Project design document form
(Version 10.1)

BASIC INFORMATION	
Title of the project activity	Embralixo/Araúna – Bragança Landfill Gas Project
Scale of the project activity	☒ Large-scale ☐ Small-scale
Version number of the PDD	8.0
Completion date of the PDD	04/08/2017
Project participants	Embralixo – Empresa Bragantina de Varricao e Coleta de Lixo Ltda Araúna Participaçoes e Investimentos Ltda EcoSecurities Group Plc
Host Party	Brazil
Applied methodologies and standardized baselines	ACM0001 – “Flaring or use of landfill gas” (version 18.0)
Sectoral scopes linked to the applied methodologies	13 - Waste handling and disposal
Estimated amount of annual average GHG emission reductions	35,504 tCO_2e per year

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The CDM project activity “Embralixo/Araúna – Bragança Landfill Gas Project” encompasses the construction and operation of a landfill gas (LFG) collection and destruction infrastructure at the Bragança landfill. LFG (which is rich in methane (CH_4)) has been historically generated at the Bragança landfill as a result of anaerobic decomposition of municipal solid waste (MSW) disposed in this site. Thus, by promoting effective an efficient collection and combustion (flaring) of LFG at the Bragança landfill, the project activity promotes real and measurable greenhouse gas (GHG) emission reductions.

The Bragança landfill is operated by the solid waste management company and host-country project participant Embralixo – Empresa Bragantina de Varricao e Coleta de Lixo Ltda and is located in the city of Bragança Paulista, São Paulo State, in the Southeast region of Brazil. The waste disposal facility operated as a controlled landfill from 1990 to 2001. In 2002 it was transformed in a Sanitary Landfill and has employed *state-of-the-art* waste landfilling techniques and operation management. In the absence of the CDM project activity (that was commissioned in the end of year 2007), no efficient management of LFG would occur.

The project activity involves the installation of all equipment and instruments required to promote LFG collection and destruction (in high temperature enclosed flare [1]) under high efficiency level at the Bragança landfill.

Equipment currently installed as part of the project activity consists of vertical LFG collecting wells and horizontal LFG drains (which are interconnected through a LFG pipeline network made of High Density Polyethylene (HDPE) pipes, manifolds and connecting parts). Through the LFG pipeline network, all collected LFG is directed to the project’s LFG destruction facility for combustion in high temperature enclosed flare.

As a result of the implementation of the project activity, the operation and management of the Bragança landfill has not changed when compared to the situation prior to the implementation of the project activity and it is not expected to change during the time period to be encompassed by the 2nd 7-year renewable crediting period of the project activity either.

Regarding applicable environmental regulations and good practices for landfill projects, construction and operation, the Bragança landfill was recently granted in 2013 with an operation license (permit) valid until 16/06/2018. This permit was issued by the local environmental authority named Companhia Ambiental do Estado de São Paulo - CETESB (São Paulo State Environmental Agency).

Summarized description of the baseline scenario under the 2nd 7-year crediting period:

For the 2nd 7-year renewable crediting period, the baseline scenario for LFG management at the Bragança landfill remains being the same as the scenario existing prior to the implementation of the project activity:

- Largest share of LFG generated at the Bragança landfill (with high content of methane) being freely emitted into the atmosphere without any treatment, collection, combustion or control through the surfaces of the landfill; with a small fraction of generated LFG (rich in methane) being destroyed in passive and conventional LFG venting/combustion drains (regardless of non-existence of any requirement for the combustion/destruction of LFG

[1] As outlined in both Sections A.3. and B.6.2, in March 2017 a unique high temperature enclosed flare was installed as part of the project activity. Additional flare(s) may however be installed in the future in order to meet forecasted increase in the amount of LFG to be collected by the project activity. If applicable, the installation of additional flare(s) will be opportunely addressed in the future as per applicable CDM rules and procedures for addressing post-registration changes in registered CDM project activities.

under the baseline scenario (absence of the project activity)) [2].

Environmental aspects and other contribution of the project activity towards Sustainable Development locally and in the whole host-country Brazil:
While methane is a strong greenhouse gas (GHG), the pre-project situation of emission of LFG into the atmosphere thus contributes to global warming.

The collection and combustion/utilization of LFG through the implementation and operation of an active LFG collection and flaring system as part of the project activity promotes abatement of GHG emissions at the Bragança landfill.

Besides climate change mitigation, the project activity also promotes important local environmental benefits. LFG contains trace amounts of volatile organic compounds, which are local air pollutants. Capturing of LFG using an active (forced) collection system and its controlled combustion (by flaring) greatly reduces such emissions, thereby contributing towards sustainable development. Furthermore, the implementation and operation of the project activity promotes strong reduction of LFG odors at the landfill and nearby regions.

As a summary, the project provides the following additional important local environmental and social benefits, thus contributing towards sustainable development in Brazil:

- Reduction in emissions of other air pollutants such as hydrogen sulphide (that is present in trace quantities in LFG).
- Reduction of risk of occurrence of fire and/or explosions at the landfill due to improved LFG management.
- Reduction of odors at the landfill and nearby regions.
- Local job opportunities

GHG emission reductions to be achieved by the project activity during the 2nd 7-year crediting period:
The project activity is expected to promote total GHG emission reductions of 248,529 tCO_2e during the 2nd 7-year crediting period. This value is equivalent to average annual GHG emission reductions of 35,504 tCO_2/year.

The project activity does not represent a Component Project Activity (CPA) that has been excluded from a previously registered CDM Programme of Activities (CDM-PoA) as a result of erroneous inclusion of CPAs.

A.2. Location of project activity

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The landfill where the project activity is implemented serves as a Municipal Solid Waste (MSW) disposal site for the city of Bragança Paulista and other cities in the region and it is named Bragança landfill. This landfill is located in the Estrada Municipal do Campo Novo / no number – Bragança Paulista – São Paulo, Brazil

The exact geographic coordinates of the project site (in decimal and in Degree, Minute, Second (DMS) formats) are as follows:

[2] Regardless of non-existence of any requirement for the combustion/destruction of LFG under the baseline scenario (absence of the project activity), it is assumed that under such scenario, a very small share of LFG generated at the Bragança landfill would be destroyed through inefficient combustion in the pre-project conventional passive LFG venting/combustion drains at the Bragança landfill. Further related details are included in Section B.6.1 (under "*Determination of $F_{CH4,BL,y}$*")

Format	Latitude	Longitude
DMS	23° 14' 51" S	45° 52' 03" W
Decimal	-23.2475	-45.8675

The following images show the location of the project activity.

Figure 1 - Project's location within Brazil
(as visible in March 2017 by using Google Earth PC application)

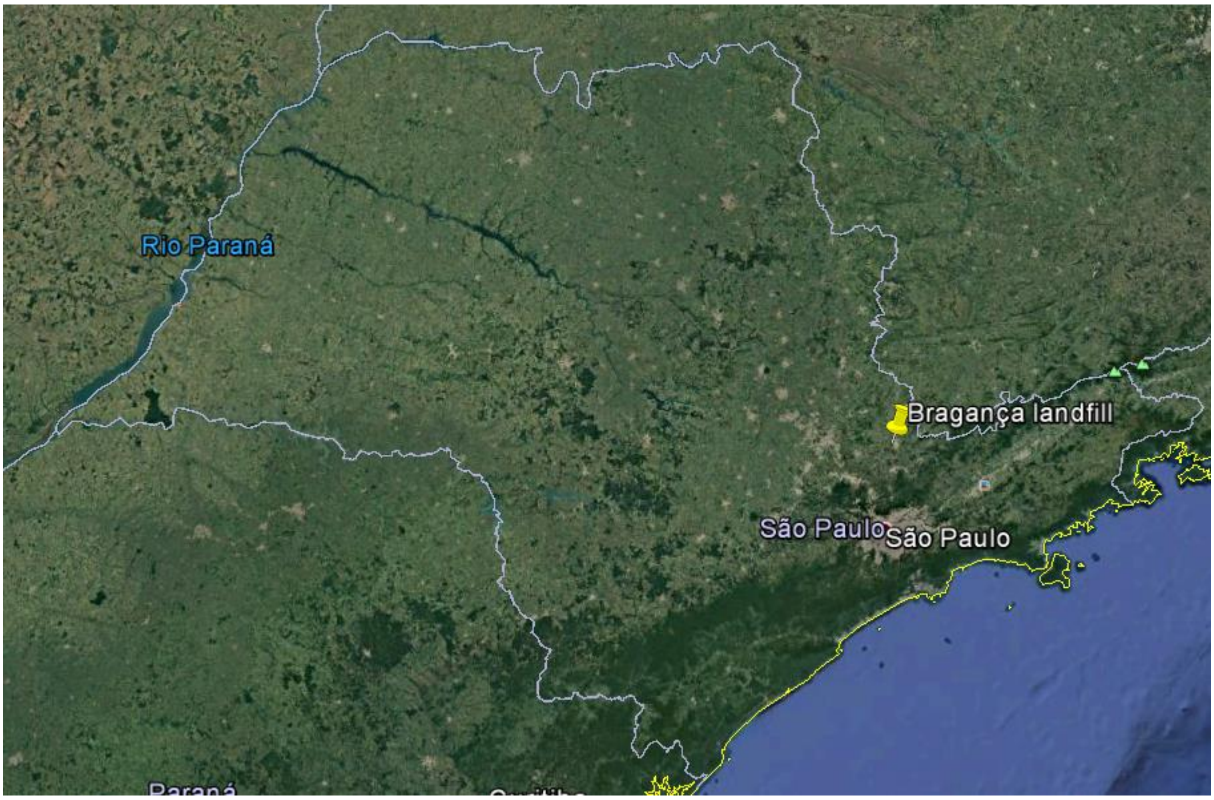

Figure 2 - Project's location within São Paulo State
(as visible in March 2017 by using Google Earth PC application)

Figure 3 - Project's location within the city of Bragança Paulista
(as visible in March 2017 by using Google Earth PC application)

A.3. Technologies/measures

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Pre-project and baseline situation at the Bragança landfill:

The pre-project situation (situation prior to the implementation of the project activity) in the period within year 2007[3] represents the non-existence of appropriate LFG management infrastructure and/or practice that would allow LFG collection and its destruction by combustion at the landfill site under efficient manner [4]. Regardless of non-existence of any requirement for the combustion/destruction of LFG under the baseline scenario (absence of the project activity), under such scenario, a very small share of LFG generated at the Bragança landfill would be destroyed through inefficient combustion in the pre-project conventional passive LFG venting/combustion drains previously existent at the landfill site[5].

While, currently there are still no legal municipal, state or national requirements in the city of Bragança Paulista, State of São Paulo nor in Brazil (respectively) that establish any requirement or guidance in terms of LFG management in new or existing landfills or waste dump sites, the baseline scenario for the project activity within its 2nd 7-year crediting period remains being the same as the scenario valid for its expired 1st crediting period.

As required by ACM0001 (version 18.0), the design, operation and management plan of the Bragança landfill was not compromised or changed as a result of the implementation of the project activity. While no practice to increase methane generation has ever occurred prior to the implementation of the project activity, none of such practice (to increase methane generation) has ever occurred after the implementation of the project activity either. Furthermore, none of such practices are expected to occur during the time period to be encompassed by the 2nd 7-year renewable crediting period of the project activity either. As required by the applied baseline and monitoring methodology ACM0001 (version 18.0), the occurrence or planning of any change in the management of the Bragança landfill during the time period to be encompassed by the 2nd 7-year renewable crediting period will be reported and will be justified by referring to applicable technical or regulatory specifications.

Technology and measures encompassed by the project design:
The employed technology encompasses deep improvements of LFG management at the Bragança landfill through the installation and operation of an active LFG collection system composed by a LFG collection and transportation pipeline network plus the installation and operation of a LFG flaring station using high temperature enclosed flare.

LFG collection system:
In order to maximize LFG collection efficiency, the pre-project passive conventional LFG venting/combustion drains are replaced by appropriate and efficient active (forced) LFG collection wells. The project's LFG collection system consists of a series of vertical extraction wells interconnected by header piping and horizontal drains. LFG is extracted from the landfill using a vacuum system and conducted to high temperature enclosed flare(s). Also as part of the designed project's LFG collection system, collected LFG is sent to the project's flaring station through LFG High Density Polyethylene (HDPE) pipes and manifolds.

[3] The project activity was commissioned and started to operate in 01/01/2008.

[4] While CDM validation of the project activity was initiated in October 2005 (with its CDM registration occurring in October 2007), the construction of the project activity was initiated in year 2007 and the starting of operation of the project activity is also dated January 2008, the pre-project situation (in the particular context of the previously occurred determination and assessment of baseline scenario for the project activity is thus assumed as being dated year 2007.

[5] Further related details about the share/amount of LFG assumed as being combusted in the baseline scenario (absence of the project activity) are included in Section B.6.1 (under "*Determination of* $F_{CH4,BL,y}$").

Figure 4 – View of LFG's destruction facility of the project activity

High temperature enclosed flare:
The main operational characteristics and specifications of the currently installed high temperature enclosed flare (as per the project's configuration in March 2017) are as follows:

Installed LFG flaring equipment	Characteristics/specifications
High temperature enclosed flare	Manufacturer: Brasmetano Ind. e Com. Ltda. Max. LFG flaring capacity (for continuous operation): 1,500 Nm^3/h Min. LFG flaring capacity (for continuous operation): 200 Nm^3/h Required min. temperature of the exhaust gas of the flare (to ensure LFG destruction under high CH_4 destruction efficiency): 500 ^oC Required max. temperature of the exhaust gas of the flare (to ensure LFG destruction under high CH_4 destruction efficiency): 1000 ^oC Required frequency for inspection service (incl. inspection in the conditions of the flare's isolation ceramics revetment material): every 10 (ten) years

Source: Equipment technical declarations made available by the respective equipment's manufacturers

Figure 5: Partial view of the LFG collection and destruction station

Expected operational lifetime for the project activity:
The expected operational lifetime for the project's LFG collection and destruction system (using high temperature enclosed flare(s)) is at least 20 years. However, project lifetime may even exceed 20 years if required service and maintenance is performed correctly and in case the project activity is always operated as per recommendation and requirements set by manufacturers of related equipment/instruments.

Project monitoring system:
The project activity also includes all needed monitoring system (instruments, equipment and procedures) required to ensure that all applicable monitoring activities are performed as established in the monitoring plan and under conformity with ACM0001 (version 18.0) and applicable methodological tools. Such measurements and monitoring include continuous measurements of LFG flow sent to the flare, continuous measurements of methane content in collected LFG, etc. ACM0001 (version 18.0) requires ex-post monitoring whether equipment destroying LFG through flaring operates under compliance with operational requirements and/or recommendations as set by flaring equipment manufacturer. Moreover, consumption of grid-sourced electricity by the project activity (+ related emission factors) is also monitored in order to have project emissions being determined.

Consumption of grid-sourced electricity by the project activity:
As per the project design configuration valid in the context of the renewal of the crediting period, all project's electricity demand has been met by consumption of grid-sourced electricity.

Technology transfer due to the implementation and operation of the project activity:
While the currently installed high temperature enclosed flare and some of the monitoring instruments (some of the currently installed meters and sensors) are manufactured in Brazil, the project activity uses imported components (equipment, instruments, etc.). While all currently 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, such project activities (including the project activity "Embralixo/Araúna – Bragança Landfill Gas Project") indeed involve/promote transfer of technology and improvements in practices for LFG management to the host country Brazil.

No change in the design and operational conditions of the Bragança landfill:

As required by ACM0001 (version 18.0), the design and operational conditions of the Bragança landfill has not changed after the implementation of the project activity and no change is expected to occur within the 2nd 7-year renewable crediting period. While the surface covered with disposed MSW at the Bragança landfill and height of MSW disposed piles have both increased as part of the normal operational dynamics of such large landfill, the landfill design and operational requirements in place are still being the same since the start of operations of the landfill in year 2002 regardless of the implementation and start of continuous operation of the project activity.

The Bragança landfill is thus expected to remain being operated with the application of the same and previously applied MSW landfilling technics and procedures. Embralixo – Empresa Bragantina de Varricao e Coleta de Lixo Ltda has designed and has managed and operated the Bragança landfill in accordance with its design, construction, operational and management requirements as required and established in the environmental permits and licenses applicable for the Bragança landfill and best practices for landfill construction and operations in Brazil.

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)	Embralixo – Empresa Bragantina de Varricao e Coleta de Lixo Ltda (Private Entity)	No
	Arauna Participacoes e Investimentos Ltda (Private Entity)	
United Kingdom of Great Britain and Northern Ireland	EcoSecurities Group Plc	No

A.5. Public funding of project activity

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No public funding is involved for the implementation and operation of this project activity.

A.6. History of project activity

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The “Embralixo/Araúna – Bragança Landfill Gas Project” was registered as a CDM project activity on 15/10/2007. This revised version of the PDD is applicable for the renewal of crediting period for the project activity, which encompasses the period from 01/01/2015 to 31/12/2021. The “Embralixo/Araúna – Bragança Landfill Gas Project” is not included as a component project activity in a registered CDM programme of activities and it was not deregistered as a CDM project activity.

A.7. Debundling

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Not applicable.

SECTION B. Application of selected methodologies and standardized baselines

B.1. Reference to methodologies and standardized baselines

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Consolidated baseline and monitoring methodology ACM0001 – version 18.0: “*Flaring or use of landfill gas*” (https://cdm.unfccc.int/methodologies/DB/Y88077XT5O83TZ2PYEZ36LFIAMAODR)

The following methodological tools are also applied:

- "Emissions from solid waste disposal sites" (version 08.0, EB94) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-04-v8.0.pdf)
- "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 02.0, EB 87) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v2.0.pdf) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf)
- "Project emissions from flaring" (version 02.0.0, EB 68) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v2.0.pdf)
- "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0, EB 87) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf)
- "Tool to calculate the emission factor for an electricity system" (version 05.0, EB 87) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v5.0.pdf)
- Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion (version 02, EB41) (http://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf)
- "Combined tool to identify the baseline scenario and demonstrate additionality" (version 06.0, EB 85) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v6.0.pdf)
- "Assessment of validity of the original/current baseline and to update the baseline at the renewal of a crediting period" (version 03.0.1, EB66) (https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-11-v3.0.1.pdf)

B.2. Applicability of methodologies and standardized baselines

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The approved baseline and monitoring methodology ACM0001 (version 18.0) is applied. In addition, the above-listed methodological tools (which are referred by this CDM baseline and monitoring methodology or by other applied methodological tools) are also applied. Demonstration of applicability conditions for ACM0001 (version 18.0) and all above-referred methodological tools are included in the tables below:

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 18.0)	**Justification**
"*The methodology is applicable under the following conditions:* *(a) Install a new LFG capture system in existing or new (Greenfield) SWDS*[6] *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:*	As per the CDM Project Standard, in the context of the renewal of crediting period for a previously registered CDM project activity, the PDD valid for the additional new 2nd 7-year crediting period should be completed by applying the latest version of the CDM baseline and monitoring methodology which was previously applied or, if applicable, the latest version of the CDM baseline and monitoring methodology of which the previously applied CDM methodology was consolidated into. The project activity was previously registered as a CDM project activity by applying the CDM baseline and monitoring methodology ACM0001 (version 05). While ACM0001 (version 18.0) is the latest valid version of the ACM0001 baseline and monitoring

[6] SWDS = Solid Waste Disposal Site. In the particular case of the project activity, the considered SWDS is the Bragança landfill.

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 18.0)	**Justification**
(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."*	methodology, it is thus the one to be applied in the context of the renewal of crediting period for the registered CDM project activity. The project activity is implemented in an existing SWDS partially replacing a previously existent LFG managing system (using conventional passive LFG venting/combustion drains) in which LFG was predominantly vented [7]. The project was implemented in year 2008. In this sense, condition (a) of the quoted applicability criteria is not applicable and condition (b – i) is thus met. It is important to note that, at the time the project design was conceived (during time period encompassing the year of 2007) and later in 2008 (when the project activity was implemented), there were no pre-project active/forced LFG capture system that has been in operation in the last calendar year prior to the start of the project activity (in year 2008). The project design encompasses collection of LFG and its destruction by flaring. Besides destruction of LFG, the project design does not encompass any other type of utilization of collected LFG. Thus, the project activity meets condition (c). *The implementation and operation of the project activity does not reduce the amount of organic waste that would be recycled in the absence of the project activity:* As a result of the previously occurred implementation of the project activity, there were no quantitative, qualitative, procedural or regulatory change occurred or triggered in terms of MSW management activities and policies valid for the Bragança landfill and/or valid for any other existing solid waste treatment or solid waste disposal facility under the area of influence of this landfill that would be promoted or triggered by the project activity in comparison with what would occur in the absence of the project activity (baseline scenario). The situation is expected to remain the same during the 2nd 7-year crediting period. It is crucial to note that, mainly by taking into consideration the nature of the project activity and aspects related to recycling of organic fraction of

[7] While the installed active (forced) LFG capture system as part of the project activity encompasses entirely new equipment (centrifugal blowers, flares, etc.), by assuming that the project activity replaces the previously existent pre-project passive LFG venting and combustion system (using conventional passive LFG venting/combustion drains), in the particular context of the demonstration of meeting of applicability criteria for ACM0001 (version 18.0), it is assumed that condition (a) is not applicable and condition (b – i) is applicable.

