTR Rosario

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

According to the Resolutions Number 1[46], 4[47] and 7[48] of the Brazilian Designed National Authority (CIMGC – Comissão Interministerial de Mudança Global do Clima / *Interministerial Commission on Global Climate Change*), project participants shall send letters to local stakeholders 15 days before the start of the validation period, in order to receive comments. It includes:

- Name and type of the activity project;
- PDD (translated to Portuguese), made available through a website;
- Description of the project's contribution to the sustainable development, also made available through a website.

The link for PDD translated to Portuguese and project contributions to the sustainable development is http://www.econergy.com.br/Vital/RosarioDCPLSP.pdf

Letters were sent on 18/05/2012 to the following stakeholders involved and affected by the project activity:

- *Prefeitura municipal de Rosario* / Municipal Administration of *Rosario*;
- *Câmara dos vereadores de Rosario* / Legislation Chamber of *Rosario*;
- *Secretaria Municipal de Meio Ambiente de Rosario* / Municipal Secretary Environmental of *Rosario* City;
- Secretaria Estadual do Meio Ambiente do Maranhão / Secretary of Environmental of Maranhão State;

[46] http://www.mct.gov.br/upd_blob/0002/2736.pdf (Art. 3º, II)

[47] http://www.mct.gov.br/upd_blob/0011/11780.pdf (Artº 5°, unique paragraph)

[48] http://www.mct.gov.br/upd_blob/0023/23744.pdf, accessed on July 21st, 2008.

- *Fórum Brasileiro das Organizações Não Governamentais e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento - FBOMS* / Brazilian Forum of Non-Governmental Organizations and Social Movements for Environment and Development;
- *Ministério Público do Estado do Maranhão* / *Maranhão* -Pr*osecutor's Office;*
- *Ministério Público Federal* / Federal Prosecutor's Office.
- Local associations;
    - ONG LIBERTAS
    - SOMADENA – Sociedade Maranhense de Defesa a Natureza
    - Sindicato dos Trabalhadores e Trabalhadoras Rurais Rosario – MA

E.2. Summary of comments received

>>
No comments were received.

E.3. Consideration of comments received

>>
No comments were received.

Not applicable

SECTION F. Approval and authorization

>>
TheIn 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", the project participant has already obtained a letter of approval (LoA) from the Party is nothost 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 09/11/2012). 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	Vital Engenharia Ambiental S.A.
Country	Brazil
Address	Rua Santa Luzia, 651, 21º andar – Centro – Rio de Janeiro
Telephone	+55 (21) 2131-7204
Fax	-
E-mail	neiber.silva@vitalambiental.com.br
Website	http://www.vitalambiental.com.br/
Contact person	Mr. Neiber Rodrigues Da Silva

Appendix 2. Affirmation regarding public funding

Not applicable. There is no public funding involved in the project activity.

Appendix 3. Applicability of methodologies and standardized baselines

All the information about the applicability of selected methodology is described in Section B.2. above.

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

~~The baseline study and monitoring methodology was developed by:~~

~~Econergy Brasil Ltda, São Paulo, Brazil~~
~~Telephone: +55 (11) 3555-5700~~
~~Contact person: Mr. Francisco do Espirito Santo Filho~~
~~Email: francisco.santo@econergy.com.br~~

~~Econergy Brasil Ltda is not a Project Participant.~~

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 ~~emission reductions~~baseline scenario.

~~**Table 18 - Key financial parameters**~~

1. Key Parameters

~~Year landfilling~~Landfill operations ~~started~~start	2013
Projected year for landfill closure - estimated based on current filling rate	2033
GWP for methane ~~-~~(UNFCCC and Kyoto Protocol decisions)[49]	~~21~~25
Methane concentration in LFG (% by volume) ~~—~~typical assumption for baseline scenario	50
LFG collection efficiency (%)	65
Flare efficiencies (%) operational data from flare manufacturer	50%
~~Unit price of electricity sold~~Electricity consumption from the grid due to the ~~grid (R$/~~project activity (MWh~~)~~/year)	~~102.18~~0
Combined margin emission factor for electricity displacement (tCO_2/MWh) calculated based on the ~~"~~Tool to calculate the emission factor for an electricity system~~"~~.	0.~~1988~~3380
Installed capacity of Power Plant (MW) – End of 1st CP	~~5.7~~3.000
Load factor ~~(%)~~	90.00
~~Price per MW installed (kR$/MWe)~~	~~2,394.36~~
~~O&M costs (R$/MWh)~~	~~46.93~~
Operational lifetime of the project activity (years)	25
~~LFG destruction rate~~Adjustment Factor (AF)	20%

