



**Monitoring report form for CDM project activity**  
**(Version 06.0)**

**MONITORING REPORT**

<b>Title of the project activity</b>	Central de Resíduos do Recreio Landfill Gas Project (CRRLGP)	
<b>UNFCCC reference number of the project activity</b>	0648	
<b>Version number of the PDD applicable to this monitoring report</b>	9.2	
<b>Version number of this monitoring report</b>	1.0	
<b>Completion date of this monitoring report</b>	08/03/2019	
<b>Monitoring period number</b>	Monitoring period: #16	
<b>Duration of this monitoring period</b>	From 01/06/2018 to 31/01/2019	
<b>Monitoring report number for this monitoring report</b>	Not applicable.	
<b>Project participants</b>	Companhia Riograndense de Valorização de Resíduos S/A Biogas Riograndense Ltda. Belektron d.o.o.	
<b>Host Party</b>	Brazil	
<b>Sectoral scopes</b>	13 - Waste handling and disposal	
<b>Applied methodologies and standardized baselines</b>	ACM0001 - "Flaring or use of landfill gas" (version 15.0)	
<b>Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period</b>	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	-	272,028 tCO <sub>2</sub> e
<b>Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD</b>	339,150 tCO <sub>2</sub> e	

## SECTION A. Description of project activity

### A.1. General description of project activity

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The CDM project activity Central de Resíduos do Recreio Landfill Gas Project - CRRLGP currently comprises collection of landfill gas (LFG) and its destruction (by combustion in a high temperature enclosed flare) and its utilization as gaseous fuel in the project's electricity generation infrastructure. LFG has been generated at the Central de Resíduos do Recreio (CRR) landfill as a result of anaerobic decomposition of Municipal Solid Waste (MSW) historically disposed at the landfill. This landfill is located in the city of Minas do Leão, State of Rio Grande do Sul, in the Southern Region of Brazil.

The CRR landfill construction was concluded in October 2001. The landfill is implemented in the valley of an old and not any longer under operation coal exploration mine. The CRR landfill has an area of 1,280,020 m<sup>2</sup> and by considering the average MSW disposal rate of 90,000 ton of MSW per month, the CRR landfill currently has a forecasted total lifetime of about 22 years<sup>1</sup>. The total designed solid waste disposal capacity for the CRR landfill is of approximately 30 million ton.

The CRR landfill currently serves as solid waste final disposal site for more than one hundred and thirty public and private clients, with the vast majority of these clients (in volume basis) representing municipalities located in different regions of the Rio Grande do Sul State (which is a Federal State located in the Southern Region of Brazil). The CRR landfill thus plays an important role as a major municipal solid waste (MSW) disposal site in this important region of Brazil.

The CDM project activity "Central de Resíduos do Recreio Landfill Gas Project (CRRLGP)" had its implementation initiated in year 2007 by the former host country project participant SIL - Soluções Ambientais Ltda.<sup>2</sup>, which has also operated the CRR landfill since the starting of its operations.

As part of the operation of the project activity during the considered monitoring period, LFG generated at the CRR landfill was collected and converted into carbon dioxide (CO<sub>2</sub>) through both combustion in a high temperature enclosed flare and through its utilization as gaseous fuel for electricity generation in the engine-generator sets of the project's electricity generation infrastructure. The operation of the project activity thus mitigates emissions of the greenhouse gas (GHG) methane (CH<sub>4</sub>) that would otherwise be directly emitted into the atmosphere in the absence of the project activity (baseline scenario). The project activity has also promoted carbon dioxide (CO<sub>2</sub>) emission reductions due to displacement of electricity (under amount equivalent to the amount of electricity generated by the project's electricity generation infrastructure) which would

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<sup>1</sup> The expected total operation lifetime for the CRR landfill of 22 years is established in the landfill's Operating License of no. 06073/2018.

<sup>2</sup> As outlined in the PDD, as a result of an occurred corporate merging process between the waste management companies/enterprises SIL Soluções Ambientais Ltda. and Solvi Group S.A., the CRR landfill is since 12/09/2012 owned and operated by the established enterprise Companhia Riograndense de Valorização de Resíduos S/A (CRVR). This change of the host country project participant for the project activity is reflected in the latest version of the Modalities of Communication (MoC) form valid for the project activity (valid as of 30/11/2015). Since year 2016 the company Biogas Riograndense Ltda. is also listed as a project participant for the project activity. Biogas Riograndense Ltda. also has Solvi Group as its main shareholder.

otherwise be generated by existing grid-connected power plants, including fossil-fuel fired power plants (and addition of new power generation units) within the National Electricity Grid of Brazil<sup>3</sup>.