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 18.0)	Justification
	MSW in the region of landfill and in the rest of Brazil, both the implementation and operation of the project activity *per se* are not expected to promote any quantitative or qualitative change in terms of waste disposal activities historically undertaken at the Bragança landfill. Furthermore, no quantitative or qualitative changes in terms of waste management practices are expected to occur in any other existent or potential solid waste disposal site (SWDS) or solid waste treatment facility (located or to be located in the region under influence of the Bragança landfill) as a direct outcome or consequence of the implementation and operation of the CDM project activity during the 2nd 7-year crediting period. Thus, the mere previously occurred implementation of the project activity and its continuous operation as a LFG collection and destruction initiative have not promoted and are not expected to promote or trigger any reduction (or prevention) of the amount of organic type of MSW (or any other type of solid waste) that would eventually be recycled or utilized in the region (e.g. no prevention by the project activity of the implementation or and non-promotion of any reduction of activity in an existent or hypothetical waste composting facility that would promote utilization/recycling of waste in the region (for example)). As demonstrated in applicable construction, design and operational documented requirements valid for the Bragança landfill (as previously defined by Embralixo – Empresa Bragantina de Varricao e Coleta de Lixo Ltda and later confirmed in the environmental permits valid for the construction and operation of this landfill), the Bragança landfill is not expected to include any activity or initiative promoting recycling or utilization of organic fraction of waste disposed in this landfill (such as implementation of a large scale waste sorting or waste composting facility for example). Thus, without any organic waste recycling activity being under operation within the limits of the Bragança landfill, it is clearly not expected that the mere implementation of the project activity promoting collection and destruction of LFG could eventually promote any reduction in the amount of organic waste recycling activities in the Bragança landfill and/or in any other site located in region under influence of the Bragança landfill. The design, construction and operational aspects for the Bragança landfill were previously defined in accordance with the commercial agreements that the project participant Embralixo – Empresa Bragantina

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 18.0)	**Justification**
	de Varricao e Coleta de Lixo Ltda holds and is expected to hold in the position of the owner of the Bragança landfill and also in the position of a private regional waste management company (service provider) acting as a player in market and providing MSW disposal services for the city of Bragança Paulista and other municipalities located in the region. Furthermore, it is also crucial to take into account that currently there is not even any existent or planned large-scale MSW sorting, recycling or utilization facility for organic fraction of MSW (e.g. a large-scale waste composting plant) with comparable size/capacity and located in the region of influence of the Bragança landfill. In fact, recycling and utilization of organic fraction of MSW is not a common practice in the whole country of Brazil. In this sense, the implementation and operation of the project activity thus clearly does not represent any perverse incentive or driver for the promotion of any quantitative or qualitative reduction or even prevention of waste recycling related activities or initiatives for any type of organic fraction of solid waste or solid residues that would occur in the absence of the project activity at the Bragança landfill or in the region of influence of this landfill [8]. The same

[8] As per the Brazilian Federal Law 12.305/10, waste recycling is defined as a process of transformation of waste material and residues through promotion of changes in their physical, chemical or biological properties in order to allow and promote use of such materials as raw material or even as new products. Although waste recycling is being regarded in the national sector directives for waste management as a priority goal, solid waste recycling initiatives in Brazil are still being quite limited (especially in the case of organic fraction of MSW). As outlined in the publication "*Panorama dos Resíduos Sólidos no Brasil – 2014*" (tittle translated into English language as "*Outlook of Solid Waste Sector in Brazil – year 2014"* and available online at: http://www.abrelpe.org.br/panorama_apresentacao.cfm), solid waste recycling initiatives in Brazil have encompassed mainly the following by-products/waste types with higher economic value:

- aluminum (mainly beverage aluminum cans),
- pre-separated/sorted clean (not contaminated) paper,
- pre-separated/sorted (not contaminated) plastic material (mainly PET beverage bottles),
- glass material.

The "*Panorama dos Resíduos Sólidos no Brasil*" is a publication annually published by the Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais – ABRELPE (translated into English language as "Brazilian Association for Municipal Solid Waste and Special Waste") and represents one of the most credible annual outlook and statistics source for the solid waste management in Brazil. The most recent Greenhouse Gases Emissions National Inventory (published by the Brazilian Ministry of Technology and Science in 2010 also confirms that non-conventional MSW treatment alternatives (such as composting of organic fraction of MSW and waste incineration) are not meaningful practices in Brazil (including the region where the project activity was implemented).
In fact, in year 2012 the Brazilian Ministry of City Infrastructure (through its National Secretary of Sanitation) has published the year 2010 edition of a very comprehensive and detailed sectoral analysis/diagnostic about the whole MSW sector in Brazil: the publication "*Diagnóstico do Manejo de Resíduos Sólidos Urbanos – 2010*" (tittle translated into English language as "Diagnostics of Urban Solid Waste Management - 2010" and available online at: http://www.snis.gov.br/PaginaCarrega.php?EWRErterterTERTer=93). Like the Report "*Panorama dos*

Resíduos Sólidos no Brasil – 2014", this Government official publication also includes relevant and detailed statistics for MSW management for the main municipalities, States and regions in Brazil. Available statistics includes prevailing practices in terms of waste management practices (collection, disposal and re-use/recycle).

In the particular case of the region under potential influence of the Bragança landfill (city of Porto Alegre and surrounding cities), all solid waste materials (organic or inert) to be eventually/potentially recycled (very small share of collected MSW) are normally previously sorted in the waste generation sources (prior to be mixed with other types of MSW to be disposed in landfills or waste dump sites in the region). In the particular case of recycling of organic fraction of waste material to be disposed in landfills or dump sites, the current *status quo* is also expected to be the prevailing situation valid in the future: paper waste streams (mixed with other MSW types), food residues, textile, wood waste etc. when ready to be disposed in landfills/dump sites or already disposed in a particular landfill or dump site) are not even regarded as recyclable material (and thus not even accounted in the available statistics for recyclable material).

Under the category "organic MSW fraction" only clean (not contaminated) and previously sorted pulp/paper/cardboard waste materials has actually been considered as recyclable material (as per both available statistics and available recycling practices). Besides some particular inert waste materials with commercial value (e.g. aluminum, clean plastic material and glass), no other waste materials have been collected from stream of MSW to be disposed in landfills in order to be recycled in the region where the project activity is implemented or transported to be recycled in other region. This has also been the common recycling scenario in other regions of Brazil.

Thus, in the particular case of the Bragança landfill, both under the baseline and project scenarios (with or without the implementation of the project activity), no organic fraction of solid waste stream that has been directed to this landfill would be expected to be collected and directed to any type of recycling facility (e.g. composting facility) after or prior its disposal in the landfill site. This situation is expected to remain being the practice in the future. In fact, as established by related construction and design documents for the Bragança landfill, no waste pickers or waste sorting teams have ever operated in the landfill area. No composting plant for organic waste (or any other type of alternative management for MSW organic content) was ever implemented or is expected to be implemented in the area in the future either.

That confirms that no relevant sorting and collection of recyclable organic material from MSW already disposed in the Bragança landfill are expected to occur regardless of the implementation of the project activity (under both baseline and project scenarios). Thus, recycling or alternative use from organic fraction of waste already disposed in the landfill are not expected to occur either (regardless of the implementation of the project activity).

In summary, based on information and data included in the "*Diagnóstico do Manejo de Resíduos Sólidos Urbanos – 2010*"; information and data available in the "*Panorama dos Resíduos Sólidos no Brasil – 2014*" and also based on common practice for waste collection, disposal e recycling in the region of the project activity and even in other regions in Brazil, and by also taking into account the local situation at the region of the project site, the following assertions are valid for potential of recycling of organic fraction of MSW in the region of influence of the Bragança landfill:

- The current MSW management practice in Brazil (and its trend for the future) represents disposal of collected MSW in existing and new landfills (and still existing open dump sites). This practice currently represents almost all undertaken management for all stream of MSW which is actually collected (in mass basis); with very reduced share of collected MSW in Brazil being currently treated under non-conventional methods such as waste incineration (0.03%) and composting (0.11%) (in mass basis as per data of year 2010 (data organized and published in year 2012)).
- It is important to note that in all regions in Brazil with existing MSW disposal activities using landfilling techniques (in existing landfill or existing dump sites) significant quality improvements in terms of MSW disposal services and techniques are still required especially for cases where solid waste is disposed in existing dump sites and in existing not well designed/managed landfills. Such required improvements include construction of better-designed landfills, use of more appropriated technics for waste compacting and covering, etc. In this sense, the Bragança landfill represents a very well designed and managed landfill. The main barrier for improving MSW management in Brazil is still being lack of capital and investment capacity from municipalities to face high associated costs for implementing environmentally friendly MSW management operations. Under the region of influence of the Bragança landfill, organic fraction of solid waste material that is collected as MSW has been historically disposed by applying landfilling techniques.
- In all geographical regions in Brazil, relative low share of previously sorted pulp/paper/cardboard (clean and not contaminated) waste materials have been used as recycling material in the region. Materials under such conditions are termed in the available statistics as "dry recyclable material" and are normally not mixed with MSW stream to be sent to landfills or dump sites. It is important to note that the initiatives and businesses involving recycling of previously sorted dry pulp/paper/cardboard materials (clean and not contaminated materials) have their particular dynamics and characteristics and with not so detailed statistics in some cases. However, under no circumstance such activities are to be affected or even influenced by change, improvements or aspects related to MSW disposal activities employing good landfilling technics (for example: in most of the well managed landfills in Brazil, the landfill is implemented in a closed and controlled area without waste pickers collecting waste from the landfill as a way or living). By taking into consideration the dynamics of initiatives promoting recycling of paper material, it is correct

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – “Flaring or use of landfill gas” (version 18.0)	Justification
	is actually also applicable for recycling of inert waste material. Furthermore, regardless of the non-existence of any MSW recycling or utilization facility with comparable capacity that could eventually somehow compete with the Bragança landfill in terms of processing of organic fraction of MSW waste, aspects and actions related to

to assume that, differently than for MSW disposal activities; policies, planning and practices related to MSW collection and sorting could indeed under a certain limit play a role such initiatives.

- By merely promoting efficient collection and destruction/utilization of LFG in a landfill (where LFG is generated due to anaerobic degradation of organic fraction of MSW which is to be disposed in the landfill under the framework of contracts for MSW disposal signed with municipalities in the region), the implementation of the project activity and its continuous operation *per-se* clearly does not represent any driver or incentive for promoting any change in the MSW management situation in the region where it is implemented (including waste recycling practices or initiatives for organic content of MSW to be disposed in landfills or dump sites).

By taking into account (i) the institutional and regulatory framework for the public service of MSW management; (ii) the dynamics of MSW sector in the region where the project activity is to be implemented and in Brazil, and (iii) magnitude of average costs for existing MSW management options (which could be regarded as alternatives to disposal of MSW in landfills (e.g employment of MSW composting techniques)), (iv) the available related statistics, the following aspects are to be noted:

- it is clear that promotion or even disincentive of recycling of organic fraction of MSW are not waste policy aspects that would be under any influence or willingness of the project participant Embralixo – Empresa Bragantina de Varricao e Coleta de Lixo Ltda (owner and operator of the Bragança landfill). Aspects and actions related to promotion of any increase or even reduction of recycling of organic fraction of waste (and/or recycling of any other type of solid waste material) in the region where the project activity is implemented, are to be seen as dependent in a last instance on public service policies (including policies, laws, regulations and programmes) to be set by competent governmental authorities (under a regional and national level) and by practitioners of recycling. In Brazil, the administrations of municipalities are responsible for addressing all MSW management services. Furthermore, there are federal directives and laws to be considered by Municipalities for the implementation and operation of their local waste management policies. This is the case in the geographical region of the project site. Waste collection and disposal services are normally performed by the municipality and/or are performed by private companies hired and paid by one or more municipalities (under contractual commercial agreements for provision of public service on behalf of such municipality (ies)) for the provision of MSW collection and/or MSW disposal services by completely following directives and requirements established by the municipalities in signed contracts. In this context, both under the baseline and project scenarios (with or without the implementation of the project activity), Embralixo – Empresa Bragantina de Varricao e Coleta de Lixo Ltda is not under a position to design or plan the implementation of any initiative promoting recycling or use of organic waste (e.g. operation of a solid waste composting plant) at the Bragança landfill or at other location in the region.
- The implementation of the project-based initiative promoting collection of LFG and its destruction in high temperature flare and utilization as fuel for electricity generation in the Bragança landfill *per se* would not trigger any change in the regional policies and practices for MSW management in the region or outside its region of influence either. As further discussed in Section B.6.1, so far, there is still no legal restriction neither requirement for LFG gas collection and its destruction using high temperature enclosed flares in Brazil. Moreover, there is still no legal restriction neither requirement for passive venting of LFG or its combustion in conventional LFG destruction systems either. Actually, there is no applicable regulation/law that deals with LFG management in Brazil. Thus, the implementation (and operation) of more appropriate and environmentally safe management of LFG at the Bragança landfill as part of the project activity does not represent a driver or incentive to promote incremental disposal of organic waste stream at this landfill thus displacing or preventing such waste stream from being treated under an existent or potential (hypothetical) MSW recycling/utilization facilities (e.g. a hypothetical waste composting plant) instead.

In summary, by taking into consideration the nature of project activity and all aspects and information above-presented, the project activity does not pose any risk or potential to promote any relative decrease of the amount of organic fraction of MSW that would be otherwise recycled or utilized or prevention of any mean of waste recycling or utilization.

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 18.0)	Justification
	promotion of recycling or utilization of organic fraction of solid waste are to be seen as fully dependent on public service policies in the case of Brazil (including policies, laws, regulations and programmes) and are to be defined/triggered by competent governmental authorities (under a regional and national level) and/or to be eventually implemented/operated by practitioners of waste recycling. In Brazil, the administrations of municipalities are the entities responsible for all MSW management services. Waste management companies such Embralixo – Empresa Bragantina de Varricao e Coleta de Lixo Ltda normally acts as service providers, providing MSW collection and disposal services as per directives and contractual requirements which are set by the municipalities from where generated MSW are to be managed. In this sense, in the position of a MSW management company operating a LFG collection and destruction initiative in the landfill it operates, Embralixo – Empresa Bragantina de Varricao e Coleta de Lixo Ltda is not under a position to trigger, establish or promote any promotion of reduction or prevention of organic waste recycling in the region where it operates. Finally, the implementation and operation of the project activity has never represented any incentive or driver for involved municipalities, any other public entity or any other relevant recycling practitioner for the promotion of changes in the policies and practices related to recycling of inert or organic solid waste in the region (or even outside the region) of influence of the Bragança landfill. No change in this sense is expected to occur during the 2nd 7-year crediting period either. As outlined in Section B.6.1, so far, there is still no legal restriction or requirement for LFG gas collection and its destruction or utilization using high temperature enclosed flares or any other device/equipment in Brazil. Actually, there is no applicable regulation that deals with LFG management in Brazil at all. Thus, the implementation of more appropriate and environmentally safe management of LFG at the Bragança landfill (as a direct outcome of the implementation and operation of the project activity) *per se* does not represent any driver or incentive to dispose incremental amount of MSW in the Bragança landfill (when compared to the situation that would occur in the absence of the project).

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – “Flaring or use of landfill gas” (version 18.0)	Justification
	In this sense, under no circumstance the project activity *per se* potentially promote any displacement of volumes of organic waste stream from eventual treatments/utilization in an existent or hypothetical MSW recycling/utilization facilities (e.g. a MSW composting plant for example) to be disposed at the Bragança landfill because of the implementation and continuous operation of the project activity. Therefore, applicability condition (d) is also satisfied.
“*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 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* *(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.”*	As further demonstrated in Section B.4, the most plausible baseline scenario remains being the release of LFG from the SWDS into the atmosphere (with minor share of generated LFG being partially destroyed in conventional LFG passive venting/combustion drains). Therefore, the application of the procedure to identify the baseline scenario falls into condition (a). The quoted applicability condition is thus satisfactory met.
Non applicability conditions	**Justification**
“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*	Neither options (a) and/or (b) occur. The only GHG emission reductions claimed are due to destruction of methane through combustion in high temperature enclosed flare. After the implementation of the project activity in year 2008, the landfill operator has continued with MSW

Applicability Condition of CDM baseline and monitoring methodology ACM0001 – "Flaring or use of landfill gas" (version 18.0)	Justification
in a kiln or glass melting furnace, where the purpose of the CDM project activity is to implement energy efficiency measures at a kiln or glass melting furnace; (b) *If the management of the SWDS in the project activity is deliberately changed during the crediting in order to increase methane generation compared to the situation prior to the implementation of the project activity.*	disposal activities at the Bragança landfill as per its normal and previously planned/defined operation conditions and practices (as per the practice prior to the implementation of the project activity). MSW disposal practices and management at the Bragança landfill are not expected to change during the 2nd 7-year crediting period either. The quoted applicability conditions are thus satisfactory met.

Regarding the applied methodological tools, the table below summarizes how the project activity meets their applicability conditions:

Methodological tool	Version	Applicability conditions	Comments
"Tool to determine the mass flow of a greenhouse gas in a gaseous stream"	03.0	This tool provides procedures to determine the parameter $F_{i,t}$ (kg/h) "Mass flow of a greenhouse gas *i* (CO_2, CH_4, N_2O, SF_6 or a PFC) in the gaseous stream in time interval *t*" based on measurements of: (a) the total volume flow or mass flow of the gas stream, (b) the volumetric fraction of the gas in the gas stream and (c) the gas composition and water content. *"Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions."*	As established by ACM0001 (version 18.0), this tool is applied as per the methodology for determining the mass flow of CH_4 which is sent to the flare. The applicability condition of the methodological tool is thus met.

Methodological tool	Version	Applicability conditions	Comments
"Project emissions from flaring"	02.0.0	*"This tool provides procedures to calculate project emissions from flaring of a residual gas. The tool is applicable to enclosed or open flares and project participants should document in the CDM-PDD the type of flare used in the project activity.* *This tool is applicable to the flaring of flammable greenhouse gases where:* *o Methane is the component with the highest concentration in the flammable residual gas; and* *o The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g. biogas, landfill gas or wastewater treatment gas).* *The tool is not applicable to the use of auxiliary fuels and therefore the residual gas must have sufficient flammable gas present to sustain combustion. For the case of an enclosed flare, there shall be operating specifications provided by the manufacturer of the flare.* *This methodology refers to the latest approved version of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". The applicability conditions of this tool also apply."*	As part of the project activity, all collected LFG (whose component with the highest concentration is methane) is combusted in the high temperature enclosed flare. LFG is a flammable gas generated from the anaerobic decomposition of organic waste material disposed in the Bragança landfill. LFG is thus a gas from a biogenic source. Methane is the component with the highest concentration in LFG. No auxiliary fuel is required to make the flammability of LFG sufficiently enough to be combusted in the project flare. As demonstrated above, the applicability conditions for the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" are also sufficiently met. Thus, the quoted applicability criteria defined in the methodological tool are sufficiently met.
"Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"	02.0	*"This tool provides procedures to estimate the baseline, project and/or leakage emissions associated with the consumption of electricity, and procedures to monitor the amount of electricity generated by the project power plant."* *"If emissions are calculated for electricity consumption, the tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption:* *(a) Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either*	As established by ACM0001 (version 18.0), consumption of grid-sourced electricity by the project activity is to be accounted as project emissions. The electricity demand of the project activity is met by imports of grid-sourced electricity as part of the normal operation of the project activity. No captive renewable power generation technologies are installed or are expected to be

Methodological tool	Version	Applicability conditions	Comments
		no captive power plant is installed at the site of electricity consumption or, if any captive power plant exits on site, it is either not operating or it is not physically able provide electricity to the of electricity consumer. *(b) Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid, or* *(c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power plant(s) and the grid.*"	installed to provide electricity to the project activity. Thus, Scenario A of the tool is applicable.
"Emissions from solid waste disposal sites"	08.0	"*This tool provides procedures to calculate baseline, project or leakage emissions of methane from solid waste disposed or prevented from disposal at a solid waste disposal site (SWDS).*" "*The tool can be used to determine emissions for the following types of applications:* *(a) Application A: The CDM project activity mitigates methane emissions from a specific existing SWDS. Methane emissions are mitigated by capturing and flaring or combusting*	The project mitigates methane emissions from a landfill. The applicability of the methodological tool is thus met. Application A in the methodological tool is selected and applied as established by ACM0001 (version 18.0).

Methodological tool	Version	Applicability conditions	Comments
		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 project design document (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); *(b) Application B: The CDM project activity avoids or involves the disposal of waste at a SWDS. An example of this application of the tool is ACM0022, in which municipal solid waste (MSW) is treated with an alternative option, such as composting or anaerobic digestion, and is then prevented from being disposed of in a SWDS. The methane is generated from waste disposed or avoided from disposal during the crediting period. In these cases, the tool can be applied for both ex ante and ex post estimation of emissions. These project activities may apply the simplified approach detailed in 0 when calculating baseline emissions.*"	
"Tool to calculate the emission factor for an electricity system"	05.0	*"This tool is also referred to in the "Tool to calculate project emissions from electricity consumption" for the purpose of calculating project and leakage emissions in case where a project activity consumes electricity from the grid or results in increase of consumption of electricity from the grid outside the project boundary."*	Project emissions due to the consumption of grid-sourced electricity by the project activity are determined by applying applicable guidance of the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (of which ACM0001 version 18.0 refers to). The "Tool to calculate the emission factor for an electricity system" is referred to in the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" for the purpose

Methodological tool	Version	Applicability conditions	Comments
			of calculating project emissions in cases where a project activity consumes electricity from the grid. The CO_2 emission factor for the electricity grid which sources electricity to the project activity is determined as the combined margin CO_2 emission factor. The relevant applicability condition of the methodological tool is thus fully met.
Methodological tool "Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period"	03.0.1	"*This tool provides a stepwise procedure to assess the continued validity of the baseline and to update the baseline at the renewal of a crediting period, as required by paragraph 49 (a) of the modalities and procedures of the clean development mechanism. The tool consists of two steps. The first step provides an approach to evaluate whether the current baseline is still valid for the next crediting period. The second step provides an approach to update the baseline in case that the current baseline is not valid anymore for the next crediting period.*"	The application of this tool in the context of the renewal of the 7-year crediting period is required as per the CDM Project Standard. The applicability condition of the methodological tool is thus met.
"Combined tool to identify the baseline scenario and demonstrate additionality"	06.0	"*This tool is only applicable to methodologies for which the potential alternative scenarios to the proposed project activity available to project participants cannot be implemented in parallel to the proposed project activity"* *(…)* *For example, in the following situations a methodology could refer to this tool:* - *For an energy efficiency CDM project where the identified potential alternative scenarios are: (a) retrofit of an existing equipment, or (b) replacement of the existing equipment by new equipment, or (c) the continued use of the existing equipment without any retrofits;* - *For a CDM project activity related to the destruction of a greenhouse gas in one site where the*	As established by ACM0001 (version 18.0), this methodological tool is applied as per the methodology for the demonstration of the continuation of the baseline scenario. The project activity encompasses destruction of a greenhouse gas in one site where one of the identified potential alternative scenarios is no abatement of the greenhouse gas. The continuation of the baseline scenario is demonstrated by applying the stepwise procedure of ACM0001 (version 18.0) for the determination of the

Methodological tool	Version	Applicability conditions	Comments
		identified potential alternative scenarios are: (a) installation of a thermal destruction unit, or (b) installation of a catalytic destruction system, or (c) no abatement of the greenhouse gas. *In these cases, the project proponents could not implement the three alternatives in parallel but they could only implement one of them.”* *However, the tool is, for example, not applicable in the following situation: the CDM project activity is the installation of a Greenfield facility that provides a product to a market (i.e. electricity, cement, etc.) where the output could be provided by other existing facilities or new facilities that could be implemented in parallel with the CDM project activity.”*	baseline scenario. Baseline emissions are also determined by applying methodological approach also established by ACM0001 (version 18.0) and applicable methodological tools. The applicability condition of the methodological tool is thus met.

