Project design document form
(Version 12.0)

BASIC INFORMATION	
Title of the project activity	Landfill Gas to Energy Project at Lara Landfill, Mauá, Brazil
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	3.0
Completion date of the PDD	16/12/2021
Project participants	Lara Co-Geracao e Comercio de Energia BHP Billiton Marketing AG
Host Party	Brazil
Applied methodologies and standardized baselines	ACM0001 – “Flaring or use of landfill gas” (version 19.0)
Sectoral scopes	1 – Energy industries (renewable / non-renewable sources) 13 - Waste handling and disposal
Estimated amount of annual average GHG emission reductions	375,614

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The purpose of the project activity is to capture and burn landfill gas (LFG) from Lara landfill. The initial configuration of the project included electricity generation to the grid considering 10MW installed capacity, but the power generation facility was not implemented during the first and second crediting periods due to uncertainties related to LFG generation as result of its pioneering initiative in the Host Country and financial constraints[1]. During the third crediting period, the Project Participant (PP) will implement the power generating facility with 6.40MW installed capacity[2] forecasted date to start operation in December 2021. Currently, there are 2 enclosed flares installed at the project site, which destroy LFG rich in methane (CH_4) resulted from the anaerobic decomposition of the municipal solid waste (MSW) disposed at Lara landfill. By promoting collection and destruction of LFG through flaring in high temperature enclosed flares, the project activity avoids methane emissions to atmosphere.

The Lara landfill is located in an industrial area of the municipality of Mauá, which is a city located in the metropolitan area of São Paulo city, the capital of São Paulo State. The Lara landfill has been operated since 1987 and, according to the registered PDD, the landfill was forecasted to close in 2014 when the landfill would reach its total capacity of solid waste disposal. However, the Lara landfill location is strategic in a region which few solid waste disposal sites area available, thus receiving waste from nine municipalities: Mauá, Ribeirão Pires, Diadema, São Bernardo do Campo, Rio Grande da Serra, São Caetano do Sul, São Vicente, Praia Grande and Santo André. Based on the landfill limitations and the necessity for having adequate locations for waste disposal in the region, the PP has developed further technical engineering studies for the potential expansion of the area of the landfill, which are dated prior to the project registration[3]. However, as it can be confirmed in the registered PDD, no decision or final approval was available at that time. After analysis from the local environmental agency (CETESB), the approval for the area expansion was authorized and the current Operation License is valid up to June 2025[4]. Due to the increment of the disposed area, the landfill is expected to operate up to 2027 year[5], based on 1,204,500 tonnes of waste received per year[6].

An active LFG collection and destruction system (encompassing LFG collecting wells, LFG pipeline network (incl. manifolds), centrifugal blowers, monitoring and control systems and a high temperature enclosed flare were initially installed in 2006 as part of the implementation of the CDM project activity. As per the project design, all previously existing passive conventional LFG venting/combustion drains were adapted/converted into a new active LFG collecting wells. The implementation of the project activity also included the installation of appropriate well heads in the LFG collecting wells in order to have them connected to the project's LFG collecting network. Furthermore, additional LFG collecting wells were also built along the project's operation.

Therefore, the project activity boundary encompasses the site where the LFG is captured and flared, i.e. the landfill. Since that electricity generation is included in the third crediting period, the project

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[1] Detailed explanations regarding delays for the implementation of the electricity generation component are presented in the registered PDD in the first crediting period. In summary, uncertainties related to LFG generation and financial constraints impacted by, but not restricted to, delays in the CERs issuance, reduced the investment capacity of the project implementation.

[2] Installed capacity is based on equipment nameplate: 4 units x 1,600kW installed power = 6,400kW installed capacity.

[3] "Projeto Executivo Boa Hora and Sertãozinho" studies prepared by GEOTECH – Geotecnial Ambiental Consultoria e Projetos.

[4] Operating Licensing (LO) 16010948 issued CETESB on 10/06/2020 and valid up to 17/06/2025.

[5] The expected date of the landfill closing is based on the validity of the LO up to 2025 year plus two years for the implementation of the closure plan.

[6] Report "Estimativa de Produção Teórica de Biogas", document 10546-0000-GN-RT001-0 (Appendix A).

power plant/unit and the electricity system are also included in the project boundary. During the third crediting period, the project activity is expected to reduce 2,629,301 tCO_2e, *i.e*. 375,614 tCO_2e/year.

A.2. Location of project activity

The project activity is located in the city of Mauá, State of São Paulo, South-eastern region of Brazil.

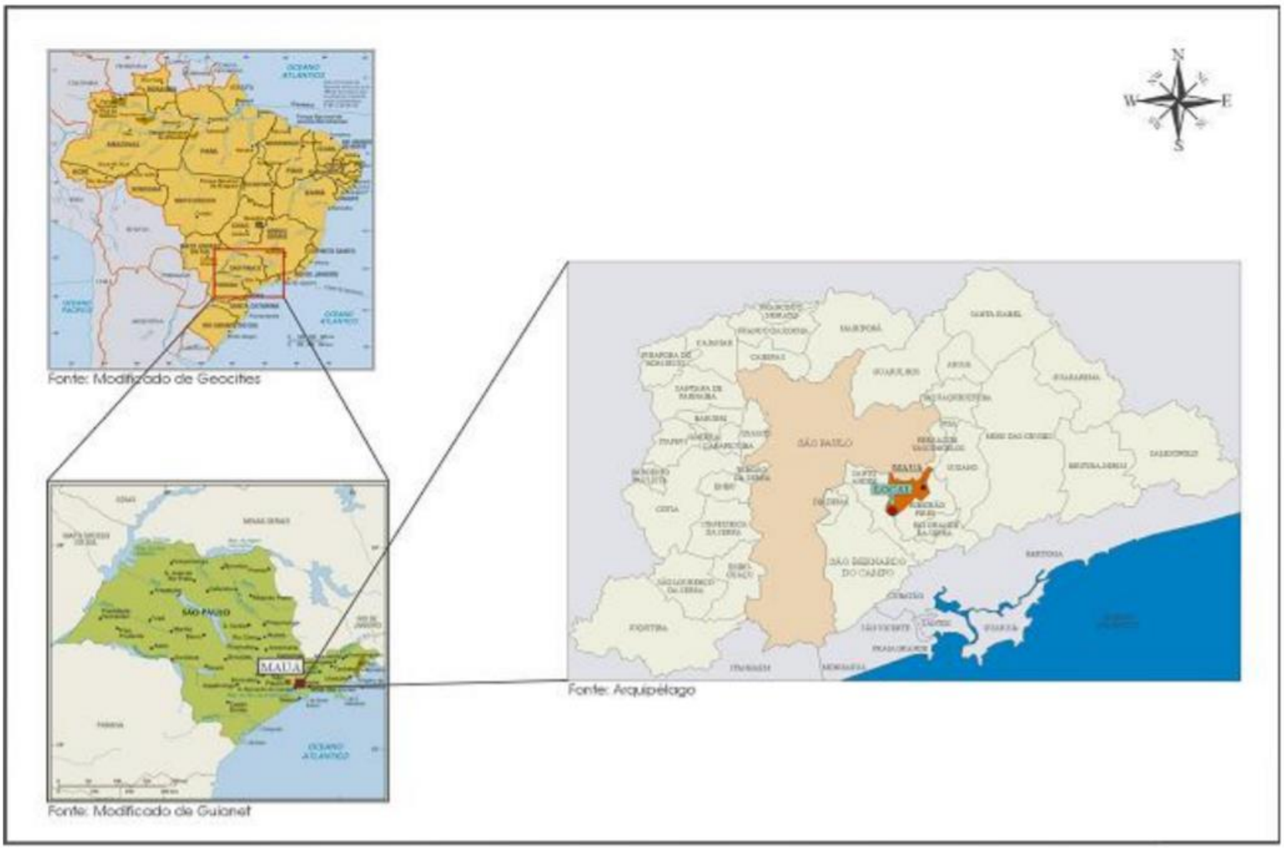

Figure 1 – Mauá city, where the project activity is located.

GPS coordinates of the administrative office are as follows (Figure 2):

- Latitude: 23° 42' 18.05" S (-23.705014) datum SAD 69;
- Longitude: 46° 28' 27.21" W (-46.474225) datum SAD 69.

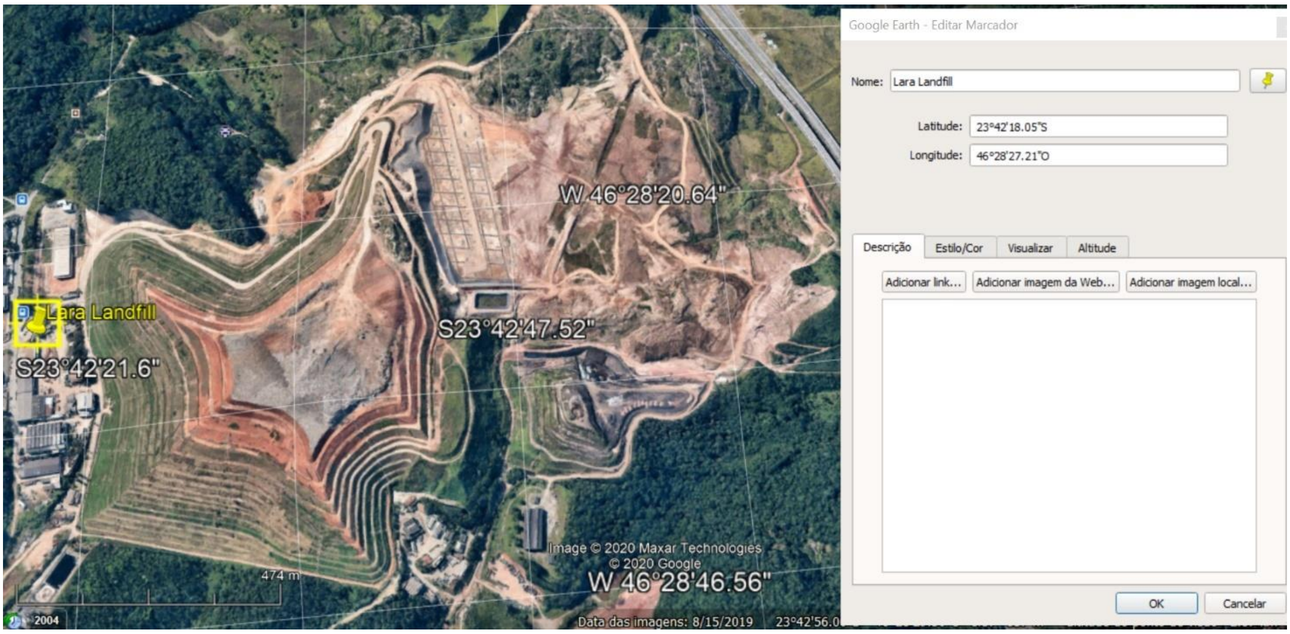

Figure 2 – Aerial view of the location of the Lara landfill (as visible in August 2020 by using Google Earth software application).

A.3. Technologies/measures

The project activity currently encompasses collection and flaring of LFG generated as a result of anaerobic decomposition of MSW disposed in the Lara landfill. The project design also encompasses the use of collected LFG for electricity generation in 6.40MW installed capacity in a yet to be implemented electricity generation facility. Since this power generation facility was not implemented during the 2nd crediting period of the project, it was not included in the technology/measures of the project.

Then, the project design infrastructure includes an active forced LFG recovery system composed by a LFG collection and transportation pipeline network, a power generation facility and a LFG flaring system detailed below:

- LFG collection network comprising vertical LFG collecting wells;
- Electricity generation facility consisting of:
  - Four engines with 1,600kW each;
- LFG flaring plant consisting of:
  - Four centrifugals blowers powered by electric motors;
  - Two enclosed high temperature flares;
  - All other supporting mechanical and electrical subsystems and appurtenances necessary to collect, measure and record LFG related parameters (LFG flow meters, $CH_4/O_2/CO_2$ content gas analyser unit, LFG temperature sensor, LFG pressure sensor, electricity meters).

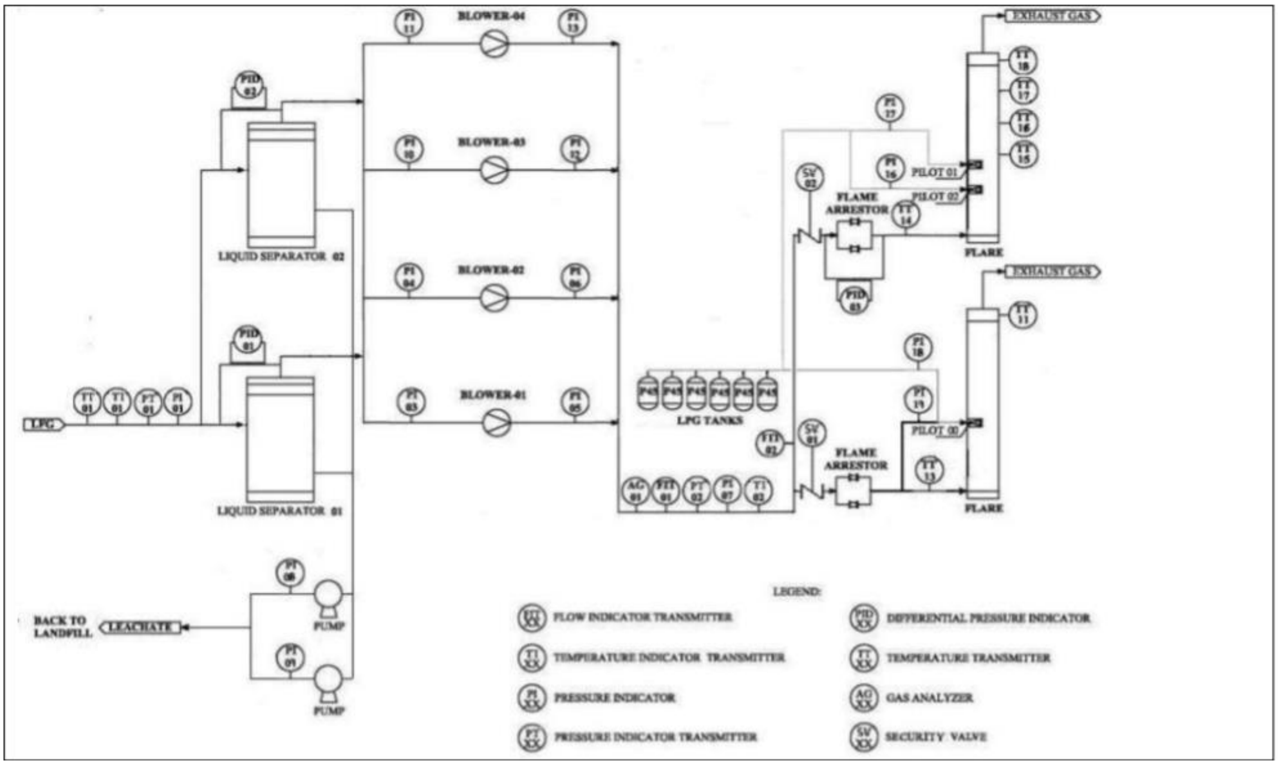

Figure 3 – Current project process flow chart – without electricity generation

As presented in the manufacturer's technical record, the combustion temperature curve varies from 800°C to 1,200°C. Flare dimensions are: 16,025m height and 4,500m diameter (low height flare)[7].

Figure 4 – Flares installed at the project site

The LFG is extracted from the landfill through the gas wells and it is transported to the gas plant by the pipelines for treatment – removal of condensates formed during the LFG transportation due to temperature gradients. Blowers are used to provide correct suction pressure into the pipeline system for transportation of the LFG extracted and are also equipped with necessary safety equipment. Flow capacity and pressure are adjusted by electrical motors with frequency control.

