Project design document form
(Version 11.0)

BASIC INFORMATION	
Title of the project activity	Macaúbas Landfill Gas Project
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	11
Completion date of the PDD	04/09/2020
Project participants	Vital Engenharia Ambiental S.A.
Host Party	Brazil
Applied methodologies and standardized baselines	ACM0001: Flaring or use of landfill gas, version 19.0;
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	445,100 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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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 Macaúbas*" (hereinafter referred to as *CTR Macaúbas*) located in the municipality of Sabará in the state of Minas Gerais, Brazil.

The project activity will result in greenhouse gas (GHG) emission reduction from the CTR Macaúbas 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.

Prior to the implementation of the project activity the scenario for LFG destruction is the partial release to atmosphere through the exiting LFG passive capture system and partial LFG combustion in open flares. 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 445,100 tCO_2e;
- Total GHG emission reduction is 3,115,703 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 installed generation capacity will be expected to change during the lifetime of the project, totalizing at the end 9.982 MW.

The project will be to construct an efficient capture, collection and flaring system to burn CH_4 (a greenhouse gas), and this will reduce odours and adverse environmental impacts. Moreover, it will install generators that will combust the LFG to produce electricity, using part of the electricity for self-consumption and the other part will be exported to the grid. The flares will be 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 9.982 MW upon project completion.

The LFG capture and collection systems and flaring station will consist 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 comprised of LFG engine generator sets of high performance standards. The engine-generator sets will be the primary equipment to combust the collected LFG once they are installed. A fraction of the collected LFG will be diverted to flares, which will be used to combust any gas in excess of the fuel demand for the engines, as well as a contingency backup.

In order to guarantee an efficient LFG capture and maximum quality, compaction and sanitary coverage of waste are carried out daily as well as connection of vertical drains. When operationally feasible, LFG is captured from the drains near to the waste discharge front and the quality of LFG

[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.

flow is monitored. Also, continuous adjustments are carried out for the collection drains and the field is monitoring by specialized consultants.

The landfill began its operation in November 2005, receiving solid waste (type Class II-A Inert and Class II-B Non-inert)[2], according to License of Operation nº 145, dated of 30/05/2011 valid up to 30/05/2017. The License Operation was issued by COPAM (environmental agency of Minas Gerais State) and all requirements established by COPAM were fulfilling, including technical report and environmental constraints. Since the landfill has already initiated its operational licensing renewal process, a declaration nº 0035998/2019 issued by Environmental and Sustainable Development Secretary from Minas Gerais Government State on 22/01/2019, states that License of Operation nº 145 validity is postponed until the moment the operational license renewal.

For the electricity generation plant, a simplified environmental license was issued by SEMAD (environmental and sustainable development secretary of Minas Gerais State) on 14/10/2019[3] and valid until 14/10/2029.

CTR Macaúbas also counts on a code of ethics an implemented compliance system and policies.

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 Macaúbas 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

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Host Party:
Brazil

Region/State/Province:
Minas Gerais

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

[3] Source SEMAD : http://sistemas.meioambiente.mg.gov.br/licenciamento/uploads/FNSahoUQUXQhJCvcL0T1A4kkR4RMxWP9.pdf

<u>City/Town/Community:</u>
Sabará

<u>Physical/Geographical location:</u>
CTR Macaúbas is located at Rodovia MG-05, Km 8, 1-Parte, Sabará (city), Minas Gerais (State), Brazil.

Geo-coordinates: Latitude: 19° 51’ 23” S and Longitude: 43° 50’ 40” W
Decimal coordinates: Latitude: -19.856389° Longitude: -43.844444°

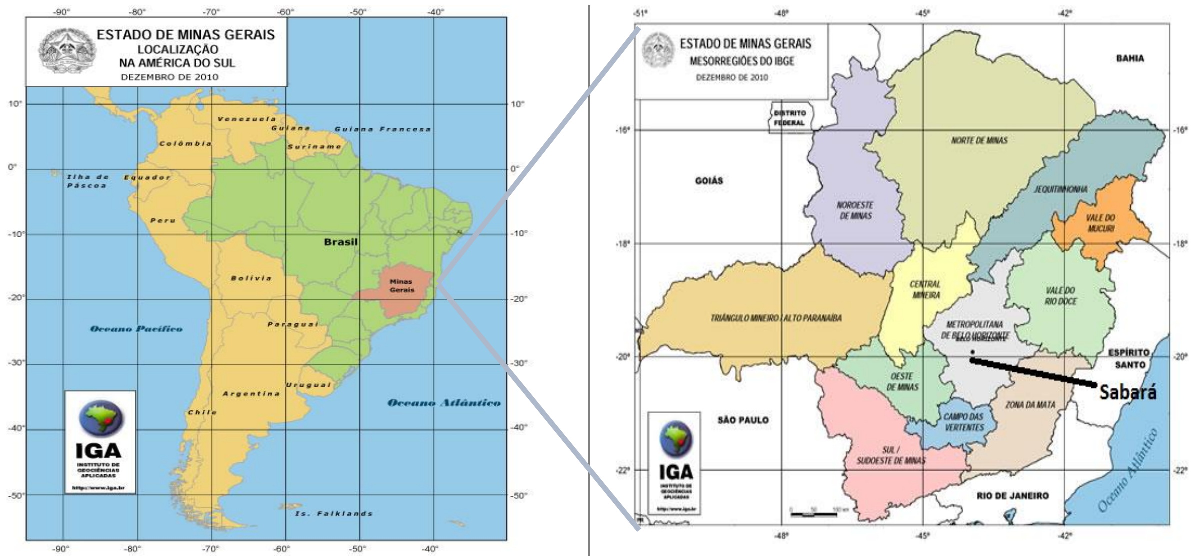

Figure 1 - Geographical position of Sabará city, inside of Minas Gerais State in Brazil

(Source: Minas Gerais State website)

Figure 2 – CTR Macaúbas Landfill

(Source: CTR Macaúbas)

A.3. Technologies/measures

>>
The landfill is 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.

Figure 3 – Collection system (manifolds)

(Source: CTR Macaúbas)

CTR Macaúbas 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 4 - Example of collection system (well head)

(Source: CTR Macaúbas)

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 5 - Transport system

(Source: CTR Macaúbas)

Blower System

The blower 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 4,000 to 7,000 Nm^3/h per each blower and the installed capacity around 75 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 6 - Example of blower system

(Source: CTR Macaúbas)

Flare System

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

The flare operational flow may range between 2,000 to 10,000 Nm^3/h depending on the manufacturer and design that will be chosen in the purchasing moment. The standard combustion temperature is around 850º C.