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

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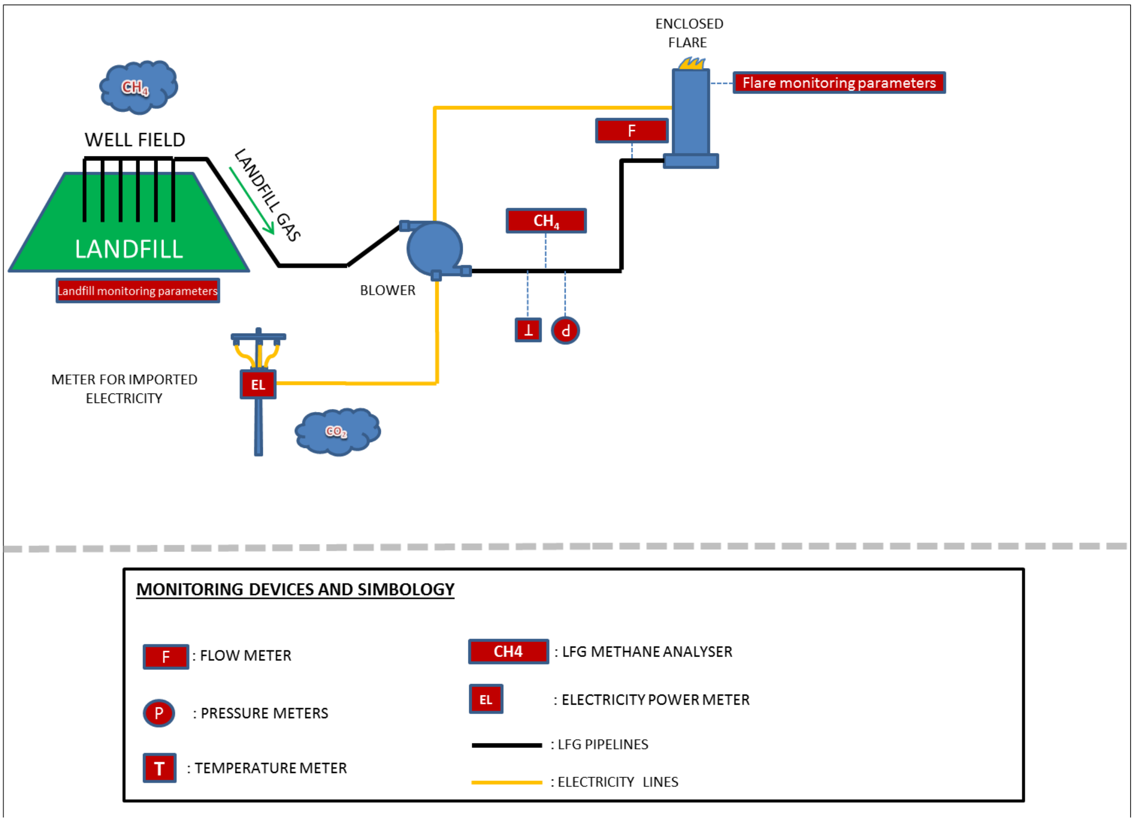
The project boundary of the project activity includes the landfill site where the LFG is captured and destroyed by combustion in high temperature enclosed flare. The electricity grid from which grid-sourced electricity is imported is the National Electricity Grid of Brazil.

The table below provides a summary of the delineation of greenhouse gases (GHG) and sources included and excluded from the project boundary:

	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 very small when compared to CH_4 emissions from SWDS (in tCO_2e). This is conservative.
Project activity	Emissions from consumption of grid electricity by the project activity	CO_2	Yes	May be an important emission source.
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small.

The schematic flow diagram below summarizes the project boundary and delineates the project activity (equipment, parameters to be monitored, and GHG included in the project boundary).



B.4. Establishment and description of baseline scenario

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This Section includes the required application of the stepwise approach of the methodological tool "Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period" for demonstrating the validity of the previously derived baseline scenario. This is performed by presenting the whole determination of the baseline scenario by following applicable guidance and stepwise procedure of ACM0001 (version 18.0).

Application of the stepwise approach of the methodological tool "Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period":

In the context of the renewal of the 7-year crediting period of the project activity, as per applicable guidance of the CDM Project Cycle Procedure, the stepwise approach of the methodological tool "Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period" (version 03.0.1) is applied as follows.

The objective of applying this methodological tool is demonstrating the continuation of validity of the baseline scenario (which was previously determined and assessed at the time of the validation of the project activity in year 2007).

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

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

As further explained in Section B.6.1, prior to the registration of the project as a CDM, there was no legal obligation to capture and destroy the LFG at the Bragança landfill and in any other existing landfill in Brazil. This situation currently prevails[9].

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[9] In March 2017, there was still no legal requirement for LFG gas collection and its destruction using active or passive high temperature enclosed flares in Brazil. Moreover, there was still no legal restriction neither requirement for passive venting of LFG or its combustion in conventional LFG destruction systems (e.g. passive flares and/or combustion drains). Actually, there is still no applicable regulation that deals with LFG management in Brazil.

The Brazilian National Policy on Waste Management:

After years of studies and negotiations, the Brazilian Regulation termed National Policy on Waste Management, established by Decree No. 7,404/10 (the Decree), was finally published on 23/12/2010. In force since its publication, this decree regulates the National Policy on Waste Management (PNRS), established by Federal Law No. 12,305 (the LPNRS), and creates the Steering Committee for the Implementation of Reverse Logistics Systems (Steering Committee) and the PNRS Interministerial Committee. This new Brazilian Regulation of the National Policy on Waste Management does not establish any requirement, obligation or recommendation related to LFG management at landfills in Brazil. As outlined by the law firm "Tauil & Chequer Advogados" in a recently published article:

Although there was no regional or national legal requirement in Brazil establishing LFG to be collected and destroyed in landfills at the time the project activity was validated, in the particular case of the Bragança landfill, a very small share of generated LFG flare was voluntarily combusted in previously existent pre-project LFG venting/combustion drains located in the Bragança landfill[10].

The demonstration of continuation of the baseline scenario for the project activity is thus in full compliance with mandatory national, regional and/or sectorial policies and requirements.

Step 1.2: Assess the impact of circumstances

> *"(...) The Regulation of the National Policy on Waste Management, established by Decree No. 7,404/10 (the Decree), was published on December 23, 2010. In force since its publication, the Decree regulates the National Policy on Waste Management (PNRS), established by Federal Law No. 12,305/10 (the LPNRS), and creates the Steering Committee for the Implementation of Reverse Logistics Systems (Steering Committee) and the PNRS Interministerial Committee. The main purpose of the PNRS Interministerial Committee is to support the PNRS structuring and implementation, in order to enable the accomplishment of the provisions and goals set forth by the LPNRS. The Steering Committee has the basic function of guiding the implementation of reverse logistics. Among the instruments regulated by the Decree are the Reverse Logistics Systems, the Waste Management Plans (PGRS) and the National Registry for Hazardous Waste Operators. The Decree lists three specific instruments for the implementation and operation of the reverse logistic systems: (i) sectorial agreements, executed between public authorities and the industry; (ii) regulations, issued by the executive branch; and (iii) commitment agreements—which are to be adopted in the absence of sectorial agreements and regulations and when specific circumstances require more restrictive obligations—to be approved by the competent environmental agency. Regarding the obligation to prepare a PGRS, which should be required within environmental permitting proceedings, the Decree mentions the possibility of jointly submitting the PGRS under specific conditions and in cases where activities are conducted in the same condominium, municipality, micro-region or metropolitan/urban areas. Additionally, the Decree establishes that small companies that generate household waste, as provided for by article 30 of the LPNRS, are not required to submit a PGRS. Regarding the National Registry for Hazardous Waste Operators, which must be integrated to the already existing Federal Technical Registry of IBAMA, the Decree establishes a registration obligation for companies that manipulate or operate hazardous waste. The Decree also describes those who are considered generators or operators of hazardous waste, establishing several requirements for their authorization or permitting. These include the preparation of hazardous waste management plan, the demonstration of technical and economic capacity and the obtaining of civil liability insurance for environmental damages."*

[10] The following related information is outlined in the latest version of the PDD valid for the currently expired 1st 7-year crediting period of the project activity:

> *"The existing contractual documents do not require capturing or flaring the landfill gas. On the landfill, there is an implemented venting system that does not, adequately, support the flaring of the LFG. The flow on the passive drains has been measured and estimated (At the time of the project initial design conceptualization) to flare about 2.63% of the expected landfill gas on 2008, descending to about 2.27% on 2014*."

The previously identified baseline scenario for the project activity is demonstrate as not changed at the time of requesting renewal of the crediting period[11].

While the baseline scenario identified at the validation stage of the project activity was the continuation of the current practice without any investment, an assessment of the changes in market characteristics is thus required for the renewal of the crediting period. This is required by the methodological tool "Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period" (version 03.0.1).

As an outcome of such analysis, it is confirmed the following:

- The conditions and circumstances considered or taken into account to determine the baseline emissions in the previous crediting period are still valid. LFG (rich in CH_4) generated at the Bragança landfill would still being freely emitted into the atmosphere (with minor share of generated LFG being destroyed in the pre-project conventional passive LFG venting/combustion drains) in the absence of the project activity. Generated LFG would still be freely emitted into the atmosphere through both the surface of the landfill and the pre-project conventional LFG venting/combustion drains.
- There is no change in market or regulatory characteristics/aspects (incl. legal requirements) or new market or regulatory circumstances that would demand any type of re-assessment or re-evaluation for the determination of the baseline scenario for the 2nd 7-year renewable 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 renewable is requested.

While the baseline scenario identified at the validation of the project activity was not selected as "*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",* this step is thus not applicable.

The pre-project situation at the Bragança landfill does not include baseline equipment or investment.

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

Some methodological requirements, ex-ante selected data and parameters which were previously determined during the project validation period (within year 2007) and thus prior to the start of the 1st 7-year crediting period as per the applicable requirements of the earlier applied CDM baseline and monitoring methodology (ACM0001 (version 05)) will not any longer be valid/applicable during the 2nd 7-year crediting period. As per the applied latest version of the valid CDM baseline and

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[11] Although the previously identified baseline scenario for the project activity remains the same, it is important to note that baseline emissions and ex-ante estimations of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period have significantly changed when compared assumptions as presented in the latest version of the PDD (and related emission reduction spreadsheet) valid for the 1st 7-year crediting period (PDD version 06, dated 05/03/2007). While the version of ACM0001 baseline and monitoring methodology which was previously applied in the PDD for the 1st crediting period (ACM0001, version 05) includes a methodological approach for determining the baseline emissions due to methane destruction which is based in specific set of methodological assumptions and approaches, the methodological assumptions (incl. default values) applicable as per the latest version of ACM0001 (version 18.0) are slightly different. Such differences promote a relative decrease in estimations of ex-ante estimations of baseline emissions to be achieved by the project activity along the 2nd 7-year crediting period. Furthermore, it is also noteworthy that the ex-ante selected value for Global Warming Potential (GWP) for methane (CH_4) which is valid for the 2nd 7 year crediting period (the value valid for the 2nd commitment period of the Kyoto Protocol) is higher than the one previously applied (value of 25 instead of 21 values previously applied).

monitoring methodology (ACM0001 (version 18.0)) and related methodological tools, there are differentiated methodological approaches which are applicable and thus should be considered (incl. some of the ex-ante determined parameters, other default values and even other assumptions). Due to that, other data and ex-ante determined parameters are thus applied in the context of the demonstration of the validity of the earlier derived baseline scenario and also applied in the determination of baseline emissions during the 2nd 7-year crediting period. Thus, some of data and parameters as presented in the latest version of the PDD valid for the 1st crediting period not any longer valid.

As a conclusion, since (i) the demonstration of validity of the earlier derived baseline scenario, (ii) determination of baseline emissions during the 2nd 7-year crediting period and (iii) ex-ante determined parameters and default values are all determined/calculated as per applicable guidance of ACM0001 (version 18.0) and related methodological tools, the validity of earlier defined ex-ante determined parameters is thus limited. The methodological approaches for the demonstration of validity of the earlier derived baseline scenario, baseline emissions during the 2nd 7-year crediting period, ex-ante determined parameters and monitored parameters are presented and justified in this Section, in Section B.6.1, Section B.6.2 and Section B.7.1 respectively.

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

Step 2.1: Update the current baseline

The determination of the baseline scenario (as per applicable guidance of ACM0001 (version 18.0)) is included below under "*Determination of the baseline scenario*". It is important to note that while the baseline scenario for the project activity was not changed for the 2nd 7-year renewable crediting period, the applied methodological approaches for the determination of baseline scenario and baseline emissions (as per ACM0001 (version 18.0)) is indeed different than the one required by the previously applied methodology ACM0001 (version 05). Thus, for completeness reasons, this PDD includes the whole determination of the baseline scenario and baseline emissions as per the applicable guidance and requirements and stepwise approaches of ACM0001 (version 18.0) regardless the fact baseline scenario remains being the same.

The determination of baseline emissions (by following all applicable guidance and requirements of ACM0001 (version 18.0) and applicable related methodological tools) is presented in Section B.6.1. Related ex-ante estimations of baseline emissions for the 2nd 7-year crediting period are summarized in Section B.6.3.

Step 2.2: Update the data and parameters

All applicable and required ex-ante determined parameters valid for the 2nd 7-year renewable crediting period are presented in Sections B.6.1 and B.6.2.

While some of the ex-ante determined parameters (which are summarized in Sections B.6.1.and B.6.2) are applied only in the context of ex-ante estimations of emission reductions along the 2nd crediting period, other ex-ante determined parameters will however be used for the calculation/determination of emission reductions in an ex-post basis (in conjunction with parameters determined ex-post) along the 2nd 7-year crediting period.

It is also important to consider that ACM0001 (version 18.0) and applicable methodological tools include parameters (ex-ante or ex-post determined) which were not previously applied/considered in the PDD valid for the 1st 7-year crediting period (as this PDD was completed in accordance requirements and guidance of the baseline and monitoring methodology ACM0001 (version 05)). Furthermore, as also outlined in Section B.6.2 the value for the Global Warming Potential (GWP) for the GHG methane is also changed for the 2nd crediting period when compared to the value previously applied during the largest fraction of the 1st crediting period. The applied revised value for the ex-ante determined parameter GWP_{CH4} is in accordance with the "Standard for application of the global warming potential to clean development mechanism project activities and programmes of activities for the second commitment period of the Kyoto Protocol".

Determination of the baseline scenario (in order to demonstrate the continuation of earlier identified baseline scenario) by following applicable stepwise procedure of the "Combined tool to identify the baseline scenario and demonstrate additionality" as required by ACM0001 (version 18.0)):

On the next steps, the continuation of the earlier identified baseline scenario for the project activity is confirmed through the application of the stepwise approach for determining baseline scenario as per the "Combined tool to identify the baseline scenario and demonstrate additionality"[12] (version 06.0) as required by ACM0001 (version 18.0).

Application of the stepwise approach for determining baseline scenario as per the "Combined tool to identify the baseline scenario and demonstrate additionality":

STEP 0: Demonstration whether the proposed project activity is the *First-of-its-kind*

This optional step is not applied for the renewal of the crediting period of a registered CDM project activity.

STEP 1: Identification of alternative scenarios

SUB-STEP 1a: Define alternatives to the proposed CDM project activity

Identification of alternatives for the destruction of LFG
In this step, the following baseline alternatives for the destruction of LFG are taken into consideration:

LFG1: The project activity undertaken without being registered as a CDM project activity (i.e. capture of landfill gas and its flaring and/or its use). This is a plausible alternative scenario, however involves significant investment and additional costs of landfill operations with no associated revenues in the case of flaring of collected LFG.

LFG2: Atmospheric release of the landfill gas or partial 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 scenario corresponds to the continuation of the current situation (the proposed project activity or any other alternatives are not implemented).

LFG3: LFG generation is partially avoided because part of the organic fraction of the solid waste is recycled and not disposed in the SWDS;

LFG4: LFG generation is partially avoided because part of the organic fraction of the solid waste is treated aerobically and not disposed in the SWDS;

LFG5: LFG generation is partially avoided because part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS.

The project activity was implemented at a landfill site whose purpose is the final disposition of waste through adopting of landfilling practices and techniques. As further explained in

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[12] As outlined in Section B.5, this PDD does not include assessment and demonstration of additionality. This is in accordance with applicable procedures and rules for renewal of 7-year crediting period of registered CDM project activities.

Section B.2, the project activity has not previously promoted and is not expected to promote any change in waste recycling activities in the region where the Bragança landfill is located. In these contexts, it is crucial to note that with or without the project activity being implemented, no recycling of the organic fraction of waste disposed at the Bragança landfill, neither aerobic treatment, neither incineration of disposed waste streams have occurred or have prevented (or would have occurred or would have prevented) at this landfill and/or in any other landfill, or recycling station located in the region where the Bragança landfill is located. Thus alternative scenarios LFG3, LFG4 and LFG5 are hereby automatically excluded from the determination of baseline alternatives. Such exclusion is in accordance with applicable guidance of ACM0001 (version 18.0). In fact, recycling of organic matter, aerobic treatment and incineration of Municipal Solid Waste (MS) has not been common practice in Brazil. The implementation and operation of the project activity has never promoted and is not expected to promote any quantitative change (including reduction) in the amount of organic solid waste that could or would be eventually recycled. This is an applicability condition/criteria of ACM0001 (version 18.0) of which compliance is further explained in Section B.2.

Identification of alternatives for the utilization of LFG for electricity and/or heat generation:
The project design does not encompass any continuous utilization of LFG as gaseous fuel for electricity. Thus, as established by ACM0001 (version 18.0), scenarios E1, E2 and E3 are not considered on the present analysis. This is in accordance with ACM0001 (version 18.0).

Heat generation scenarios using LFG collected at the landfill as fuel are not part of the project design either, as there are no heat requirements at the landfill and the project activity does not encompass use of collected LFG for heating or thermal purposes (i.e. use of collected LFG as gaseous fuel in boiler, air heater, glass melting furnace(s) and/or kiln). Therefore, scenarios H1 trough H7 are not considered either. This is also in accordance with ACM0001 (version 18.0).

Identification of alternatives for the supply of LFG to natural gas distribution network and/or dedicated pipeline and/or distribution of compressed/liquefied LFG using trucks

Supply of LFG to a natural gas distribution network and/or dedicated pipeline and/or distribution of compressed/liquefied LFG by using trucks are currently not considered as part of the project activity either. Therefore, this option is not considered on the present analysis.

Outcome of SUB-STEP 1a: The only alternatives to be taken into consideration, after SUB-STEP 1a) are LFG1 and LFG2.

SUB-STEP 1b: Consistency with mandatory applicable laws and regulations:

So far, there are still no legal restrictions or requirements for LFG collection and destruction in Brazil, neither for passive venting of LFG. Therefore, the remaining alternatives LFG1 and LFG2 are thus both under compliance with all applicable mandatory laws and regulations.

Outcome of SUB-STEP 1b: The only remaining alternatives to be taken into consideration after SUB-STEP 1b) are identified as LFG1 and LFG2.

STEP 2: Barrier analysis + **STEP 3: Investment analysis + STEP 4: Common practice analysis**

As per the “Combined tool to identify the baseline scenario and demonstrate additionality”, STEP 2 (Barrier analysis) serves to identify barriers and to assess which alternative scenarios are prevented by these barriers.

The “Combined tool to identify the baseline scenario and demonstrate additionality” established the following regarding STEP 3 (Investment analysis):

> “*(…) The objective of Step 3 is to compare the economic or financial attractiveness of the alternative scenarios remaining after Step 2 by conducting an investment analysis. The analysis should include all alternative scenarios remaining after Step 2, including scenarios where the project participants do not undertake an investment (S2 or S3)*.”

Finally the methodological tool outlines the following regarding STEP 4 (Common practice analysis):

> “*If the proposed project activity is the first-of-its-kind then this step is not applicable. Otherwise, the previous Steps shall be complemented with an analysis of the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and applicable geographical area. This test is a credibility check to demonstrate additionality and complements the barrier analysis (Step 2) and, where applicable, the investment analysis (Step 3).”*

As per the applicable methodological guidance of both ACM0001 (version 18.0) and the “Combined tool to identify the baseline scenario and demonstrate additionality”, determining baseline scenario for a LFG collection and destruction/utilization initiative proposed as a CDM project activity is somehow combined with assessing and demonstrating additionality for such proposed CDM project activity.

While in the particular situation of the renewal of the 7-year crediting period of a registered CDM project activity it is not required to assess and demonstrate the validity of the earlier assessed/demonstrated additionality (of which in the particular case of the “Embralixo/Araúna – Bragança Landfill Gas Project” was previously assessed and demonstrated as presented in the latest version of the PDD valid for the 1st 7-year crediting period (PDD version 06)), the application of STEP 2, STEP 3 and STEP 4 are thus regarded as not applicable in the context of the demonstration of the continuation of the previously identified baseline scenario for the project activity during its 2nd 7-year crediting period (as a requirement for the renewal of the crediting period). This is in accordance with the methodological tool “Assessment of the validity of the original/current baseline and to update the baseline at the renewal of a crediting period” and other applicable CDM guidelines and rules.

In summary, as part of the previously performed assessment and demonstration of additionality for the project activity (as outlined in the latest version of the PDD valid for the currently expired 7-year crediting period (PDD version 06, dated 05/03/2007)), it was previously demonstrated that the alternative LFG1 (the project activity being undertaken without being registered as a CDM project activity) does not represent a baseline alternative. Thus, the only remaining baseline alternative is the alternative LFG2 (atmospheric release of the LFG or partial capture of LFG and destruction to comply with regulations or contractual requirements, or to address safety and odors concerns).