The design, engineering and construction of the project's LFG collecting and flaring system took place during the period from March 2005 to July 2006. Commissioning and testing phases of the project activity occurred in August 2006 and September 2006 respectively. The project activity

[7] Flare set layout "Projeto de Queima de Biogás - conjunto flare" issued by Arquipélago Engenharia Ambiental Ltda. Document P562-DME-007-R01.

started to operate on 15/09/2006. The electricity generation facility is planned to startup in December 2021 using collected LFG as fuel.

It is worth mentioning that there is no backup captive off-grid electricity generator fuelled with diesel oil or any type of fossil fuel. All electricity consumed in the project will be generated with LFG nor imported from the grid. The only fossil fuel used in the project is the liquefied petroleum gas (LPG) for flare ignition.

The high temperature enclosed flares and some of the monitoring instruments are manufactured in the host party Brazil, but the project activity also uses imported components (equipment, instruments, etc.). All existent forced (active) LFG collection and destruction systems under operation in landfills located in Brazil were implemented (or are currently being implemented/validated) as project-based initiatives under the CDM. All of such project activities thus indeed involves transfer of technology and improvements in terms of practices for LFG management to the host country Brazil.
Ok, abbreviation excluded.

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 Party)	Private entity Lara Co-Geracao e Comercio de Energia	No
Netherlands	Private entity BHP Billiton Marketing AG	No
Switzerland	Private entity BHP Billiton Marketing AG	No

Note: BHP Billiton Marketing AG was included after the project registration.

A.5. Public funding of project activity

There is no public funding from Parties included in Annex I involved in this project activity.

A.6. History of project activity

The Project Participant confirms that:

(a) The proposed CDM project activity is not included as a component project activity (CPA) in a registered CDM programme of activities (PoA);
(b) The proposed CDM project activity is not a project activity that has been deregistered;
(c) The proposed CDM project activity is not a CPA that has been excluded from a registered CDM PoA;
(d) The proposed CDM project activity is not a registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) exists in the same geographical location as the proposed CDM project activity.

A.7. Debundling

Not applicable. The project activity is a large scale project type.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

The project activity applies the ACM0001 methodology – “Flaring or use of landfill gas” (version 19.0). ACM0001 refers to the following methodological tools:

- TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality (version 7.0);
- TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (version 3.0);
- TOOL04: Emissions from solid waste disposal sites (version 08.0);
- TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0);
- TOOL06: Project emissions from flaring (version 03.0);
- TOOL07: “Tool to calculate the emission factor for an electricity system” (version 07.0);
- TOOL08: Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0);
- TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems (version 3.0);
- TOOL10: Tool to determine the remaining lifetime of equipment (version 1.0);
- TOOL11: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of a crediting period (version 03.0.1);
- TOOL12: Project and leakage emissions from transportation of freight (version 1.1);
- TOOL32: Positive list of technologies (version 3.0).

Please note that TOOL02 is not applicable as the project complies with the conditions established for simplified procedures to identify the baseline scenario and demonstrate additionality and, therefore, it applies TOOL32. Also, since this PDD refers to the third crediting period, TOOL11 is used instead of TOOL02.

TOOL09 and TOOL12 are not applicable to the project activity, since it does not involve thermal energy generation nor LFG transported by trucks. TOOL 10 is also not used, since the project equipment does not exist in the baseline scenario (no reform or expansion is involved).

B.2. Applicability of methodologies and standardized baselines

According to ACM0001, it is applicable to “*project activities that include the destruction of methane emissions and displacement of a more-GHG-intensive service by capturing landfill gas from the landfill site and/or flaring and/or using to produce energy (i.e. electricity, thermal energy); and/or using to supply consumers through natural gas distribution network, dedicated pipeline or trucks”*. Then ACM0001 is applicable to the project activity as it destructs methane by capturing landfill gas from the landfill site for flaring.

The project complies with the applicability conditions described in the methodology ACM0001 as further detailed below.

This methodology is applicable under the following conditions:

(a) Install a new LFG capture system in an existing or new 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; and/or*
- *(iii) Supplying the LFG to consumers through a natural gas distribution network;*
- *(iv) Supplying compressed/liquefied LFG to consumers using trucks;*
- *(v) Supplying the LFG to consumers through a dedicated pipeline.*

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

Previously to the implementation of the project activity, the LFG flow could not be controlled to avoid free emission to the atmosphere. Then, investment was made to convert the passive conventional LFG capture system to an active LFG collection and destruction system (encompassing LFG collecting wells, LFG pipeline network (incl. manifolds), centrifugal blowers, monitoring and control systems and high temperature enclosed flares). The project activity captures LFG, which was burned in an uncontrolled manner prior to the implementation of the project (option b, item (i) above) and uses to generate electricity and flaring (option c, item i) above). Furthermore, the implementation of the proposed CDM project activity does not reduce the amount of organic waste that would be recycled in the absence of the project activity as there is no recycling system for organic waste in the landfill and this type of infrastructure is not foreseen to be implemented.

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.

The baseline scenario applied to the project activity is option (a), i.e. atmospheric release of the LFG and b) electricity generated by the power plants connected to the grid. Please refer to Section B.4 for details.

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 the 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.*

ACM0001 is applicable to the proposed project activity since “Landfill Gas to Energy Project at Lara Landfill, Mauá, Brazil” does not use any other CDM approved methodology. The project was initially registered applying AM0003 - Simplified financial analysis for landfill gas capture projects (v.3), however this methodology was replaced by ACM0001.

In addition, the management of the landfill in the project activity was not changed in order to increase methane generation compared to the situation prior to the implementation of the project activity. There is neither the addition of liquids to the SWDS and pre-treating waste to seed it with bacteria for the purpose of increasing the anaerobic degradation environment of the SWDS nor changing the shape of the SWDS to increase the Methane Correction Factor.

Besides the ACM0001 methodology applicability conditions, the ones listed in the tools applied must also be assessed.

TOOL03 is applicable as it establishes procedures to calculate CO2 emissions from the combustion of fossil fuels based on the quantity of fuel combusted and its properties. Therefore, this tool is used to account project emissions due to LPG use for flare ignition (process *j*) at the project site.

TOOL04 is applicable as it is used under Application A of the tool:

> *¨The CDM project activity mitigates methane emissions from a specific existing SWDS. Methane emissions are mitigated by capturing and flaring or combusting the methane (e.g. “ACM0001: Flaring or use of landfill gas”). The methane is generated from waste disposed in the past, including prior to the start of the CDM project activity. In these cases, the tool is only applied for an ex- ante estimation of emissions in the CDM-PDD. The emissions will then be monitored during the crediting period using the applicable approaches in the relevant methodologies (e.g. measuring the amount of methane captured from the SWDS).*

TOOL05 is applicable since the project activity consumes electricity from the grid (scenario A) and, then, procedures established in this tool are used to account for project emissions. Also, since the project activity is expected to generate electricity from December 2021 onwards, TOOL05 is also applicable to account baseline emissions.

TOOL06 is applicable to the flaring of flammable greenhouse gases where:

- *Methane is the component with the highest concentration in the flammable residual gas;*
- *The source of the residual gas is coal mine or gas from biogenic source (e.g. biogas, landfill gas or wastewater treatment gas).*

The flammable residual gas is LFG (gas from biogenic source), which is composed by CH_4, H_2S, CO_2 and N_2, among other components. By default, the methodology adopts that the default fraction of methane in the LFG of 50%. Therefore, it can be assumed that methane is the component with the highest concentration in the LFG. In this sense, both applicability conditions of the tool are met.

Since the project activity consumes electricity from the grid, TOOL07 is also used to determine the CO_2 emission factor of the grid (option A1 of TOOL05) for calculation of project emissions. As the project electricity system is not located partially/totally in an Annex I country, the tool is applicable.

Regarding TOOL08, the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline and project emissions. Therefore, this tool is applicable.

TOOL11 is applied since this version of the PDD refers to the third crediting period of the project. Therefore, this tool is used to confirm the validity of the original/current baseline and updated it at the time of the renew of the crediting period.

According to ACM0001, in order to apply TOOL32, the baseline scenario for LFG is assumed to be the atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons. This is the baseline scenario identified for the project activity and, then, this tool is also applied. Detailed description of the TOOL32 application is presented in section B.4

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

	Source	GHG	Included?	Justification/Explanation
Baseline	Emissions from decomposition of waste at the SWDS site	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
		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
	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	Not applicable as heat generation is not included in the project activity
		CH_4	No	Not applicable as heat generation is not included in the project activity
		N_2O	No	Not applicable as heat generation is not included in the project activity
	Emissions from the use of natural gas	CO_2	No	Not applicable since the baseline scenario does not include the use of natural gas
		CH_4	No	Not applicable since the baseline scenario does not include the use of natural gas
		N_2O	No	Not applicable since the baseline scenario does not include the 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	Yes	Included as the project uses LPG for flare ignition at the project site
		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	Included as this is an important emission source
		N_2O	No	Emissions are considered negligible
	Emissions from electricity consumption due to the project activity	CO_2	Yes	Included as the project may consume electricity from the grid
		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 distribution of LFG using trucks and dedicated pipelines	CO_2	No	Not applicable as the project activity does not involve LFG distribution using trucks
		CH_4	No	Not applicable as the project activity does not involve LFG distribution using trucks
		N_2O	No	Not applicable as the project activity does not involve LFG distribution using trucks

According to the ACM0001, the project boundary includes the site where the LFG is captured (Lara landfill) and:

(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);

(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;

(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;

(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

(e) The transportation of the compressed/liquefied LFG from the biogas processing facility to consumers.

In the case of the project activity, the sites where the LFG is flared/used consists of the collection system, the gas station facility and flares – item (a) above. Since electricity generation to the grid is forecasted during the third crediting period, the Brazilian Interconnected Grid (from the Portuguese "Sistema Interligado Nacional – SIN") is also included in the project boundary (options (b) and (c) above).

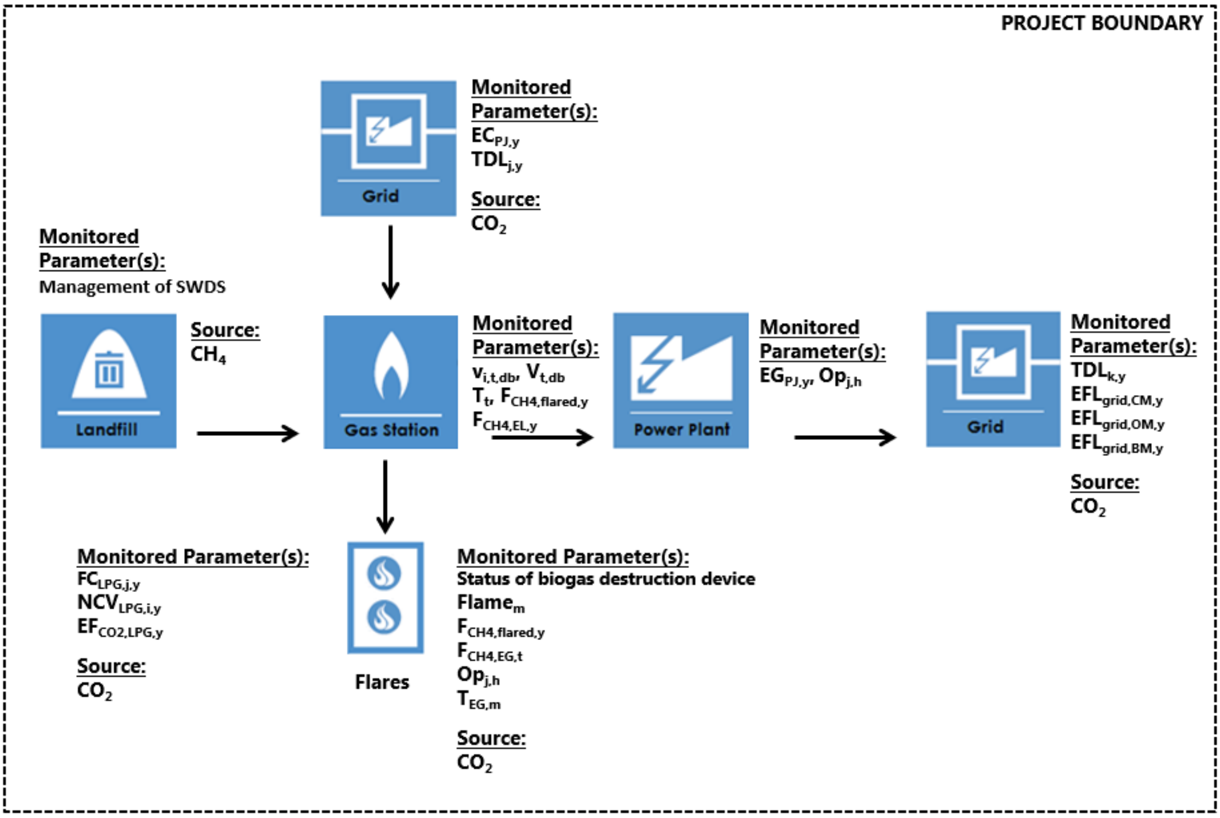

Figure 5 – Figure of the project boundary.

B.4. Establishment and description of baseline scenario

According to the CDM Project Standard for Project Activities (v3.0):

> *"283. To demonstrate the validity of the original baseline or its update, project participants are not required to re-assess the baseline scenario. Instead, project participants shall assess the GHG emission reductions that would have resulted from that scenario.*

284. The project participants shall assess and incorporate the impact of national and/or sectoral policies and circumstances, existing at the time of requesting the renewal of the crediting period, on the current baseline GHG emissions, without reassessing the baseline scenario".

In order to confirm the original baseline, the following steps were taken from TOOL11:

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

According to ACM0001, TOOL32 may be applied to select the most plausible baseline scenario and demonstrate additionality, if in the baseline scenario, the LFG is assumed to be the atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.

As described in the registered PDD, before the implementation of the project activity, no LFG collection and flaring equipment was installed at the project site. Only few venting drains were installed to avoid fire hazards, then the vented gas was occasionally combusted by manually igniting the gas in the head of the LFG venting drains. More information is presented in section B.5.

As there was no requirement for methane destruction, no technology was employed up to 2005, when the project activity started construction. Regarding electricity generation, it was part of the project activity full implementation, but it was never carried out due to financial constraints. In this third crediting period, the four 1.6MW generators will be finally installed at the project to generate electricity. Therefore, the baseline scenario identified for LFG is the atmospheric release and occasionally manually and inefficiently combusted and the baseline scenario for the electricity generation is the electricity generated by the existing and/or new grid-connected power plants as reflected in the CO_2 combined margin emission factor of the grid.

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

In Brazil, before the project implementation and nowadays, there were/are no policies regarding mandatory LFG capture and destruction requirements neither local environmental regulations nor policies which promote the energetic use of LFG.

In the beginning of 2010, the National Solid Waste Policy ("PNRS" from the Portuguese Política Nacional de Resíduos Sólidos), under discussion since 2000, was approved by Law # 12,305/2010)[8]. One of the scopes of this policy is to enforce the adequate environmental final destination of the solid waste. On 15/07/2020, Law # 12,305/2010 was revised by Law # 14,026/2020[9], which includes deadlines for appropriate waste disposal under the cities' management duty and responsibility. Deadlines will depend on the population size of cities and if they have prepared the Integrated Solid Waste Management Plan, which has to include tax collection mechanisms to ensure economic and financial sustainability. As can be seen, the main concern of current policies still is the irregular disposal practices. The previous and current policies do not foresee either the obligation of landfill gas destruction or the promotion of the landfill gas use such as those for the production of renewable energy and processing of organic waste. No incentive to promote LFG flaring, the energetic use of biogas nor new technologies for waste treatment can be noted.