During the considered monitoring period, there were 350 existent LFG extraction wells at the CRR landfill, of which an average of 170 were under regular operation.

During the considered monitoring period the project activity operated under complete conformance with project design information and applicable monitoring requirements as per the latest registered version of the PDD valid for 2<sup>nd</sup> 7-year crediting period of the project activity (PDD version 9.2, dated 16/06/2017, herein after termed "PDD").

Emission Reductions (ER) achieved during the 16<sup>th</sup> monitoring period from 01/06/2018 to 31/01/2019 are reported as **272,028 tCO<sub>2</sub>e**.

## A.2. Location of project activity

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The project activity is implemented in the Central de Resíduos do Recreio (CRR) landfill which is located in the Municipality of Minas do Leão, Rio Grande do Sul State (approximately 80 km Western from the Porto Alegre city) in the Southern Region of Brazil.

The geographical coordinates of the project site (in decimal notation format and in DMS – Degree, Minute, Second) are as follows:

Geographical coordinates format	Latitude	Longitude
Decimal	-30.1469444	-52.0258333
Degree Minutes Seconds (DMS)	30° 8' 49" S	52° 1' 33" W

## A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Brazil (host)	Companhia Riograndense de Valorização de Resíduos S/A	No
Brazil (host)	Biogás Riograndense Ltda.	No
United Kingdom of Great Britain and Northern Ireland	Belektron d.o.o.	No

## A.4. Reference to applied methodologies and standardized baselines

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<sup>3</sup> Prior to the occurred implementation and starting of operations of the project's electricity generation infrastructure (on 26/07/2015), the company/enterprise Biotérmica Energia S.A. was established with the goal of implementing and operating such project's electricity generation infrastructure. While playing the role of an Independent Power Producer (IPP) within the Brazilian electricity market, besides of being currently responsible for the day-to-day operation of the project's electricity generation infrastructure, commercialization of generated electricity, the Biotérmica Energia S.A.'s technical staff team is also in charge of supporting the project participant CRVR S.A. with the operationalization of the CDM monitoring plan for the electricity generation infrastructure of the project activity (incl. inter-alia assurance of continuous measurement and data recording of flow of LFG sent to each engine-generator sets, LFG pressure in the LFG pipeline to each engine-generator set and LFG temperature in the LFG pipeline to each engine generator set as well as continuous measurements of net electricity generation and checking of the operational status of each individual engine-generator set). Related supporting activities towards CRVR S.A. also include ensuring performance of calibrations of related monitoring instruments and application of related safety and emergency procedures, etc. Like the host country project participant and project owner CRVR S.A, Biotérmica Energia S.A. is mostly owned by Solvi Group ([www.solvi.com](http://www.solvi.com)).

The project activity applies the following large-scale CDM baseline and monitoring methodology:

- ACM0001 - "Flaring or use of landfill gas" (version 15.0)  
(<http://cdm.unfccc.int/methodologies/DB/D44X8FH8SFCXREE6037AXJSBGGFVDO>);

For the considered monitoring period, as also established in the PDD, the following methodological tools are also applied<sup>4</sup>:

- "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" (version 01)  
(<http://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-05-v1.pdf>).

The application of this tool refers to the ex-post application of the latest version of the "Tool to calculate the emission factor for an electricity system" (version 04.0)  
(<http://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-07-v4.0.pdf>)

- "Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion" (version 02)  
(<http://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-03-v2.pdf>)
- "Project emissions from flaring" (version 02.0.0, EB 68)  
(<http://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 02.0.0, EB 61)  
(<http://cdm.unfccc.int/methodologies/PAMethodologies/tools/am-tool-08-v2.0.0.pdf>);

#### **A.5. Crediting period type and duration**

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2<sup>nd</sup> 7-year renewable crediting period from 01/12/2014 to 30/11/2021

## **SECTION B. Implementation of project activity**

### **B.1. Description of implemented project activity**

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During the considered monitoring period, the project activity encompassed the operation of the following equipment:

- LFG gas extraction system composed of 350 vertical extraction wells, of which 170 were under operation, connected by HDPE pipes.
- Six centrifugal blowers each with a 3,350 Nm<sup>3</sup>/h capacity and total capacity of 20,100 Nm<sup>3</sup>/h,
- Two LFG condensation traps (for separating undesirable liquids in the collected LFG (leachate and condensate))
- One enclosed high temperature flare (designed and supplied by Arquipélago Engenharia Ambiental Ltda.) The flare is equipped with a pilot flame fuelled by LPG. The flare has a declared maximum LFG flow operational capacity of 8,100 Nm<sup>3</sup>/h.