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:

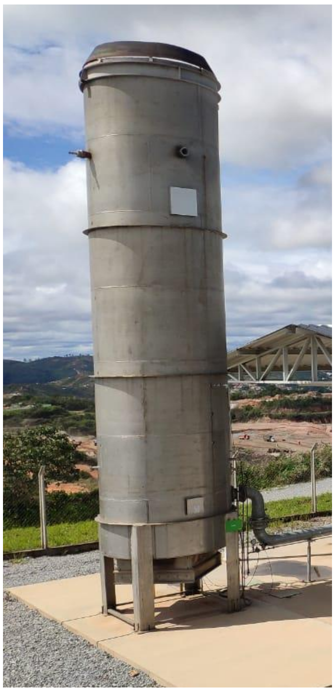

Figure 7 - Detail of flare system (enclosed flare)

(Source: CTR Macaúbas)

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 - Example of a flare system

(Source: CTR Macaúbas)

The biogas station will have, even a system of destruction of methane through flares. This system will be composed initially by 1 enclosure flare and can get others 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 9.982 MW. The electricity generated by the project will be supplied to the grid.

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[4]" 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.

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[4] 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.

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.

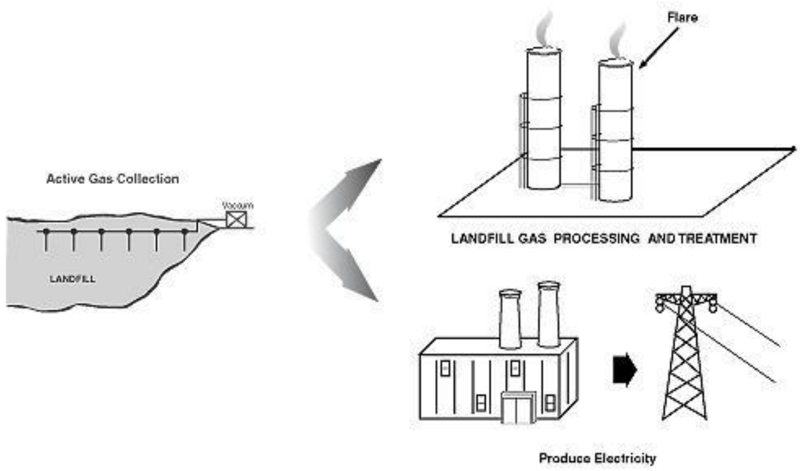

Figure 9 – Power generation diagram

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

Table 1 - Electricity generation

Year	Number of engines installed (unit)	Installed capacity (MW)*	Net electricity generated in the plant (MWh)
2020	7	9.982	32,898
2021	7	9.982	78,698
2022	7	9.982	78,698
2023	7	9.982	78,698
2024	7	9.982	78,698
2025	7	9.982	78,698
2026	7	9.982	78,698
2027	7	9.982	45,494

*The installed capacity for each group generator is 1.426MW.

The lifetime of the equipment is 25 years and it was based on "Tool to determine the remaining lifetime of equipment – Option (c) Default Values" (Electric Generators, air cooled) [5]. The equipment that will be installed in the project site will be all new.

The only equipment 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.

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

The load factor is 90% based on manufacturer's specification[6].

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 equipment and their location in the systems along with the balance of the system are presented below:

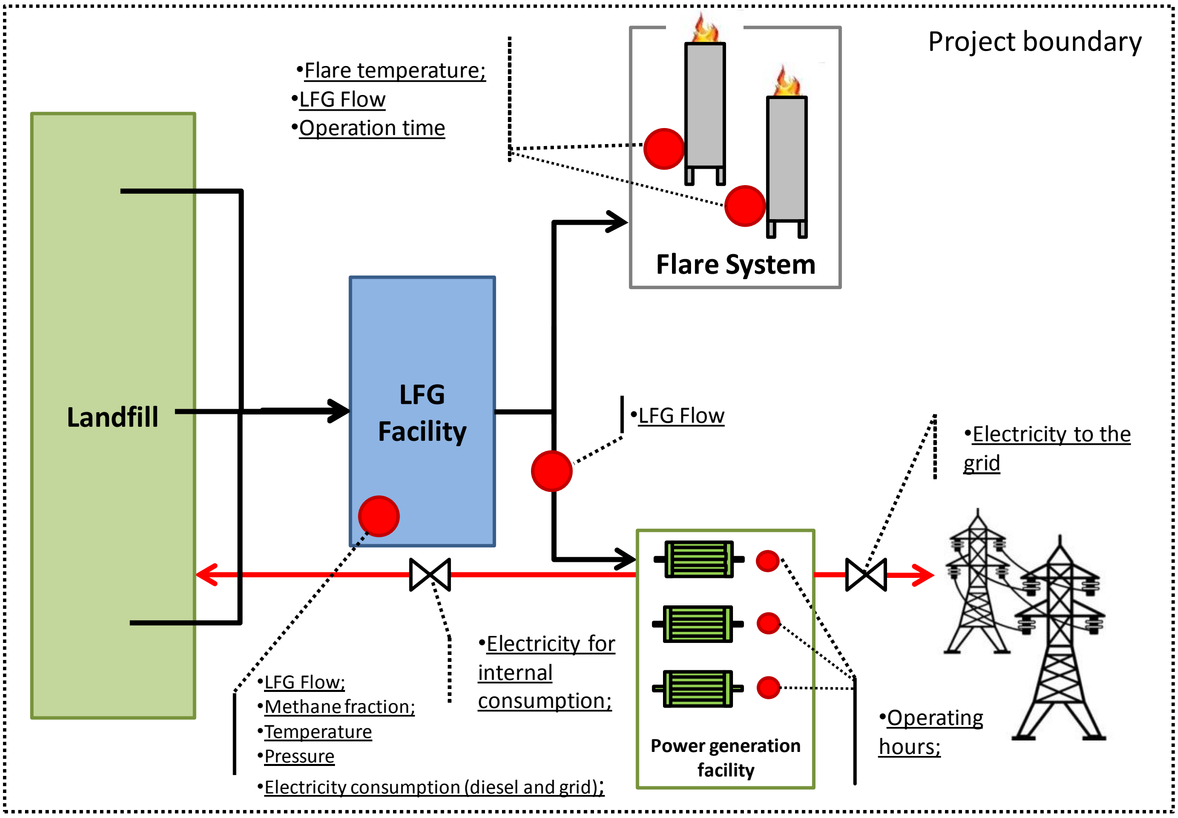

Figure 10 - Technologies and measures of the project activity

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)	No

CTR Macaúbas belongs to Vital Engenharia Ambiental S.A. a company specialized in waste treatment and disposal.

[6] The document was made available to DOE in validation visit.

A.5. Public funding of project activity

>>
There is no public funding involved in the project activity.

A.6. History of project activity

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

A.7. Debundling

>>
Not applicable.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

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- Large-scale Consolidated Methodology ACM0001: “Flaring or use of landfill gas” (Version 19.0)[7];
- TOOL02 Methodological tool: “Combined tool to identify the baseline scenario and demonstrate additionality” (Version 07.0)[8];
- TOOL03 Methodological tool: “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 03.0)[9].
- TOOL04 Methodological tool: “Emissions from solid waste disposal sites” (Version 08.0)[10];
- TOOL05 Methodological tool: “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0)[11];
- TOOL06 Methodological tool: “Project emissions from flaring” (Version 03.0)[12];
- TOOL07 Methodological tool: “Tool to calculate the emission factor for an electricity system” (Version 07.0)[13];
- TOOL08 Methodological tool: “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0)[14];
- TOOL09 Methodological tool: “Determining the baseline efficiency of thermal or electric energy generation systems” (Version 02.0)[15];

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7 https://cdm.unfccc.int/methodologies/DB/JPYB4DYQUXQPZLBDVPHA87479EMY9M

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

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

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

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

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

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

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

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

- TOOL10 Methodological Tool: "Tool to determine the remaining lifetime of equipment" (Version 01)[16];
- TOOL11 Methodological Tool: "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period" (Version 03.0.1)[17];
- TOOL12 Methodological tool: "Project and leakage emissions from transportation of freight" (Version 01.1.0)[18];
- TOOL32 Methodological tool: "Positive lists of technologies" (Version 02.0)[19]

B.2. Applicability of methodologies and standardized baselines

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

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

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

"...