Concerning specifically the energetic use of the LFG, the project initial conception was in line with the Brazilian government initiatives to increase the renewable energy share in the electric matrix. Through Law # 10,438/2002[10], the Brazilian government created PROINFA (Program for Alternative Energy Sources) for promoting the renewable electricity generation by celebrating long-term power purchase agreements (20-year period) at a guaranteed price of at least 80% of the average energy

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[8] Law # 12,305/2010. Available at: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/l12305.htm

[9] Law # 14,026/2020. Available at: http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2020/Lei/L14026.htm#art11

[10] Available at: <http://www.planalto.gov.br/ccivil_03/leis/2002/L10438.htm>

supply tariff charged to ultimate consumers. However, the public call for the first phase of the program occurred in 2004, which no biogas projects participated[11]. Currently, there is no indication by the Brazilian government when the second phase of the program will occur or if it will occur indeed.

More recently, the government has been trying to promote distributed micro-scale renewable electricity generation by regulating the access of these small generation facilities to distribution systems and establishing the electricity compensation syste[12]. ANEEL Resolution which establishes rules and conditions for small scale initiatives was firstly published in 2012 and revised twice in 2015 and 2017 years. Revisions were conducted by adjusting installed capacities, requirements and strictness of the compensation system as few initiatives have been noticed since regulation came into force. These government initiatives strong indicates that clean and distributed electricity needs incentives to be implemented. In spite of this government initiative, only few photovoltaic projects have emerged and there are no new or specific regulations to promote LFG energetic use.

Based on information above, the baseline scenario of the project did not change at the time of this renewal of the crediting period and the baseline scenario identified in the registered PDD is still applicable. No new relevant national and/or sectoral policies and/or circumstances regarding the waste management sector occurred in comparison to the time of the submission of the project activity for validation, which could impact the compliance of the current baseline scenario. Therefore, the baseline scenario is still the same.

Step 1.2. Assess the impact of circumstances

As discussed above, there are no new relevant national and/or sectoral policies and/or circumstances in the waste management sector applicable to the project activity, in comparison to the time of the submission of the project activity for validation, which could impact the validity of the current baseline for the proposed crediting period.

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

The project activity consists of the implementation of a forced extraction system to collect LFG for flaring, where neither similar system was operated prior to its implementation. In the absence of the project activity, the PP would not have constructed the project’s infrastructure. Therefore, the LFG would continue to be emitted to the atmosphere as there was no incentive to implement an infrastructure to burn efficiently the methane.

In this context, this sub-step is not applicable since the identified baseline scenario at the validation of the project activity did not correspond to the continuation of use of the current equipment(s) without any investment and, the projects proponents or third party (or parties) would undertake an investment later due, for example, to the end of the technical lifetime of the equipment(s) before the end of the crediting period or the availability of a new technology.

In light of the definition above, independently of the penetration rate of different technologies, it is concluded that the baseline scenario remains valid and applicable for the third crediting period.

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

According to TOOL11, updates should be undertaken in the following cases:

- Where IPCC default values are used, the values should be updated if any new default values have been adopted and published by the IPCC, for example, in guidelines for national GHG inventories, IPCC assessment report or special reports by the IPCC;

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[11] Information available at: <https://eletrobras.com/pt/Paginas/Proinfa.aspx>

[12] ANEEL Resolution # 482 issued on 17-April-2012. Available at: <http://www2.aneel.gov.br/cedoc/ren2012482.pdf>

- Where emission factors, values or emission benchmarks are used and determined only once for the crediting period, they should be updated, except if the emission factors, values or emission benchmarks are based on the historical situation at the site of the project activity prior to the implementation of the project and cannot be updated because the historical situation does not exist anymore as a result of the CDM project activity.

In the first crediting period of the project, AM0003 (v3.0) was used. This methodology was replaced by ACM0001 and, therefore, the PDD from the second crediting period reflected the updated procedures of ACM0001 and referred tools. Since the third crediting period includes electricity generation to the grid, algorithms were revised and electricity generation related parameters were included in this PDD. Detailed description of methods used to calculate ex-ante emission reductions is presented in section B.6.

Step 2. Update the current baseline and the data and parameters
Step 2.1. Update the current baseline

The baseline emissions for the third 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 and has not impacted the project. Detailed description on how baseline emissions were determined for this third crediting period is presented in section B.6.

Step 2.2. Update the data and parameters

All parameters regarding the baseline emissions calculation have been updated for the third crediting period. Further information can be seen in section B.6.

B.5. Demonstration of additionality

According to §280 of the CDM Project Standard for Project Activities (v3.0), for renewal of crediting period of a registered CDM project activity, the project participants are not required to reassess the additionality of the project activity nor update the section of the PDD relating to additionality. However, since the project activity was registered in the first crediting period applying AM0003 (v3.0), which was replaced by ACM0001, this PDD reflects the changes for the application of the latest available version of ACM0001.

According to ACM0001, TOOL32 can be applied if, in the baseline scenario, the LFG is assumed to be the atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons (scenario (a) of ACM0001).

The Lara landfill started operations in 1987 without installing any efficient LFG collection and flaring equipment. Only few venting drains were installed in order to avoid fire hazards and, then the vented gas then was occasionally combusted by manually igniting the gas in the head of the LFG venting drains. As there was no requirement for methane destruction, no technology was employed up to 2005, when the project activity started construction. Therefore, item a) of ACM0001 is the baseline scenario of the project activity.

According to TOOL32, project activities are automatically additional if the LFG vented and/or flared but not utilized for energy generation and that under of the project activity 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.

In the baseline scenario, the LFG would be vented and occasionally combusted by manually igniting the gas in the head of the LFG venting drains. Currently, the project activity only uses LFG for flaring and, from December 2021 onwards, it will generate electricity in a 6.40MW installed capacity facility. Therefore, the project complies with TOOL32 requirements – item a) and c) above – and it is automatically additional.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

Baseline Emissions

Baseline emissions are determined according to the following equation:

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$ **Equation 1**

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 ($t\ CO_2/yr$)
$BE_{HG4,y}$	=	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 ($t\ CO_2/yr$)

Baseline emissions associated with natural gas use ($BE_{NG,y}$) and heat generation ($BE_{HG,y}$) are not applicable to the proposed project activity. Therefore, $BE_y = BE_{CH4,y} + BE_{EC,y}$.

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

Baseline emissions of methane from the SWDS are determined, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account[13].

$$BE_{CH4,y} = \left(\left(1 - OX_{top\_layer}\right) \times F_{CH4,PJ,y} - F_{CH4,BL,y}\right) \times GWP_{CH4}$$ **Equation 2**

Where,

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

Ex post determination of $F_{CH4,PJ,y}$

[13] $OX_{top\text{-}layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in the methodological tool "Emissions from solid waste disposal sites". In addition to this effect, the installation of a LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, such as with a high suction pressure, the air may decrease the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used this effect was considered to be very small, as the operators of the SWDS have in most cases an incentive to main a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.

During the crediting period, $F_{CH4,PJ,y}$ is to be determined as the sum of the quantities of methane flared and forwarded to the electricity generation plant, considering the following equation:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y}$$ **Equation 3**

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* (tCH_4/yr)
$F_{CH4,EL,y}$	=	Amount of methane in the LFG which is used for electricity generation in year *y* (tCH_4/yr)
$F_{CH4,HG,y}$	=	Amount of methane in the LFG which is used for heat generation in year *y* (tCH_4/yr)
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network in year *y* (tCH_4/yr)

In the case of the project activity, $F_{CH4,HG,y}$ and $F_{CH4,NG,y}$ are zero since the proposed project activity neither produces heat nor distributes natural gas through a network. Therefore, $F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$.

According to ACM0001, $F_{CH4,flared,y}$ and $F_{CH4,EL}$ shall be determined using TOOL08 applying the following requirements apply:

- 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;
- CH_4 is the greenhouse gases for which the mass flow should be determined;
- The flow of the gaseous stream should be measured on continuous basis;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the tool); and
- The mass flow will be summed to a yearly unit basis (tCH_4/yr).

For calculating $F_{CH4,flared,y}$ and $F_{CH4,EL}$, measurement options (A, B or C) from the TOOL08 will be used as follows.

Option A

While applying option A, it is necessary to demonstrate that the gaseous stream is dry by using one of the following methods:

(a) Measure the moisture content of the gaseous stream ($C_{H2O,t,db,n}$) and demonstrate that this is less or equal to 0.05 kg H_2O/m^3 dry gas; or
(b) Demonstrate that the temperature of the gaseous stream (Tt) 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:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t}$$ **Equation 4**

With

$$\rho_{i,t} = (P_t \times MM_i) / (R_u \times T_t)$$ **Equation 5**

Where,

$F_{i,t}$	=	Mass flow of CH_4 in the gaseous stream (gas sent to electricity generation facility) 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) – of the gas sent to electricity generation facility
$v_{i,t,db}$	=	Volumetric fraction of CH_4 in the gaseous stream in time interval *t* on a dry basis (m^3 gas *i*/m3 dry gas)
$\rho_{i,n}$	=	Density of CH_4 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)
T_t	=	Temperature of the gaseous stream in time interval t (K)
MM_i	=	Molecular mass of CH_4 (kg/kmol)
R_u	=	Universal ideal gases constant ($Pa.m^3/kmol.K$)

If it cannot be demonstrated that the gaseous stream is dry, then the flow measurement should be assumed to be on a wet basis while applying option B or C below.

Option B

The mass flow of greenhouse gas i (Fi,t) is determined using equations 4 and 5 above. The volumetric flow of the gaseous stream in time interval t on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,db} = V_{t,wb} \ / \ (1 \times v_{H2O,t,db})$$ **Equation 6**

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 gas *i*/m^3 dry gas)
$v_{H2O,t,db}$	=	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 equation:

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} \times MM_{t,db}}{MM_{H2O}}$$ **Equation 7**

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)

And,

$$MM_{t,db} = \sum_k v_{k,t,db} \times MM_k$$ **Equation 8**

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, CO_2, O_2, CO, H_2, CH_4, N_2O, NO, NO_2, SO_2, SF_6 and PFCs).

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, the volumetric fraction of only the gases k that are greenhouse gases and are 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 absolute humidity of the gaseous stream ($m_{H2O,t,db}$) is determined using either Option 1 or 2 below:

- *Option 1: Calculation using measurement of the moisture content*

This option provides a procedure to determine the absolute humidity of the gaseous stream ($m_{H2O,t,db}$) from measurements of the moisture content of the gas:

$$\boldsymbol{m_{H2O,t,db} = \frac{C_{H2O,t,db,n}}{10^6 \times \rho_{t,db,n}}}$$ **Equation 9**

Where,

$m_{H2O,t,db}$	=	Absolute humidity in the gaseous stream in time interval t on a dry basis (kg H_2O/kg dry gas)
$C_{H2O,t,db,n}$	=	Moisture content of the gaseous stream in time interval t on a dry basis at normal conditions (mg H2O/m3 dry gas)
$\rho_{t,db,n}$	=	Density of the gaseous stream in time interval t on a dry basis at normal conditions (kg dry gas/m3 dry gas)

And.

$$\boldsymbol{\rho_{t,db,n} = \frac{P_n \times MM_{t,db}}{R_u \times T_n}}$$ **Equation 10**

Where,

$\rho_{t,db,n}$	=	Density of the gaseous stream in time interval t on a dry basis at normal conditions (kg dry gas/m^3 dry gas)
P_n	=	Absolute pressure at normal conditions (Pa)
T_n	=	Temperature at normal conditions (K)
$MM_{t,db}$	=	Molecular mass of the gaseous stream in a time interval t on a dry basis (kg dry gas/kmol dry gas)
R_u	=	Universal ideal gases constant (Pa.m^3 /kmol.K)

- *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. If it is conservative to assume that the gaseous stream is dry, then $m_{H2O,t,db}$ is assumed to equal 0. If it is conservative 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 as follows:

$$\boldsymbol{m_{H2O,t,db,Sat} = \frac{p_{H2O,t,Sat} \times MM_{H2O}}{(P_t - p_{H2O,t,Sat}) \times MM_{t,db}}}$$ **Equation 11**

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 H2O/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)

Option C

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

$$F_{i,t} = V_{t,wb,n} \times v_{i,t,wb} \times \rho_{i,n}$$ **Equation 12**

With

$$\rho_{i,n} = (P_n \times MM_i) / (R_u \times T_n)$$ **Equation 13**

Where,

$F_{i,t}$	=	Mass flow of CH_4 in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,wb,n}$	=	Volumetric flow of the gaseous stream in time interval *t* on a wet basis at normal conditions (m^3 wet gas/h)
$v_{i,t,wb}$	=	Volumetric fraction of CH_4 in the gaseous stream in time interval *t* on a wet basis (m^3 gas *i*/m^3 wet gas)
$\rho_{i,n}$	=	Density of greenhouse gas i in the gaseous stream at normal conditions (kg gas i/m^3 wet gas i)
P_n	=	Absolute pressure at normal conditions (Pa)
T_n	=	Temperature at normal conditions (K)
MM_i	=	Molecular mass of CH_4 (kg/kmol)
R_u	=	Universal ideal gases constant (Pa.m^3/kmol.K)

The following equation should be used to convert the volumetric flow of the gaseous stream from actual conditions to normal conditions of temperature and pressure:

$$V_{t,wb,n} = V_{t,wb} \times [(T_n / T_t) \times (P_t / P_n)]$$ **Equation 14**

Where,

$V_{t,wb,n}$	=	Volumetric flow of the gaseous stream in a time interval t on a wet basis at normal conditions (m3 wet gas/h)
$V_{t,wb}$	=	Volumetric flow of the gaseous stream in time interval t on a wet basis (m^3 wet gas/h)
P_t	=	Pressure of the gaseous stream in time interval t (Pa)
T_t	=	Temperature of the gaseous stream in time interval t (K)
P_n	=	Absolute pressure at normal conditions (Pa)
T_n	=	Temperature at normal conditions (K)

It is important mentioning that flow meters installed convert automatically the volumetric flow of the gaseous stream from actual conditions to normal conditions of temperature and pressure.

Amount of methane destroyed by flaring ($F_{CH4,flared,y}$)

$F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flares and any methane emissions from the flares, as follows:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$$ **Equation 15**

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)

$F_{CH4,sent\_flare,y}$ is determined directly using TOOL08 and will be used for emission reductions calculation.

Project Emissions from flaring:

Project emissions are related to the amount of methane not destroyed in the flares and will be calculated following the procedures of TOOL06 as follows.

<u>STEP 1</u>: *Determination of the methane mass flow of the residual gas*

The mass flow of methane in the residual gaseous stream in the minute *m* ($F_{CH4,m}$) will be determined using the procedures set out by *TOOL08* and 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;
- CH_4 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. Please note that this parameter corresponds to $F_{CH4,sent\_flare,y}$. Therefore, the same methodological approaches apply to both parameters (Option A of the tool). Data is collected in a 1-minute interval as required by the tool.

The tool also requires that <u>low height flares</u> shall be adjusted, as a conservative approach, by subtracting 0.1 from the efficiency. According to definitions from the tool, a low height flare is an enclosed flare for which the flame enclosure has a height between 10 and two times the diameter of the enclosure.

Since the project flares have 4,500m diameter and 16,025 m height, its height is between the indicated range (2 x 4,500m = 9,000m and 10 x 3,098m = 45,000m). Therefore, the project flares are classified as low height flares and efficiency to be used is 80%, *i.e.* 90% by default minus 10% discount for low height flares.

<u>STEP 2</u>: *Determination of flare efficiency*

The project has installed enclosed flares and Option A will be used to determine efficiency as follows:

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

(1) The temperature of the 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 $\eta_{flare,m}$ is 0%.