Procedure for estimating the end of the remaining lifetime of existing equipment

While remaining lifetime of existing equipment and prior consideration of CDM are also aspects that, if applicable, are required to be considered in the context of the determination of the baseline scenario, the following details are also relevant in the particular context of the demonstration of validity of the previously derived baseline scenario for the project activity:

As per ACM0001 (version 18.0), this procedure is only applicable (in the context of the determination of baseline scenario for the project activity) if LFG has been ever utilized in existing equipment that was in operation prior to the implementation of the project activity.

The project activity started to operate in 2008 in a landfill of which start of operations is dated year 1990. No type of LFG utilization equipment was in place prior to the implementation of the project activity as there was no efficient LFG management at all prior of the implementation of the project activity[13]. This step of ACM0001 (version 18.0) is thus not required in the context of the demonstration of the continuation of the baseline scenario for the project activity.

Conclusion about the demonstration of the continuation of validity of the previously identified baseline scenario):

As an outcome of the application of the applicable guidance of the “Combined tool to identify the baseline scenario and demonstrate additionality” and ACM0001 (version 18.0), it is demonstrated the continuation of previously identified baseline scenario.

The baseline scenario for the project activity remains being identified as the atmospheric release of the LFG (with minor share of generated LFG being partially collected and destroyed in the pre-project venting/combustion drains).

Prior consideration of CDM

This step is not applicable for the renewal of the crediting period of a registered CDM project activity. As per currently valid applicable CDM rules, it is not required demonstrate prior consideration of the CDM for the project activity in the context of the renewal of its 7-year crediting period. This step of ACM0001 (version 18.0) is thus not required in the context of the demonstration of the continuation of the baseline scenario for the project activity.

B.5. Demonstration of additionality

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As also indicated in Section B.4, demonstration of additionality is not applicable/required for the renewal of the crediting period of a registered CDM project activity[14]. Not including the demonstration of additionality in this section is thus under conformance with currently valid applicable CDM rules.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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In accordance with ACM0001 (version 18.0) and applicable methodological tools, yearly emission reductions to be achieved by the project activity (ER_y) during the 2nd 7-year crediting period are

[13] In the context assessment of remaining lifetime of equipment previously existent (prior to the implementation of the project activity); the previously existent pre-project rudimentary infrastructure for LFG management at the Bragança landfill (conventional passive LFG venting/combustion drains) are not regarded as equipment.

[14] The whole assessment and demonstration of additionality for the registered CDM project activity “Embralixo/Araúna – Bragança Landfill Gas Project” is presented in the latest version of the PDD valid for the 1st 7-year renewable crediting period (version 06, dated 05/03/2007).

determined (in tCO_2e) as the difference between baseline emissions (BE_Y) and project emissions (PE_Y) as follows:

$$ER_y = BE_y - PE_y \quad \textbf{(0)}$$

Where:

BE_y = Baseline emissions in year *y* (in tCO_{2e}/yr)
PE_y = Project emissions in year *y* (in tCO_{2e}/yr)

Determination of Baseline Emissions (BE_y):

As per ACM0001 (version 18.0), baseline emissions (BE_y) for the 2nd 7-year renewable crediting period of the project activity are determined according to equation (1) and comprises the following emission sources:

a) Methane emissions from the SWDS in the absence of the project activity;

b) Emissions for electricity generation using fossil fuels or supplied by the grid in the absence of the project activity;

c) Emissions for heat generation using fossil fuels in the absence of the project activity; and

d) Emissions for natural gas use from existing natural gas network in the absence of the project activity.

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \textbf{(1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (in tCO_2e/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (in tCO_2e/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year *y* (in tCO_2e/yr)
$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (in tCO_2e/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (in tCO_2e/yr)

For the particular case of the project activity, as no collected LFG is used as gaseous fuel for electricity and/or heat generation purposes and as no collected LFG is injected in a natural gas distribution pipeline or even displace/complement the use of natural gas; $BE_{EC,y}$, $BE_{HG,y}$ and $BE_{NG,y}$ are not applicable in the context of the determination of baseline emissions for the project activity during its 2nd 7-year renewable crediting period and are thus regarded as null.

Thus, the determination approach for baseline emissions is summarized as follows:

$$BE_y = BE_{CH4,y} \quad \textbf{(2)}$$

In accordance with ACM0001 (version 18.0), baseline methane emissions are calculated according to the following stepwise approach:

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

Baseline methane emissions from the anaerobic waste decomposition in the considered SWDS ($BE_{CH4,y}$) are determined (in tCO_2e/yr) as per the formulas presented below.

The determination of $BE_{CH4,y}$ is based on the amount of methane that is actually captured and combusted by the project activity (in the high temperature enclosed flare) and also by taking in account the amount of methane that would be captured and destroyed in the landfill in the absence of the project activity (baseline scenario).

In addition, the effect of methane oxidation (that is assumed as existing in the baseline and not in the project scenario) is also taken into account as also required by ACM0001 (version 18.0)[15]:

$$BE_{CH4,y} = \left(\left(1 - OX_{top\_layer}\right) * F_{CH4,PJ,y} - F_{CH4,BL,y}\right) * GWP_{CH4} \quad \textbf{(3)}$$

Where:

OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline scenario (dimensionless)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (in tCH_4/yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline (absence of project activity) in year *y* (in tCH_4/yr). $F_{CH4,BL,y}$ is determined under "*Determination of* $F_{CH4,BL,y}$" in Section B.6.1.
GWP_{CH4}	=	Global warming potential of CH_4 (in tCO_2e/tCH_4)

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

As per ACM0001 (version 18.0), the amount of methane in the LFG which is flared and/or utilized by the project activity ($F_{CH4,PJ,y}$) is to be determined (in tCH_4/yr) as the sum of quantities of methane flared and used in power plant(s), boiler(s), air heater(s), glass melting furnace(s), kiln(s) and natural gas distribution network and/or dedicated pipeline and/or to the trucks based on ex-post measurements, as follows:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y} + F_{CH4,NG,y} \quad \textbf{(4)}$$

Where:

$F_{CH4,PJ,y}$	= Amount of methane in the LFG which is flared and/or used in the project activity in year y (in tCH_4)
$F_{CH4,flared,y}$	= Amount of methane in the LFG which is destroyed by flaring in year *y* (in tCH_4)
$F_{CH4,EL,y}$	= Amount of methane in the LFG which is used for electricity generation in year *y* (in tCH_4/yr), While the project design currently does not encompass use of LFG as gaseous fuel for electricity generation, $F_{CH4,EL,y}$ is thus assumed as null (zero).
$F_{CH4,HG,y}$	= Amount of methane in the LFG which is used for heat generation in year *y* (in tCH_4/yr). While the project design currently does not encompass use of LFG as gaseous fuel for heat generation, $F_{CH4,HG,y}$ is thus assumed as null (zero).
$F_{CH4,NG,y}$	= Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year *y* (in tCH_4/yr). While the project design currently does not encompass utilization of collected for

[15] As established by ACM0001 (version 18.0), the ex-ante determined parameter $OX_{top-layer}$ is the fraction of the methane that would be oxidized in the top layer of the considered SWDS (Bragança landfill) in the absence of the project activity (baseline scenario). As per ACM0001 (version 18.0), it is assumed that for a typical landfill hosting a LFG collection and destruction and/or utilization CDM project activity, this effect is reduced as part of the LFG which is captured does not pass through the top layer of the considered 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 considered SWDS. In some cases, such as project activities where the LFG collection is based on high suction pressure, the suction effort may decrease the amount of methane that is generated in the landfill under the project scenario. However, in most circumstances where the LFG is captured and used this effect was considered to be very small, as the operators of landfills 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.

displacement/complement of the use of natural gas, $F_{CH4,NG,y}$ is thus assumed as null (zero).

In the particular case of the project activity, as no collected LFG is expected to be used as gaseous fuel for electricity and/or heat generation purposes and as no collected LFG is expected to be injected in a natural gas distribution system or sent to an end-user through a dedicated pipeline and/or through trucks (displacing/complementing the use of natural gas), $F_{CH4,EL,y}$, $F_{CH4,HG,y}$ and $F_{CH4,NG,y}$ are not applicable in the context of the determination of $F_{CH4,PJ,y}$.

Thus, the amount of methane in the LFG which is flared and/or utilized by the project activity will be determined by:

$$F_{CH4,PJ,y} = F_{CH4,flared,y} \qquad \textbf{(5)}$$

Where:
$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year *y* (in tCH_4)

Determination of the amount of methane in collected LFG which is 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:

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}} \qquad \textbf{(6)}$$

Where:

$F_{CH4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year *y* (in tCH_4/yr)
$F_{CH4,sent\_flare,y}$ = Amount of methane in the LFG which is sent to the flare in year *y* (in tCH_4/yr)
$PE_{flare,y}$ = Project emissions from flaring of the residual gas stream in year *y* (in tCO_2e/yr)
GWP_{CH4} = Global warming potential of CH_4 (in $tCO_2e/t\ CH_4$)

Determination of $F_{CH4,sent\_flare,y}$:

As per ACM0001 (version 18.0), for each individual installed high temperature enclosed flare, $F_{CH4,flared,y}$ is determined by following applicable guidance of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. The following requirements apply for the determination of $F_{CH4,flared,y}$:

- The gaseous stream that shall be considered in the application of the methodological tool is the stream of collected LFG which is sent to the flares;
- CH_4 is the greenhouse gas for which the mass flow is determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the methodological tool); and
- The mass flow should be calculated on an hourly basis for each hour *h* in year *y*;

Applicable guidance of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” will be applied to determine $F_{CH4,sent\_flare,y}$ [16] by using one of the options A, B, C or D. The selection of the determination option will depend on project conditions and equipment to be installed.

Use of Option A, B, C or D:

Depending on the project conditions, one of the following measurement options will be chosen and the following formulas applied for the determination of as $F_{i,t}$ [17]:

Option	Flow of gaseous stream	Volumetric fraction
A	Volume flow dry basis	Dry or wet basis[18]
B	Volume flow wet basis	Dry basis
C	Volume flow wet basis	Wet basis
D	Mass flow dry basis	Dry or wet basis

Option A:
Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

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

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

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

[16] In the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” the mass flow of greenhouse gas in a gaseous stream (which in the particular case of the project activity is the amount of methane sent to the flare(s) ($F_{CH4,sent\_flare,y}$)) is actually represented as $F_{i,t}$.

[17] The selection of option A, B, C or D will be done on an ex-post basis.

[18] Flow measurement on a dry basis is not feasible at reasonable costs for a wet gaseous stream, so there will be no difference in the readings for volumetric fraction in wet basis analysers and dry basis analysers and both types can be used indistinctly for calculation Options A and D.

$$F_{i,t} = V_{t,db} * v_{i,t,db} * \rho_{i,t} \quad \textbf{(7)}$$

with

$$\rho_{i,t} = \frac{P_t * MM_i}{R_u * T_t} \quad \textbf{(8)}$$

Where:

$F_{i,t}$	=	Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (in kg gas/h)
$V_{t,db}$,	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis at normal conditions (in m³ dry gas/h)
$v_{i,t,db}$	=	Volumetric fraction of greenhouse gas *i* in the gaseous stream in time interval *t* on a dry basis (in m³ gas *i*/m³ dry gas)
$\rho_{i,t}$	=	Density of greenhouse gas *i* in the gaseous stream (in kg gas *i*/m³ gas *i*)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (in Pa)
MM_i	=	Molecular mass of greenhouse gas *i* (in kg/kmol)
R_u	=	Universal ideal gases constant (in Pa.m^3/kmol.K)
T_t	=	Temperature of the gaseous stream in time interval *t* (in K)

Option B:

The mass flow of greenhouse gas *I* ($F_{i,t}$) is determined using equations (7) and (8). The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,db} = V_{t,wb} / (1 + v_{H2O,t,db}) \quad \textbf{(9)}$$

Where:

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

$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}} \quad \textbf{(10)}$$

Where:

$v_{H2O,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (in 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 (in 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 (in kg H_2O/kmol H_2O)

In case this Option is selected, the absolute humidity of the gaseous stream ($m_{H2O,t,db}$) will be determined using Option 2 specified below under "*Determination of the absolute humidity of the gaseous stream"* and the molecular mass of the gaseous stream ($MM_{t,db}$) will be determined using the following equation:

$$MM_{t,db} = \sum_{k} (v_{k,t,db} * MM_k) \quad \textbf{(11)}$$

Where:

$v_{k,t,db}$	=	Volumetric fraction of gas *k* in the gaseous stream in time interval *t* on a dry basis (in 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). See simplification below. The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (*k*) in the gaseous stream. However as a simplification, 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 simplification is not acceptable if it is differently specified in the underlying methodology.

<u>Option C:</u>

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

$$F_{i,t} = V_{t,wb,n} * v_{i,t,wb} * \rho_{i,n} \quad \textbf{(12)}$$

with

$$\rho_{i,n} = \frac{P_n * MM_i}{R_u * T_n} \quad \textbf{(13)}$$

Where:

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

$$V_{t,wb,n} = V_{t,wb} * (T_n/T_t) * (P_t/P_n) \tag{14}$$

Where:

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

Option D:

Flow measurement on a dry basis is not doable for a wet gaseous stream. Therefore, it is necessary to demonstrate that the gaseous stream is dry to use this option. There are two ways to do this:

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

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

The mass flow of greenhouse gas *i* ($F_{i,t}$) is determined using equations (7) and (8). The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the mass flow of the gaseous stream to a volumetric flow as follows:

$$V_{t,db} = M_{t,db}/\rho_{t,db} \tag{15}$$

Where:

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

The density of the gaseous stream ($\rho_{t,db}$) should be determined as follows:

$$\rho_{t,db} = \frac{P_t * MM_{t,db}}{R_u * T_t} \tag{16}$$

Where:

$\rho_{t,db}$	=	Density of the gaseous stream in a time interval *t* on a dry basis (in kg dry gas/m^3 dry gas)
P_t	=	Pressure of the gaseous stream in time interval *t* (in Pa)

T_t = Temperature of the gaseous stream in time interval *t* (in K)
$MM_{t,db}$ = Molecular mass of the gaseous stream in a time interval *t* on a dry basis (in kg dry gas/kmol dry gas). The molecular mass of the gaseous stream ($MM_{t,db}$) is estimated by using equation (11).

Determination of the absolute humidity of the gaseous stream

The absolute humidity is a parameter required for Options B and E only, thus it will be used only in case Option B is adopted (as Option E is not selected as a measurement option for the project activity). Option 2 of the tool is selected for the project activity:

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 using equation (7).

$$m_{H_2O,t,db,SAT} = \frac{p_{H2O,t,Sat} * MM_{H2O}}{(P_t - p_{H2O,t,Sat}) * MM_{t,db}} \quad \textbf{(17)}$$

Where:
$m_{H2O,t,db,sat}$ = Saturation absolute humidity in time interval *t* on a dry basis (in kg H_2O/kg dry gas)
$p_{H20,t,sat}$ = Saturation pressure of H_2O at temperature T_t in time interval *t* (in Pa)
T_t = Temperature of the gaseous stream in time interval *t* (in K)
P_t = Absolute pressure of the gaseous stream in time interval *t* (in Pa)
MM_{H2O} = Molecular mass of H_2O (in kg H_2O/kmol H_2O)
$MM_{t,db}$ = Molecular mass of the gaseous stream in a time interval *t* on a dry basis (in kg dry gas/kmol dry gas). $MM_{t,db}$ is estimated by using equation (11).

Determination of $PE_{flare,y}$ (required for the determination of $F_{CH4,flared,y}$):
As established by ACM0001 (version 18.0), $PE_{flare,y}$ is determined by following applicable guidance of the methodological tool “Project emissions from flaring”.

The calculation procedure in the referred methodological tool is applied to determine project emissions from flaring the residual gas ($PE_{flare,y}$) based on the flare efficiency ($\eta_{flare,m}$) and the mass flow of methane to the flare in question ($F_{CH4,RG,m}$)[19]. The flare efficiency is determined for each minute *m* of year *y* based either on monitored data or default values.

Calculation procedure for the determination of project emissions from flaring applied as follows under a stepwise approach:

STEP 1: Determination of the methane mass flow of the residual gas;

[19] Although in June 2017 there was only one high temperature enclosed flare installed as part of the operation of the project activity, additional flare might be installed in the future depending on forecasted increase of the amount of LFG generated and collected at the Bragança landfill.

STEP 2: Determination of the flare efficiency;

STEP 3: Calculation of project emissions from flaring.

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

The “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” shall be used to determine, in kg, the mass flow of methane in the residual gaseous stream in the minute *m*: $F_{CH4,m}$.

The following requirements apply for the determination of the mass flow of methane in the gaseous stream in minute *m*:

- The “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” 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 question in the minute *m* ($F_{CH4,RG,m}$). $F_{CH4,m}$ shall be determined on a dry basis.

Step 2: Determination of flare efficiency:

As required by ACM0001 (version 18.0), the flare efficiency values will be determined for each installed flare. Also as per ACM0001 (version 18.0), flare efficiency represents the combustion efficiency of LFG in the flare in terms of CH_4 by considering *inter alia* the time that the flare in question is operating. For determining the combustion efficiency for the enclosed flare in question, there is the option to apply a default efficiency value or determining the flare efficiency based on monitored data (based on applicable measurements and calculations).

The time each of the project’s high temperature enclosed flare has operated is determined by monitoring the flame combustion status/condition by using a flame detector and, for the case of enclosed high temperature flare, the monitoring requirements related to operational requirements/conditions (as provided by the manufacturer’s specifications for operating conditions) shall be met in addition to the confirmation of flare status/condition.

The flare efficiency for each minute *m* ($\eta_{flare,m}$) will be determined by following applicable guidance of one of the options provided by the methodological tool “Project emissions from flaring” as follows:

Option A: Apply default value for flare efficiency[20].

Option B: Measure the flare efficiency.

Option A: Application of default value:
The flare efficiency for each minute *m* ($\eta_{flare,m}$) is 90% when the following two operational conditions/requirements are simultaneously met (in order to demonstrate that the flare is operating as per the recommendations and requirements set by the equipment manufacturer for the minute *m* in question):

(1) The temperature of the exhaust gases of the flare (monitoring parameter $T_{EG.m}$) and the flow rate of LFG to the flare (monitoring parameter $F_{RG,m}$) is within the manufacturer's specification/requirements for the flare (monitoring parameter $SPEC_{flare}$) in minute *m*

;

(2) Flame is detected in the flare in minute *m* (monitoring parameter $Flame_m$).

If for the minute *m*, conditions (1) and/or (2) are not met, $\eta_{flare,m}$ is set as 0% for the minute in question

Option B: Measured flare efficiency:
The flare efficiency in the minute *m* is determined as a value which is calculated based on performed related measurements ($\eta_{flare,m} = \eta_{flare,calc,m}$) when the following conditions are simultaneously met (in order to demonstrate that the flare is operating):

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

(2) Flame is detected in the flare in minute *m* (monitoring parameter $Flame_m$).

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

Option B.1: Biannual measurement of the flare efficiency
The calculated flare efficiency $\eta_{flare,calc,m}$ is determined as the average of two measurements of the flare efficiency made in year *y* ($\eta_{flare,calc,y}$), as follows:

$$\eta_{flare,calc,y} = 1 - \frac{1}{2}\sum_{t=1}^{2}\left(\frac{F_{CH4,EG,t}}{F_{CH4,RG,t}}\right) \quad \textbf{(18)}$$

Where:

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

Note: $F_{CH4,EG,t}$ is measured for each individual flare according to an appropriate national or international standard. $F_{CH4,RG,t}$ is calculated for each flare according to Step 1[21], and consists of the sum of methane flow in the minutes *m* that makes up the time period *t*.

Option B.2: Measurement of flare efficiency in each minute

The flare efficiency ($\eta_{flare,calc,m}$) is determined based on monitoring the methane content in the exhaust gas, the residual gas, and the air used in the combustion process during the minute *m* in year *y*. In case this Option is adopted, the flare efficiency for minute m will be calculate by following the provisions of the methodological tool "Project emissions from flaring" (version 02.0.0) as follows:

$$\eta_{flare,calc,m} = 1 - \frac{F_{CH4,EG,m}}{F_{CH4,RG,m}} \qquad \textbf{(19)}$$

Where:

$\eta_{flare,calc,m}$ Flare efficiency in the minute *m*

$F_{CH4,EG,m}$ Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute *m* (in kg)

$F_{CH4,RG,m}$ Mass flow of methane in the residual gas on a dry basis at reference conditions in the minute *m* (in kg)

Step 2.1: Determine the methane mass flow in the exhaust gas on a dry basis

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

$$F_{CH4,EG,m} = V_{EG,m} \times fc_{CH4,EG,m} \times 10^{-6} \qquad \textbf{(20)}$$

Where:

$V_{EG,m}$ Volumetric flow of the exhaust gas of the flare on a dry basis at reference conditions in minute *m* (m^3)

$fc_{CH4,EG,m}$ Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in minute *m* (in mg/m^3)

Step 2.2: Determine the volumetric flow of the exhaust gas ($V_{EG,m}$)

Determine the average volume flow of the exhaust gas in minute *m* based on a stoichiometric calculation of the combustion process. This depends on the chemical composition of the residual gas, the amount of air supplied to combust it and the composition of the exhaust gas. It is calculated as follows:

$$V_{EG,m} = Q_{EG,m} \times M_{RG,m} \qquad \textbf{(21)}$$

Where:

$Q_{EG,m}$ Volume of the exhaust gas on a dry basis at reference conditions per kilogram of residual gas on a dry basis at reference conditions in minute *m* (in m^3 exhaust gas/kg residual gas)

[21] As per Step 1 $F_{CH4,RG,t}$ is equal to the sum of methane flow values ($F_{CH4,sent\_flare,y}$) in the minutes *m* that make up the time period *t*.