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

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

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

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

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

(i) *Generating electricity;*

(ii) *Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace;*[20] *and/or*

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

(iv) *Supplying compressed/liquefied LFG to consumers using trucks;*[21]

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

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

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

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

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

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

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

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

Justification: - Part 1

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

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

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

"...

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

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

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

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

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

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

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

This methodology is not applicable:

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

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

..."

Justification: - Part 2

According to Section B.4 and B.5, the methodology is applicable because:

- The most plausible baseline scenario is released the LFG to atmosphere from the SWDS, and;

- The electricity would be generated in the grid.

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

The 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.

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

The "Positive lists of technologies" is **not applicable** to the project activity since the LFG is not exclusively used to generate electricity but also to supply external consumers through a dedicated pipeline.

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

>>

	Source	GHG	Included?	Justification/Explanation
Baseline	Emissions from decomposition of waste at the SWDS site	CH_4	Yes	The major source of emissions in the baseline.
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from SWDS. This is conservative.
		CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted since the CO_2 is also released under the project activity.
	Emissions from electricity generation	CO_2	Yes	Major emission source if power generation is included in the project activity.
		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 no heat generation.
		CH_4	No	There is no heat generation.
		N_2O	No	There is no heat generation.
	Emissions from the use of natural gas	CO_2	No	There is no use of natural gas.
		CH_4	No	There is no use of natural gas.
		N_2O	No	There is no use of natural gas.
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 activity
		CH_4	No	There is no fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity
		N_2O	No	There is no fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity
	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:

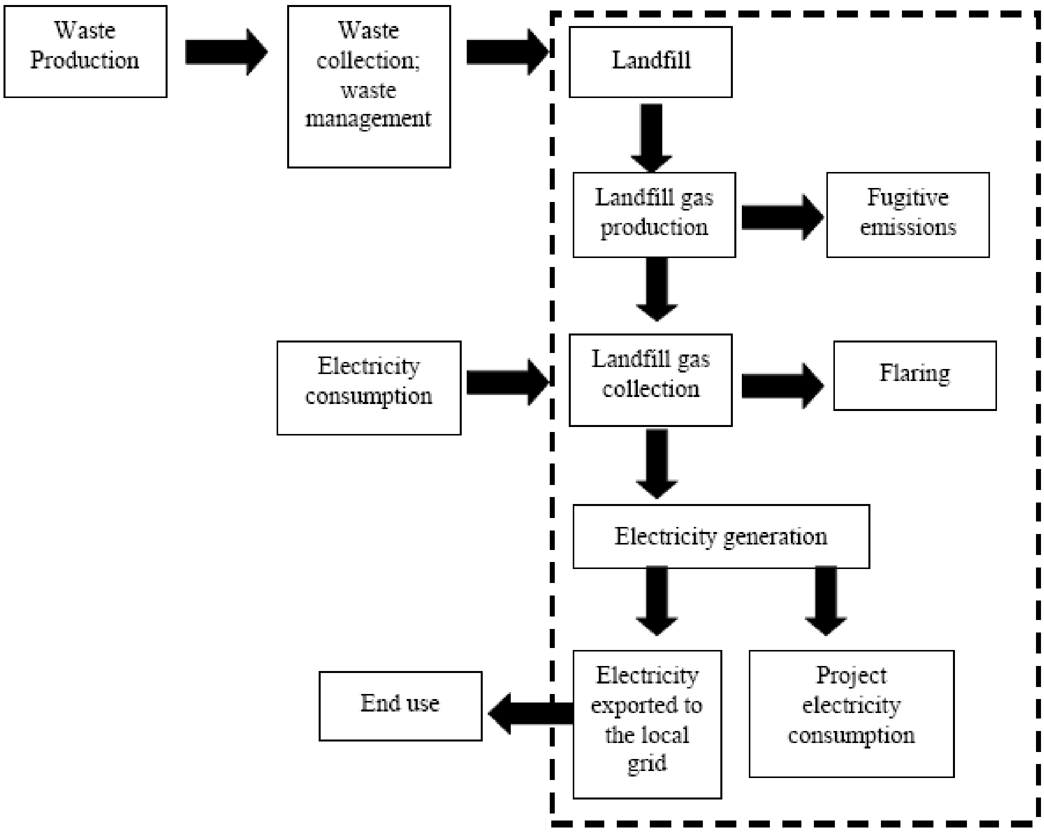

Figure 11 – Flow diagram project boundary

B.4. Establishment and description of baseline scenario

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

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

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

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

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

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

Prior to the implementation of the project activity the landfill gas was released to atmosphere and electricity was generated in existing and/or new grid-connected power plants, other than the project activity power plant.

Thus the baseline remains the same as defined in the 1st crediting period and required regulations.

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

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

At the start of the project activity in 2004, the Brazilian legislation did not require landfills to capture and/or flare and/or use the LFG. After the registration of the project activity in 29/09/2011, the project participant, in order to assess if the current baseline complies with all relevant mandatory national and/or sectorial policies which have come into effect after the submission of the project activity for validation, has verified that the current baseline complies with all applicable laws and regulations.

Brazil's New National Solid Waste Policy (NSWP),[22] 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[23].

By analysing the LFG electricity generation plant operational license N° 1231079/2016, issued in 26/10/2016 and valid up to 26/10/2020 it is possible to notice that LFG use is permitted by legislation. Also, there is an authorization issued by the National Electricity Agency (ANEEL) permitting the electricity generation at the landfill.

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

Step 1.2: Assess the impact of circumstances

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

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

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

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

This sub-step is not applicable since the baseline scenario of the project activity is the business as usual (BAU) scenario (passive venting system).
Also, in the baseline scenario, electricity is being generated in existing and/or new grid-connected power plants, other than the project activity power plant.

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

According to the “Tool to assess the validity of the original/current baseline and to update the baseline at the renewal of a crediting period”, where any data and parameter used and not monitored during the crediting period are not valid anymore they should be updated following the Step 2 as follows:

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

Step 2.1: Update the current baseline

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

Step 2.2: Update the data and parameters

All parameters regarding the grid emission factor calculation have been updated for the 2nd crediting period ($EF_{grid,OM,y}$ is ex post monitored, $EF_{grid,BM,y}$ is ex-ante monitored and thus $EF_{grid,CM,y}$ is ex post monitored).

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”.