<u>STEP 3</u>: *Calculation of project emissions from flaring*

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

$$PE_{flare,y} = GWP_{CH_4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \cdot \left(1 - \eta_{flare,m}\right) \times 10^{-3}$$ **Equation 16**

Where,

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

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

It is determined as follows:

$$\mathrm{F_{CH4,PJ,y}} = \eta_{\mathrm{PJ}} \cdot \mathrm{BE_{CH4,SWDS,y}} / \mathrm{GWP_{CH4}}$$ **Equation 17**

Where,

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$BE_{CH4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (t CO_2e/yr)
η_{PJ}	=	Efficiency of the LFG capture system installed in the project activity, this is considered as 75% based on the registered PDD and a third-party study[14]
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

$BE_{CH4,SWDS,y}$ is determined using TOOL04 and the following guidance should be taken into account as established in ACM0001:

- f_y in the tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in $F_{CH4,BL,y}$;
- In the tool, x begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation); and
- Sampling to determine the fractions of different waste types is not necessary because the waste composition can be obtained from previous studies (obtained from data from ECOURBIS – landfill operator).

Application A of the Tool is used (i.e., the project activity mitigates methane emissions from a specific existing SWDS-solid waste disposal site). A yearly selection has been chosen considering the massive amount of data since the landfill started receiving waste.

The amount of methane that would in the absence of the project activity be generated from disposal of waste at the solid waste disposal site ($BE_{CH4,SWDS,y}$) is calculated with a multi-phase model. The calculation is based on a first order decay (FOD) model.

$$BE_{CH_\$,SWDS,y} = \varphi y \times (1 - \mathrm{f_y}) * \mathrm{GWP_{CH_4}} * (1 - \mathrm{OX}) * \frac{16}{12} * \mathrm{F} * \mathrm{DOC_{f,y}} * \mathrm{MCFy} * \sum_{x=1}^{y} \sum_{j} \mathrm{W_{j,x}} * \mathrm{DOC_j} \times e^{-k_j (y-x)} * \left(1 - e^{-k_j}\right)$$ **Equation 18**

Where,

$BE_{CH4,SWSD,y}$	=	Baseline methane emissions occurring in year y generated from waste disposal at the solid waste disposal site (SWDS) during a period ending in year y (tCO_2e/y)
φ	=	Model correction factor to account for model uncertainties (default value of 0.75), Option 1 in the Tool has been selected, value as per Table 3 of the Tool (Application A and humid wet conditions).
f	=	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

[14] Report "Estimativa de Produção Teórica de Biogas", document 10546-0000-GN-RT001-0, page 4.

		y. As this is already accounted for in $F_{CH4,BL,y}$, "f" in the Tool shall be assigned a value of 0.
GWP_{CH4}	=	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
OX	=	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste) (default Tool value 0.1)
F	=	Fraction of methane in the SWDS gas (volume fraction) (0.5)
$DOC_{f,y}$	=	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWSD for year y (weight fraction). Default value of 0.5 for Application A
MCF_y	=	Methane correction factor for year y (1)
$W_{j,x}$	=	Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year *x* (t)
DOC	=	Fraction of degradable organic carbon (by weight fraction) in the waste type *j*
k_j	=	Decay rate for the waste type *j (1/yr)*
j	=	Type of residual waste or types of waste in the MSW
x	=	Years in the time period in which waste is disposed at the SWSD, extending from the first year in the time period (x=1) to year (x = y)
y	=	Year for which methane emissions are calculated (considering a consecutive period of 12 months)

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

NBR 13896/97, consisting of the technical standard published by ABNT (Brazilian Association of Technical Standards - *Associação Brasileira de Normas Técnicas*), sets out the requirements for the development of the design, implementation and operation of landfills aiming at minimizing gaseous emissions and promoting its capture and correct management. However, its use is not mandatory and the norm neither specifies the amount of methane to be destroyed nor the system that shall be put in place. In addition, there is no federal/state/local law requiring the destruction of the methane.

Previously to the implementation of the project activity no active system was implemented and methane was burned in an uncontrolled manner. Hence, in the case of the project Case 3 is applicable (*i.e*., there is no technical requirement to destroy methane and there was an existing LFG capture and destruction system).

In accordance with the ACM0001 methodology, Case 3 is applicable to the project. Since there is no monitored or historical data on the amount of methane that was captured in the year prior to the implementation of the project, the following equation applies:

$$F_{CH4,BL,sys,y} = 0.2 \times F_{CH4,PJ,y}$$ **Equation 19**

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

According to ACM0001, $BE_{EC,y}$ shall be calculated following procedures set out in TOOL05 while applying scenario I as follows:

$$BE_{EC,y} = \sum EC_{BL,k,y} \times EF_{EL,,k,y} \times \left(1 + TDL_{k,y}\right)$$ **Equation 20**

Where,

$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year *y* (t CO_2/yr)
$EC_{BL,k,y}$	=	Net amount of electricity generated using LFG in year y (MWh/yr)
$EF_{EL,k,y}$	=	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*
k	=	Sources of electricity generated in the baseline

The CO_2 emission factor of the grid will be calculated following the steps of TOOL07, where $EF_{EL,k,y} = EF_{grid,CM,y}$, as follows (option A1 of TOOL05).

- **STEP 1** - Identify the relevant electricity systems

According to the tool, "*If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used. If such delineations are not available, project participants should define the project electricity system and any connected electricity system and justify and document their assumptions in the CDM-PDD*".

The Brazilian DNA published Resolution #8, issued on 26th May, 2008, defines the Brazilian Interconnected Grid as a single system that covers all the five macro-geographical regions of the country (North, Northeast, South, Southeast and Midwest). Hence this figure is used to calculate the baseline emission factor of the grid.

- **STEP 2** – Choose whether to include off-grid power plants in the project electricity system (optional)

Option I of the tool is chosen, which is to include only grid power plants in the calculation.

- **STEP 3 -** Select a method to determine 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 simple operating margin can only be used where low-cost/must-run resources[15] constitute less than 50% of total grid generation in: 1) average of 5 most recent years, or 2) based on long-term normalities for hydroelectricity production. Figure 6 shows the share of hydroelectricity in the total electricity production for the Brazilian interconnected system. The results show the non-applicability of the simple operating margin to the proposed CDM Project Activity.

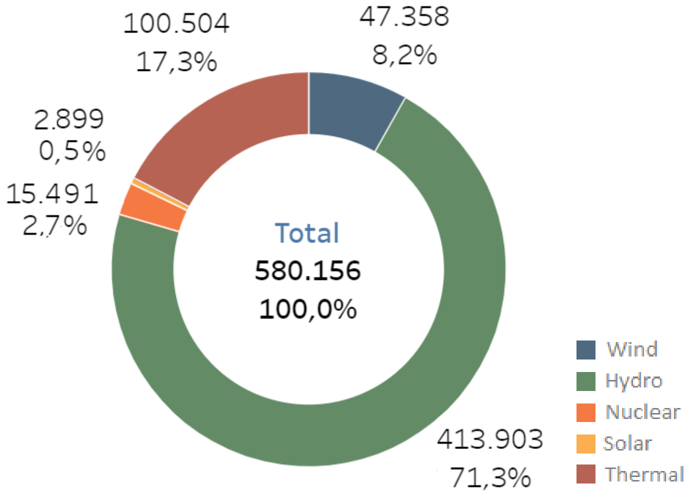

Figure 6 – Electricity generation in the Brazilian interconnected system by source, 2016-2020(GWh)[16].
Source: *ONS: Histórico da Operação. Available at* <http://www.ons.org.br/Paginas/resultados-da-operacao/historico-da-operacao/geracao_energia.aspx>.

[15] Low operating cost and must run resources typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation.

[16] Data for the 5-year average for the most recent years at the time of the start of the second crediting period of the project.

The fourth alternative, an average operating margin, is an oversimplification and does not reflect in any way the impact of the project activity on the operating margin. The use of the dispatch data analysis method requires hourly monitoring of electricity and, in order to reduce data demand, the simple adjusted operating margin option b) of the tool was chosen. Since the *ex-post* data vintage was applied in the first and second crediting periods, the same data vintage was chosen for the third crediting period.

- **STEP 4** - Calculate the operating margin emission factor according to the selected method

The simple adjusted OM shall be calculated based on the following equation:

$$EF_{grid,OM-adj,y} = (1-\lambda_y)\cdot\frac{\sum_m EG_{m.y}\times EF_{EL,m,y}}{\sum_m EG_{m.y}} + \lambda_y\cdot\frac{\sum_k EG_{k,y}\times EF_{EL,k,y}}{\sum_k EG_{k,y}} \quad \textbf{Equation 21}$$

Where,

$EF_{grid,OM-adj,y}$	=	Simple adjusted operating margin CO_2 emission factor in year *y* (tCO_2/MWh)
λ_y	=	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year *y*
$EG_{m,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EG_{k,y}$	=	Net quantity of electricity generated and delivered to the grid by power unit *k* in year *y* (MWh)
$EF_{EL,m,y}$	=	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{EL,k,y}$	=	CO_2 emission factor of power unit *k* in year *y* (tCO_2/MWh)
m	=	All grid power units serving the grid in year *y* except low-cost/must-run power units
k	=	All low-cost/must run grid power units serving the grid in year *y*
y	=	The relevant year as per the data vintage chosen in Step 3

For the simple OM, the simple adjusted OM and the average OM, the emissions factor can be calculated using either of the two following data vintages:

(a) Ex ante option: if the ex ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation. For off-grid power plants, use a single calendar year within the five most recent calendar years prior to the time of submission of the CDM-PDD for validation;

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

Since the project activity applies the ex-post data vintage, $EF_{grid,OM-adj,y}$ will be determined for the year in which the project activity displaces grid electricity and thus requiring annually update during monitoring. Data made available by the Brazilian DNA for the operating margin emission factor is considered for the ex-ante estimative and will be updated at the time of the project verification following TOOL07.

- **STEP 5** - Calculate the build margin (BM) emission factor

The sample group of power units *m* used to calculate the build margin was determined following the procedure provided by the tool and BM emission factor shall be calculated based on the equation below:

$$EF_{grid,BM,y} = \frac{\sum mEG_{m,y} \times EF_{EL,m,y}}{\sum mEG_{m,y}}$$ **Equation 22**

Where:

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_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 (tCO_2/MWh)
m	=	Power units included in the build margin
y	=	Most recent historical year for which electricity generation data is available

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 shall be updated annually, ex-post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions 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 chosen by the Project Participants is option 2, *i.e.* for the third crediting period, the build margin emission factor calculated for the second crediting period is used[17].

- **STEP 6 –** Calculate the combined margin (CM) emissions factor

The calculation of the combined margin (CM) emission factor is based on one of the following methods:

(a) Weighted average CM; or
(b) Simplified CM.

Since power grid is not located in LDC/SIDs/URC and the weighted average CM method (option A) is the preferred option, this method was considered. The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$$ **Equation 23**

Where,

$EF_{grid,BM,y}$	=	Build margin CO_2 emission factor in year y (tCO_2/MWh);

[17] In the second crediting period, the build margin emission factor of the grid was used to determine project emissions due to electricity consumption. Therefore, the same figure is considered in the third crediting period.

$EF_{grid,OM,y}$	=	Operating margin CO_2 emission factor in year y (tCO_2/MWh);
w_{OM}	=	Weighting of operating margin emissions factor (%);
w_{BM}	=	Weighting of build margin emissions factor (%).

According to TOOL07, values adopted for w_{OM} and w_{BM} in the third crediting period are 0.25 and 0.75, respectively.

Steps (C) and (D) of ACM0001 methodology are not applicable since there won't be either heat generation or natural gas distribution through a network in the project activity.

Project Emissions

Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} + PE_{SP,y}$$ **Equation 24**

Where,

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

$PE_{DT,y}$ and $PE_{SP,y}$ are not applicable to the proposed project activity. In the project activity, liquefied petroleum gas (LPG) is consumed for flare ignition system. Also, electricity from the grid may be consumed for the operation of the active LFG collection and destruction systems.

Emissions from consumption of electricity due to the project activity ($PE_{EC,y}$)

Electricity consumed at the project activity can be generated at the project site with LFG or imported from the grid. If electricity will be generated at the project site with LFG, project emissions will be zero. In case electricity is imported from the grid, project emissions shall be calculated following the procedures set out by TOOL05 under scenario A (electricity consumption from the grid) as follows:

$$PE_{EC,\ grid,\ y} = \sum_j EC_{PJ,\ j,\ y} \times EF_{EL,\ j,\ y} \times \left(1 + TDL_{j,\ y}\right)$$ **Equation 25**

Where,

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

Electricity sources *j* corresponds to all the sources of electricity consumed for the operation of the LFG capture system and transportation of the LFG to the flares. As allowed by TOOL05, $TDL_{j,y}$ will be following TOOL05.

The emission factor for electricity generation will be determined as presented above in "Step B: Baseline emissions associated with electricity generation ($BE_{EC,y}$)".

Emissions from consumption of fossil fuels ($PE_{FC,y}$)

In order to calculate project emissions resulting from combustion of fossil fuels, TOOL03 shall be used. During the crediting period, it is used Liquefied Petroleum Gas (LPG) ignition of the flare. Project emissions related to this source are estimated using the following formulae:

$$PE_{FC,j,y} = \sum_{i} FC_{i,j,y} \times COEF_{i,y} \qquad \textbf{Equation 26}$$

Where,

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

The CO_2 emission coefficient $COEF_{i,y}$ will be calculated using Option B of TOOL03 since the necessary data for Option A is not available. As per Option B, the CO_2 emission coefficient $COEF_{i,y}$ is calculated based on net calorific value and CO_2 emission factor of the fuel type *i*, as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2,i,y} \qquad \textbf{Equation 27}$$

Where,

$COEF_{i,y}$	=	Is the CO_2 emission coefficient of fuel type *i* in year *y* (tCO_2/mass or volume unit)
$NCV_{i,y}$	=	Is the weighted average net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	=	Is the weighted average CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ)
i	=	Are the fuel types combusted in process j during the year *y*

Leakage

According with ACM0001 there is no need to account for leakage.

Emission reductions

Emission reductions will be calculated using the formula below:

$$ER_y = BE_y - PE_y \qquad \textbf{Equation 28}$$

Where,

ER_y	=	Emission reductions during the year *y* (tCO_2e)
BE_y	=	Baseline emissions in year *y* (tCO_2e)
PE_y	=	Project emissions in year *y* (tCO_2e)

B.6.2. Data and parameters fixed ex ante

"ACM0001 Methodology"

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 TOOL04 (v8.0)
Value(s) applied	0.1
Choice of data or measurement methods and procedures	As per the ACM0001.
Purpose of data	Calculation of baseline emissions
Additional comment	$OX_{top\text{-}layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in TOOL04. In addition to this effect, the installation of a LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, such as with a high suction pressure, the air may decrease the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used this effect was very small, as the operators of the SWDS have in most cases an incentive to maintain a high methane concentration in the LFG. For these reasons, the oxidation factor shall be included in the calculation of baseline emissions whereas the effect of oxidation is, as a conservative assumption, neglected under the project activity

Data/Parameter	***GWP_{CH4}***
Data unit	tCO_2e/tCH_4
Description	Global Warming Potential of CH_4
Source of data	IPCC
Value(s) applied	25 for the second commitment period. Shall be updated according to any future COP/MOP decisions.
Choice of data or measurement methods and procedures	As per the applicable methodology
Purpose of data	Calculation of baseline 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	Data from a third-party company presented in "Estimativa de Produção Teórica de Biogas". Document 10546-0000-GN-RT001-0 (page 4).
Value(s) applied	75%
Choice of data or measurement methods and procedures	Technical specifications of the LFG capture system according to a third-party study. η_{PJ} is also according to the parameter effectiveness of the gas capturing system as established in the registered PDD.
Purpose of data	Calculation of baseline emissions
Additional comment	Applicable to Step A.1.1

TOOL04: "Tool Emissions from solid waste disposal sites"

Data/Parameter	$\varphi_{default}$
Data unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	-
Value(s) applied	0.75
Choice of data or measurement methods and procedures	As per TOOL04. This parameter is used to determine the baseline emissions following the procedures related to Application A. Further, the project is located near São Paulo city (São Paulo state) which possesses tropical weather conditions[18]: MAT 21ºC > 20ºC MAP 1,752mm > 1,000mm Therefore, the value correspondent to this condition as presented in Table 3 of the methodology is chosen.
Purpose of data	Calculation of baseline emissions
Additional comment	As per Table 3 since the project participants have chosen to apply Option 1 to determine this parameter.