$M_{RG,m}$ Mass flow of the residual gas on a dry basis at reference conditions in the minute *m* (in kg)

Step 2.3: Determine the mass flow of the residual gas ($M_{RG,m}$)

Project participants may select to monitor the mass flow of the residual gas in minute *m* directly (see monitored parameter $M_{RG,m}$) or, according to the procedure given in this step, calculate $M_{RG,m}$ based on the volumetric flow and the density of the residual gas. The density of the residual gas is determined based on the volumetric fraction of all components in the gas.

$$M_{RG,m} = \rho_{RG,ref,m} \times V_{RG,m} \quad \textbf{(22)}$$

Where:

$P_{RG,ref,m}$ Density of the residual gas at reference conditions in minute *m* (in kg/m^3)

$V_{RG,m}$ Volumetric flow of the residual gas on a dry basis at reference conditions in the minute *m* (in m^3)

And

$$\rho_{RG,ref,m} = \frac{P_{ref}}{\frac{R_u}{MM_{RG,m}} \times T_{ref}} \quad \textbf{(23)}$$

Where:

P_{ref} Atmospheric pressure at reference conditions (in Pa)

R_u (universal ideal gas constant (in Pa.m^3/kmol.K)

$MM_{RG,m}$ Molecular mass of the residual gas in minute *m* (kg/kmol)

T_{ref} Temperature at reference conditions (K)

Use the equation below to calculate $MM_{RG,m}$. When applying this equation, project participants may choose to either a) use the measured volumetric fraction of each component *i* of the residual gas, or b) as a simplification, measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N_2). The same equation applies, irrespective of which option is selected.

$$MM_{RG,m} = \sum_{t} \left(v_{i,RG,m} \times MM_i \right) \quad \textbf{(24)}$$

Where:

MM_i molecular mass of residual gas in minute *m* (in kg/kmol)

$v_{i,RG,m}$ Volumetric fraction of component *i* in the residual gas on a dry basis at reference conditions in the hour *h*

i Components of the residual gas. If Option (a) is selected to measure the volumetric fraction, then I = CH_4, CO, CO_2, O_2, H_2, H_2S, NH_3, N_2 or if Option (b) is selected then i = CH_4 and N_2.

Step 2.4: Determine the volume of the exhaust gas on a dry basis at reference conditions per kilogram of residual gas ($Q_{EG,m}$)

$Q_{EG,m}$ shall be determined as follows:

$$Q_{EG,m} = Q_{CO2,EG,m} + Q_{O_2,EG,m} + Q_{N_2,EG,m} \quad \textbf{(25)}$$

$Q_{CO2,EG,m}$ Volume of the exhaust gas on a dry basis per kg of residual gas on a dry basis at reference conditions in the minute *m* (m3/kg residual gas)

$Q_{CO2,EG,m}$ Quantity of CO2 volume in the exhaust gas per kg of residual gas on a dry basis at reference conditions in the minute *m* (m3/kg residual gas)

$Q_{N2,EG,m}$ Quantity of N2 volume in the exhaust gas per kg of residual gas on a dry basis at reference conditions in the minute *m* (m3/kg residual gas)

$Q_{O2,EG,m}$ Quantity of O2 volume in the exhaust gas per kg of residual gas on a dry basis at reference conditions in the minute *m* (m3/kg residual gas)

With

$$Q_{O_2,EG,m} = n_{O2,EG,m} \times VM_{ref} \qquad \textbf{(26)}$$

Where:

$n_{O2,EG,m}$ Quantity of O_2 (moles) in the exhaust gas per kg of residual gas flared on a dry basis at reference conditions in minute *m* (kmol/kg residual gas)

VM_{ref} Volume of one mole of any ideal gas at reference temperature and pressure (m3/kmol)

$$Q_{N_2,EG,m} = VM_{ref} \times \left\{ \frac{MF_{N,RG,m}}{2 \times AM_N} + \left(\frac{1 - v_{O2,air}}{v_{O2,air}} \right) \times \left[F_{O2,RG,m} + n_{O2,EG,m} \right] \right\} \qquad \textbf{(27)}$$

Where:

$MF_{N,RG,m}$ Mass fraction of nitrogen in the residual gas in the minute *m*

AM_N Atomic mass of nitrogen (kg/kmol)

$v_{O2,air}$ Volumetric fraction of O_2 in air

$F_{O2,RG,m}$ Stochiometric quantity of moles of O_2 required for a complete oxidation of one kg residual gas in minute *m* (kmol/kg residual gas)

$$Q_{CO2,EG,m} = \frac{MF_{C,RG,m}}{AM_C} \times VM_{ref} \qquad \textbf{(26)}$$

Where:

$MF_{C,RG,m}$ Mass fraction of carbon in the residual gas in the minute m

AM_C Atomic mass of carbon (kg/kmol)

VM_{ref} Volume of one mole of any ideal gas at reference temperature and pressure (m^3/kmol)

$$n_{O2,EG,m} = \frac{v_{O2,EG,m}}{\left(1 - \left(v_{O2,EG,m} / v_{O2,air}\right)\right)} \times \left[\frac{MF_{C,RG,m}}{AM_c} + \frac{MF_{N,RG,m}}{2 \times AM} + \left(\frac{1 - v_{O2,air}}{v_{O2,air}} \right) \times F_{O2,RG,m} \right] \textbf{(28)}$$

Where:

$v_{O2,EG,m}$ Volumetric fraction of O_2 in the exhaust gas on a dry basis at reference conditions in the minute *m*

$MF_{C,RG,m}$ Mass fraction of carbon in the residual gas in the minute m

$MF_{N,RG,m}$ Mass fraction of nitrogen in the residual gas in the minute m

AM_N Atomic mass of nitrogen (kg/kmol)

$$F_{O2<RG,m} = \frac{MF_{C,RG,m}}{AM_C} + \frac{MF_{H,RG,m}}{4AM_H} - \frac{MF_{O,RG,m}}{2AM_O} \qquad \textbf{(29)}$$

Where:

$MF_{O,RG,m}$ Mass fraction of oxygen in the residual gas in the minute m

AM_O Atomic mass of oxygen (kg/kmol)

$MF_{H,RG,m}$ Mass fraction of hydrogen in the residual gas in the minute m
AM_H Atomic mass of hydrogen (kg/kmol)

Determine the mass fractions of carbon, hydrogen, oxygen and nitrogen in the residual gas, using the volumetric fraction of component *i* in the residual gas and applying the equation below. In applying this equation, the project participants may choose to either a) use the measured volumetric fraction of each component *i* of the residual gas, or (b) as a simplification, measure the volumetric fraction of methane and consider the difference to 100% as being nitrogen (N2). The same equation applies, irrespective of which option is selected.

$$MF_{j,RG,m} = \frac{\sum_{i} v_{i,RG,m} \times AM_j \times NA_{j,i}}{MM_{RG,m}} \quad \textbf{(30)}$$

Where:

$MF_{j,RG,m}$ Mass fraction of element *j* in the residual gas in the minute *m*
$v_{i,RG,m}$ Volumetric fraction of component *i* in the residual gas on a dry basis in the minute *m*
AM_j Atomic mass of element *j* (kg/kmol)
$NA_{j,i}$ Number of atoms of element *j* in component *i*
$MM_{RG,m}$ Molecular mass of the residual gas in minute m (kg/kmol)
j Elements C, O, H and N
i Component of residual gas. If Option (a) is selected to measure the volumetric fraction, then *i* = CH_4, CO, CO_2, O_2, H_2, H_2S, NH_3, N_2 or if Option (b) is selected then *i* = CH_4 and N_2

Step 3: Calculation of project emissions from flaring:
For each individual flare, project emissions from flaring are calculated as the sum of emissions for each minute *m* in year *y*, based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH4} * \sum_{m=1}^{525,600} F_{CH4,RG,m} * \left(1-\eta_{flare,m}\right) * 10^{-3} \quad \textbf{(31)}$$

Where:

$PE_{flare,y}$ = Project emissions from flaring of the residual gas in year *y* (in tCO_{2e})
GWP_{CH4} = Global warming potential of methane valid for the commitment period (in tCO_2e/tCH_4)
$F_{CH4,RG,m}$ = Mass flow of methane in the residual gas in the minute *m* (in kg)
$\eta_{flare,m}$ = Flare efficiency in minute *m*

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

An *ex-ante* estimate of $F_{CH4,PJ,y}$ is required to estimate methane baseline emissions from the Bragança landfill in order to estimate the emission reductions to be achieved by project activity during the 2nd 7-year crediting period. As established by ACM0001 (version 18.0), $F_{CH4,PJ,y}$ is estimated as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} * BE_{CH4,SWDS,y}/GWP_{CH4} \quad \textbf{(32)}$$

Where:

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

$BE_{CH4,SWDS,y}$ is determined using the methodological tool "Emissions from solid waste disposal sites". The following guidance should be taken into account when applying the tool:

- f_y as per the methodological tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for when applying ACM0001 (version 18.0);
- 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.

Thus, for the ex-ante estimation of the amount of methane destroyed/combusted by the project activity ($F_{CH4,PJ,y}$) during each year y of the 2nd 7-year crediting period, the calculation of $BE_{CH4,SWDS,y}$ is given by:

$$BE_{CH4,SWDS,y} = \varphi_y * (1 - f_y) * GWP_{CH4} * (1 - OX) * \frac{16}{12} * F * DOC_{f,y} * MCF_y * \sum_{x=1}^{y} \sum_{j} W_{j,x} * DOC_j * e^{-k_j.(y-x)} * (1 - e^{-k_j}) \quad \textbf{(33)}$$

Where:

$BE_{CH4,SWDS,y}$	= Baseline methane emissions occurring in year *y* generated from waste disposal at a SWDS during a time period ending in year *y* (in tCO_2e / yr)
x	= Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = *y*)
y	= Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)
$DOC_{f,y}$	= Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)
$W_{j,x}$	= Amount of solid waste type *j* disposed or prevented from disposal in the SWDS in the year *x* (t)
φ_y	= Model correction factor to account for model uncertainties for year *y*. The default value (as per Option 1 of applicable guidance in the methodological tool) is selected. Thus, $\varphi_y = \varphi_{default}$
f_y	= Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*. f_y in the methodological tool "Emission from solid waste disposal sites" shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for when applying ACM0001 (version 18.0). While as per the methodological tool "Emissions from solid waste disposal sites", f_y is presented as a parameter to be monitored ex-post; by considering the related methodological approach of ACM0001 (version 18.0.) and assigned value for f_y, this parameter will thus not be monitored ex-post during the 2nd 7-year credtiting period.
GWP_{CH4}	= Global Warming Potential of methane

OX	= Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	= Fraction of methane in the SWDS gas (volume fraction)
MCF_y	= Methane correction factor for year *y*
DOC_j	= Fraction of degradable organic carbon in the waste type *j* (weight fraction)
k_j	= Decay rate for the waste type *j* (1 / yr)
j	= Type of residual waste or types of waste in the MSW

The value and source of information for each of the variables above are given in section B.6.2. It is important to note that the approach to take into account characteristics of the disposed waste (used as inputs for the ex-ante estimation) are the ones recommended by IPCC. Due to that, no sampling of waste is necessary. This is in accordance with both the methodological tool "Emissions from solid waste disposal sites" and ACM0001 (version 18.0). While the project activity only involves collection and destruction of LFG at the Bragança landfill (without promoting any change in the management and operation of the landfill), it does not prevent any solid waste from being disposed at the Bragança landfill.

The determination of $BE_{CH4,SWDS,y}$ in the context of the calculation of ex-ante estimations of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period is included in Section B.6.3. An emission reduction calculation spreadsheet which includes all related calculations for figures presented in Section B.6.3 is enclosed to this PDD.

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

As required by ACM0001 (version 18.0), this step represents the application of the stepwise procedure for the determination of the amount of methane that is assumed as captured and destroyed in the baseline scenario (absence of the CDM project activity) at the Bragança landfill due to eventually applicable regulatory or contractual requirements, or to address eventually existent applicable safety and odors concerns (which are collectively referred to as "*requirement*" under this step).

The four cases summarized in the table below are distinguished in ACM0001 (version 18.0). As also required by ACM0001 (version 18.0), the appropriate case for the particular baseline context of the project activity is identified and justified below.

Possible cases for determining methane captured and destroyed in the baseline as per ACM0001 (version 18.0)

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

Requirement to destroy methane:

Non-existence of regional or national regulatory or contractual requirements related to LFG management in the region of the project site:

Like the situation valid prior to the implementation of the project activity (and thus prior to the start of the 1st 7-year crediting period), currently there is still being no legal obligation to capture and destroy the LFG at the Bragança landfill. Furthermore, this situation is currently not expected to be changed during the time period to be encompassed by the 2nd 7-year crediting period either.

Non-existence of requirements to destroy methane due to safety or odor concerns: In the case of the project activity, there are no applicable requirements to destroy methane at the Bragança landfill due to safety or odor concerns either.

In the particular case of the Bragança Landfill, as per design and licensing requirements applicable for this particular landfill, no LFG was ever required to be destroyed by combustion in pre-project LFG venting/combustion drains in order to address odors or safety concerns or any other type of concern. Thus, in the absence of the project activity, direct venting of LFG through pre-project LFG venting drains (with no combustion) would remain being enough to prevent dangerous accumulation of LFG in the inner section of the landfill (regardless of sporadic combustion of small share of LFG in the pre-project scenario (including the occurred recorded and reported sporadic combustion of LFG in year 2007 (year prior to project implementation of the project activity))). While as per the methodological approach of ACM0001 (version 18.0) for determination of $F_{CH4,BL,y}$ any destruction of LFG to address safety and/or odor concerns and/or other concern would be regarded as an existing requirement to destroy methane, it is thus assumed that, in the particular case of the Bragança landfill, there is no requirement to destroy methane.

By taking this assumption into account, Case 2 and Case 4 are thus both regarded as not applicable for the determination of $F_{CH4,BL,y}$.

Existence of LFG capture and destruction system at the Bragança landfill:

As outlined in Section A.3, until January 2008 (prior of the project activity starting of operation), despite of the non-existence of requirements to destroy methane at the Bragança landfill, this landfill was under regular operation with LFG being sporadically combusted in a reduced number of previously existent conventional passive LFG venting/combustion drains. Historical data on the amount of LFG collected and combusted by such pre-project previously existent conventional passive LFG venting/combustion drains are available for year 2007 (last calendar year prior to the implementation of the project activity) as a result of an interest of Embralixo – Empresa Bragantina de Varrição e Coleta de Lixo Ltda. of better understanding the role of LFG generation within the geotechniques (physical stability) of the Bragança landfill at that time.

Thus, by taking into account the definitions of "LFG capture system" and "existing LFG capture system" as per ACM0001 (version 18.0)[22], it is thus assumed that there was an existing LFG capture system at the Bragança landfill prior to the implementation of the project activity. Therefore, Case 3 is applicable

In summary, the only option/case applicable for the Bragança landfill (in the absence of the project activity) is Case 3.

The following is thus valid in the context of the application of the stepwise procedure for the determination of $F_{CH4,BL,y}$ for the project activity during the 2nd crediting period:

- Requirement to destroy methane = NO

[22] As per ACM0001 (version 18.0), "LFG capture system" is defined as follows: "*A system to capture LFG. The system may be passive, active or a combination of both active and passive components. Passive systems capture LFG by means of natural pressure, concentration, and density gradients. Active systems use mechanical equipment to capture LFG by providing pressure gradients. Captured LFG can be vented, flared or used.*"
As per ACM0001 (version 188.0), "existing LFG capture system" is defined as follows: "*An existing active LFG capture system is a system that has been in operation in the last calendar year prior to the start of the operation of the project activity.*"

- Existing LFG capture and destruction system = YES

$F_{CH4,Bl,y}$ is thus calculated as:

$$F_{CH4,BL,y} = F_{CH4,BL,sys,y} \quad \textbf{(34)}$$

In the particular case of the Bragança landfill, the amount of methane captured through the use of the pre-project LFG management infrastructure cannot be monitored ex-post since such previously existent infrastructure (under the configuration existent until the start of operation of the project activity) is not any longer available. Such pre-project LFG management infrastructure (comprising rudimentary passive conventional venting/combustion drains) was decommissioned and disassembled as a result of the starting of operations of the project activity in 2008[23]. Thus, Case 3 - (b) of ACM0001 (version 18.0) is directly applied as follows:

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

$$F_{CH4,BL,sys,y} = F_{CH4,hist,y} \quad \textbf{(35)}$$

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

$$F_{CH4,hist,y} = F_{CH4,BL,x-1} / F_{CH4,x-1} * F_{CH4,PJ,y} \quad \textbf{(36)}$$

Where:

$F_{CH4,hist,y}$	*= Historical amount of methane in the LFG which is captured and destroyed (t CH_4/yr)*
$F_{CH4,BL,x-1}$	*= Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (t CH_4/yr)*
$F_{CH,x-1}$	*= Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (t CH_4/yr)*
$F_{CH4,PJ,y}$	*= Amount of methane in the LFG which is captured in the project activity in year y (t CH_4/yr)*

$F_{CH4,x-1}$ shall be estimated using the methodological tool "Emissions from solid waste disposal sites". The guidance and requirements described in section 5.4.1.2 for applying the tool shall be followed. The year y in the tool is equivalent to the year prior to the implementation of the project activity."

In the particular case of the Bragança landfill, the following is thus valid in the context of the determination of $F_{CH4,BL,y}$:

$$F_{CH4,BL,y} = F_{CH4,hist,y} = F_{CH4,BL,x-1} / F_{CH4,x-1} * F_{CH4,PJ,y} \quad \textbf{(37)}$$

Where:

$F_{CH4,x-1}$	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity. The value for $F_{CH4,x-1}$ is the value calculated for year 2007 (last calendar year prior to the implementation of the project activity). The value for $F_{CH4,2007}$ is calculated as 2,430.66 tCH_4. Related calculations are included

[23] As part of the implementation of the project activity, some of the rudimentary passive conventional venting/combustion drains that were part of the pre-project LFG management infrastructure were just abandoned/disassembled, while other drains were converted into better designed and more efficient LFG collection wells.

in emission reduction calculation spreadsheet that is enclosed to this PDD (under the sheet "*FCHBL*").

$F_{CH4,BL,x-1}$ Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity. As per historical measurement records available, the value for $F_{CH4,BL,x-1}$ is calculated as 71.20 tCH_4. Related calculations are included in emission reduction calculation spreadsheet that is enclosed to this PDD (under the sheet "*FCH4BL*"). While $F_{CH4,BL,x-1}$ represents a ex-ante selected (fixed) parameter, details for this parameter are summarized in Section B.6.2.

$F_{CH4,BL,y}$ is thus determined as follows:

$F_{CH4,BL,y} = (71.20 / 2{,}430.66) * F_{CH4,PJ,y} = 0.0293 * F_{CH4,PJ,y}$

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

As the project design does not encompass any utilization of collected LFG as gaseous fuel for electricity generation, baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) are not considered. Thus, this step is not applicable.

Baseline emissions associated with heat generation ($BE_{HG,y}$)

As the project design does not encompass any utilization of collected LFG for heat generation (in boiler, air heater, glass melting furnace(s) and/or kiln), baseline emissions associated with heat generation in year *y* ($BE_{HG,y}$) are not considered. Thus, this step is not applicable.

Baseline emissions associated with natural gas use ($BE_{NG,y}$)

As the project design does not encompass any utilization of collected LFG displacing the use of natural gas or injection of collected LFG into a natural gas distribution network or used by trucks, baseline emissions associated with natural gas use in year *y* ($BE_{NG,y}$) are not considered. Thus, this step is not applicable.

<u>Determination of project emissions (PE_y):</u>

As established by ACM0001 (version 18.0), project emissions (PE_y) for the 2nd 7-year crediting period are calculated (in tCO_2/yr) as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} \quad \textbf{(38)}$$

Where:

PE_y = Project emissions in year *y* (in tCO_2/yr)

$PE_{EC,y}$ = Emissions from consumption of electricity due to the project activity in year *y* (in tCO_2/yr)

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

$PE_{DT,y}$ = Emissions from the distribution of compressed/liquefied LFG using trucks, in year y (in tCO_2/yr)

Since the project activity will not sell any compressed/liquefied LFG, there will be no project emissions from the distribution of compressed/liquefied LFG using trucks ($PE_{DT,y}$ = 0). Moreover, as the operation of the project activity does not encompass consumption fossil fuels, $PE_{FC,y}$ = 0.

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

As required by ACM0001 (version 18.0), project emissions from consumption of electricity by the project activity ($PE_{EC,y}$) shall be calculated by applying the methodological approach established by the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". This methodological tool establishes the following:

> "*In the generic approach, project, baseline and leakage emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses (…)*" *"Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the "Tool to calculate the emission factor for an electricity system"*

ACM0001 (version 18.0) establishes the *following* when applying this methodological tool:

- *"$EC_{PJ,k,y}$[24] in the tool is equivalent to the amount of electricity consumed by the project activity in year y ($EC_{PJ,y}$)."* In the particular case of the project activity, electricity sources *j* in the tool corresponds to the sources of electricity consumed due to the project activity. In the particular case of the project activity, grid-sourced electricity has been consumed for the operation of the project activity.

- *"If in the baseline a proportion of LFG is destroyed ($F_{CH4,BL,y} > 0$), then the electricity consumption in the tool ($EC_{PJ,j,y}$) should refer to the net quantity of electricity consumption (i.e. the increase due to the project activity). The determination of the amount of electricity consumed in the baseline shall be transparently documented in the CDM-PDD"*. In the particular case of the project activity, although LFG is destroyed in the baseline scenario ($F_{CH4,BL,y} > 0$), while no electricity has been used in the pre-project and/or scenario for collecting and destroying LFG (no LFG destruction in the pre-project scenario and small share of generated LFG being collected along the baseline scenario through conventional passive LFG (not consuming any electricity) that would otherwise implemented and used), this requirement is thus not applicable as no electricity would be used for collecting and combusting LFG in the pre-project and/or baseline scenario (absence of the project activity).