B.5. Demonstration of additionality

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It is crucial to consider that the simplified procedure to identify the baseline scenario and demonstrate additionality of ACM0001 remains being considered for the crediting period for the project activity. According to TOOL32 Methodological tool: “Positive lists of technologies”, the additionality of the project activities and PoAs is demonstrated as follows:

“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;
(c) The LFG is flared.

Taking into account simplified procedure to identify the baseline scenario and demonstrate additionality of ACM0001, the project activity is thus automatically/directly assumed as additional since types a) and c) mentioned above applies for this project activity.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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Baseline emission calculation

The baseline emission was calculated according to the following formula:

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

Where:

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

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

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

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

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

Where:

$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year y (tCO2e/yr)
OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

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

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

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

Where:

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

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

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

$F_{CH4,EL,y}$ are 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:

(c) 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;

(d) CH_4 is the greenhouse gas for which the mass flow should be determined;

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

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

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

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

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

Where:

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

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

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

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

  And

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

Option A

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

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

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

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

With

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

Where:
$F_{i,t}$ = Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$ = Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$ = Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m^3 gas *i*/m^3 dry gas)
$\rho_{i,t}$ = Density of greenhouse gas i in the gaseous stream in time interval *t* (kg gas *i*/m^3 gas *i*)
P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i = Molecular mass of greenhouse gas *i* (kg/kmol)
R_u = Universal ideal gases constant (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[24].

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

[24] 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).

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

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

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

To determine the project emissions from flaring gases was used the tool “Project emissions from flaring”. The project emissions calculation procedure is given in the following steps:

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

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

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

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

The following requirements apply:

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

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

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

Step 2: Determination of flare efficiency

Enclosed flare

In the case of enclosed flares, 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.

The project participant has chosen Option A.

Option A: Default value

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

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

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

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

For 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%.

Step 3: Calculation of project emissions from flaring

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

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

Where:

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

Table 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[25]	tCO_2/tCH_4
$\rho_{CH4,n}$	Density of methane at reference conditions	0.716	kg/m^3

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

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

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

Where:

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

$F_{CH4,PJ,y}$	=	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:

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

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
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** 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

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

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

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

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

Where:

$BE_{EC,y}$	=	Baseline emissions from electricity generation in year *y* (tCO_2/yr)
$EC_{BL,k,y} = EG_{PJ,y}$	=	Net amount of electricity generated using LFG in year y (MWh/yr)
$EF_{EL,k,y}$[26]	=	Emission factor for electricity generation for source *k* in year *y* (tCO_2/MWh)
$TDL_{k,y}$	=	Average technical transmission and distribution losses for providing electricity to source *k* in year *y*.

Emission Factor calculation

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

Step 1. Identify the relevant electric power system

For the purpose of determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without signification transmission constraints.

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

The Brazilian DNA published an official delineation of the project electricity system in Brazil, considering a national interconnected system.[27]

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)
h	=	hours in year y in which the project activity is displacing grid electricity
y	=	Year in **w**hich the project activity is displacing grid electricity

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

[27] DNA Resolution n°8 was published on 26/05/2008 on http://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 16/03/2020.

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

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

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

In terms of vintage of data, project participants can choose between one of the following two options:

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

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

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

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

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

Where:

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

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

$EF_{grid,BM,2018}$[28] = 0.1370 tCO_2/MWh

Step 6. Calculate the combined margin emissions factor

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

[28] According to STEP 5, option 1 of Tool to calculate the emission factor for an electricity system

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

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

$$EF_{2018} = (0.5390 \times 0.25) + (0.1370 \times 0.75) = 0.2375 \ tCO_2/MWh$$[29]

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

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)

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

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

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

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

Thus,

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

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

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

[29] The source of the data is from Brazilian DNA. The link is http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html, accessed on 23/03/2020.

Option A1: Calculate the combined margin emission factor of the applicable electricity system, using the procedures of the "Tool to calculate the emission factor for an electricity system" ($EF_{EL,j/k/l,y} = EF_{grid,CM,y}$).

Thus, the project emission is calculated as following:

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

Where:

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

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);

B.6.2. Data and parameters fixed ex ante

Data / Parameter	$EF_{grid,BM,y}$
Unit	tCO2 /MWh
Description	Build margin emission factor of the Brazilian grid
Source of data	Calculations based on parameters described above.
Value(s) applied	0.1370
Choice of data or Measurement methods and procedures	The build margin emission factor has been defined by the Brazilian DNA
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	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	25 Updated for the 2nd commitment period according to COP/MOP decisions[30]
Choice of data or measurement methods and procedures	Default value used, according to IPCC Fourth Assessment Report: Climate Change 2007, item 2.10.2: Direct Global Warming Potentials, Table 2.14
Purpose of data	Calculation of baseline emission
Additional comment	In opposite of the PDD registered on 31/07/2013 using GWP of 21, it has been updated to 25.

Data / Parameter	Waste composition
Unit	%
Description	Waste composition
Source of data	landfill internal studies
Value(s) applied	see table below
Choice of data or Measurement methods and procedures	Internal Report

Composition of waste	
A) Wood and wood products	0.38%
B) Pulp, paper and cardboard (other than sludge)	11.72%
C) Food, food waste, beverages and tobacco (other than sludge)	52.23%
D) Textiles	0.77%
E) Garden, yard and park waste	0.00%
F) Glass, plastic, metal, other inert waste	34.90%
TOTAL	**100.00%**

[30] 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.

Purpose of data	Calculation of baseline emission
Additional comment	Used for projection of methane avoidance

Data / Parameter	R_u
Unit	Pa.m³/kmol.K
Description	Universal ideal gas constant
Source of data	Methodological tool “Project emissions from flaring”
Value(s) applied	8,314
Choice of data or Measurement methods and procedures	Default value used, according to Methodological tool “Project emissions from flaring”, table 1: Constants used in equations
Purpose of data	Calculation of baseline emission
Additional comment	-

Data / Parameter	$SPEC_{flare}$
Unit	Temperature - °C Flow rate - Nm³/h Maintenance schedule - number of days
Description	Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule
Source of data	Flare Manufacturer
Value(s) applied	According to “Choice of data or Measurement methods and procedures” below
Choice of data or Measurement methods and procedures	**Enclosed flares** There is no control of minimum and maximum temperatures, only the detection of the flame. The methods and procedures will be manufacturer manual/recommendation. According to manufacturer manual/recommendation.