[18] INMET (2019). The National Meteorology Institute. Meteorological Database – São Paulo (Banco de Dados Meteorológicos – São Paulo), available at: <https://bdmep.inmet.gov.br/>. As there is no INMET monitoring station in Mauá municipality, São Paulo station was used (Mirante station) as it is the nearest station of Mauá.

Data/Parameter	***f_y***
Data 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	ACM0001
Value(s) applied	0
Choice of data or measurement methods and procedures	In accordance with the ACM0001 methodology this value is to be assigned since the amount of LFG that would have been captured and destroyed is already accounted for in Equation 2. As per *TOOL04*, for application A, this parameter is determined once for the crediting period ($f_y = f$).
Purpose of data	Calculation of baseline emissions
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	As per TOOL04
Purpose of data	Calculation of baseline emissions
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	As per TOOL04
Purpose of data	Calculation of baseline emissions
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 proposed project activity corresponds to Application A described in TOOL04. Therefore, in accordance with the requirements set out by tool, the default value was chosen.
Purpose of data	Calculation of baseline emissions
Additional comment	This factor reflects the fact that some of the degradable organic carbon does not degrade, or degrades very slowly, in the SWDS.

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
Choice of data or measurement methods and procedures	The proposed project activity matches Application A described in TOOL04. The Lara Landfill meets the criteria of managed SWDS. Hence, the value corresponding to **anaerobic managed solid waste disposal sites** is chosen.
Purpose of data	Calculation of baseline emissions
Additional comment	The methane correction factor (MCF) accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS.

<table>
<tr><th>Data/Parameter</th><th>DOC_j</th></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>DOC_j
(% wet waste)</th><th>Waste type j</th></tr>
<tr><td>43%</td><td>Wood and wood products</td></tr>
<tr><td>40%</td><td>Pulp, paper and cardboard</td></tr>
<tr><td>15%</td><td>Food, food waste, beverages and tobacco</td></tr>
<tr><td>24%</td><td>Textiles</td></tr>
<tr><td>20%</td><td>Garden, yard and park waste</td></tr>
<tr><td>0%</td><td>Glass, plastic, metal, other inert waste</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Values for MSW, as per Table 6 of TOOL04.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><th>Data/Parameter</th><th>k_j</th></tr>
<tr><td>Data unit</td><td>1/yr</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">Waste type j</th><th>k_j</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>As per Table 7 of TOOL04.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>The project is located near São Paulo city (São Paulo state) which possesses tropical weather conditions[18]:
MAT 21ºC > 20ºC
MAP 1,752mm > 1,000mm</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>W_x</td></tr>
<tr><td>Data unit</td><td>T</td></tr>
<tr><td>Description</td><td>Total amount of waste disposed in a SWDS in year x</td></tr>
<tr><td>Source of data</td><td>Onsite measurements</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Year</th><th>Wx</th><th>Year</th><th>Wx</th></tr>
<tr><td>1987</td><td>165,518</td><td>2007</td><td>688,201</td></tr>
<tr><td>1988</td><td>170,981</td><td>2008</td><td>873,638</td></tr>
<tr><td>1989</td><td>176,623</td><td>2009</td><td>853,185</td></tr>
<tr><td>1990</td><td>182,451</td><td>2010</td><td>1,068,760</td></tr>
<tr><td>1991</td><td>188,472</td><td>2011</td><td>1,241,627</td></tr>
<tr><td>1992</td><td>194,692</td><td>2012</td><td>1,193,232</td></tr>
<tr><td>1993</td><td>201,117</td><td>2013</td><td>1,186,458</td></tr>
<tr><td>1994</td><td>207,754</td><td>2014</td><td>836,690</td></tr>
<tr><td>1995</td><td>214,609</td><td>2015</td><td>814,742</td></tr>
<tr><td>1996</td><td>448,978</td><td>2016</td><td>872,176</td></tr>
<tr><td>1997</td><td>457,361</td><td>2017</td><td>1,313,029</td></tr>
<tr><td>1998</td><td>460,910</td><td>2018</td><td>1,204,389</td></tr>
<tr><td>1999</td><td>468,405</td><td>2019</td><td>1,207,053</td></tr>
<tr><td>2000</td><td>473,610</td><td>2020</td><td>1,762,200</td></tr>
<tr><td>2001</td><td>489,484</td><td>2021</td><td>1,204,500</td></tr>
<tr><td>2002</td><td>545,091</td><td>2022</td><td>1,204,500</td></tr>
<tr><td>2003</td><td>536,158</td><td>2023</td><td>1,204,500</td></tr>
<tr><td>2004</td><td>615,327</td><td>2024</td><td>1,204,500</td></tr>
<tr><td>2005</td><td>641,362</td><td>2025</td><td>1,204,500</td></tr>
<tr><td>2006</td><td>672,777</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Data from a third-party company presented in "Estimativa de Produção Teórica de Biogas". Document 10546-0000-GN-RT001-0 (Appendix A).</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>Waste disposal for the 2020-2025 period was estimated.</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>Waste composition</td></tr>
<tr><td>Data unit</td><td>-</td></tr>
<tr><td>Description</td><td>Types of waste in the MSW</td></tr>
<tr><td>Source of data</td><td>Onsite measurements</td></tr>
<tr><td>Value(s) applied</td><td><table>
<tr><th>Waste Type</th><th>Fraction</th></tr>
<tr><td>Wood and wood products</td><td>1.7%</td></tr>
<tr><td>Pulp, paper and cardboard</td><td>20.4%</td></tr>
<tr><td>Food, food waste, beverages and tobacco</td><td>47.4%</td></tr>
<tr><td>Textiles</td><td>5.1%</td></tr>
<tr><td>Garden, yard and park waste</td><td>0.0%</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>25.4%</td></tr>
</table></td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Data from a third-party company presented in "Estimativa de Produção Teórica de Biogas". Document 10546-0000-GN-RT001-0 (page 14).</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

TOOL06: "Project emissions from flaring"

Data/Parameter	***$SPEC_{flare}$***
Data unit	Temperature - ºC Flow rate or heat flux – kg/h or m^3/h Maintenance schedule – number of days
Description	Manufacturer's flare specification for temperature and flow rate and maintenance schedule
Source of data	Flare manufacturer
Value(s) applied	Not used for *ex-ante* calculations
Choice of data or measurement methods and procedures	The flare specifications set by the manufacturer for the correct operation of the flare for the selected parameters are: (a) Minimum and maximum inlet flow rate, if necessary converted to flow rate at reference conditions or heat flux: Min. 1,000Nm^3/h Max. 8,000Nm^3/h (for each flare) (b) Minimum and maximum operating temperature: 800ºC – 1,200ºC (c) Maintenance schedule: 365 days
Purpose of data	Calculation of project emissions
Additional comment	-

TOOL07: "Tool to calculate the emission factor for an electricity system"

Data/Parameter	$EF_{grid,BM,y}$
Data unit	tCO_2/MWh
Description	Build margin CO_2 emission factor in year *y*
Source of data	The Brazilian DNA: http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_despacho.html
Value(s) applied	0.2713 based on the most recent information available (2013 year)
Choice of data or measurement methods and procedures	According to TOOL07, while applying option 2 (ex-post data vintage) for the third crediting period, the build margin emission factor of the second crediting period shall be applied. Value from the registered PDD was used.
Purpose of data	Calculation of project emissions
Additional comment	For methodological choices details, please refer to section B.6.1.

TOOL08: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data/Parameter	***Ru***
Data unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	As per the applicable tool
Value(s) applied	8,314
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	-

Data/Parameter	***MMi***
Data unit	kg/kmol
Description	Molecular mass of greenhouse gas *i*
Source of data	TOOL08
Value(s) applied	16.04 (for methane)
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	-

Data/Parameter	***MM_k***
Data unit	kg/kmol
Description	Molecular mass of gas *k*
Source of data	TOOL08
Value(s) applied	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
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline and project 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	TOOL08
Value(s) applied	18.0152
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	-

Data/Parameter	***P_n***
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	TOOL08
Value(s) applied	101,325
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	-

Data/Parameter	T_n
Data unit	K
Description	Temperature at normal conditions
Source of data	TOOL08
Value(s) applied	273.15
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline and project emissions
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

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

Baseline emissions of methane from the SWDS were calculated according to equation 2:

Table 1 – Baseline emissions of methane from the SWDS.

Year	$BE_{CH4,SWSD,y}$ (t_{CO2})	$F_{CH4,PJ,y}$ (t_{CH4})	$F_{CH4,BL,y}$ (t_{CH4})	$BE_{CH4,y}$ (t_{CO2})
From 15/09/2020	292,365	8,771	1,754	153,492
2021	993,365	29,801	5,960	521,517
2022	994,479	29,834	5,967	522,101
2023	998,745	29,962	5,992	524,341
2024	1,004,895	30,147	6,029	527,570
2025	1,012,094	30,363	6,073	531,349
2026	816,475	24,494	4,899	428,649
Up to 14/09/2027	478,028	14,341	2,868	250,965
TOTAL	**6,590,445**	**197,713**	**39,542**	**3,459,984**
Average during the crediting period	**941,492**	**28,245**	**5,649**	**494,283**

The following data was used to calculate the *ex-ante* methane estimative (as per TOOL04):

- Model correction factor (φ) to account for model uncertainties: 0.75 (default value for Option 1 as per the Tool);
- The fraction of methane captured at the SWDS and flared (f), combusted or used in another manner is zero according to ACM0001;
- The global warming potential of methane (GWP_{CH4}) is 25 tCO_2/tCH_4 for the 2nd commitment period of Kyoto Protocol;
- Oxidation factor, reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste: 0.1 (default value as per ACM0001);
- The fraction of methane in the SWDS gas (F) is 50% according to the default value of the tool;
- Fraction of degradable organic carbon (DOCf) that can decompose is 0.5 according to the default value of the tool;
- The values of fraction of degradable organic carbon (DOCj) and the decay rate of waste (kj) were used according to default values available in the tool of each type of waste j;
- MFC (Methane Conversion Factor): MCF value is adopted according with the type of SWDS. The Lara Landfill is a managed SWDS; thus, the MCF adopted is equal to 1.0;
- W_x (Total amount of organic waste prevented disposed in year x, in tons).

The amount of the solid waste entering in Lara Landfill has been monitored by the project developer and it presented in "Estimativa de Produção Teórica de Biogas" issued by a third-party company. Waste disposal for the 2020-2025 period was estimated. The waste composition is also taken from the same document.

Table 2 – Historical deposited solid waste at the site.

Year	Deposited waste (tons)	Year	Deposited waste (tons)	Year	Deposited waste (tons)
1987	165,518	2000	473,610	2013	1,186,458
1988	170,981	2001	489,484	2014	836,690
1989	176,623	2002	545,091	2015	814,742
1990	182,451	2003	536,158	2016	872,176
1991	188,472	2004	615,327	2017	1,313,029
1992	194,692	2005	641,362	2018	1,204,389
1993	201,117	2006	672,777	2019	1,207,053
1994	207,754	2007	688,201	2020	1,762,200
1995	214,609	2008	873,638	2021	1,204,500
1996	448,978	2009	853,185	2022	1,204,500
1997	457,361	2010	1,068,760	2023	1,204,500
1998	460,910	2011	1,241,627	2024	1,204,500
1999	468,405	2012	1,193,232	2025	1,204,500

Table 3 – Waste types historically disposed at the project site.

Category	**% (wet basis)**
Wood and wood products	1.7%
Pulp, paper and cardboard	20.4%
Food, food waste, beverages and tobacco	47.4%
Textiles	5.1%
Garden, yard and park waste	0.0%
Glass, plastic, metal, other inert waste	25.4%

b) Baseline emissions associated with electricity generation ($BE_{EC,y}$)

Baseline emissions due to electricity generation were calculated according to equation 20. Electricity generation is based on 6.40MW installed capacity and 93.0% plant load factor according to availability presented in the signed contract with the equipment supplier.

Regarding transmission losses, data from the Brazilian Power Regulatory Agency ("ANEEL" from the Portuguese Agência Nacional de Energia Elétrica) for 2018 year was used[19], i.e. 7.5%.

The calculation of the combined margin CO_2 emission factor for grid connected power generation ($EF_{grid,CM,y}$) follows the steps established in TOOL07. The most recent data available from the Brazilian DNA is considered for the OM EF determination (2020 year). BM EF established in the second crediting period (2013 year), as wells as weights for the OM and BM emission factor available in TOOL07 were applied:

Table 4 – Data used to calculate the emission factor.

$EF_{grid,BM,y}$ (tCO_2e/MWh)	w_{BM}	$EF_{grid,OM,y}$ (tCO_2e/MWh)	w_{OM}	$EF_{grid,CM,y}$ (tCO_2e/MWh)

[19] ANEEL Report "Perdas de Energia Elétrica na Distribuição" – edition 01/2019. Available at: <https://www.aneel.gov.br/documents/654800/18766993/Relat%C3%B3rio+Perdas+de+Energia_+Edi%C3%A7%C3%A3o+1-2019-02-07.pdf/d7cc619e-0f85-2556-17ff-f84ad74f1c8d>

0.2713	0.75	0.3490	0.25	0.2907

Therefore, baseline emissions are calculated as follows:

Table 5 – Baseline emissions due to electricity generation.

Year	***Operating Days***	***$EC_{BL,k,y}$ (MWh/yr)***	***$BE_{EC,y}$ (tCO_2/yr)***
From 15/09/2020	0	0	0
2021	31	4,428	1,384
2022	365	52,140	16,295
2023	365	52,140	16,295
2024	365	52,140	16,295
2025	365	52,140	16,295
2026	365	52,140	16,295
Up to 14/09/2027	258	36,855	11,518
TOTAL	**2,114**	**301,980**	**94,377**
Average during the crediting period	**302**	**43,140**	**13,482**

c) Project emission due to flaring

As described in section B.6.1. above, Project Participants have opted to consider the default value for flare efficiency using Option B.2. of TOOL08. Then the project emissions due to flaring gases have been estimated as:

Table 6 – Project emissions from flaring.

Year	***$F_{CH4,sent-flare,y}$ (tCH_4/yr)†***	***$PE_{flare,y}$ (tCO_2e/year)***
From 15/09/2020	8,771	43,855
2021	29,612	148,061
2022	27,611	138,055
2023	27,739	138,695
2024	27,924	139,618
2025	28,140	140,698
2026	22,271	111,355
Up to 14/09/2027	12,769	63,847
Total	**184,836**	**924,182**
Average during the crediting period	**26,405**	**132,026**

†Project emissions were calculated based on the difference between the LFG generated in the landfill and the amount of LFG sent to generators.

d) Project emissions due to electricity consumption from the grid

Project emissions due to electricity consumption from the grid are calculated following equation 25. For the ex-ante estimative, electricity consumed by the project activity on 3-year average (2018-2020) based on the electricity invoices issued by the power utility.

Regarding transmission losses, data from the Brazilian Power Regulatory Agency ("ANEEL" from the Portuguese Agência Nacional de Energia Elétrica) for 2018 year was used[20].

[20] ANEEL Report "Perdas de Energia Elétrica na Distribuição" – edition 01/2019. Available at: <https://www.aneel.gov.br/documents/654800/18766993/Relat%C3%B3rio+Perdas+de+Energia_+Edi%C3%A7%C3%A3o+1-2019-02-07.pdf/d7cc619e-0f85-2556-17ff-f84ad74f1c8d>

The calculation of the combined margin CO_2 emission factor for grid connected power generation ($EF_{grid,CM,y}$) follows the steps established in TOOL07. Values considered for the emission factor calculation is presented in **Erro! Fonte de referência não encontrada.**. $EF_{grid,CM,y}$ is 0.2907.