49 In opposite of the PDD registered on 26 Feb 13 using GWP of 21, it has been updated to 25

~~1.~~2. Waste disposal ~~and composition~~

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

~~Table 19 - Forecast amount of waste disposal in project activity~~

~~The waste composition will consist of:~~

Year	Waste disposal (tonnes/yr)
2013	436,800
2014	436,800
2015	436,800
2016	436,800
2017	436,800
2018	436,800
2019	436,800
2020	436,800
2021	436,800
2022	436,800
2023	436,800
2024	436,800
2025	436,800
2026	436,800
2027	436,800
2028	436,800
2029	436,800
2030	436,800
2031	436,800
2032	436,800
2033	436,800

~~Composition of the waste~~	~~%~~
~~A) Wood and wood products~~	~~29.40~~
~~B) Pulp, paper and cardboard (other than sludge)~~	~~6.40~~
~~C) Food, food waste, beverages and tobacco (other than sludge)~~	~~29.40~~
~~D) Textiles~~	~~0.00~~
~~E) Garden, yard and park waste~~	~~0.00~~
~~F) Glass, plastic, metal, other inert waste~~	~~34.80~~
~~TOTAL~~	~~100.0~~

Formatado: Justificado

2.3. 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[50].

Combined Margin Emission Factor 2011 (tCO_2/MWh)		
1st crediting Period		0.1988
Build Margin - 2011		0.1056
Operating Margin 2011	0.2621	0.2111
	0.2876	0.2798
	0.2076	0.2428
	0.1977	0.2379
	0.2698	0.3405
	0.341	0.4809
	0.3076	0.4347
	0.3009	0.6848
	0.2734	0.7306
	0.3498	0.732
	0.3565	0.7341
	0.3495	0.6348
	0.2920	0.4787

Source: Brazilian DNA[51]

[50] https://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html, accessed on 30/10/2019.

[51] Emission factor from Brazilian DNA: http://www.mct.gov.br/index.php/content/view/333605.html#ancora, accessed on 06/07/2012.

Combined Margin Emission Factor 2018 (tCO_2/MWh) [8]		
1st crediting Period		0.3380
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 5. Further background information on monitoring plan

All the information about the monitoring plan were described in section B.7.1 and B.7.3

Appendix 6. Summary report of comments received from local stakeholders

~~No comments were received.~~
Presented in section E.2.

Appendix 7. Summary of post-registration changes

~~It was left blank intentionally.~~
A summary of the Permanent Changes of the post registration changes is presented below:

All Post Registration Changes are applicable to the applied methodologies, in compliance with the monitoring plan. The level of accuracy and completeness in the monitoring of the project activity is in line with the requirements contained in the registered monitoring plan. Changes did not affected the project activity additionality or scale.

Permanent changes to project design:

a. By voluntary update of the applied methodology version, ACM0001 v19.0. All applicable tools, emission reductions calculations and parameters inclusion related to the applied methodology have been updated accordingly.
b. Change in the electricity generation plant installed capacity estimation from 5.7 MW to 3 MW. The investments into the electricity generators were not under the PP's control. Emission reductions calculations were updated according to the new installed capacity.

c. Change in the electricity generation plant installed capacity currently installed from 4.3 MW to 2 MW. The investments into the electricity generators were not under the PP's control.
d. Change in flare design from enclosed flare to open flare.
e. Change in the value of technical transmission and distribution losses ($TDL_{k,y}$) from 16% to 20%, as being the default value from TOOL05.

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Document information

Version	*Date*	*Description*
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.

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