Flare model	2500 HT
Minimum flare temperature	850 ºC
Maximum flare temperature	1200 ºC
Minimum and maximum inlet flow rate	Minimum flow: 500 Nm³/h * --- Maximum flow: 2,500 Nm³/h
Maximum duration in days between	7 days[31]

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

	maintenance events	
Purpose of data	Calculation of project emissions	
Additional comment		

Data/Parameter	η_{PJ}
Data unit	Dimensionless
Description	Efficiency of the LFG capture system installed in the project activity
Source of data	Feasibility study
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 equipment 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 the methane emissions are being mitigated by capturing and flaring the methane (ACM0001).
Purpose of data	Calculation of baseline emission
Additional comment	-

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

Data/Parameter	$MCF_{default}$
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 sites with controlled placement of waste (i.e. waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and is include: (i) cover material; (ii) mechanical compacting and (iii) leveling of the waste;
Purpose of data	Calculation of baseline emission
Additional comment	-

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

<table>
<tr><th>Data/Parameter</th><th>kj</th></tr>
<tr><td>Data unit</td><td>-</td></tr>
<tr><td>Description</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th colspan="2" rowspan="2">Waste type j</th><th>Tropical (MAT > 20 °C)</th></tr>
<tr><th>Wet (MAP > 1,000 mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.40</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>IPCC default value for anaerobic managed solid waste disposal site is applied.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emission</td></tr>
<tr><td>Additional comment</td><td>The mean annual temperature (MAT) is 21.1ºC and the mean annual precipitation (MAP) 1,490 mm. Source: INMET - Instituto Nacional de Meteorologia (http://www.bdclima.cnpm.embrapa.br)</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
Value(s) applied	see table below
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	$c\text{-}C4F_8$	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
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)
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
Sulfur dioxide	SO_2	64.06

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	-

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”, 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.[32]

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.

[32] DNA Resolution n.8 was published on 26/05/2008 on http://www.mct.gov.br/index.php/content/view/14797.html, accessed on 10/02/2015.

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)
h	=	hours in year y in which the project activity is displacing grid electricity
y	=	Year in which the project activity is displacing grid electricity

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

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

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

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

In terms of vintage of data, project participants can choose between one of the following two options:

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

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

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

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

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

Where:

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

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

$EF_{grid,BM,2018}$[33] = 0.1370 tCO_2/MWh

Step 6. Calculate the combined margin emissions factor

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

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

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

EF_{2018} = (0.5390 × 0.25) + (0.1370 × 0.75) = 0.2375 tCO_2/MWh[34]

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

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

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

Emission reduction

Baseline emission calculation

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

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

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[33] According to STEP 5, option 1 of Tool to calculate the emission factor for an electricity system

[34] The source of the data is from Brazilian DNA. The link is http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html, accessed on 23/03/2020.

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

- Methane content in LFG = 50% (default value);
- LFG collection efficiency = 65%: (Based on technical specifications from the equipment provider for the active LFG capture system);
- Density of methane = 0.716 kg/m^3 (as per "*Tool to determine 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 was applied to the estimate of LFG produced, under assumption that generated LFG is composed of 50% methane.

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

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

Where:

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

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

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

Year	$F_{CH4,PJ,y}$ (tCH_4/yr)
From 31/07/2020	8,929
2021	22,077
2022	22,706
2023	23,272
2024	23,792
2025	24,279
2026	24,741
Until 30/07/2027	14,559

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

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

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

Year	$F_{CH4,BL,y}$ (tCH_4/yr)
From 31/07/2020	1,786
2021	4,415
2022	4,541
2023	4,654
2024	4,758
2025	4,856
2026	4,948
Until 30/07/2027	2,912

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

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

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

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

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

Year	$BE_{CH4,y}$ (tCO_2/year)
From 31/07/2020	160,717
2021	397,395
2022	408,713
2023	418,891
2024	428,252
2025	437,020
2026	445,346
Until 30/07/2027	262,066

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

The ex-ante calculation is:

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

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

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

Year	$EC_{BL,k,y}$ (MWh/yr)	$BE_{EC,y}$ (tCO_2/yr)
From 31/07/2020	32,898	9,869
2021	78,698	23,608
2022	78,698	23,608
2023	78,698	23,608
2024	78,698	23,608
2025	78,698	23,608
2026	78,698	23,608
Until 30/07/2027	45,494	13,647

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)
From 31/07/2020	7	9.982	32,898
2021	7	9.982	78,698
2022	7	9.982	78,698
2023	7	9.982	78,698
2024	7	9.982	78,698
2025	7	9.982	78,698
2026	7	9.982	78,698
Until 30/07/2027	7	9.982	45,494

Values extracted from ER spreadsheet

[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 7 - baseline emission calculation

Year	$BE_{CH4,y}$ (tCO_2/year)	$BE_{EC,y}$ (tCO2/yr)	BE_y (tCO_2/yr)
From 31/07/2020	160,717	9,869	170,586
2021	397,395	23,608	421,002
2022	408,713	23,608	432,321
2023	418,891	23,608	442,498
2024	428,252	23,608	451,860
2025	437,020	23,608	460,627
2026	445,346	23,608	468,953
Until 30/07/2027	262,066	13,647	275,713

Project emissions

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

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

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

There are two emission project sources:

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

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

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

In the project activity, the electricity consumption from the grid is estimated around 3,742 MWh/year.

The option A1 of the "*Tool to calculate baseline, project and/or leakage emissions from electricity consumption*", states that a value of the combined margin emission factor ($EF_{grid,CM,y}$) may be used as the emission factor ($EF_{ELj/k/l,y}$). Therefore a value of 0.2375 tCO_2/MWh will be used.

Finally the technical transmission and distribution losses ($TDL_{j,y}$) value has been assumed to be 26.3%, according to National Energy Balance -published on 2020 (data basis 2019).[35] Table below summarizes the project emissions resulting from electrical consumption in the plant.

[35] National Energy Balance published on 2020 – data basis 2019 (26.3% for 2019 is the most recent data). Source: https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-479/topico-521/Relato%CC%81rio%20Si%CC%81ntese%20BEN%202020-ab%202019_Final.pdf

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

Year	**Electricity consumption from the grid – $EC_{PJ1,y}$** (MWh/yr)	**$PE_{EC1,y}$ (tCO_2/year)**
From 31/07/2020	1,564	470
2021	3,742	1,123
2022	3,742	1,123
2023	3,742	1,123
2024	3,742	1,123
2025	3,742	1,123
2026	3,742	1,123
Until 30/07/2027	2,163	649

Calculation of $PE_{FC,y}$ – project emission from consumption of fossil fuel

There is no project emission from consumption of heat.

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);

Year	**BE_y (tCO_2/year)**	**PE_y (tCO_2/year)**	**ER_y (tCO_2/year)**
From 31/07/2020	170,586	470	170,116
2021	421,002	1,123	419,879
2022	432,321	1,123	431,198
2023	442,498	1,123	441,375
2024	451,860	1,123	450,737
2025	460,627	1,123	459,504
2026	468,953	1,123	467,830
Until 30/07/2027	275,713	649	275,064

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

Year	Baseline emissions ($t CO_2e$)	Project emissions ($t CO_2e$)	Leakage ($t CO_2e$)	Emission reductions ($t CO_2e$)
From 31/07/2020	170,586	470	0	170,116
2021	421,002	1,123	0	419,879
2022	432,321	1,123	0	431,198
2023	442,498	1,123	0	441,375
2024	451,860	1,123	0	450,737
2025	460,627	1,123	0	459,504
2026	468,953	1,123	0	467,830
Until 30/07/2027	275,713	649	0	275,064
Total	3,123,560	7,857	0	3,115,703
Total number of crediting years	7			
Annual average over the crediting period	**446,223**	**1,122**	**0**	**445,100**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Flaring or use of landfill gas

Data/Parameter	Management of SWDS
Data 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	Calculation of baseline emissions
Additional comment	-

Data/Parameter	$O_{pj,h}$
Data unit	-
Description	Operation of the equipment that consumes the LFG
Source of data	Measurements by Project participant using a device integrated with the operational software at the landfill gas plant.