Estimation of project emissions due to electricity consumption is as follows:

Table 7 – Project emissions due to electricity consumption.

Year	*$EC_{PJ,y}$ (MWh/yr)*	*$EF_{EL,j,y}$ (MWh/yr)*	*$TDL_{j,y}$ (tCO_2/yr)*	*$PE_{EC,y}$ (tCO_2/yr)*
From 15/09/2020	117	0.2907	7.5%	37
2021	401	0.2907	7.5%	125
2022	401	0.2907	7.5%	125
2023	401	0.2907	7.5%	125
2024	401	0.2907	7.5%	125
2025	401	0.2907	7.5%	125
2026	401	0.2907	7.5%	125
Up to 14/09/2027	283	0.2907	7.5%	88
TOTAL	**2,803**	**-**	**-**	**876**
Average during the crediting period	**400**	**0.2907**	**7.5%**	**125**

*Value is based on data from 2018 year, as values for 2019 and 2020 year are not available yet.

e) Emissions from consumption of fossil fuels ($PE_{FC,y}$)

The quantity of LPG used in the project activity during the crediting period was 67.5kg per year. Considering a value for $NCV_{i,y}$ of 0.0465 GJ/kg from the 2020 Brazilian Energy Balance and $EF_{CO2i,y}$ of 0.0656tCO_2/GJ from the 2006 IPCC Guidelines on National GHG Inventories (at the upper limit of the uncertainty at a 95% confidence interval following the Tool), $COEF_{i,y}$ = 0.00305 tCO_2/kg while using Option B of TOOL03.

Table 8 – Estimative of project emissions from fossil fuel consumption.

Year	**LPG Consumption (kg)**	**$COEF_{i,y}$ (tCO_2/kg)**	**Project emissions (tCO_2e)**
From 15/09/2020	41	0.00305	0.13
2021	68		0.21
2022	68		0.21
2023	68		0.21
2024	68		0.21
2025	68		0.21
2026	68		0.21
Up to 14/09/2027	26		0.08
TOTAL	**473**		**1.44**

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 15/09/2020	153,492	43,892	0	109,600
2021	522,901	148,186	0	374,715
2022	538,396	138,181	0	400,216
2023	540,636	138,821	0	401,816
2024	543,865	139,743	0	404,122

2025	547,645	140,823	0	406,821
2026	444,944	111,480	0	333,464
Up to 14/09/2027	262,483	63,935	0	198,548
Total	**3,554,361**	**925,060**	**0**	**2,629,301**
Total number of crediting years	**7**			
Annual average over the crediting period	**507,766**	**132,151**	**0**	**375,614**

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

"ACM0001 Methodology"

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	$Op_{j,h}$
Data unit	-
Description	Operation of the equipment that consumes the LFG
Source of data	Project participants
Value(s) applied	Not used for *ex-ante* calculations.

Measurement methods and procedures	In the context of the proposed project activity, equipment unit *j* using *the LFG* consists of the flaring system. Hence, the following parameters are to be used to ensure that the plant is operating in hour *h*: *For the flaring system* • Temperature: according to the manufacturer's technical record, the combustion temperature varies from 800 to 1,200°C. Temperature shall varies between this range; • Flame: flame detection system is used to ensure that the equipment is operational. *For the power facility* • Products generated: data from the power utility based on energy meters readings. $Op_{j,h}$=0 when: • One of more temperature measurements are missing or below the minimum threshold in hour *h* (instantaneous measurements are made at least every minute); • Flame is not detected continuously in hour *h* (instantaneous measurements are made at least every minute); • No products are generated in the hour h; Otherwise, $Op_{j,h}$=1
Monitoring frequency	Hourly
QA/QC procedures	Flame detectors, temperature devices and energy meters shall be subject to a regular maintenance and testing regime to ensure accuracy. Calibration will be conducted according to manufacturers' specifications.
Purpose of data	Calculation of baseline emissions
Additional comment	Monitoring of working hours of equipment is required in order to ensure that no emission reductions are claimed for methane destruction during non-working hours.

Data/Parameter	$EG_{PJ,y}$
Data unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year y
Source of data	Electricity meter
Value(s) applied	52,140MWh/yr For the ex-ante estimative, 93% availability is considered according to signed contract with the equipment supplier.
Measurement methods and procedures	Monitoring net electricity generation by the project activity using LFG.
Monitoring frequency	Continuous
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy from the local energy concessionaire's responsibility. Energy meter class is established by PRODIST module 5[21] and accuracy class is determined by INMETRO[22] based on tension level of the connection system. All grid procedure requirements for distributed power projects will be followed.

[21] PRODIST - Procedimentos de Distribuição de Energia Elétrica no Sistema Elétrico Nacional: <https://www.aneel.gov.br/prodist>.

[22] INMETRO Ordinance #587 issued on 05/11/2012. The National Institute of Metrology, Standardization and Industrial Quality ("INMETRO" from the Portuguese "Instituto Nacional de Metrologia, Qualidade e Tecnologia"). Available at: <http://www.inmetro.gov.br/legislacao/rtac/pdf/RTAC001929.pdf>

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 TOOL05. See $EG_{PJ,grid,y}$ parameter.

Data/Parameter	$EG_{EC,y}$
Data unit	MWh
Description	Amount of electricity consumed by the project activity in year y
Source of data	Electricity meter
Value(s) applied	401 MWh/yr For ex-ante estimative, data for 2018-2020 period was considered.
Measurement methods and procedures	Sources of consumption will include electricity consumed for the operation of the LFG capture system, for processing and treatment of the LFG, for transportation of the LFG to the flare and power generators.
Monitoring frequency	Continuous
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy from the local energy concessionaire's responsibility. For invoice purposes, the local concessionaire may opt for self-reading, 30-day period reading or multi-reading (twelve consecutive cycles). It is also the local concessionaire responsibility to make available metering and billing history (PRODIST module 11)[23].
Purpose of data	Calculation of project emissions
Additional comment	This parameter is required for calculating project emissions from electricity consumption from the grid using TOOL05. See $EC_{PJ,y}$ parameter. In case of electricity generated at the project site with LFG, project emissions will be zero.

TOOL03: "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion"

Data / Parameter	$FC_{i,j,y}$
Unit	kg/yr
Description	Quantity of fuel type *i* combusted in process *j* during the year y (*i* = LPG)
Source of data	Sales of receipt
Value(s) applied	67.5 (estimative for the crediting period)
Measurement methods and procedures	Conservatively, it shall be considered that all LPG purchase will be used.
Monitoring frequency	Continuously
QA/QC procedures	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records.
Purpose of data	Calculation of project emissions due to fossil fuel consumption for the flare ignition.
Additional comment	-

[23] PRODIST/ANEEL. Module 11 - Electricity Invoicing and Supplementary Information (from the Portuguese "Módulo 11 – Fatura de Energia Elétrica e Informações Suplementares"). Available at: < https://www.aneel.gov.br/modulo-11>

Data / Parameter	***$NCV_{,i,y}$***
Unit	GJ/m^3
Description	Weighted average net calorific value of fuel type *i* in year *y* (*i* = LPG)
Source of data	The Brazilian Energetic Balance ("BEN")
Value(s) applied	0.0465
Measurement methods and procedures	Measurements should be undertaken in line with national or international fuel standards
Monitoring frequency	Review appropriateness of the values annually
QA/QC procedures	Verify if the value is within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards.
Purpose of data	Calculation of project emissions due to fossil fuel consumption for the flare ignition.
Additional comment	Applicable where Option B is used.

Data / Parameter	***$EF_{CO2,i,y}$***
Unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of fuel type *i* in year *y* (*i* = LPG)
Source of data	2006 IPCC Guidelines on National GHG Inventories
Value(s) applied	0.0656
Measurement methods and procedures	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories following the tool.
Monitoring frequency	Any future revision of the IPCC Guidelines shall be taken into account.
QA/QC procedures	Official source of data.
Purpose of data	Calculation of project emissions from fossil fuel consumption for the flare ignition.
Additional comment	Option (c) of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"

TOOL04: "Methodological tool "Emissions from solid waste disposal sites"

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
Measurement methods and procedures	In accordance with the ACM0001 methodology, this value is to be assigned since the amount of LFG that would have been captured and destroyed is already accounted for in Equation 2.
Monitoring frequency	As per the applicable TOOL04 for application A, this parameter is determined once for the crediting period ($f_y = f$).
QA/QC procedures	-
Purpose of data	Calculation of baseline emissions
Additional comment	-

Note: the depth and height of the water table in the SWDS is not monitored as the MCF has been selected as a default value as per Application A of the methodological tool *"Emissions from solid waste disposal sites"*.

TOOL05: "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"

Data/Parameter	$EG_{PJ,grid,y}$
Data unit	MWh
Description	Quantity of electricity generated and supplied by the project power plant to the grid in year y
Source of data	Direct measurement or calculated based on measurements from more than one electricity meters
Value(s) applied	52,140MWh/yr For the ex-ante estimative, 93% availability is considered according to signed contract with the equipment supplier.
Measurement methods and procedures	This parameter should be either monitored using bi-directional energy meter or calculated as difference between (a) the quantity of electricity supplied by the project plant/unit to the grid; and (b) the quantity of electricity the project plant/unit from the grid. If it is calculated, then the following parameters shall be measured: (a) The quantity of electricity supplied by the project plant/unit to the grid; and (b) The quantity of electricity delivered to the project plant/unit from the grid.
Monitoring frequency	Continuous measurement and at least monthly recording.

QA/QC procedures	Electricity meters are lacked by the local utility and, in case of any failure, the concessionary will take the necessary actions for replacement. In cases where electricity meters are regulated (e.g. in case the electricity is supplied by the electric grid – scenario A), the electricity meter will be subject to regular maintenance and testing in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements. The accuracy class and frequency of calibration are determined by PRODIST applicable distributed power projects (national requirements). Calibration performing is the local concessionaire responsibility. The electricity generation shall be cross-checked with records of electricity sale (e.g. sales receipt)
Purpose of data	Calculation of project emissions due to electricity consumption
Additional comment	The project participants do not need to apply for post registration changes in the following situations and the change shall be described in the subsequent monitoring report and verification report: (a) Changing the type of meter during the monitoring period, for example from analogue to electrical or vice-versa as long as the meters comply with the accuracy class mentioned above. (b) Changing the accuracy class of meter from lower accuracy class to higher accuracy class. (c) Changing the calibration frequency of meter within the range stipulated in the national standards or requirements set by the meter supplier or requirements set by the grid operators. (d) Changing meter type from check meter to bi-directional meter.

Data/Parameter	$EC_{PJ,y}$
Data unit	MWh
Description	Quantity of electricity consumed by the project electricity consumption source *j* in year *y*
Source of data	Direct measurements or calculated based on measurements from more than one electricity meters (official source of data)
Value(s) applied	401 MWh/yr For ex-ante estimative, data for 2018-2020 period was considered.
Measurement methods and procedures	Use electricity meters installed at the electricity consumption sources. The electricity consumed by the project activity is monitored by the local power utility through electricity meters. Data from invoices shall also be considered for project emissions calculation as it is an official source of data.
Monitoring frequency	Continuous measurement and at least monthly recording.

QA/QC procedures	Electricity meters are lacked by the local utility and, in case of any failure, the concessionary will take the necessary actions for replacement. According to TOOL05, in cases where electricity meters are regulated (e.g. the electricity is supplied by the electric grid – scenario A), the electricity meter will be subject to regular maintenance and testing in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements. The calibration of meters, including the frequency of calibration, should be done in accordance with national standards or requirements set by the meter supplier or requirements set by the grid operators. The accuracy class of the meters should be in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements. In case of missing data due to meter failure or other reasons for a certain period of time, the following options to estimate electricity consumption may be applied: (a) A conservative value based on rated capacity and full operational hours (8760 hours); or (b) Estimation of electricity consumption as highest daily value among the daily monitored values multiplied by the number of days' data were missing. This is option is applicable for missing data of up to 7 consecutive days within three consecutive months; or (c) Highest value for the same calendar period of the previous years among recorded values; or (d) a value of a representative sample of the first batch7 of project devices. In other words, it may be assumed that the electricity consumption measured in a representative sample of the first batch of project devices apply to all subsequent batches. Options (c) and (d) are only applicable to project activities or PoAs, where end users of the subsystems or measures are households/communities/small and medium enterprises (SMEs), provided the gap period does not exceed 30 consecutive days within six consecutive months.
Purpose of data	Calculation of project emissions due to electricity consumption
Additional comment	The accuracy class and frequency of calibration are determined by PRODIST applicable distributed power projects (national requirements). Calibration performing is the local concessionaire responsibility.

Data/Parameter	***$TDL_{j,y}$ and $TDL_{k,y}$ and $TDL_{l,y}$***

Data unit	In case of scenario B and scenario C, case C.II, assume TDLj/k/l,y = 0 as a simplification. In case of other scenarios (scenario A and scenario C, cases C.I and C.III), choose one of the following options: 1. Use annual average value based on the most recent data available within the host country; 2. Use as default values of 20% for: (a) project or leakage electricity consumption sources; (b) baseline electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is larger than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies; 3. Use as default values of 3% for: (a) baseline electricity consumption sources; (b) project and leakage electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is smaller than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies
Description	7.5% For the ex-ante estimative, data from ANEEL Report "Perdas de Energia Elétrica na Distribuição" – edition 01/2019[24] is used.
Source of data	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
Value(s) applied	In case of scenario B and scenario C, case C.II, assume TDLj/k/l,y = 0 as a simplification. In case of other scenarios (scenario A and scenario C, cases C.I and C.III), choose one of the following options: 1. Use annual average value based on the most recent data available within the host country; 2. Use as default values of 20% for: (c) project or leakage electricity consumption sources; (d) baseline electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is larger than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies; 3. Use as default values of 3% for: (b) baseline electricity consumption sources; (b) project and leakage electricity consumption sources if the electricity consumption by all project and leakage electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies is smaller than the electricity consumption of all baseline electricity consumption sources to which scenario A or scenario C (cases C.I or C.III) applies

[24] Available at: <https://www.aneel.gov.br/documents/654800/18766993/Relat%C3%B3rio+Perdas+de+Energia_+Edi%C3%A7%C3%A3o+1-2019-02-07.pdf/d7cc619e-0f85-2556-17ff-f84ad74f1c8d>

Measurement methods and procedures	7.5% For the ex-ante estimative, data from ANEEL Report "Perdas de Energia Elétrica na Distribuição" – edition 01/2019[25] is used.
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	Data from the Brazilian Power Regulatory Agency ("ANEEL" from the Portuguese Agência Nacional de Energia Elétrica) or any other official source within the Host Country.
Purpose of data	Calculation of baseline and project emissions
Additional comment	The technical distribution losses should not contain other types of grid losses (e.g. commercial losses/theft).

Data/Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2/MWh
Description	Combined margin emission factor for the grid in year y
Source of data	The Brazilian DNA: • Operating margin CO_2 emission factor: http://antigo.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/textogeral/emissao_ajustado.html • Build margin CO_2 emission factor: From the registered PDD. According to TOOL07, while applying option 2 (ex-post data vintage) for the third crediting period, the build margin emission factor of the second crediting period shall be applied. Value from the registered PDD was used.
Value(s) applied	0.2907
Measurement methods and procedures	As per TOOL07.
Monitoring frequency	Annually
QA/QC procedures	Official source of data
Purpose of data	Calculation of project emissions due to electricity consumption from the grid.
Additional comment	Applicable to scenarios A and C of TOOL05 for electricity consumption from the grid and scenarios I, II and III of TOOL05 for electricity generation. See parameters $EF_{grid,OM-adj,y}$ (ex-post) and $EF_{grid,BM,y}$ (ex-ante).