While only grid-sourced electricity is expected to be consumed by the project activity, the following is thus valid:

$$PE_{EC,y} = PE_{EC,grid,y} \quad \textbf{(39)}$$

Where:

$PE_{EC,grid,y}$ = Project emissions due to the consumption of grid-sourced electricity by the project activity in year *y* (in tCO_2/year)

By following applicable guidance of the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation", $PE_{EC,grid,y}$, is determined as follows:

[24] As per the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation", $EC_{PJ,j,y}$ is the quantity of electricity consumed by the project electricity consumption source *j* in year *y*.

$$PE_{EC,grid,y} = EC_{PJ,grid,y} * EF_{EL,grid,y} * (1 + TDL_{grid,y}) \quad \textbf{(40)}$$

Where:

$EC_{PJ,grid,y}$	= Quantity of grid sourced electricity consumed by the project activity in year *y* (in MWh)
$EF_{EL,grid,y}$	= Emission factor for grid sourced electricity in year *y* (in tCO_2/MWh)
$TDL_{grid,y}$	= Average technical transmission and distribution losses for grid sourced electricity consumed by the project activity in year *y.*

Determination of emission factor for grid-sourced electricity:
Option A.1 of the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" is selected for determining $EF_{EL,k,,y}$. Thus, according to the selected option of the tool, the following is applicable:

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

The "Tool to calculate the emission factor for an electric system" indicates that the emission factor of the electricity grid to which the project activity is to be connected is determined by the following 6-step approach:

<u>Calculation of $EF_{grid,CM,y}$</u>
Combined margin CO_2 emissions factor is calculated in accordance with the "Tool to calculate the emission factor for an electricity system" (version 05.0). This methodological tool determines the CO_2 emission factor for the displacement of electricity generated by grid-connected power plants by calculating the combined margin emission factor ($EF_{CM,y}$) of the electricity system. As per the "Tool to calculate the emission factor for an electricity system" (version 05.0), $EF_{CM,y}$ is determined as a weighted average of two CO_2 emission factors pertaining to the electricity system:

- the CO_2 operating margin emission factor ($EF_{OM,y}$)
- the build margin emission factor ($EF_{BM,y}$).

The operating margin emission factor refers to the group of existing power plants whose current electricity generation would be potentially affected by the proposed CDM project activity. The build margin emission factor refers to the group of prospective power plants whose construction and future operation would be potentially affected by the proposed CDM project activity.

The applicable procedures of "Tool to calculate the emission factor for an electricity system" (version 05.0) tool are described in the following steps:

- Step 1. Identify the relevant electricity systems:
For determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints. The spatial extent of the project boundary includes the project site which is connected to the National Electricity Grid of Brazil which is named National Interconnected System (*Sistema Interligado Nacional – SIN*).

- 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 to be 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.

In the particular case of the determination of $EF_{OM,y}$ for ex-post calculation of project emission for the project activity during its 2nd 7-year crediting period, the simple adjusted method is selected and the operating margin is determined ex-ante by using information and data for grid-connected power units which is yearly calculated, updated and published by the Ministry of Science, Technology and Innovation of Brazil, which is the DNA of Brazil[25].

In accordance with applicable guidance from the "Tool to calculate the emission factor for an electric system", a 3-year generation-weighted average is calculated based on the most recent data calculated by the DNA of Brazil and made public available at its website (years of 2014, 2015 and 2016)[26].

- Step 4. Calculate the operating margin emission factor according to the selected method:
In order to determine the combined margin emission factor, the simple adjusted OM method has been selected among four options proposed in the methodology, and it is publicly available in Brazil.

The simple adjusted OM emission factor ($EF_{grid,OM-adj,y}$) is a variation of the simple OM, where the power plants/units (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*m*). The simple adjusted OM is calculated based on the net electricity generation of each power unit and an emission factor for each power unit as follows:

$$EF_{grid,OM-adj,y} = (1-\lambda_y) \times \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} + \lambda_y \times \frac{\sum_k EG_{k,y} \times EF_{EL,k,y}}{\sum_k EG_{k,y}} \quad \textbf{(41)}$$

Where:

$EF_{grid,OM-adj,y}$	= Simple adjusted operating margin CO_2 emission factor in year *y* (in 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 *k* in year *y* (in MWh)

[25] The Ministry of Science, Technology and Innovation (MCTI) (DNA of Brazil) has since year 2008 calculated the operating margin CO_2 emission factor through the dispatch data analysis method according to the methodology tool "Tool to calculate the emission factor for an electricity system" (version 04.0 and previous versions) (data for vintage since year 2006) with yearly calculated values being made available online at the website of the DNA of Brazil. More recently, in September 2015, the MCTI has established the "Resolução nº 12" ("*Resolution 12"* when translated into the English language*)* that deals with the reasons for the determination of the operating margin CO_2 emission factor also through the simple adjusted method for which calculated values are also made available online for the years from 2006 to 2016.

[26] Annual values for operating margin CO_2 emission factor for the National Electricity Grid of Brazil calculated through the simple-adjusted OM method are available online:

http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html

$EG_{k,y}$	= Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (in MWh)
$EF_{EL,m,y}$	= CO_2 emission factor of power unit *m* in year *y* (in tCO_2/MWh)
$EF_{EL,k,y}$	= CO_2 emission factor of power unit *k* in year *y* (in 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.

- Step 5. Calculate the build margin (BM) emission factor:
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."*

Option 1 is selected for the 2nd 7-year crediting period of the project activity The build margin emissions factor is the generation-weighted average emission factor (in tCO_2/MWh) of all power units m during the most recent year *y* for which power generation data is available. The DNA of Brazil has regularly published an official value for $EF_{grid,BM,y}$[27]. The latest published value (applicable for year 2016) is thus the value for the ex-ante selected parameter $EF_{grid,BM,y}$ and is calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \textbf{(42)}$$

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 power generation data is available

[27] Details about the determination of values for the CO_2 emission factor for the national electricity grid of Brazil by the DNA of Brazil are made available online in the website of the DNA of Brazil: http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html

- Step 6. Calculate the combined margin (CM) emissions factor

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM} \quad \textbf{(43)}$$

Where:
$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year *y* (tCO_2/MWh)
$EF_{grid,OM,y}$ = 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 (%)

The values for w_{OM} and w_{BM} are ex-ante selected as per applicable guidance of the "Tool to calculate the emission factor for an electric system", which includes the following as a requirement:

> *"The following default values should be used for w_{OM} and w_{BM}:*
> *(a) Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;*
> *(b) All other projects: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period, and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period,6 unless otherwise specified in the approved methodology which refers to this tool."*

Determination of leakage emissions (LE_y):

No leakage emissions are expected to occur. Moreover, no leakage effects are accounted for under ACM0001 (version 18.0).

B.6.2. Data and parameters fixed ex ante

Data/Parameter	**OX_{top_layer}**
Data unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool "Emissions from solid waste disposal sites" (version 08.0)
Value(s) applied	0.1
Choice of data or measurement methods and procedures	Default value as per the applied CDM baseline and monitoring methodology ACM0001 - "Flaring or use of landfill gas" (version 18.0)
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data/Parameter	**$F_{CH4,BL,x-1}$**
Data unit	tCH_4/yr
Description	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (2007).
Source of data	Measurements performed by Urbanizadora Municipal S.A. / Arauna Participacoes e Investimentos Ltda (related to year 2007).
Value(s) applied	71.20
Choice of data or measurement methods and procedures	Selected value is as per historical measurements performed by Urbanizadora Municipal S.A. / Arauna Participacoes e Investimentos Ltda
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data/Parameter	**GWP_{CH4}**
Data unit	tCO_2e/tCH_4
Description	Global Warming Potential of CH_4
Source of data	"Global Warming Potential for Given Time Horizon" in table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon. Available at: www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14 The applied value is also in accordance with the "Standard for application of the global warming potential to clean development mechanism project activities and programmes of activities for the second commitment period of the Kyoto Protocol".
Value(s) applied	25
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions.
Additional comment	The applied value shall be updated according to any future COP/MOP decisions and/or decision by the CDM-EB.

Data/Parameter	η_{PJ}
Data unit	Dimensionless
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	Value obtained from technical literature
Value(s) applied	0.9280
Choice of data or measurement methods and procedures	Value obtained from technical literature[28] and by also taking into consideration the design and operational characteristics/aspects of the Bragança landfill plus the general construction, design and forecasted implementation of the project's LFG collection network during the 2nd 7-year crediting period.
Purpose of data	Calculation of baseline emissions (in the context of determination of ex-ante estimates of emission reductions to be achieved by the project activity).
Additional comment	Selected value can also be represented as percentage, since 0.9280 = 92.80%

[28] The technical paper "*Measuring landfill gas collection efficiency using surface methane concentration*" (which was published by Raymond L. Huitric and Dung Kong, from the Solid Waste Management Department of the Los Angeles County Sanitation Districts), states the following regarding LFG collection efficiency for a well-managed LFG collection system:

> *"Measuring landfill gas collection efficiency is important for gauging emission control effectiveness and energy recovery opportunities. Though researched for years, practical measures of collection efficiency are lacking. Instead, a default efficiency of 75% based on surveys of industry estimates is commonly used, for example, by the United States Environmental Protection Agency (US EPA). Though few, actual emission measurements indicate substantially higher efficiencies ranging from 85 to 98%."*

This document also mentions that *"(…) landfill gas collection efficiencies should routinely reach 100%."*
Practical results, shown on table 4 of the study: Weighted average collection efficiency, show a collection efficiency of 92.8 to 96.1% on well-engineered landfills with vacuum systems to extract LFG.
The paper "*Measuring landfill gas collection efficiency using surface methane concentration*" is available at http://www.arb.ca.gov/cc/ccea/comments/april/huitric_kong.pdf

Data/Parameter	R_u
Data unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	Default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0)
Value(s) applied	8,314
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data/Parameter	**MM_k**
Data unit	kg/kmol
Description	Molecular mass of gas *k*
Source of data	Default values as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0)
Value(s) applied	For considered gases *k* that are greenhouse gases (GHGs), the values below are applied for MMi. As per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”: *“The determination of the molecular mass of the gaseous stream ($MM_{t,db}$) requires measuring the volumetric fraction of all gases (k) in the considered gaseous stream. However as a simplification, only the volumetric fraction of 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 simplification is not acceptable if it is differently specified in the underlying methodology.* ACM0001 (version 18.0) does not include any restriction to such simplification. Thus, only the volumetric fraction of gases that are greenhouse gases and are considered in related calculations (CH_4 in the particular case of the project activity) and the difference to 100% is just considered as pure nitrogen. Compound / Structure / Molecular mass (kg / kmol): Nitrogen / N_2 / 28.01
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions.
Additional comment	-

<table>
<tr><th>Data/Parameter</th><th>MM_i</th></tr>
<tr><td>Data unit</td><td>kg/kmol</td></tr>
<tr><td>Description</td><td>Molecular mass of greenhouse gas I</td></tr>
<tr><td>Source of data</td><td>Default values as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0)</td></tr>
<tr><td>Value(s) applied</td><td>The following values of molecular mass are applicable for CH_4 (the only GHG which is considered):
<table><tr><th>Compound</th><th>Structure</th><th>Molecular mass (kg/kmol)</th></tr><tr><td>Methane</td><td>CH_4</td><td>16.04</td></tr></table></td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>-</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions.</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data/Parameter	P_n
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	Default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0)
Value(s) applied	101,325
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data/Parameter	$\mathbf{T_n}$
Data unit	K
Description	Temperature at normal conditions
Source of data	Default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0)
Value(s) applied	273.15
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data/Parameter	$\mathbf{MM_{H2O}}$
Data unit	kg/kmol
Description	Molecular mass of water
Source of data	Default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03.0)
Value(s) applied	18.0152
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data/Parameter	$TDL_{grid,y}$
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to the grid and for grid sourced electricity consumed by the project activity.
Source of data	Applicable default as per the methodological tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".
Value(s) applied	20%
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comment	-

Data/Parameter	w_{BM}
Data unit	%
Description	Weighting of build margin emissions factor
Source of data	Applicable default value as per the "Tool to calculate the emission factor for an electricity system" (version 05.0)
Value(s) applied	0.75 (75%) during the 2nd 7-year crediting period
Choice of data or measurement methods and procedures	The applicable value valid for 2nd crediting period as per the "Tool to calculate the emission factor for an electricity system" (version 5.0) is selected.
Purpose of data	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comment	-

Data/Parameter	**w_{OM}**
Data unit	%
Description	Weighting of operating margin emissions factor
Source of data	Applicable default value as per the “Tool to calculate the emission factor for an electricity system” (version 05.0)
Value(s) applied	0.25 (25%) during the 2nd 7-year crediting period
Choice of data or measurement methods and procedures	The applicable value for the 2nd crediting period as per the “Tool to calculate the emission factor for an electricity system” (version 4.0) is selected.
Purpose of data	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comment	-

Data/Parameter	**$EF_{grid,BM,y}$**
Data unit	tCO_2/MWh
Description	Build margin CO_2 emission factor in year *y*
Source of data	Data is ex-ante determined as per applicable guidance of the “Tool to calculate the emission factor for an electricity system” valid for 2nd crediting period. The selected value valid for all years encompassed by the 2nd 7-year crediting period is the value calculated by the DNA of Brazil and valid for year 2016 ($EF_{grid,BM,2016}$).
Value(s) applied	0.1581
Choice of data or measurement methods and procedures	Official value is determined/calculated by the DNA of Brazil. Values are made available online: http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html
Purpose of data	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comment	-

Data/Parameter	$EF_{grid,OM-adj,y} = EF_{grid,OM,y}$
Data unit	tCO_2/MWh
Description	Operating margin CO_2 emission factor in year *y*
Source of data	Data is ex-ante determined as per applicable guidance of the “Tool to calculate the emission factor for an electricity system” valid for 2nd crediting period. The selected value valid for all years encompassed by the 2nd 7-year crediting period is the 3-year generation-weighted average based on the most recent data public available (years of 2014, 2015 and 2016). Calculated annual official values are made available by the DNA of Brazil.
Value(s) applied	0.4979
Choice of data or measurement methods and procedures	Official value is determined/calculated by the DNA of Brazil. Values are made available online: http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html
Purpose of data	Calculation of project emissions (due to the consumption of grid-sourced electricity by the project activity).
Additional comment	-

Data/Parameter	$\varphi_{default}$
Data unit	Dimensionless
Description	Default value for model correction factor to account for model uncertainties
Source of data	Default value applicable for determination of baseline emissions as per the methodological tool “Emissions from solid waste disposal sites” (version 08.0). Value applicable for humid/wet conditions as per Application A is selected (based on the climate conditions valid for the location of the project activity). Source for weather condition data: http://www.bbc.com/weather
Value(s) applied	0.75
Choice of data or measurement methods and procedures	Determined based on default value of table 3 of the referred methodological tool as per Option 1, Application A (value applicable for humid/wet conditions).
Purpose of data	Calculation of baseline emissions (in the context of determination of ex-ante estimates of emission reductions to be achieved by the project activity)
Additional comment	-

Data/Parameter	**OX**
Data unit	Dimensionless
Description	Oxidation factor (reflecting the amount of methane from the considered SWDS that is oxidized in the soil (or other material covering the waste))
Source of data	Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 08.0)
Value(s) applied	0.1
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions (in the context of determination of ex-ante estimates of emission reductions to be achieved by the project activity)
Additional comment	-

Data/Parameter	**F**
Data unit	Dimensionless
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 08.0)
Value(s) applied	0.5
Choice of data or measurement methods and procedures	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the considered SWDS. A default value of 0.5 is recommended by IPCC.
Purpose of data	Calculation of baseline emissions (in the context of determination of ex-ante estimates of emission reductions to be achieved by the project activity)
Additional comment	-

Data/Parameter	**$DOC_{f,default}$**
Data unit	Dimensionless
Description	Fraction of degradable organic carbon (DOC) in MSW that decomposes in the considered SWDS.
Source of data	Applicable default value as per the methodological tool “Emissions from solid waste disposal sites” (version 08.0), which refers to applicable value as per IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Value(s) applied	0.5
Choice of data or measurement methods and procedures	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, in the SWDS. The default value was applied as per Application A of the methodological tool “Emissions from solid waste disposal sites” (version 08.0): “*The CDM project activity mitigates methane emissions from a specific existing SWDS”.*
Purpose of data	Calculation of baseline emissions (in the context of determination of ex-ante estimates of emission reductions to be achieved by the project activity)
Additional comment	Application A of the methodological tool “Emissions from solid waste disposal sites” (version 08.0) is the applicable case of the project activity.

Data/Parameter	**$MCF_{default}$**
Data unit	Dimensionless
Description	Methane correction factor.
Source of data	Value is sourced by the methodological tool “Emissions from solid waste disposal sites”, that refers to IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
Value(s) applied	1.0
Choice of data or measurement methods and procedures	Value is selected as per Application A of the methodological tool, under the following conditions: “*1.0: for anaerobic managed solid waste disposal sites. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste;”* The day-to-day MSW disposal activities at the Bragança landfill encompass utilization of appropriate MSW landfilling practices (covering, leveling and mechanical compacting of disposed material, etc.) as part of the operation of this landfill. The Bragança landfill is regarded as a well-managed landfill site.
Purpose of data	Calculation of baseline emissions (in the context of determination of ex-ante estimates of emission reductions to be achieved by the project activity)
Additional comment	-

<table>
<tr><td>Data/Parameter</td><td>DOC_j</td></tr>
<tr><td>Data unit</td><td>Dimensionless</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>Values are selected as per applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0), that refers to IPCC 2006 Guidelines for National Greenhouse Gas Inventories, (adapted from Volume 5, Tables 2.4 and 2.5).</td></tr>
<tr><td>Value(s) applied</td><td>
<table>
<tr><th>Waste type j</th><th>DOC_j
(% wet waste)</th></tr>
<tr><td>Wood and wood products</td><td>43</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr>
<tr><td>Food, food waste, beverages and tobacco
(other than sludge)</td><td>15</td></tr>
<tr><td>Textiles</td><td>24</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>The selected values are based on wet waste basis (moisture concentrations in the waste streams as waste is delivered to the SWDS). The IPCC 2006 Guidelines also specifies DOC values on a dry waste basis, which refers to the moisture concentrations after complete removal of all moisture from the waste. However, this selection is not practical for the situation/practice at the Bragança landfill.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions (in the context of determination of ex-ante estimates of emission reductions to be achieved by the project activity)</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>k_j</td></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>Values are selected as per applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0). The methodological tools refers to values as per 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>Degradation speed</th><th>Waste type</th><th>k_j</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Wood, wood products</td><td>0.03</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge), textiles</td><td>0.06</td></tr>
<tr><td>Moderately Degrading</td><td>other (non-food) organic putrescible Garden, yard and park waste</td><td>0.10</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.185</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>Parameters are selected in accordance to the climate zone valid for the project site:
Mean Annual Temperature (MAT) = 18.2 ºC
Mean Annual Precipitation (MAP) = 1,397 mm – (wet climate).
Source of data for mean annual temperature (MAT) and mean annual precipitation (MAP): https://pt.climate-data.org/location/32843/</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions (in the context of determination of ex-ante estimates of emission reductions to be achieved by the project activity)</td></tr>
<tr><td>Additional comment</td><td>Domestic sludge was assumed to be rapidly degrading and rubber and leather slowly degrading waste.</td></tr>
</table>

Data/Parameter	W_j
Data unit	Dimensionless
Description	Weight fraction of the waste type *j*
Source of data	Values are selected as per applicable guidance of IPCC 2006 Guidelines for National Greenhouse Gas, Volume 5, Chapter 2, tables 2.3-2.5, MSW composition regional default values for South-America.
Value(s) applied	(see table below)
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions (in the context of determination of ex-ante estimates of emission reductions to be achieved by the project activity)
Additional comment	No composition analysis for MSW disposed at the Bragança landfill is currently available.

Waste type *j*	**W_j (% wet waste)**
Wood and wood products	4.7
Pulp, paper and cardboard (other than sludge)	17.1
Food, food waste, beverages and tobacco (other than sludge)	44.9
Textiles	2.6
Garden, yard and park waste	0.0
Glass, plastic, metal, other inert waste	30.7

<table>
<tr><td>Data/Parameter</td><td>$SPEC_{flare}$</td></tr>
<tr><td>Data unit</td><td>°C (for temperature values)
Nm^3/h (for LFG flow values)
Number of days (for maintenance schedule interval values)</td></tr>
<tr><td>Description</td><td>Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule interval.</td></tr>
<tr><td>Source of data</td><td>Flare manufacturer[29]</td></tr>
<tr><td>Value(s) applied</td><td>The specifications of the installed flare are listed below[30]:
<table>
<tr><th>$SPEC_{flare}$</th><th>Min.</th><th>Max.</th></tr>
<tr><td>Operational LFG flow (for continuous operation):</td><td>200 Nm^3/h</td><td>1,500 Nm^3/h</td></tr>
<tr><td>Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH_4 destruction efficiency):</td><td>500 °C</td><td>1,000 °C</td></tr>
<tr><td>Required minimum frequency for inspection and maintenance service (incl. inspection in the conditions of the flare isolation ceramics revetment material):</td><td colspan="2">Min. every year (min each 365 days)</td></tr>
<tr><td>Required/recommended minimum frequency for replacement of the flare isolation ceramics revetment material:</td><td colspan="2">After 10 years of regular and appropriate operation</td></tr>
</table>
</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>As established by the methodological tool “Project emissions from flaring”, the flare specifications and operational + maintenance requirements (as set/recommended by the equipment manufacturer) are documented and considered for the ex-ante determination of applicable values for the parameter $SPEC_{flare}$. During the 2nd 7-year crediting period, ex-ante selected data will be compared against monitored data related to the operation of the flares, including:
a) Minimum and maximum monitoring records for data regarding inlet LFG flow rate, if necessary converted to flow rate at reference conditions or heat flux,
(b) Minimum and maximum monitoring records for data of temperature in the exhaust gas of each individual high temperature enclosed flare; and
(c) Duration in days of time periods between maintenance events for each individual high temperature enclosed flare.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions[31].</td></tr>
</table>

[29] The manufacturer of the flare is “Brasmetano Ind. e Com. Ltda.”, which is a flaring equipment manufacturer based in Brazil.

[30] In June 2017 a unique high temperature enclosed flare was installed as part of the project activity. Additional flare(s) may however be installed in the future in order to meet forecasted increase in the amount of LFG to be collected by the project activity. If applicable, the installation of additional flare will be opportunely addressed in the future as per applicable CDM rules and procedures for addressing post-registration changes in registered CDM project activities.

[31] As also highlighted in Section B.3, it is important to note that residual project emissions of CH_4 due to the combustion of LFG in the installed enclosed flare are considered in the context of the determination of baseline emissions although ACM0001 (version 18.0) refers to the term “project emissions from flaring”.

Additional comment	All flare specification and operation details/requirements are based on information provided by the equipment manufacturer.