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

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

Data/Parameter	$V_{t,wb}$
Data unit	m³ /h
Description	Volumetric flow of the gaseous stream in time interval t on a wet basis
Source of data	Measurements by Project participants using a flow meter
Value(s) applied	n/a
Measurement methods and procedures	The volumetric flow rate of the residual gas which is sent to each individual flare, LFG engines in the hour h will be measured by the installed flow meters with digital recordable electronic signal, according to the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", the measurement option in the project activity will be: • Option (A) dry basis: when the temperature of gaseous stream is lower than 60ºC (333.15 K) at the flow measurement point; • Option (B) wet basis: when the temperature of gaseous stream is higher than 60o C (333.15 K) at the flow measurement point;
Monitoring frequency	Continuous recorded and hourly aggregated
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be in accordance with manufacturer's specifications.

Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	This parameter will be monitored only in case Options B or C of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” is applied for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$

Data/Parameter	$V_{t,db}$
Data unit	m³ /h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Measurements by Project participants using a flow meter(s)
Value(s) applied	n/a
Measurement methods and procedures	The volumetric flow rate of the residual gas which is sent to each individual flare, LFG engines in the hour h will be measured by the installed flow meters with digital recordable electronic signal, according to the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, the measurement option in the project activity will be: • Option (A) dry basis: when the temperature of gaseous stream is lower than 60ºC (333.15 K) at the flow measurement point; • Option (B) wet basis: when the temperature of gaseous stream is higher than 60o C (333.15 K) at the flow measurement point;
Monitoring frequency	Continuous recorded and hourly aggregated
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration frequency of this monitoring equipment should be in accordance with manufacturer’s specifications.
Purpose of data	(a) Calculation of baseline emissions or baseline net GHG removals by sinks;
Additional comment	This parameter will be monitored only in case Option A of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” is applied for the determination of $F_{CH4,flared,y}$, $F_{CH4,EL,y}$ and $F_{CH4,NG,y}$

Data/Parameter	$v_{i,t,db}$
Data 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	$v_{i,t,wb}$
Data 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 C and F 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
Data unit	K
Description	Temperature of the gaseous stream in time interval t
Source of data	Measurements by Project participant
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.
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. Calibration and frequency of calibration is according to manufacturer`s specifications
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 participant
Value(s) applied	n/a
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required. Examples include pressure transducers, etc.

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 according to the manufacturer's specifications.
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)

Data/Parameter	$P_{H2O,t,Sat}$
Data 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	-
Additional comment	[1] Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994, John Wiley & Sons, Inc.

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

Tool to calculate baseline, project and/or leakage emissions from electricity consumption

Data/Parameter	$EF_{grid,CM,y}$

Data unit	tCO_2 /MWh
Description	CO_2 emission factor of the Brazilian grid electricity during the year y
Source of data	Brazilian DNA
Value(s) applied	0.2375
Measurement methods and procedures	The emission factor is calculated ex-post, as the weighted average of the dispatch data analysis OM (Operating Margin) and the BM (Build margin), as described in B.6.3.
Monitoring frequency	Annual
QA/QC procedures	Apply procedures in the "Tool to calculate the emission factor for an electricity system"
Purpose of data	(b) Calculation of project emissions or actual net GHG removals by sinks;
Additional comment	All data and parameters to determine the grid electricity emission factor, as required by the "Tool to calculate the emission factor for an electricity system", were included in the monitoring plan. For more details, see Annex 3.

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

Data/Parameter	TDL_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	National Energy Balance
Value(s) applied	26.3%[36]

[36] National Energy Balance published on 2020 data basis 2019 (26.3% for 2019 is the most recent data). Source: https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-479/topico-521/Relato%CC%81rio%20Si%CC%81ntese%20BEN%202020-ab%202019_Final.pdf

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 data was based on National Energy Balance – published on 2020 (data basis 2019).[37]

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	<table><tr><th>Year</th><th>$EG_{PJ,y}$ (MWh/year)</th></tr><tr><td>From 31/07/2020</td><td>32,898</td></tr><tr><td>2021</td><td>78,698</td></tr><tr><td>2022</td><td>78,698</td></tr><tr><td>2023</td><td>78,698</td></tr><tr><td>2024</td><td>78,698</td></tr><tr><td>2025</td><td>78,698</td></tr><tr><td>2026</td><td>78,698</td></tr><tr><td>Until 30/07/2027</td><td>45,494</td></tr></table>
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.
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.
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 “Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”

Data/Parameter	$EC_{PJ1,y} = EG_{EC1,y}$
Data unit	MWh/y

[37] National Energy Balance published on 2020 data basis 2019 (26.3% for 2019 is the most recent data). Source: https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-479/topico-521/Relato%CC%81rio%20Si%CC%81ntese%20BEN%202020-ab%202019_Final.pdf

Description	Quantity of electricity consumed from the grid by the project activity during the year y
Source of data	Electricity meter
Value(s) applied	<table><tr><th>Year</th><th>$EC_{PJ1,y}$ (MWh/year)</th></tr><tr><td>From 31/07/2020</td><td>1,564</td></tr><tr><td>2021</td><td>3,742</td></tr><tr><td>2022</td><td>3,742</td></tr><tr><td>2023</td><td>3,742</td></tr><tr><td>2024</td><td>3,742</td></tr><tr><td>2025</td><td>3,742</td></tr><tr><td>2026</td><td>3,742</td></tr><tr><td>Until 30/07/2027</td><td>2,163</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	Calculation of project emissions.
Additional comment	The data will be archived throughout the crediting period and two years thereafter.

Methodological tool “Project emissions from flaring”

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

Data/Parameter	$Flame_m$
Data unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Source of data	Project Participant
Value(s) applied	-
Measurement methods and procedures	Measurements by project participants using a continuous Ultra Violet flame detector

Monitoring frequency	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations
Purpose of data	Calculation of baseline and project emissions when the flame is on[38].
Additional comment	-

Data/Parameter	$Maintenance_y$
Data unit	Calendar dates
Description	Maintenance events completed in year y
Source of data	Project participants
Value(s) applied	-
Measurement methods and procedures	Record the date that maintenance events were completed in year y. Records of maintenance logs must include all aspects of the maintenance including the details of the person(s) undertaking the work, parts replaced, or needing to be replaced, source of replacement parts, serial numbers and calibration certificates
Monitoring frequency	Annual
QA/QC procedures	Records must be kept in a maintenance log for two years beyond the life of the flare
Purpose of data	Calculation of baseline and project emissions when the flame is on[39].
Additional comment	Monitoring of this parameter is required for the case of flares and the project participant selects Option B to determine flare efficiency. These dates are required so that they can be compared to the maintenance schedule to check that maintenance events were completed within the minimum time between maintenance events specified by the manufacturer ($SPEC_{,flare}$).