TOOL06: "Project emissions from flaring"

Data/Parameter	$T_{EG,m}$
Data unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.

[25] Available at: <https://www.aneel.gov.br/documents/654800/18766993/Relat%C3%B3rio+Perdas+de+Energia_+Edi%C3%A7%C3%A3o+1-2019-02-07.pdf/d7cc619e-0f85-2556-17ff-f84ad74f1c8d>

Measurement methods and procedures	Data is measured by thermocouples installed in each flare and the reading frequency is continuously. Measurements of the temperature of the exhaust gas are recorded electronically at least each minute. Data is archived electronically. In case of frequent failure or high reading discrepancy, it will be displaced. Measure the temperature of the exhaust gas in the flare by an appropriate temperature measurement equipment. Measurements outside the operational temperature specified by the manufacturer may indicate that the flare is not functioning correctly and may require maintenance. Flare manufacturers must provide suitable monitoring ports for the monitoring of the temperature of the flare. These would normally be expected to be in the middle third of the flare. Where more than one temperature port is fitted to the flare, the flare manufacturer must provide written instructions detailing the conditions under which each location shall be used and the port most suitable for monitoring the operation of the flare according to manufacturers specifications for temperature.
Monitoring frequency	Once per minute
QA/QC procedures	Temperature measurement equipment should be replaced or calibrated in accordance with their maintenance schedule. Thermocouple respects all national requirements. In case of failure, they will be replaced accordingly.
Purpose of data	Calculation of project emissions from flaring
Additional comment	-

Data/Parameter	$\boldsymbol{Flame_m}$
Data unit	Flame on or Flame off
Description	Flame detection of flare in the minute *m*
Source of data	Project participants
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Measure using a fixed installation optical flame detector. There is flame sensors (UV photo cells) and a burner control unit for automatic ignition and flame monitoring. The UV-sensor detects the flame and gives a signal to the automatic control burner. As soon as the flame has been burning for a given retention time, the automatic burner control opens the main gas valve. Then, valve that controls the flow of gas sent to flare enclosure automatically closes whenever no flame is detected by sensors for safety reasons.
Monitoring frequency	Once per minute. Detection of flame recorder as a minute that the flame was on, otherwise recorded as a minute that the flame was off depending on the flow of gas inside the flare enclosure.
QA/QC procedures	No calibration is required. Nonetheless, due to safety reasons, tests are conducted to ensure the sensor of the valve is functioning well.
Purpose of data	Calculation of project emissions from flaring
Additional comment	-

TOOL07: "Tool to calculate the emission factor for an electricity system"

Data/Parameter	$\boldsymbol{EF_{grid,OM\text{-}adj,y}}$
Data unit	tCO_2/MWh

Description	Simple adjusted operating margin CO_2 emission factor in year *y*
Source of data	The Brazilian DNA:
Value(s) applied	
Measurement methods and procedures	According to TOOL07.
Monitoring frequency	Annually
QA/QC procedures	Official source of data
Purpose of data	Calculation of project emissions due to electricity consumption from the grid.
Additional comment	The project applies option b) Simple Adjusted OM of TOOL07 and the ex-post data vintage.

TOOL08: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream"

Data/Parameter	$V_{t,wb}$
Data unit	m^3 wet gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a wet basis
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Volumetric flow meter. Volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	In accordance with the TOOL08 it will be monitored on a minute basis, monthly aggregated and reported.
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 specification.
Purpose of data	Calculation of baseline and project emissions
Additional comment	This parameter will be monitored in Options B and C to determine $F_{CH4,flared,y}$ and/or $F_{CH4,EL}$.

Data/Parameter	$V_{t,db}$
Data unit	m^3 dry gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a dry basis
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Volumetric flow meter. Volumetric flow measurement should always refer to the actual pressure and temperature. Calculated based on the wet basis flow measurement plus water concentration measurement.
Monitoring frequency	In accordance with the TOOL08 it will be monitored on a minute basis, monthly aggregated and reported.
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 specification.
Purpose of data	Calculation of baseline and project emissions
Additional comment	This parameter will be monitored in Option A to determine $F_{CH4,flared,y}$ and/or $F_{CH4,EL}$.

Data/Parameter	$v_{i,t,db}$
Data unit	m^3 gas *i*/m^3 dry gas
Description	Volumetric fraction of greenhouse gas *i* in a time interval *t* on a dry basis (*i* = CH_4)
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Continuous gas analyzer operating in dry basis. Volumetric flow measurement should always refer to the actual pressure and temperature.
Monitoring frequency	In accordance with the TOOL08 it will be monitored on a minute basis, monthly aggregated and reported.
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. Gas analyzers are subjected to a regular maintenance and testing regime to ensure accuracy according to manufacturer's specification. In case of frequent failure or high discrepancy readings, they will be replaced.
Purpose of data	Calculation of baseline and project emissions
Additional comment	This parameter will be monitored in Option B and may be monitored in Option A to determine $F_{CH4,flared,y}$ and/or $F_{CH4,EL}$.

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 (*i* = CH_4)
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Calculated based on the dry basis analysis plus water concentration measurement or continuous in-situ analyzers if not specified in the underlying methodology.
Monitoring frequency	In accordance with the TOOL08 it will be monitored on a minute basis, monthly aggregated and reported.
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. Gas analyzers are subjected to a regular maintenance and testing regime to ensure accuracy according to manufacturer's specification. In case of frequent failure or high discrepancy readings, they will be replaced.
Purpose of data	Calculation of baseline and project emissions
Additional comment	This parameter will be monitored in Option C and may be monitored in Option A to determine $F_{CH4,flared,y}$ and/or $F_{CH4,EL}$.

Data/Parameter	$C_{H2O,t,db,n}$
Data unit	mg H_2O/m^3 dry gas
Description	Moisture content of the gaseous stream at normal conditions, in time interval t

Source of data	Measurements according to the USEPA CF42 method 4 – Gravimetric determination of water content
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Discrete measurement procedure
Monitoring frequency	The mean value among three consecutive measurements performed in the same day (at least 2 hours each) shall be considered. Measurements should coincide with the Annual Surveillance Test (associated with requirements of the EN 14181 standard) or the calibration of the flow meter for the gaseous stream.
QA/QC procedures	According to the USEPA CF42 method 4.
Purpose of data	Calculation of baseline and project emissions.
Additional comment	Monitoring is required if Option 1 described in the “Determination of the absolute humidity of the gaseous stream” section of the tool is applied, or as one of the ways of proving that the gaseous stream is dry (necessary for Options A or D).

Data/Parameter	$v_{k,t,db}$
Data unit	m³ gas k/m³ dry gas
Description	Volumetric fraction of gas k in the gaseous stream in time interval t on a dry basis
Source of data	Onsite measurements
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Continuous gas analyser operating in dry-basis
Monitoring frequency	Continuous if not specified in the underlying methodology/tool
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N2) 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. Gas analyzers are subjected to a regular maintenance and testing regime to ensure accuracy according to manufacturer’s specification. In case of frequent failure or high discrepancy readings, they will be replaced.
Purpose of data	Calculation of baseline and project emissions.
Additional comment	-

Data/Parameter	***Tt***
Data unit	K
Description	Temperature of the gaseous stream in time interval t
Source of data	PLC data records
Value(s) applied	Not used for *ex-ante* calculations.
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital). Examples include thermocouples, thermo resistance, etc.
Monitoring frequency	Continuous
QA/QC procedures	During verification, it will be confirmed that all parameters are converted to normal conditions during the monitoring process. Calibration and frequency of calibration is according to manufacturer’s specifications.
Purpose of data	Calculation of baseline and project emissions

Additional comment	Applicability condition while applying option b) of TOOL08 (gaseous stream flow temperature below 60ºC).

Data/Parameter	***Pt***
Data unit	Pa
Description	Pressure of the gaseous stream in time interval t
Source of data	PLC data records
Value(s) applied	Not used for ex-ante calculations.
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital) are required. Examples include pressure transducers, etc.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device must be performed periodically and records of calibration procedures must be kept available as well as the primary device and its calibration certificate. Pressure transducers (either capacitive or resistive) must be calibrated monthly.
Purpose of data	Calculation of baseline and project 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	***Status of LFG destruction device***
Data unit	-
Description	Operational status of LFG destruction devices
Source of data	Onsite measurements
Value(s) applied	-
Measurement methods and procedures	Monitoring and documenting is undertaken by recording the operation of flares by means of a flame detector and thermocouples to demonstrate the actual destruction of methane. Emission reductions will not accrue for periods in which the destruction device is not operational.
Monitoring frequency	Continuous
QA/QC procedures	Thermocouples calibration will be provided during verification in order to demonstrate that flares are operating properly.
Purpose of data	Calculation of project emissions
Additional comment	For flame detector devices refer to TOOL06

Data/Parameter	$p_{H20,t,Sat}$
Data unit	Pa
Description	Saturation pressure of H_2O at temperature T_t in time interval t
Source of data	PLC data records and steam tables
Value(s) applied	Not used for ex-ante calculation
Measurement methods and procedures	This parameter is solely a function of the gaseous stream temperature T_t and can be found at reference [1] for a total pressure equal to 101,325 Pa.
Monitoring frequency	According to TOOL08
QA/QC procedures	n/a
Purpose of data	Calculation of baseline and project emissions
Additional comment	[1] Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994, John Wiley & Sons, Inc.

B.7.2. Sampling plan

Not applicable. This section is intentionally left blank.

B.7.3. Other elements of monitoring plan

Section B.7.1. above describes the parameters that are to be monitored during the crediting period, as well as, the methods and procedures to be applied. A simplified diagram of monitoring equipment is presented as follows:

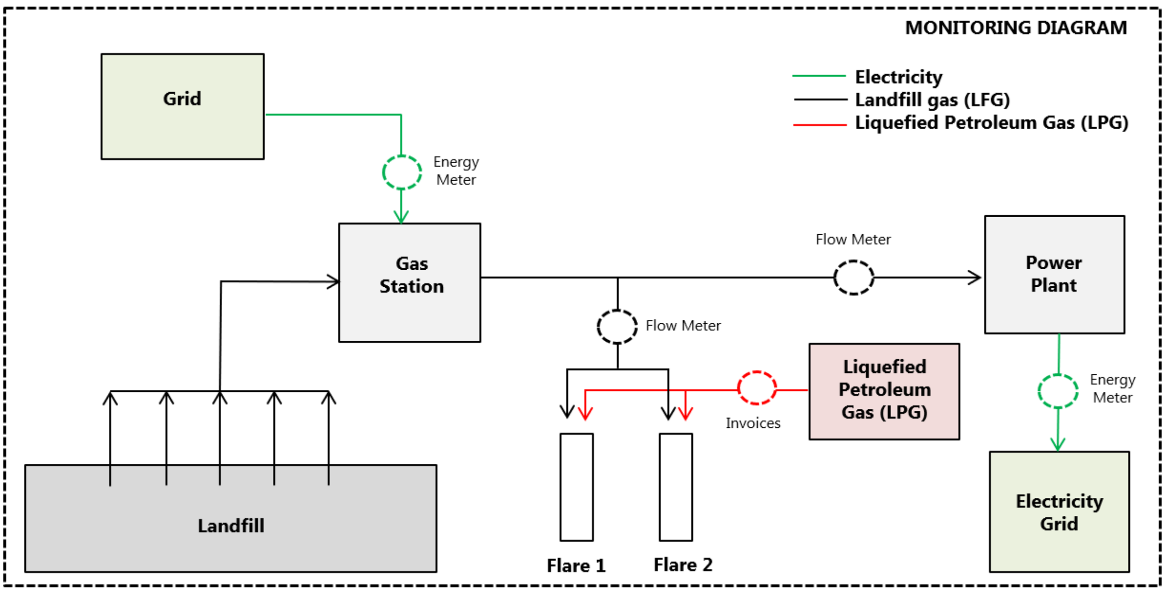

Figure 7 – Simplified diagram of monitoring equipment.

Procedures described below are also to be taken into account while performing monitoring activities related to the project activity.

a) Summary of monitoring approach

All monitoring will be conducted according to ACM0001 and referred tools. The variables described in item B.7.1 are automatically registered in a supervisory computer system. LFG flows and methane content are determined on a continuous basis. LFG flows is converted to norm cubic meters (Nm^3) using continuous measurements of pressure and temperature. Electricity generation will be monitored by data from the power concessionary based on energy meters and cross-checked with invoices.

Regarding electricity consumption from the grid, there are electricity meters installed at the plant in order to monitor electricity consumption from the grid. For the calculation of project emissions, monthly bills will be considered. Transmission losses will be accounted according reports from the Brazilian Power Regulatory Agency (ANEEL) or any other official source of data for the Host Country and will be applied to electricity generation and consumption following TOOL05.

Regarding the LPG consumption, sales of receipt will be considered to calculate project emissions from the fossil fuel use. This conservative approach will ensure that all LPG will be accounted for project emissions independently of its storage.

All monitored data and required for verification and issuance be kept and archived electronically for two years after the end of the crediting period or the last issuance of CERs, whichever occurs later.

b) Responsibilities

From the point of view of the plant operation, positions and roles for this CDM project activity are well defined. Duties, personnel replacement in the case of non-availability of the Operation Manager and O&M Coordinator and hiring requirements for job positions are determined in documented procedures presented in the functional organogram ad responsibility matrix.

The precise procedures for the monitoring will be documented in a manual, and the responsible staff will be identified and adequately trained. Key elements of the manual will include:

- Division of responsibilities between staff
- Reading of meters and analysers (method, frequency)
- Data handling and storage
- Data analysis and reporting
- Maintenance and calibration of meters and analysers
- QA / QC procedures, including internal reviews

c) Quality control and quality assurance procedures

All parameters monitored, including reading, transmitting and registration routine are under the Operation Manager and O&M Coordinator’s responsibility.

Plausibility testing of data

The plausibility of all collected data will be tested on a routine basis with respect to:

- Consistency with previous measurements (time-series);
- Deviations from ex ante estimations of emission reductions.

Any inconsistencies or implausibilities will be resolved immediately. If required, suggestions for the improvement of the monitoring system will be formulated and implemented.

<u>Equipment calibration and maintenance</u>

All meters and other sensors will be subject to regular maintenance and testing regime according to the technical specifications from the manufacturers to ensure accuracy and good performance.

Calibration of equipment will be performed periodically according to technical specifications and in agreement with the requirements of INMETRO (Metrology National Institute), norms applied to ABNT and the precision requirements established in the used equipment Maintenance Plan. Whenever applicable, the calibration will be carried out by qualified companies/entities with recognized experience in the market in this activity, using methods and instruments traceable to international standards of quality.

A maintenance plan will be elaborated with the aim of obtaining the optimum performance and regularity of the system operation, covering at least the following aspects: frequency of equipment preventive maintenance, maintenance procedures detailed according to technical specifications of the equipment manufacturers, when applicable; frequency of equipment calibration, specially of those responsible for the measurement of data to be monitored and routines of periodical check ups to verify the functioning and performance of the equipment.

Internal Audits
All monitoring data will undergo an internal review before being submitted to the designated operational entity for independent verification. During these quarterly or semi-annual reviews the records will be checked by two internal staff members that are not involved in the actual data recording. The two reviewers will a) double-check the quality of the data recorded and b) audit the GHG project compliance with operational and monitoring requirements. If a need for corrective action is identified, they will propose the same to the management of LARA Energia. The reviewers will summarize their findings in written form.

Corrective, Preventive and Improvement Actions
Actions to handle and correct deviations from the Monitoring Plan and Operational Manual procedures will be implemented as these deviations are observed either by the operator or during internal audits. If necessary, technical meetings between the operator, the developer and the sponsor of the project will be held in order to define the corrective actions to be undertaken. The quality guarantee measures include procedures for treating and correcting non-conformities in the implementation of the Project and in the operation and maintenance of the System. If such non-conformities are detected, specially those related to the corrective maintenance of the equipment:

1) An analysis of the non-conformity and its causes will be conducted immediately by the Lara Landfill staff;
2) The Lara Landfill administration will make a decision about the corrective actions adequate to eliminate the non-conformity and its causes;
3) Corrective actions are implemented and reported to the Lara Landfill administration.

d) Training
All training is supplied to operators and technical assistants if required while operating the project in compliance with the Operational Manual.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

04/03/2005[26].