B.6.3. Ex ante calculation of emission reductions

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As presented in Section B.6.1, while emission reductions to be achieved by the project activity are determined as the difference between baseline emissions (BE_y) and project emissions (PE_y), as established by ACM0001 (version 18.0), the following relevant equations and conditions are applied for the ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 7-year renewable crediting period:

Determination of ex-ante estimations for baseline emissions (BE_y):

While the project activity encompasses collection of LFG and its destruction in high temperature enclosed flares, by following the applicable methodological approaches and assumptions + ex-ante determined values presented in Section B.6.1 and B.6.2 respectively, baseline emissions (BE_y) are thus determined as follows:

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

Where:

$BE_{CH4,y}$ Baseline emissions of methane from the SWDS in year *y* (tCO_2e/yr). $BE_{CH4,y}$ is determined as follows:

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

Where:

OX_{top_layer} = Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline. OX_{top_layer} is ex-ante determined as 0.1. See Section B.6.2 for further details.

$F_{CH4,BL,y}$ = Amount of methane that would be flared in the baseline in year y (t CH_4/yr). See Section B.6.1 for further details.

GWP_{CH4} = Global warming potential of CH_4 ($tCO_2e/t\ CH_4$). GWP_{CH4} is ex-ante determined as 25.

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH_4/yr). In the context of ex-ante estimation of emission reductions, as established by ACM0001 (version 18.0), $F_{CH4,PJ,y}$ is determined (in tCH_4/year) as follows in the particular case of the project activity:

Determination of ex-ante estimations of $F_{CH4,PJ,y}$:

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

Where:

$F_{CH4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (tCH_4/yr)

η_{PJ} = Efficiency of the LFG capture system that will be installed in the project activity. η_{PJ} is ex-ante determined as 0.9280. See Section B.6.2 for further details.

$BE_{CH4,SWDS,y}$ = Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (in tCO_2e/yr). $BE_{CH4,SWDS,y}$ is estimated as follows:

$$BE_{CH4,SWDS,y} = \varphi_y * (1 - f_y) * GWP_{CH4} * (1 - OX) * \frac{16}{12} * F * DOC_f * MCF * \sum_{x=1}^{y} \sum_j W_{j,x} * DOC_j * e^{-k(y-x)} * (1 - e^{-kj})$$

For the determination of $BE_{CH4,SWDS,y}$, the ex-ante determined values for all parameters in the formulae above are applied. See Section B.6.2 for details about such ex-ante determined values.

An emisison reduction calculation spreadsheet is enclosed to this PDD. This calculation spreadsheet includes all required related calculations for the ex-ante estimation of $BE_{CH4,y}$ and $BE_{EC,y}$ during the 2nd 7-year crediting period.

The ex-ante estimation of $BE_y = BE_{CH4,y}$ is thus summarized as follows:

BE_y = $BE_{CH4,y}$	Estimation of $F_{CH4,PJ,Y}$ (tCH_4)	Estimation of $F_{CH4,BL,y}$ (tCH_4)	Estimation of $BE_{CH4,y}$ (tCH_4)	Estimation of baseline emissions (tCO_2e)
Year	$F_{CH4,PJ,y} = n_{PJ} * BE_{CH4,SWDS,y} / GWP_{CH4}$	$F_{CH4,BL,r,y} = F_{CH4,BL,x-1} * F_{CH4,PJ,y} / F_{CH4,x-1}$	$BE_{CH4,y} = (1 - OX_{top\_layer}) * (F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4}$	$BE_y = BE_{CH4,y}$
2015	1,491	44	32,554	32,554
2016	1,545	45	33,751	33,751
2017	1,592	47	34,768	34,768
2018	1,635	48	35,699	35,699
2019	1,674	49	36,559	36,559
2020	1,711	50	37,360	37,360
2021	1,745	51	38,111	38,111
Total	**11,391**	**333**	**248,802**	**248,802**

Determination of ex-ante estimations for project emissions (PE_y):

As outlined in Section B.6.1, the only source of project emissions to be considered in the context of the determination of emission reductions to be achieved by the project activity is due to the consumption of grid-sourced electricity by the project activity. The related ex-ante estimations of the corresponding project emissions are determined as follows:

Determination of ex-ante estimations of project emissions due to consumption of grid-sourced electricity by the project activity ($PE_{EC,grid,y}$):

By following the applicable methodological approaches and assumptions + ex-ante determined values presented in Section B.6.1 and B.6.2 respectively, $PE_{EC,grid,y}$ is determined as follows:

$$PE_{EC,grid,y} = EC_{PJ,grid,y} * EF_{EL,grid,y} * (1 + TDL_{grid,y})$$

Where:

$PE_{EC,grid,y}$ = Project emissions due to consumption of grid sourced electricity by the project activity in year *y* (in tCO_2/yr).

$EC_{PJ,grid,y}$ = Quantity of grid sourced electricity consumed by the project activity in year *y* (in MWh). $EC_{PJ,grid,y}$ is estimated as being 131 MWh per year. Further details are included in Section B.7.1. This value is assumed based on the installed nominal power output for the main electrical equipment currently installed as part of the project activity (e.g installed centrifugal blowers) and also by assuming that such equipment will work continuously (24 hours a day) under full power during the whole 2nd 7-year crediting period[32].

$TDL_{grid,y}$ = Average technical transmission and distribution losses for grid sourced electricity consumed by the project activity in year *y.* $TDL_{,grid,y}$ is ex-ante determined as being 20%. Further details are included in Section B.6.2.

$EF_{EL,grid,y}$ = Emission factor for grid sourced electricity in year *y* (tCO_2/MWh). Details about the estimated value for $EF_{EL,grid,y}$ are presented in Sections B.6.1 and B.6.2. Moreover, a emission reduction calculation spreadsheet that includes related calculations for the $EF_{EL,grid,y}$ is enclosed to this PDD. The calculated ex-ante determined combined margin grid CO_2 emission factor valid for the whole 2nd 7-year crediting period is determined as summarized below:

Ex-ante estimates of $EF_{grid,OM-adj,y}$:
Operating margin CO2 emission factor ($EF_{grid,OM-adj,y} = EF_{grid,OM,y}$):
As described in Section B.6.1, the simple adjusted operating margin is applied and ex-ante data vintage is selected for the calculation of $EF_{grid,OM,y}$ as follows: a 3-year generation-weighted average is calculated based on data for the years of 2014, 2015 and 2016 (the most recent data public available at the time of completion of this PDD).

The average calculated valud of $EF_{grid,OM-adj,y}$ valid for the 2nd 7-year crediting period is thus calculated as 0.4979 tCO_2/MWh

Annual values of $EF_{grid,OM-adj,y}$ are determined and reported by the DNA of Brazil. Further details are available on its website: http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html

Build margin CO2 emission factor ($EF_{grid,BM}$): The build margin CO_2 emission factor for the national electricity grid of Brazil is ex-ante determined as the value applicable for year 2016 as determined and published by the DNA of Brazil as follows:

Build Margin Emission Factor of Brazilian Integrated Electric System for year 2016:

Build Margin	
Average Emission Factor (tCO_2/MWh)	
Year	**2016**
0.1581	

$EF_{grid,BM,2016}$ = 0.1581 tCO_2/MWh

Values of $EF_{grid,BM,y}$ are determined and reported by the DNA of Brazil. Further details are available on its website:
http://www.mctic.gov.br/mctic/opencms/textogeral/emissao_despacho.html

[32] It is important to note that additional power consuming equipment (e.g. additional centrifugal blowers) may be installed as part of the project activity in order to accommodate projected increment in the quantity of LFG to be collected and destroyed by the project activity. In this sense, the conservative approach hereby assumed for estimating $EC_{PJ,grid,y}$ during the 2nd 7-year crediting period (equipment continuously operating under full power) is appropriate (and under a certain level incorporates an increase in grid electricity consumption by the project activity that may occur).

The values for w_{OM} and w_{BM} are ex-ante selected as per applicable guidance of the "Tool to calculate the emission factor for an electric system" which is valid for 2nd crediting periods as follow:

$w_{OM} = 0.25$

$w_{BM} = 0.75$

Further details about the determination of ex-ante selected values for w_{OM} and w_{BM} are presented in Section B.6.2.

$EF_{grid,CM,y}$ is thus calculated as follows:

$EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y} = 0.25 * 0.4979 + 0.75 * 0.1581 = 0.2430$ tCO_2/MWh

Ex-ante estimations of total project emissions during the 2nd 7-year crediting period are thus summarized as follows:

PE_y	Grid-sourced electricity consumption by the project activity (MWh)	Project emissions due to grid-sourced electricity consumption (tCO_2)	Total Project emissions (tCO_2)
Year	$EC_{PJ,grid,y}$	$PE_{EC,y} = EEC_{PJ,grid,y} * EF_{grid,y} * (1+TDL_{grid,y})$	$PE_y = PE_{EC,y}$
2015	131	39	39
2016	131	39	39
2017	131	39	39
2018	131	39	39
2019	131	39	39
2020	131	39	39
2021	131	39	39
Total	**920**	**273**	**273**

Summarized ex-ante estimations of emission reductions (ER_y):
By taking into account the above summarized values for baseline and project emissions, the ex-ante estimations of the emission reductions for the project activity along the 2nd 7-year renewable crediting period are summarized as follows:

ER_y	Emission reductions (tCO_2e)
Year	$ER_y = BE_y - PE_y$
2015	32,515
2016	33,712
2017	34,729
2018	35,660
2019	36,520
2020	37,321
2021	38,072
Total	**248,529**

Details about all the ex-ante determined parameters which are used for the ex-ante estimations of emissions reductions are included in the previous section. An emission reduction calculation spreadsheet with all related calculations for the ex-ante estimations of emission reductions to be achieved by the project activity during the 2nd crediting period is enclosed to this PDD.

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)
2015	32,554	39	0	32,515
2016	33,751	39	0	33,712
2017	34,768	39	0	34,729
2018	35,699	39	0	35,660
2019	36,559	39	0	36,520
2020	37,360	39	0	37,321
2021	38,111	39	0	38,072
Total	**248,802**	**273**	0	**248,529**
Total number of crediting years	7			
Annual average over the crediting period	35,543	39	0	35,504

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	**Management of SWDS**
Data unit	Dimensionless
Description	Management of the SWDS
Source of data	Measurements/monitoring performed by the project participants. The design and operational conditions of the solid waste disposal site (SWDS) Bragança landfill will be annually monitored on the basis of different sources, including *inter alia*: - Original construction and operational design of the Bragança landfill; - Technical specifications and requirements for the management of the Bragança landfill; - Applicable local or national regulations dealing with management and operation of existing landfills. Any occurred or planned relevant change in terms of management of the landfill will be reported and justified.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the

	SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Original construction and operational design of the Bragança landfill should be confirmed as not being modified during the 2nd 7-year crediting period. This is to ensure that no practice aiming to increase methane generation in the landfill has been occurring after the implementation of the project activity. As required by ACM0001 (version 18.0), any change in the management of the landfill after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
Monitoring frequency	Annually.
QA/QC procedures	Not applicable.
Purpose of data	Calculation of baseline emissions.
Additional comment	-

Data/Parameter	$V_{t,wb}$
Data unit	m^3 wet gas/h
Description	Volumetric flow of LFG stream in time interval *t* on a wet basis.
Source of data	Measurements/monitoring performed by the project participants. Measured as part of the operation of the project activity by applying appropriate LFG flow meters.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Volumetric flow measurement of collected LFG should always refer to the actual LFG absolute pressure and LFG temperature. Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is assumed.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events for the LFG flow meters will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations.

	Instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice.
Purpose of data	Calculation of baseline emissions.
Additional comment	This parameter will be monitored in case Options B or C of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0) is applied for the determination of $F_{CH4,flared,y}$.

Data/Parameter	$\mathbf{V_{t,db}}$
Data unit	m³ dry gas/h
Description	Volumetric flow of LFG stream in time interval *t* on a dry basis.
Source of data	Measurements/monitoring performed by the project participants. Measured as part of the operation of the project activity by applying appropriate LFG flow meters.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Volumetric flow measurement of collected LFG should always refer to the actual LFG absolute pressure and LFG temperature. Calculated based on the wet basis LFG flow measurement plus water concentration measurement. Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is assumed.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice.
Purpose of data	Calculation of baseline emissions.
Additional comment	This parameter will be monitored in case Option A of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) is applied for the determination of $F_{CH4,flared,y}$.

Data/Parameter	**$v_{CH4,t,db}$**
Data unit	$m^3 CH_4/m^3$ dry gas
Description	Volumetric fraction of CH_4 in the collected LFG in time interval *t* on a dry basis.
Source of data	Measurements/monitoring performed by the project participants. Measured as part of the operation of the project activity by applying an appropriate continuous CH_4 content gas analyzer.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Measurements to be performed by appropriate continuous gas analyzer operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature. Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is assumed.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events in the continuous CH_4 content gas analyzer will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases (span gases) must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice.
Purpose of data	Calculation of baseline emissions.
Additional comment	This parameter will be monitored in case Option B of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) is applied for the determination of $F_{CH4,flared,y}$. This parameter may be monitored in case Options A or D of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) are applied instead.

Data/Parameter	**$v_{CH4,t,wb}$**
Data unit	$m^3 CH_4/m^3$ wet gas

Description	Volumetric fraction of CH_4 in the collected LFG in time interval *t* on a wet basis.
Source of data	Measurements/monitoring performed by the project participants. Measured as part of the operation of the project activity by applying appropriate continuous CH_4 content gas analyzer.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Measurements to be continuously performed by appropriate gas analyzer operating in wet-basis. Volumetric flow measurement should always refer to the actual pressure and temperature. (calculated based on the dry basis analysis plus water concentration measurement or continuous in-situ analyzers). Use of measuring instrument/equipment with recordable electronic signal (analogical or digital) is assumed.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events in the continuous CH_4 content gas analyzer will be performed by utilization of calibration span gas with certified CH_4 content (for span checking/adjustment). Utilization of an inert calibration gas (e.g. N_2) will also occur (for span checking/adjustment). All calibration gases (span gases) must have a certificate provided by the gas supplier and must be under their validity period. Periodic calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice.
Purpose of data	Calculation of baseline emissions.
Additional comment	This parameter will be monitored in case Option C of the methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) is applied for the determination of $F_{CH4,flared,y}$. This parameter may be monitored in case Options A or D of the methodological tool is applied instead.

Data/Parameter	$\mathbf{M_{t,db}}$
Data unit	kg/h
Description	Mass flow of the LFG stream in time interval *t* on dry basis.

Source of data	Measurements/monitoring performed by the project participants. Measured as part of the operation of the project activity by applying appropriate LFG flow meters.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Continuous measurements to be performed by applying appropriate flow meter operating in dry-basis. Mass flow measurement should always refer to the actual pressure and temperature (calculated based on the wet basis flow measurement plus water concentration measurement). Instruments with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events for the LFG flow meter(s) will be performed by using a reference primary device provided by a third party independent accredited calibration laboratory. Calibration events will be performed in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice.
Purpose of data	Calculation of baseline emissions.
Additional comment	This parameter will be monitored only in case option D of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0) is applied for the determination of $F_{CH4,flared,y}$.

Data/Parameter	$\mathbf{T_t}$
Data unit	K[33]
Description	Temperature of the LFG stream in time interval *t*
Source of data	Measurements/monitoring performed by the project participants. Measured as part of the operation of the project activity by applying appropriate LFG temperature sensor.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is

[33] Measurements for T_t will be recorded and reported in ^oC. Recorded/reported data will be converted to Kelvin in order to also being recorded/reported in K.

	sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y}$ = $F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Measured to determine the density of methane ρ_{CH4}. No separate monitoring of LFG temperature is necessary when using LFG flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (by considering standard temperature and pressure (STP) conditions). Instruments with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events will be performed in the LFG temperature sensor by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice. Spare instrument(s) may be kept.
Purpose of data	Calculation of baseline emissions.
Additional comment	In case of measurements for the applicable LFG flow parameter are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), monitoring of this parameter may not be required except if the applicability condition related to the gaseous stream flow temperature being below 60ºC is adopted. Under this circumstance, this parameter shall be monitored continuously to assure the applicability condition is indeed met.

Data/Parameter	**P_t**
Data unit	Pa[34]
Description	Pressure of the LFG stream in time interval *t*
Source of data	Measurements/monitoring performed by the project participants. Measured as part of the operation of the project activity by applying appropriate LFG pressure sensor.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y}$

[34] Depending on installed measurement instrument, measurements for P_t will be recorded and reported in mbar. Recorded/reported data will be converted into Pascal in order to be also recorded and reported in Pa.

	= $F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Measured to determine the density of methane ρ_{CH4}. No separate monitoring of LFG pressure is necessary when using LFG flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters (by considering standard temperature and pressure (STP) conditions). Instruments with recordable electronic signal (analogical or digital) are required.
Monitoring frequency	Continuous measurements will be recorded and reported with an every-minute frequency.
QA/QC procedures	Periodic calibration events will be performed in the LFG pressure sensor by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice. Spare instrument(s) may be kept.
Purpose of data	Calculation of baseline emissions.
Additional comment	In case of measurements for the applicable LFG flow parameter are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), monitoring of this parameter may not be required.

Data/Parameter	**$EC_{PJ,grid,y}$**
Data unit	MWh
Description	Amount of grid electricity consumed by the project activity during the year *y*
Source of data	Measured as part of the operation of the project activity by applying appropriate electricity meter(s).
Value(s) applied	It is estimated that the project activity will consume 131 MWh of grid sourced electricity per year during the 2nd 7-year crediting period.
Measurement methods and procedures	Authorized electricity meters. Measurement records will be cross-checked against available electricity consumption receipts/invoices issued by the local electricity distribution company. The parameter $EC_{PJ,y}$ is equivalent to the parameter $EG_{EC,y}$ as indicated in ACM0001 (version 18.0).
Monitoring frequency	Continuous measurements will be aggregated automatically. Accumulated measurement records will be reported at least once a week.
QA/QC procedures	Periodic calibration events will be performed in a frequency as per instrument

	specifications and/or instrument manufacturer's recommendations. Instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice.
Purpose of data	Calculation of project emissions.
Additional comment	The values considered in the context of the ex-ante estimation of emission reductions were selected based on the nameplate power output for the installed centrifugal blowers and main ancillary equipment. Also as an assumption, it is considered that the project activity will operate 24 hours a day during the 2nd 7-year renewable crediting period.

Data/Parameter	**$F_{CH4,EG,t}$**
Data unit	kg
Description	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t*
Source of data	Measurements undertaken by a third party accredited entity
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y}$ = $F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Measure the mass flow of methane in the exhaust gas according to an appropriate national or international standard (such as the UK's Technical Guidance LFTGN05 or a similar standard). The time period *t* over which the mass flow is measured must be at least one hour. The average flow rate to the flare during the time period *t* must be greater than the average flow rate observed for the previous six months.
Monitoring frequency	Biannual
QA/QC procedures	QA/QC procedures are to be applied by the entity responsible for performing the related measurements as per requirements of the applied standard. Periodic calibration events in the applied instruments will be performed by a third party independent accredited calibration laboratory (in a frequency as per instrument specifications and/or instrument manufacturer's recommendations). Instrument will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice.

Purpose of data	Calculation of baseline emissions[35].
Additional comment	Monitoring of this parameter is required in the case of enclosed flares and if the project participants select Option B.1 to determine flare efficiency

Data/Parameter	$p_{H20,t,Sat}$
Data unit	Pa (depending on measurement instrument, measurement records in mbar will be converted and also reported in Pa)
Description	Saturation pressure of H_2O at temperature T_t in time interval *t*
Source of data	Data as per the literature "*Fundamentals of Classical Thermodynamics*"; Authors: Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994. Published by John Wiley & Sons, Inc.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions are ex-ante estimated by estimating the amount of methane in the LFG which is flared as part of the operation of the project activity in year y ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that will be installed in the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	This parameter is solely a function of the LFG stream temperature T_t and can be found at above-referenced literature for a total pressure equal to 101,325 Pa.
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	Data will be used for the determination of baseline emissions.
Additional comment	-

Data/Parameter	$T_{EG,m}$
Data unit	ºC
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*
Source of data	Measurements performed by the project participants
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are

[35] It is relevant to note that, as shown in Section B.6.1., as per the applied methodological approach, monitoring records of $F_{CH4,EG,t}$ are used for the determination of project emissions from flaring ($PE_{flare,y}$), of which are accounted for the determination of baseline emissions (and not used for the determination of project emissions despite of being termed as "project emissions" from flaring).

	ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool "Emissions from solid waste disposal sites" (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Measure the temperature of the exhaust gas of each installed high temperature enclosed flare by appropriate temperature measurement equipment (e.g. thermocouples). Measurements outside the operational temperature specified/recommended by the manufacturer may indicate that one or more flares is/are not functioning correctly and may require maintenance. Flare manufacturers must provide suitable monitoring ports for the monitoring of the temperature of the exhaust gas of the flare. These would normally be expected to be in the middle third of the flare.
Monitoring frequency	Continuous measurements will be recorded and reported with a least every minute frequency.
QA/QC procedures	Temperature measurement equipment should be replaced or calibrated in accordance with their maintenance schedule.
Purpose of data	Calculation of baseline emissions[36].
Additional comment	Unexpected changes such as a sudden increase/drop in temperature can occur for different reasons. As part of the monitoring procedure, these events will be noted in the site records along with any corrective action that was implemented to correct the issue. Measurements are required to determine if manufacturer's flare specifications for operating temperature are met. Periodic calibration events will be performed in the instruments by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer's recommendations. Instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice. Spare instrument(s) may be kept.

Data/Parameter	**$Flame_m$**
Data unit	Flame status "*on*" or flame status "*off*"
Description	Flame detection of flare in the minute *m*
Source of data	Measurements/monitoring performed by the project participants. Whenever, flame is detected in the flare, flame status "*on*" is attributed. Whenever, flame is not detected in the flare, flame status "*off*" is attributed.

[36] It is relevant to note that, as shown in Section B.6.1., as per the applied methodological approach, monitoring records of $T_{EG,m}$ are used for the determination of project emissions from flaring ($PE_{flare,y}$), of which are accounted for the determination of baseline emissions (and not used for the determination of project emissions despite of being termed as "project emissions" from flaring).

Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0) and considering aspects/characteristics of the landfill.
Measurement methods and procedures	Measure using a fixed installation optical flame detector: Ultra Violet detector or Infra-red or both.
Monitoring frequency	Every minute.
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer’s recommendations.
Purpose of data	Calculation of baseline emissions.
Additional comment	Applicable to all flares. The condition will be regularly monitored for each individual high temperature enclosed flare. Periodic calibration events will be performed in the instruments by a third party independent accredited calibration laboratory in a frequency as per instrument specifications and/or instrument manufacturer’s recommendations. Instruments will be subject to a regular maintenance and testing regime in accordance to appropriate national/international standards/requirements and/or best practice. Spare instrument(s) may be kept.