B.7.2. Sampling plan

>>
Not applicable.

B.7.3. Other elements of monitoring plan

>>
The monitoring plan will be done according to the methodology ACM0001 and the applicable tools. The monitoring equipment locations are presented in the picture below:

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

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

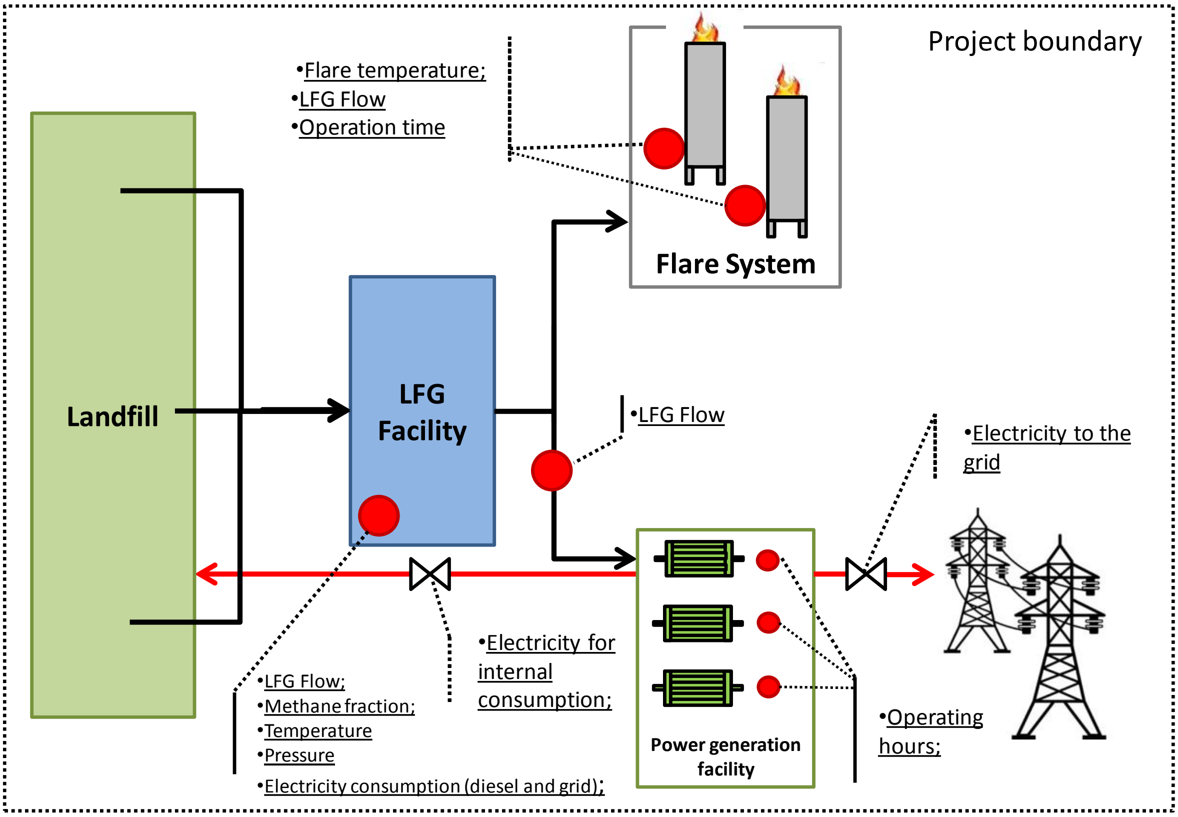

Figure 12 - Monitoring equipment locations

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 the site boundary which will have the capability to aggregate and print the collected data in the frequencies range specified above. It will be the Site Operator responsibility to provide all requested data logs which will be stored during 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

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

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

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 1'

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

2. Monitoring Work Program

The LFG monitoring program is designed to collect system operating data required for the safe system operation and for the verification of CERs. This data is collected in real time, and will provide continuous recording which can be easily monitored, reviewed, and validated.

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

- LFG Flow;
- LFG quality;
- Uncombusted methane;
- Electricity consumption;
- Project electricity output;
- Regulatory requirements;
- Data records;
- Data assessment and reporting.

2.1. LFG Flow

The data will be collected continuously using flow meters located in the piping leading to the flare, to the electricity generation plant and the other on the main piping measuring the total collected landfill gas. The data will be aggregated monthly and yearly for the flare. 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 later.

The meter will be provided with a normalizer unit which normalizes the flow rate at standard temperature and pressure.

The equipment selected for the project activity will utilize a continuous monitoring system as defined in ACM0001, which measures and aggregates flow data.

2.2. LFG Quality

The concentration of methane will be measured via common sample line that runs to the main collection system piping and is measured in real time. The equipment selected for the site aggregates gas composition as per the definition of a continuous monitoring system in ACM0001.

Regular calibrations will be made according to manufacturer specification.

2.3. Uncombusted Methane

The efficiency of the enclosed flare will be measured per the methodological "Project emissions from flaring ".

2.4. Electrical Consumption

The consumed electricity from the grid by the project activity will be continuously measured by electricity meters for the grid. The respective data will be electronically recorded.

Monthly electrical bills charged to the project will be monitored and considered as the actual energy consumption for the project.

2.5. Project Electricity Output

The generated electricity 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[40] will be continuously measured by an electricity meter and 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.

2.6. Regulatory Requirements

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

2.7. Data Records

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.

2.8. Data Assessment and Reporting

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.

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 records of regular maintenance performed will also be a component of the verification reports.

3. 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.

4. Procedures for monitoring personnel training

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

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. Emergency procedures

As a precautionary measure, it will be made regularly backups to avoid data loss due to power outages. The LFG Plant Manager will check daily the records. In addition, an emergency plan will be developed including other types of emergencies such as fire and *work accidents.*

6. 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 the operators. The LFG Plant Manager will be responsible for checking the equipment's proper working conditions, as well as checking and storing up the calibration certificates and records. Calibration certificates will be kept for all the equipment during the crediting period and two years after.

7. Date of completion of application of methodology and standardized baseline and contact information of responsible persons/ entities

The date of completion the application of the methodology to the project activity study is 31/12/2019.

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

Beng Engenharia Ltda is not a Project Participant.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
Project starting date: 22/07/2015.
The starting date of the project activity is the date of signature of the purchasing agreement[41] of the main equipment.

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 (3 x 7 years)

[41] Agreement sent to DOE

C.3.2. Start date of crediting period

>>

The 2nd crediting period will start on 31/07/2020

C.3.3. Duration of crediting period

>>

7 years and 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

An analysis of the environmental impacts was done for the landfill gas 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 neighborhood.
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 present project activity and the possible environmental impacts were analyzed by the *Conselho Estadual de Politica Ambiental do Estado de Minas Gerais - COPAM* (responsible agency to issue environmental licenses in Minas Gerais State). The project activity has satisfied all the requirements for implementation of the landfill gas project and the CTR Macaúbas received from COPAM the Operational License nº 145 dated of 30/05/2011 valid up to 30/05/2017.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 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 analyzed by COPAM, thus CTR Macaúbas has obtained all pertinent Licenses for the operation.