C.2. Expected operational lifetime of project activity

21 years, 0 month.

C.3. Crediting period of project activity

C.3.1. Type of crediting period

[26] The design and construction of the project's LFG collecting and flaring system took place during the period from March 2005 to July 2006. Commissioning and testing phases of the project activity occurred in August 2006 and September 2006 respectively. The project activity started to operate on 15/09/2006.

Renewable crediting period.

C.3.2. Start date of crediting period

15/09/2020

C.3.3. Duration of crediting period

7 years – 0 months

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

As per information available at the time of the project design conceptualization, in order to obtain the environmental license, new landfills or site expansions need an Environmental Impact Assessment (EIA-RIMA by Brazilian law). The EIA for the Lara landfill was conducted 1991 by the specialized engineering company KMG. Therefore, all environmental impacts related to the construction and operation of Lara landfill were raised in its EIA and submitted to the environmental agency of São Paulo (CETESB), as part of the licensing process of the landfill.

As mentioned in section A.1, the area of waste disposal was expanded due to necessities in the region to have adequate local for waste treatment where few SWDSs are available. Technical studies were conducted and the final approval by CETESB only occurred after the project was registered[27]. For this expansion, there was no need to prepare another EIA/RIMA. According to this study, no transboundary impacts for the operation of Lara landfill were identified, otherwise, licenses would not be issued. The current Operating License is LO 16010948 valid up to 17/06/2025.

For the implementation of the landfill gas collecting system no further EIA is necessary as there are no specific environmental policies or regulations regarding LFG capture and destruction. Despite that, by collecting and combusting landfill gas, the project activity reduces both global and local environmental effects of uncontrolled releases. The major components of LFG, methane and carbon dioxide, are colourless and odourless. The main global environmental concern over these compounds is the fact that they are greenhouse gases. Although the majority of LFG emissions are quickly diluted in the atmosphere, in confined spaces there is a risk of asphyxiation and/or toxic effects if landfill gas is present at high concentrations. LFG also contains over 150 trace components that can cause other local and global environmental effects such as odour nuisances, stratospheric ozone layer depletion, and ground level ozone creation. Through an appropriate management, LFG is captured and combusted, removing the risks of toxic effects on the local community and local environment.

For the electricity generation to the grid, no studies nor impact assessment were required for the renewable electricity generation component considering its small scale and minor impact. However, environmental licenses are required for the installation of generator. Then, the environmental agency issued two licenses for the electricity generation of the project activity:

- Preliminary License LP nr. 16003308 issued on 07/06/2021, valid for two years;
- Installation License LI nr. 16005420 issued on 16/07/2021, valid for three years.

For the operation of the power plant, the environmental agency will issue the Operating License (LO) and all requirements listed in the license will be followed.

[27] The registered PDD already mentions studies conducted for the expansion area of the SWDS for which final approval was not available that time.

Regarding local air pollutants, LFG flares produce nitrogen oxide (NOx) emissions that vary widely from one site to another, depending on the type of generator and the extent to which steps have been taken to minimise such emissions. In the case of the proposed project activity, NOx emissions are according to the applicable environmental regulations (which do not specify any limits for this type of installation), and well below those of other industrial sites such as e.g. cement plants. The project is likely to result in a reduction of toxic trace gases such as H_2S. On the other hand, formation of new toxic trace compounds, and notably dioxins, as a result of the project is likely to be completely negligible due to the fact that the Lara landfill receives almost no industrial (but rather municipal) waste.

The project activity contributes towards a global sustainable development by reducing methane emissions through LFG capture and flaring, avoiding global warming and explosion risks at the landfill site. Also, the implemented infrastructure is ready to include the power generation facility and the energetic LFG use will contribute to a cleaner electricity generation matrix to the Host Country.

D.2. Environmental impact assessment

As mentioned in Section D.1, the development of an Environment Impact Assessment (EIA) was not required for the project activity. Thus, no separate EIA was developed for the implementation of the project activity.

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

At the time of the project design initial conceptualization, based on the resolution No 1 of the Brazilian Designate National Authority represented by the Interministerial Commission on Climate Change (Comissão Interministerial de Mudança Global do Clima), the following entities were to be addressed in the course of the stakeholder process:

- Municipal governments and City Councils;
- State and Municipal Environmental Agencies;
- Brazilian Forum of NGOs and Social Movements for Environment and Development;
- Community associations;
- Ministério Público (State Attorney for the Public Interest).

In line with this resolution, the following stakeholders were invited for comments during the period of October and November 2003. For the expansion of the landfill area mentioned in section A.1, there was no need to conduct another stakeholder consultation[28].

Table 9 – Stakeholder invited for consultation regarding the CDM project activity.

Institution / entity	Name of contact person
ALTRAN / POLEN	Rodrigo Gonçalves Pires
Assessora Legislativa	Silvana Lages
Associação UAB	Sidinei A. A. Júnior
Aterro Boa Hora	Júlio Gurgel
Colégio Barão de Mauá	Giovanna
Câmara Municipal de Mauá	Paulo Sérgio Pereira
Câmara Municipal de Mauá	Suzana Lages
Câmara Municipal de Mauá	Manoel Lopes
Câmara Municipal de Mauá	Rogério Santana
Câmara Municipal de Mauá	Ricardo Llaques

[28] The registered PDD already mentions studies conducted for the expansion area of the SWDS for which final approval was not available that time.

Câmara Municipal de Mauá	Luiz Grigio
Câmara Municipal de Mauá	Paulo Bio
Câmara Municipal de Mauá	Claudete Porto
Câmara Municipal de Mauá	Teka
CENBIO / USP	Vanessa Pecora
CENBIO / USP	Américo Varkuslya Júnior
CETESB	Flávio Yamamoto
CETESB	Joao Wagner
CETESB	Ana Carla Rodero
CETESB	Eduardo Cardoso
DER	Gilda Roseli Napoleão
DER	Leda Maria Delambro
DER	Marlene Pinto Ceccon
Diario do Grande ABC	Lione Farias
Diario do Grande ABC	Mario Barbosa
DNV	Cândido Capoy
Ecco Press	Paula Pierri
EM Peter Pan	José A. Soares Cruz
Factor Ag.	Christoph Sutter
FAMA - Faculdade Mauá	Cláudio Milânez
Hospital Brasil	Patricia A. Martins
LARA	Francisco Molnar
LARA	Renato Damo
LARA	Delmo Alves
MCT	Newton Paciornik
MCT	José Domingos Gonzales Miguez
PART	Rodrigo S. Gozalez
Portadores de deficiência	José de Souza
Prefeitura Municipal de Mauá	Eliésio F. Silva
Prefeitura Municipal de Mauá	Ronaldo V. Pereira
Prefeitura Municipal de Mauá	Oswaldo Dias
Prefeitura Municipal de Mauá	Antonio P. Loreto
Prefeitura Municipal de Mauá	Geraldo Vieira
Prefeitura Municipal de Mauá – SMDES	Reinaldo M. Mussini
Prefeitura Municipal de Ribeirão Pires	Marcio Vale
Prefeitura Municipal Rio Grande da Serra	Luiz Carlos Ramos
Revista Livre Mercado	Fabiano
Rodrigo Lex	Karina G. Martins
Revista Saneamento Ambiental	Paulo Antunes
SANPPER	Renato Sanches Pinheiro
SEMASA	Iracegis M. dos Santos
SEMASA	Pedro H. Milani
SEMASA	Marcelo Bispo
UBS Vila Carlina	Idinéia Ferreira
UBS Vila Carlina	Joana de Fátima Rodrigues
UBS Vila Carlina	Adriana Alves dos Santos
VALIN	Luiz Fernando Adelto
AEPIS	Roseli Maria Biason Mussini
Associação de bairro dos moradores da Vila Assis	Sidney
CAMBRAS TVA	Beto Bedokerr
DAIA	Pedro José Stech
DEPRN ABC	Ademir Celso Menegueti
DEPRN SP	Roberto Guimarães Mafra
Diretoria de Ensino da Região de Mauá	Marilene Pinto Seccon
Escola Estadual Marilene de Camargo Acetto	Jane Donattielo de Campos
FIESP	Horácio Lafer Piva
FNMA	Raimunda Nonata Monteiro da Silva
IPT	Guilherme Ary Plonsky
Jornal Folha de São Paulo	Otavio Frias Filho
Jornal O Estado de São Paulo	Luiz Octavio Lima

MMA	Maria Osmarina da Silva Vaz de Lima
NEA-ABC	Cleyde Angelica Ferreira da Silva Chiregatto
Prefeitura do Município de Diadema	José de Filippi Jr
Prefeitura do Município de Praia Grande	Alberto Pereira Mourão
Prefeitura do Município de Rio Grande da Serra	Ramon Alvaro Velasquez
Prefeitura do Município de Santo André	João Avaliemo
Prefeitura do Município de São Caetando do Sul	Luiz Olinto Tortorello
Prefeitura do Município de São Bernardo do Campo	Willian Dib
Prefeitura do Município de São Vicente	Marcio Luiz França Gomes
Revista Banas Qualidade	Fernando Banas
Revista Maio Ambiente Industrial	Julio Tocalino Neto
Escola Politécnica da USP	Vahan Agopyan
Núcleo de Educação Infanti Vila Carlina	José Antonio
Ministério Público Federal	Paula Bajer Fernandes Martins da Costa

Activities undertaken:

The Stakeholder Consultation Process for the LARA Energia project included two workshops, in November 2003, targeting both the national and the local community. All the stakeholders identified above got an invitation, per conventional mail and per e-mail. Some neighbours from the community of Vila Carlina were invited personally. This invitation included a first introduction to the project, and gave a telephone number and an e-mail address to collect comments.

During the workshops, the public were asked for their comments regarding the technical, environmental and social issues of the project.

Up to present date, all organizations agreed with the project concept and most of them emphasize the importance of renewable energy production and the mitigation of the global warming impacts.

Workshops:

November 27th, 2003 – Santo André City Hall - All the stakeholders, including local and federal authorities, industry and university stakeholders, were invited to the hearing, which informed about technical aspects of the project, Kyoto Protocol basics, clean development mechanism, Lara landfill history and operational procedures, description of social programs and the role of government agencies in the project.

November 28th, 2003 - Lara landfill - The same hearing took place, this time inviting community and local school leaders. The focus of this hearing was less technical.

Media Coverage:

TV:

- TV Globo - Jornal Nacional – Nov. 1st, 2003 – 8:15pm - 2’43” long.

Newspaper:

- O Estado de S. Paulo - Economia – Oct. 10th, 2003 - Nota na coluna da Sônia Racy "Do futuro"
- Diário do Grande ABC – Economia – Nov. 28th 2003

Magazines:

- Revista Livre Mercado – Jan 4th, 2004 - pages 5, 88 and 89.
- Revista Banas Qualidade - ed. January/04 - page 66.
- Revista Saneamento Ambiental – Nov./Dec. issue, 2003 - page 52.
- Revista Energia e Mercado – Dec./Jan. issue, 2004 - page 7.

E.2. Summary of comments received

Lara Energia invited the stakeholders to submit comments. One comment was received.

Comment 1: Initially, Lara Energia suggested to finance the instalment of a sewage water collecting system at Vila Carlina. The municipality of Mauá told Lara to consider this as a duty of the municipality. At that time, the municipality of Mauá planned already to install a sewage water collecting system at Vila Carlina.

E.3. Consideration of comments received

The only comment received concerned the social programme planned by Lara Energia (see comment 1 in section E.2). Following this comment the social programme was redesigned and the idea of financing a sewage water collecting system at Vila Carlina was dropped. As a substitution, leisure installations and leisure activities was supported. Therefore, the comment could be taken fully into account.

SECTION F. Approval and authorization

The project activity received Letter of Approvals and authorizations from Brazil – the Host Country – , Netherlands and Switzerland. They are available at the UNFCCC's website:

<https://cdm.unfccc.int/Projects/DB/DNV-CUK1138957573.9/view>

Appendix 1. Contact information of project participants

Organization name	Lara Co-Geração e Comércio de Energia
Country	Brazil
Address	Estrada de Guaraciaba, n° 1.985, Sala 2, Bairro Sertãozinho, 09370-840, Mauá, SP
Telephone	+55 (11) 4544-1077
Fax	-
E-mail	ralf.lattouf@laraenergia.com.br
Website	-
Contact person	Mr. Ralf Lattouf

Organization name	BHP Billiton Marketing AG
Country	Netherlands
Address	Verheeskade 25, 2521 BE - 2500 CM The Hague
Telephone	-
Fax	-
E-mail	-
Website	-
Contact person	Mr. T. Briant

Appendix 2. Affirmation regarding public funding

No public funding for this project has been obtained.

Appendix 3. Applicability of methodologies and standardized baselines

Not applicable. This section is intentionally left blank. Please refer to sections B.1 and B2.

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

Not applicable. This section is intentionally left blank. Please refer to sections B.6.1 and B.6.3 for details regarding the ex-ante calculation of emissions reductions.

Appendix 5. Further background information on monitoring plan

Not applicable. This section is intentionally left blank.

Appendix 6. Summary report of comments received from local stakeholders

Not applicable. This section is intentionally left blank.

Appendix 7. Summary of post-registration changes

The project was registered on 15/05/2006, under PDD version 3 dated 26/01/2006.

The PDD registered at UNFCCC in the first crediting period was changed and approved by the Board on 08/07/2014. The approved PDD, version 4.3, dated 10/12/2013, mentions the following post-registration changes:

- Occurred permanent modification in the design of the project activity:

Since the start of operation of the project activity, the project has consumed grid-sourced electricity and Liquefied Petroleum Gas (LPG). While the consumption both grid-sourced electricity and LPG were not considered at the project design description as per the previous version of the registered PDD (version 3, dated 26/01/2006), this revised version of the PDD addresses consumption of both grid-sourced electricity and LPG as occurred permanent changes in the project design.

- Permanent changes of the monitoring plan from the registered PDD:

While the previous version of the registered PDD (version 3, dated 26/01/2006) does not include any appropriate monitoring or calculation requirements/approaches for accounting consumption of grid-sourced electricity and LPG by the project activity as leakage emissions either, this revised PDD addresses these previously existent deficiencies as permanent changes in the monitoring plan as follows:

- Appropriate approach for monitoring parameters associated with the determination of leakage emissions due to the consumption of grid electricity by the project activity (with related calculation approach also being included in the PDD);

- Appropriate approach for monitoring parameters associated with leakage emissions due to the consumption of fossil fuel LPG by the project activity (with related calculation approach also being included in the PDD).

While during the whole already expired 1st 7-year crediting period no LFG was used as gaseous fuel for electricity generation, the monitoring plan does not any longer encompass any monitoring as per Step 1 of the methodological approach to determine baseline emissions related to methane destruction by combustion of LFG in the project's electricity generation component. The previous version of the registered PDD (version 3, dated 26/01/2006) includes the monitoring parameters Gross electricity production (EG) and Generator heat rate (HR). However, by taking into account that these parameters are not applicable under the project's configuration valid for the whole already expired 1st 7-year crediting period, no parameter related to the project's electricity generation component are included as part of the revised monitoring plan.

- Corrections (that do not affect the project design):
- Revised ex-ante estimations of emission reductions (due to correction of the amount of MSW historically disposed in the landfill);
- Minor corrections/improvements in the project description (which does not affect the description of the project design);
- Addition of details related to the occurred delay in the implementation of the project's electricity generation component.

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Document information

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

Version	*Date*	*Description*
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