Data/Parameter	**$Maintenance_y$**
Data unit	Calendar dates
Description	Maintenance events completed in year *y* as monitored by the project participants.
Source of data	Measurements/monitoring performed by the project participants.
Value(s) applied	No estimated value is required for the determination of ex-ante estimation of emission reduction to be achieved by the project activity during the 2nd 7-year crediting period. Baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are ex-ante estimated by estimating the amount of methane in the LFG which is sent to the flares as part of the operation of the project activity in year *y* ($F_{CH4,PJ,y} = F_{CH4,flared,y}$) as a function of ex-ante estimated values for efficiency of the LFG capture system that is currently installed as part of the project activity (η_{PJ}) as well as ex-ante estimations for the amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y ($BE_{CH4,SWDS,y}$) by using applicable guidance of the methodological tool “Emissions from solid waste disposal sites” (version 08.0) and considering aspects/characteristics of the landfill.

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

Data/Parameter	**Status of biogas destruction device**
Data unit	
Description	Operational status of biogas destruction devices
Source of data	Not applicable.
Value(s) applied	Not applicable.
Measurement methods and procedures	Monitoring and documenting may be undertaken through monitoring of the operation of the flare (by means of a flame detector) in order to demonstrate the actual destruction of methane in such uniquely installed biogas destruction device. Emission reductions will not accrue for periods in which the underlying destruction device (high temperature enclosed flare) is not operational.
Monitoring frequency	Continuous measurements will be recorded and reported with a least every minute frequency.
QA/QC procedures	Not applicable.
Purpose of data	Calculation of baseline emissions.
Additional comment	Monitoring records for the monitoring parameter “Flame detection of flare in the minute *m*” ($Flame_m$) will be considered.

Data/Parameter	$\mathbf{v_{i,RG,m}}$
Data unit	--
Description	Volumetric fraction of component *i* in the residual gas on a dry basis in the minute m where *i* = CH_4, CO, CO_2, O_2, H_2, H_2S, NH_4, N_2
Source of data	Measurements by project participants using a continuous gas analyser
Value(s) applied	-

Measurement methods and procedures	Monitored continuously as per the "*Tool to determine project emissions from flaring gases containing methane*". A gas analyzer will be adopted. The gas analyzer will: 1) sample and analyze the methane, carbon dioxide and oxygen content of LFG, 2) provide continuous monitoring of the parameter and 3) transfer data to monitoring system for storage of the information
Monitoring frequency	Continuously. Values to be averaged on a minute basis
QA/QC procedures	Analysers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard certified gas
Purpose of data	Calculation of baseline emissions.
Additional comment	As a simplified approach, project participants may only measure the content CH_4, CO and CO_2 of the residual gas and consider the remaining part as N_2. Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency.

Data/Parameter	$\mathbf{M_{RG,m}}$
Data unit	kg
Description	Mass flow of the residual gas on a dry basis at reference conditions in the minute *m*
Source of data	-
Value(s) applied	-
Measurement methods and procedures	Instruments with recordable electronic signal (analogical or digital)
Monitoring frequency	Continuous values to be averaged on a minute basis
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications
Purpose of data	Calculation of baseline emissions.
Additional comment	Monitoring of this parameter is applicable in case of enclosed flares and continuous monitoring of the flare efficiency and if project participant selects to monitor $M_{RG,m}$ directly, instead of calculating. Monitoring of this parameter may also be necessary for confirming that the manufacturer's specifications for flow rate/heat flux are met. In this case the flow rate should be measured in a kg/h basis

Data/Parameter	$\mathbf{v_{O2,EG,m}}$
Data unit	-

Description	Volumetric fraction of O_2 in the exhaust gas on a dry basis at reference conditions in the minute *m*
Source of data	Measurements by project participants using a continuous gas analyser
Value(s) applied	-
Measurement methods and procedures	Extractive sampling analysers with water and particulates removal devices or in situ analysers for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes)
Monitoring frequency	Continuously. Values to be averaged on a minute basis
QA/QC procedures	Analysers must be periodically calibrated according to the manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard gas
Purpose of data	Calculation of baseline emissions.
Additional comment	Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency

Data/Parameter	$\mathbf{fc_{CH4,EG,m}}$
Data unit	mg/m^3
Description	Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute *m*
Source of data	Measurements by project participants using a continuous gas analyser
Value(s) applied	-
Measurement methods and procedures	Extractive sampling analysers with water and particulates removal devices or in situ analyser for wet basis determination. The point of measurement (sampling point) shall be in the upper section of the flare in order that the sampling is of the gas after consumption has taken place (80% of total flare height). Sampling shall be conducted with appropriate sampling probes adequate to high temperatures level (e.g. inconel probes)
Monitoring frequency	Continuously. Values to be averaged on a minute basis
QA/QC procedures	Analysers must be periodically calibrated according to manufacturer's recommendation. A zero check and a typical value check should be performed by comparison with a standard gas
Purpose of data	Calculation of baseline emissions.
Additional comment	Monitoring of this parameter is only applicable in case of enclosed flares and continuous monitoring of the flare efficiency. Measurement instruments may read ppmv or % values. To convert from ppmv to mg/m3 simply multiply by 0.716. 1% equals 10 000 ppmv

B.7.2. Sampling plan

>>
Not applicable.

B.7.3. Other elements of monitoring plan

>>
General monitoring:
The following instruments/equipment will be used to monitor required data along the 2nd 7-year renewable crediting period (depending on the applied measurement options and calculation approaches - to be chosen ex-post)[37]:

Instrument or Source of data	Measurement option		Data monitored	
Appropriate volumetric or mass flow meters (one individual LFG flow meter for each high temperature enclosed flare, with separated measurement data being recorded and reported for each flare)[38]	A	Volume flow – dry basis; Volumetric fraction dry or wet basis	$V_{t,db}$	Volumetric flow of LFG stream *j* in time interval *t* on a dry basis (in m^3 dry gas/h). *j* = LFG delivery pipeline to each operative high temperature enclosed flare
	B	Volume flow – wet basis; Volumetric fraction dry basis	$V_{t,wb}$	Volumetric flow of LFG stream *j* in time interval *t* on a wet basis (in m^3 dry gas/h). *j* = LFG delivery pipeline to each operative high temperature enclosed flare
	C	Volume flow – wet basis; Volumetric fraction wet basis	$V_{t,wb}$	Volumetric flow of LFG stream *j* in time interval *t* on a wet basis (in m^3 wet gas/h). *j* = LFG delivery pipeline to each operative high temperature enclosed flare
	D	Mass flow – dry basis; Volumetric fraction dry or wet basis	$M_{t,db}$	Mass flow of LFG stream *j* in time interval *t* on a dry basis (in kg/h). *j* = LFG delivery pipeline to each operative high temperature enclosed flare
Continuous CH_4 content gas	-		$v_{CH4,t,db/wb}$	Volumetric fraction of methane on the LFG stream directed to the flares in a

[37] Measurement options defined in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0) when referring to "Adequate volumetric or mass flow meter (s)" and defined in the methodological tool Project emissions from flaring" (Version 02.0.0) in other cases.

Different measurement options are indeed defined in the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (Version 03.0) when referring to "Adequate volumetric or mass flow meter (s)". The applicable guidance of the methodological tool "Project emissions from flaring" (Version 02.0.0) also refers to different measurement and calculation options.

[38] As outlined in both Sections A.3. and B.6.2, in June 2017 a unique high temperature enclosed flare was installed as part of the project activity. Additional flare may however be installed in the future in order to meet forecasted increase in the amount of LFG to be collected by the project activity. If applicable, the installation of additional flare will be opportunely addressed in the future as per applicable CDM rules and procedures for addressing post-registration changes in registered CDM project activities.

Instrument or Source of data	**Measurement option**	**Data monitored**	
analyser unit			time interval *t* on a dry or wet basis (in m^3 CH_4/m^3 dry or wet gas)
LFG pressure sensor	-	$\mathbf{P_t}$	Pressure of the LFG stream directed to the flare in time interval *t* (in Pa or mbar) Note: $\mathbf{P_t}$ may not be monitored when using LFG flow meter(s) that automatically consider and measures LFG temperature and LFG pressure, thus expressing LFG volumetric or mass flows in normalised units.
LFG temperature sensor	-	$\mathbf{T_t}$	Temperature of the LFG stream directed to the flare in time interval *t* (in K or ºC) Note: $\mathbf{T_t}$ may not be monitored when using LFG flow meter(s) that automatically consider and measures LFG temperature and LFG pressure, thus expressing LFG volumetric or mass flows in normalised units.
Not based on measurements. Monitoring performed in the context of operation/monitoring for the project activity (based on calculations)	-	$\mathbf{p_{H20,t,Sat}}$	Saturation pressure of H_2O at temperature T_t in time interval *t* This parameter is solely a function of the LFG stream temperature T_t and can be found at referenced literature.
Electricity meter	-	$\mathbf{EC_{PJ,y} = EC_{grid,y}}$	Amount of grid electricity consumed by the project activity in year *y* (in MWh)
Not based on measurements. Monitoring performed in the context of operation/monitoring for the project activity (based on calculations)	-	$\mathbf{EF_{grid,OM,y} = EF_{grid,OM\text{-}DD,y}}$	Operation margin CO_2 emission factor in year *y* = Dispatch data analysis operating margin CO_2 emission factor in year *y.* (in tCO_2/MWh). Data will be determined as per applicable guidance for dispatch data analysis operating margin CO_2 emission factor of the "Tool to calculate the emission factor for an electricity system".
Not based on measurements performed in the context of operation/monitoring for the project activity	-	**Management of SWDS**	Management of SWDS The design and operational conditions of the landfill will be annually monitored on the basis of different sources, including *inter alia*: - Original design of the landfill; - Technical specifications for the management of the landfill; - Applicable local or national

Instrument or Source of data	Measurement option	Data monitored	
		regulations	
Measurements undertaken by a third party accredited entity	**B.1**	**$F_{CH4,EG,t}$**	Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t* (kg) For each one of the installed high temperature enclosed flare, it will be measured the mass flow of methane in the exhaust gas according to an appropriate national or international standard (e.g. UKs Technical Guidance LFTGN05). The time period *t* over which the mass flow is measured must be at least one hour. The average flow rate to the flare during the time period *t* must be greater than the average flow rate observed for the previous six months Monitoring of this parameter is only required in the case the project participants select Option B.1 to determine the efficiency values for the high temperature enclosed flares.
Thermocouple(s)	**A or B.1**	**$T_{EG,m}$**	Temperature in the exhaust gas of the enclosed flare in minute *m* (ºC) For each one of the installed high temperature enclosed flare, it will be continuously measured the temperature of the exhaust gas through use of appropriate temperature measurement instrument (e.g. thermocouples). Measurements outside the operational temperature specified by the flare manufacturer may indicate that the flare is not functioning correctly and may require maintenance or repair work. For each flare, the temperature of the exhaust gas in each flare have to be measured in a suitable monitoring port. In high temperature enclosed flares, monitoring ports are normally expected to be located within the middle third of the flare. In case more than one temperature port is fitted to the high temperature enclosed 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 manufacturer's specifications for

Instrument or Source of data	Measurement option	Data monitored	
			temperature of exhaust gas. The four high temperature enclosed flares currently installed as part of the project activity only have one monitoring port for temperature of the exhaust gas. Measurements are required to determine if manufacturer's flare specifications for operating temperature are met.
Project participants	**A or B.1**	**$Flame_m$**	Flame detection of flare in the minute *m* (Flame "*on*" or Flame "*off*") For each installed high temperature enclosed flare, continuous monitoring of flame detection through use of appropriate installation (e.g. optical flame detector (using ultra violet or infrared technology or both).
Project participants	**B.1**	**$Maintenance_y$**	Maintenance events completed in year *y* (Calendar dates) for each one of the high temperature enclosed flare combusting LFG. For each installed high temperature enclosed flare, record the date when maintenance events are performed in year *y*. Records of maintenance logs will include all aspects of the maintenance including the details of the person(s) undertaking the work, parts replaced/repaired, or needing to be replaced, source of replacement parts, serial numbers and related calibration certificates.
Project participants	**-**	**Status of biogas destruction device**	Operational status of biogas destruction devices The same procedure as adopted for monitoring parameter $Flame_m$. For the installed high temperature enclosed flare, continuous monitoring of flame detection through use of appropriate installation (e.g. optical flame detector (using ultra violet or infrared technology or both).
Continuous gas analyser unit	**Option B.2**	**$v_{i,RG,m}$**	Volumetric fraction of component *i* in the residual gas on a dry basis in the minute m where i = CH_4, CO, CO_2, O_2, H_2, H_2S, NH_4, N_2.
Mass flow meter	**Option B.2**	**$M_{RG,m}$**	Mass flow of the residual gas on a dry

Instrument or Source of data	Measurement option	Data monitored	
			basis at reference conditions in the minute *m*.
Continuous gas analyser unit	**Option B.2**	$v_{O2,EG,m}$	Volumetric fraction of O_2 in the exhaust gas on a dry basis at reference conditions in the minute *m*.
Continuous gas analyser unit	**Option B.2**	$fc_{CH4,EG,m}$	Concentration of methane in the exhaust gas of the flare on a dry basis at reference conditions in the minute *m*.

During the 2nd 7-year crediting period, all continuously measured LFG related parameters as well as measurements related to the exhaust gas of the flares (temperature in the exhaust gas of the flare and eventually other parameters related to flare operational conditions) will all be recorded electronically via an appropriate data logger / data acquisition system (to be located within the site boundary). The data logger / data acquisition system will have the capability to record all data in a safe and reliable manner (thus ensuring the required data reliability and validity). Data recording and reporting frequency for these parameters will be at least every one minute.

Records of electricity consumed by the project activity will also be recorded electronically via an appropriate data logger / data acquisition system (to be located within the site boundary). Data from related electricity purchase invoices (issued by local electricity distribution company) will also be used as cross-checking.

By the use of appropriate software application, recorded monitoring data will be regularly retrieved, aggregated and reported in order to be considered in the context of calculations of emission reduction achieved by the project activity.

Monitoring records available in the data logger / data acquisition system might be regularly retrieved remotely by modem or directly on site. If automatic data logging by the logger / data acquisition system fails, measurement data might be recorded manually (whenever it is possible). If data is not properly recorded or cannot be retrieved, no emissions reductions will be claimed for the period encompassing such data recording/reporting failure.

During the 2nd 7-year crediting period, all monitoring data will be recorded and backed-up in a central database. As per the applicable monitoring procedure, data records will be summarized into emission reduction calculations prior to each periodic CDM verification. All data recorded by the data logger / data acquisition system will be made available to the Designated Operational Entities (DOEs) responsible for each periodic verification. This will ensure that data integrity and reliability for related monitoring data.

As per the monitoring procedure adopted, access to monitoring data will be restricted and controlled. All monitoring records will be kept archived until at least two years after the end of the crediting period or at least two years after the last issuance of CERs for the project activity, whichever occurs later.

It will be the responsibility of the appointed monitoring team manager to ensure that all monitoring data is properly measured and recorded as part of operation of the project activity.

Technical specifications for monitoring instruments/equipment (e.g. manufacturer, model, serial numbers, accuracy, etc.) will be detailed in the Monitoring Reports for each periodic verification.

Maintenance and calibration for monitoring instruments/equipment and project's equipment/components in general:

During the 2nd 7-year crediting period, all maintenance service and routines will include all preventive and corrective actions necessary for ensuring good functioning of all project related equipment, such as:

- Visual control of the equipment state and real-time check of displayed parameters,
- Cleaning up the equipment and the sensors,
- Lubrication and greasing,
- Replacement or overhauling of defective parts (including regular welding service in the HDPE pipelines and manifolds).

Calibration events in monitoring instruments/equipment will be periodically and appropriately performed as per applicable frequency, procedures and methods established or recommended by instrument/ equipment manufacturer, applicable national/international standards and/or best practice, as available.

General malfunction of equipment: if monitoring instruments/equipment or project's equipment/components present failure or malfunction, applicable repair or replacement actions will be carried out. Spare units for some of the monitoring instruments/equipment may be kept on site.

Project's operational and management structure:

An appropriate project's operational and management structure will be made available as part of the operation of the project activity during the 2nd 7-year crediting period.

The project's operational and management structure will rely on trained staff with responsibilities clearly defined. All collaborators and employees involved with operation of project and/or monitoring will be trained internally and/or externally. Training efforts may include *inter alia*:

a) General competence development about LFG generation and collection;
b) Review of equipment operational principles and captors;
c) Maintenance and calibration requirements for project's related equipment;
d) Procedures for monitoring data gathering and handling;
e) Emergency and safety procedures;

The monitoring plan will be implemented during the 2nd 7-year crediting period by reflecting the best practice in terms of monitoring efforts for LFG collection and destruction project based initiatives under de CDM.

Monitoring of the management of the landfill:

As required by ACM0001 (version 18.0), the design and operational conditions of the Bragança landfill during the 2nd 7-year renewable crediting period will be monitored on the basis of different sources, including *inter alia*:

- Original design of the landfill;
- Technical specifications for the management of the Bragança landfill;
- Applicable local or national regulations

During the 2nd 7-year crediting period, original operational design of the landfill should be confirmed not to be modified in order to ensure that no practice to increase methane generation at the landfill have been occurring, when compared to the landfill management and operation condition prior to implementation of the project activity. As required by ACM0001 (version 18.0), any change in the management of the landfill after the implementation of the project activity should be justified by referring to technical or regulatory specifications and impacts of such changes in the determination of baseline emissions should in this case be taken into account appropriately. Such monitoring requirement will be used for the determination/confirmation of baseline emissions and/or confirmation of the project's implementation as described in the PDD (in terms of operation and management conditions of the landfill from which LFG is combusted). Further monitoring details are included in Section B.7.1 (under parameter "Management of SWDS").

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
At the time the CDM project activity "Embralixo/Araúna – Bragança Landfill Gas Project" was validated and registered as a CDM project activity (during period encompassing the year of 2007), the start date of the project was selected as being 01/01/2008.

C.2. Expected operational lifetime of project activity

>>
A total operational lifetime of 21 years has been expected for the project activity. While the project activity started to operate in 2008, the currently expected remaining operational lifetime for the LFG collection and destruction component of the project activity exceeds 12 years.

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
While the project activity applies 7-year renewable crediting period option, this PDD is thus valid for the 2nd 7-year renewable crediting period.

C.3.2. Start date of crediting period

>>
01/01/2015.

C.3.3. Duration of crediting period

>>
7 years and 0 months.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
Information about the analysis of the environmental impacts for the project activity (under its previous design configuration) and related validation assessment by the responsible DOE are all presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period of the project activity (PDD version 06, dated 05/03/2007) + Validation Report for the project activity (dated 15/06/2007).

D.2. Environmental impact assessment

>>
Information about the analysis of the environmental impacts for the project activity (under its previous design configuration) and related validation assessment by the responsible DOE are all presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period

of the project activity (PDD version 06, dated 05/03/2007) + Validation Report for the project activity (dated 15/06/2007).

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

Information about solicitation of comments from local stakeholders (including received comments) and related validation assessment by the responsible DOE are all presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period of the project activity (PDD version 06, dated 05/03/2007) + Validation Report for the project activity (dated 15/06/2007).

E.2. Summary of comments received

>>

Information about solicitation of comments from local stakeholders (including received comments) and related validation assessment by the responsible DOE are all presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period of the project activity (PDD version 06, dated 05/03/2007) + Validation Report for the project activity (dated 15/06/2007).

E.3. Consideration of comments received

>>

Information about solicitation of comments from local stakeholders (including received comments) and related validation assessment by the responsible DOE are all presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period of the project activity (PDD version 06, dated 05/03/2007) + Validation Report for the project activity (dated 15/06/2007).

SECTION F. Approval and authorization

>>

A Letter of Approval (LoA) was issued by the Designated National Authority of Brazil (which is the host and only identified Party for the project activity) on 06/06/2007.

Appendix 1. Contact information of project participants

Organization name	Araúna Participações e Investimentos Ltda
Country	Brazil
Address	Al. Jaú, 1742 - cj. 11, São Paulo, Brazil
Telephone	+ 55 11 3791 5435
Fax	+ 55 11 3791 5435
E-mail	luis@arauna.com.br
Website	www.arauna.com.br
Contact person	Mr. Luis Carlos Carvalho

Organization name	EcoSecurities Group Plc
Country	Ireland
Address	40, Dawson Street, Dublin 02, Ireland
Telephone	
Fax	
E-mail	
Website	
Contact person	Mr. Patrick James Browne

Organization name	Embralixo - Empresa Bragantina de Varrição e Coleta de Lixo Ltda.
Country	Brazil
Address	Rua Tupi, nº 140, Bairro do Taboão, Bragança Paulista, Brazil
Telephone	+ 55 11 4031-5000
Fax	+ 55 11 4031-5500
E-mail	n.sfatima@uol.com,br
Website	http://www.embralixo.com.br/
Contact person	Mr. Manoel Rodrigues

Appendix 2. Affirmation regarding public funding

Not applicable. The implementation and operation of the project do not involve any kind of public funding from Parties included in Annex I.

Appendix 3. Applicability of methodologies and standardized baselines

All information about the applicability of the selected methodology are summarized in Section B.2.

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

All information about the ex-ante calculation of emission reductions are summarized in Section B.6.3. An emission reduction calculation spreadsheet includes all calculations of figures which are indicated in Section B.6.3. This spreadsheet is enclosed to this PDD.

Appendix 5. Further background information on monitoring plan

All information about the design and operation of the monitoring plan are presented in Section B.7.1.

Appendix 6. Summary report of comments received from local stakeholders

Information about solicitation of comments from local stakeholders (including received comments) and related validation assessment by the DOE are presented in the latest version of the PDD valid for the currently expired 1st 7-year crediting period (PDD version 06, dated 05/03/2007) + Validation Report for the project activity (dated 15/06/2007).

Appendix 7. Summary of post-registration changes

This section is intentionally left in blank.

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Document information

Version	Date	Description
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.
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

Version	*Date*	*Description*
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