A summary of the environmental impacts and mitigation measures are explained in the Table 9 and in the Table 10 are showed the positive impacts due to the implementation of project activity.

Table 9 - 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 equipment. • Odour and biogas emissions from landfill.	• Wetting, calculated explosions for lower emissions of dust and vegetation surround. • Maintenance of vehicles and equipment. • Vegetation surround, drainage of leachate, daily coverage of waste, deodorizer, maintenance of waste water 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.
Soil destabilization. Siltation	• Cut and filling of soil. • Leaching of soils.	• Pluvial drainage, reutilization of soil and revegetation. • Preservation of coverage, dike and reutilization of soils.
Noise Pollution	• Noise emissions from civil works, vehicular traffic and equipment.	• Vegetation surround and calculated explosions for lower noise emissions, signalization and planning schedules. • Maintenance of vehicles and equipment.
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.
Landscape reconfiguration and landscape alteration	• Suppression of vegetation	• 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 - 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 monitoring plan to verify and monitor in the proper frequency, the effective implantation of mitigation measures proposed.

The monitoring plan consists of the following specifics monitoring plans:

- Monitoring plan of air quality
- Monitoring plan of superficial waters
- Monitoring plan of ground waters
- Monitoring plan of noise
- Monitoring plan of landfill stability
- Monitoring plan of flora and fauna
- Monitoring plan of unit operations
- Monitoring plan of environmental-society conditions.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

According to the Resolutions Number 1[42], 4[43] and 7[44] 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.

Letters were sent on 27/04/2012 to the following stakeholders involved and affected by the project activity:

- *Prefeitura municipal de Sabará* / Municipal Administration of *Sabará*;
- *Câmara dos vereadores de Sabará* / Legislation Chamber of *Sabará*;
- *Secretaria Municipal de Meio Ambiente de Sabará* / Municipal Secretariat Environmental of *Sabará* City;
- Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável (SEMAD) / Secretariat of Environmental and Sustainable Develpment of Minas Gerais State;

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

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

[44] 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 de* Minas Gerais / Minas Gerais Pr*osecutor's Office;*
- *Ministério Público Federal* / Federal Prosecutor's Office.
- Local associations;
    - Projeto Bom Pastor;
    - FUNCIF- Associação Fundamental Cidade Feliz

E.2. Summary of comments received

>>
During the local stakeholder consultation, one letter was received from the Secretariat of Environmental and Sustainable Development of Minas Gerais State (SEMAD). This letter acknowledges the initiative from the Project Participant and emphasizes the socioeconomic and environmental benefits that the project will bring to the region. The letter was signed by its secretary, Adriano Magalhães Chaves.

E.3. Consideration of comments received

>>
The Project Participant (PP) considered every comment as welcome and has been open to any criticism or suggestion to improve the project quality and its relationship with the local community and region. After the information received, the PP concluded that no additional action was needed and decided to proceed with the project as initially planned.

SECTION F. Approval and authorization

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

Thus, the Party involved is Brazil.

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

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 20/12/2012). 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	Rodovia MG-05, Km 8, 1- Parte – Sabará/MG
Telephone	+55 (31) 3036-6300
Fax	+55 (31) 3036-6300
E-mail	neiber.silva@vitalambiental.com.br
Website	http://www.vitalambiental.com.br/
Contact person	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 scenario for the project activity is the uncontrolled release of landfill gas to the atmosphere and also the generation of electricity from other sources.

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

1. Key Parameters

Year landfilling operations started	2005
Projected year for landfill closure - estimated based on current filling rate	2045
GWP for methane (UNFCCC and Kyoto Protocol decisions)	25
Methane concentration in LFG (% by volume) typical assumption for baseline scenario	50
LFG collection efficiency (%)	65
Electricity consumption from the grid due to the project activity (MWh/year)	3,742
Combined margin emission factor for electricity displacement (tCO_2/MWh) calculated based on the “Tool to calculate the emission factor for an electricity system”.	0.2375
Installed capacity of Power Plant (MW)	9.982

Load factor (%)	90.00
Operational lifetime of the project activity (years)	25
LFG destruction rate	20%

2. Waste disposal

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

Table 11 - Forecast amount of waste disposal in project activity

Year	Waste disposal (tonnes/yr)
2005	2,742
2006	46,921
2007	457,333
2008	1,254,621
2009	1,417,489
2010	1,348,794
2011	1,410,226
2012	1,330,155
2013	1,276,374
2014	1,215,615
2015	1,226,811
2016	1,089,597
2017	1,098,102
2018	1,295,637
2019	1,429,456
2020	1,443,751
2021	1,458,188
2022	1,472,770
2023	1,487,498
2024	1,502,373
2025	1,517,396
2026	1,532,570
2027	1,547,896
2028	1,563,375
2029	1,579,009
2030	1,594,799
2031	1,610,747
2032	1,626,854
2033	1,643,123
2034	1,659,554
2035	1,676,150
2036	1,692,911
2037	1,709,840
2038	1,726,939
2039	1,744,208
2040	1,761,650

2041	1,779,267
2042	1,797,059
2043	1,815,030
2044	1,833,180
2045	1,851,512

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.

Combined Margin Emission Factor 2018 (tCO_2/MWh) [9]		
2nd crediting Period		**0.2375**
Build Margin - 2018[1]		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

1. According to STEP 5, option 2 of Tool to calculate the emission factor for an electricity system

Appendix 5. Further background information on monitoring plan

All the information about the monitoring plan were described in section B.7.1 and B.7.2

Appendix 6. Summary report of comments received from local stakeholders

All the information about comments received from local stakeholders were described in sections E.2. and E.3.

Appendix 7. Summary of post-registration changes

1) Permanent changes to project design by voluntary update of the applied methodology version, ACM0001 v19.0;

2) Permanent changes to project design by emission reduction calculation changes due to consequential changes to the methodology version;
3) Permanent changes to the registered monitoring plan description due to consequential changes to the methodology version;
4) Permanent changes to the project design, not affecting the additionality, since the LFG power plant will be expected to install approximately 9.982 MW upon project completion which is below 10 MW defined in TOOL32 Methodological tool: “Positive lists of technologies.
5) Permanent changes in the Demonstration of additionality considering the simplified procedure to identify the baseline scenario and demonstrate additionality of Methodological tool: Positive lists of technologies Version 01.0 due to the changes of project design and methodology version update;
6) Permanent changes in the annual estimation of emission reductions in tonnes of CO2e due to the changes of project design and methodology version update;
7) Permanent change in the project design regarding the electricity generation plant installed capacity due to LFG availability and waste disposal increase;
8) Permanent change in the project design regarding Appendix 4 - Further background information on ex ante calculation of emission reductions, including baseline Information, key parameters and waste disposal due to changes in project design;
    a) GWP for methane: from 21 to 25
    b) Installed capacity of Power Plant (MW): from 12.8 to 9.982 MW
9) Permanent changes in determination of flare efficiency option (Option A: Default value of the flare efficiency) according to “Project emissions from flaring” due to changes in project design.

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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).

Version	*Date*	*Description*
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.
05.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.

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