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<sup>4</sup> The PDD also refers to the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1, EB66). However, it is crucial to note that, as outlined in the PDD, applicable guidance of this methodological tool is only applied in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2<sup>nd</sup> 7-year crediting period. This methodological tool is not applied for the ex-post determination of emission reductions achieved by the project activity.

- One off-grid captive backup electricity generator (fuelled by diesel) with 180 kVA of nameplate power generation capacity. As per the project design, this back-up off-grid electricity generator is used for emergency purposes only (during temporary interruptions of supply of grid-sourced electricity to the project activity). This power generation unit is composed by a diesel powered engine (model 6.10.TCA, manufactured by MWM International) (215 HP (160.3 kW) of power output), and a brushless electricity generator set of 180 kVA of nameplate power generation capacity. The unit is assembled/packed by STEMAC Grupos Geradores S.A.  
This power generator set was designed to supply electricity to only 2 of the existing centrifugal blowers and to the plant control/monitoring systems during emergency situations. The back-up power generator normally enters into operation automatically whenever an interruption of supply of grid-sourced electricity to the project activity occurs.
- Electricity generation infrastructure using collected LFG as gaseous fuel comprising 6 engine-generator modular package sets (container based assembly) of which each one includes an engine-generator set manufactured by GE Jenbacher, of type 4 model G-420 with individual nameplate installed capacity of 1.426 MW. The project's electricity generation infrastructure also encompasses the installation and operation of a LFG cooling/treatment unit (electrical LFG chilling and activated-carbon LFG purification/filtering equipment).

Details about monitoring instruments/equipment utilized within the considered monitoring period are described in Section C.

During the whole monitoring period covered by this Monitoring Report, the project activity has in general operated in accordance with the technical project description as per the PDD. From an operational perspective, there were no post-registration changes on the project activity during the considered monitoring period.

During the considered monitoring period, the project activity faced events it became temporarily out of operation due to different reasons (incl. temporarily interruption in the supply of grid-sourced electricity, planned and unplanned equipment maintenance/repair, performance of regular calibration events, drainage of condensate from the project's LFG pipeline, unexpected problems in the PLC panel, data communication problems, etc.).

## **B.2. Post-registration changes**

### **B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines**

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Not applicable for the considered and/or previous monitoring periods. There are no temporary deviations from the registered monitoring plan and/or applied CDM baseline and monitoring methodology and/or applicable methodological tools encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

In fact, no temporary deviations from the registered monitoring plan and/or applied CDM baseline and monitoring methodology and/or applicable methodological tools were ever addressed in the context of previously performed and approved post-registration changes for the project activity (PRC-0648-001. PRC-0648-002 and PRC-0648-003/004/005).

### **B.2.2. Corrections**

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Not applicable for the considered monitoring period. There are no Corrections (in information that do not affect the project design) encompassed by the considered monitoring period that are to be submitted with this Monitoring Report as part of the request for issuance (post-registration change – issuance track).

It is however relevant to note that Corrections (in information that do not affect the project design) were previously approved under PRC-0648-001. PRC-0648-002 and PRC-0648-003/004/005 as changes applicable/valid for monitoring period(s) prior to the considered monitoring period (thus not the context of the verification assessment for the considered monitoring period) as follows:

Ref of PRC processes so far encompassed by the project activity	Approval date	Description of the post-registration change(s) under the category “Corrections (in information that do not affect the project design)”
PRC-0648-001	31/10/2012 (issuance track)	- Corrections and improvements in information in the previous PDD which do not affect the project design (due existent minor errors, inconsistencies and not updated information).
PRC-0648-002	20/04/2015 (prior-approval track)	<ul style="list-style-type: none"> <li>- Inclusion of new fixed (ex-ante determined) parameters as required by ACM0001 (version 15.0) + applicable methodological tools.</li> <li>- General text revisions of project description in order to fully comply the currently applicable requirements for completing the CDM-PDD form (version 05.0) as established by the “Guidelines for completing the CDM-PDD form” and to enhance/improve the project design description.</li> <li>- Minor text improvements (incl. review of statements and correction of previously existent typographic mistakes) in order to improve the overall project description.</li> <li>- Revision of the ex-antes estimates of GHG emission reductions to be achieved by the project activity during the 1st 7-year crediting period by applying calculation approaches as established by ACM0001 (version 15.0) + methodological tool “Emission from solid waste disposal sites” (version 06.0.1).</li> </ul>
PRC-0648-003/004/005 <sup>5</sup>	31/08/2017 (PRC-0648-003/004)  26/09/2017 (PRC-0648-005)  (issuance track)	<ul style="list-style-type: none"> <li>- Missing default value (applicable for generated electricity exported through the electricity grid the project activity is connected to) is added in details for the ex-ante determined (fixed) parameter “Average technical transmission and distribution losses for providing electricity to the grid and/or for grid sourced electricity consumed by the project activity” (<math>TDL_{grid,y}</math>) in Section B.6.2. Furthermore, while the previously selected 20% default value became applicable only for grid-sourced electricity imported by the project activity and is termed as <math>TDL_{grid,import,y}</math>, the added 3% missing default value is termed as <math>TDL_{grid,export,y}</math>. Texts in Sections B.6.1 and B.6.3 are adjusted accordingly.</li> <li>- Calculations of ex-ante estimates of emission reductions to be achieved by the project activity during the 2<sup>nd</sup> 7-year crediting period are corrected in both Section B.6.3 and in a revised version of the emission reduction calculation spreadsheet (that is enclosed to the PDD) by taking into account the missing 3% default value for the ex-ante determined (fixed) parameter <math>TDL_{grid,y}</math> (value applicable for</li> </ul>

<sup>5</sup> The contents of PRC-0648-003, PRC-0648-005 and PRC-0648-005 are identical. Thus such PRCs are jointly referred as “PRC-0648-003/004/005”.

		<p>generated electricity exported through the electricity grid the project activity is connected to).</p> <ul style="list-style-type: none"> <li>- The formula for the determination of baseline emissions of methane (<math>BE_{CH_4,y}</math>) applied in the context of ex-ante estimates of emission reductions to be achieved by the project activity is corrected in the emission reduction calculation spreadsheet that is enclosed to the PDD with related annual values being corrected accordingly. Figures for ex-ante estimates of emission reductions to be achieved by the project activity during the 2<sup>nd</sup> 7-year crediting period as reported in Section B.6.3 are corrected accordingly.</li> <li>- Information details for the project participants are updated (as per the latest version of the completed Modalities of Communication (MoC) form for the project activity).</li> </ul>
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### B.2.3. Changes to the start date of the crediting period

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Not applicable for the considered and/or previous monitoring periods. There are no changes to start date of the crediting period encompassed by the considered monitoring period and/or previously approved by the CDM-EB.

In fact, no change to start date of the crediting period was ever addressed in the context of previously performed and approved post-registration changes for the project activity (PRC-0648-001. PRC-0648-002 and PRC-0648-003/004/005).

### B.2.4. Inclusion of monitoring plan

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Not applicable for the considered and/or previous monitoring periods. There is no inclusion of monitoring plan (and/or applicable methodological tools) encompassed by the considered monitoring period and/or previously approved by the CDM-EB as being applicable for the considered monitoring period.

In fact, no inclusion of monitoring plan was ever addressed in the context of previously performed and approved post-registration changes for the project activity (PRC-0648-001. PRC-0648-002 and PRC-0648-003/004/005).

### B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

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Not applicable for the considered monitoring period. There are no permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied CDM baseline and monitoring methodology and/or applicable methodological tools encompassed by the considered monitoring period that are to be submitted with this Monitoring Report as part of the request for issuance (post-registration change – issuance track).

It is however relevant to note that permanent changes to the registered monitoring plan (revision of the monitoring plan) were previously approved under PRC-0648-001 and PRC-0648-002 as changes applicable/valid for monitoring period(s) prior to the considered monitoring period (thus not the context of the verification assessment for the considered monitoring period) as follows:

Ref of PRC processes so far encompassed by the project activity	Approval date	Description of the post-registration change(s) under the category <i>"Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied CDM baseline and monitoring methodology and/or applicable methodological tools"</i>
PRC-0648-001	31/10/2012 (issuance track)	<ul style="list-style-type: none"> <li>- Appropriate approach for monitoring parameters associated with the determination of project emissions due to consumption of electricity sourced by the captive off-grid electricity generator (fuelled by diesel) (with related calculation approach also being included in the PDD)</li> <li>- Appropriate approach for monitoring parameters associated with the determination of project emissions due to the consumption of LPG by the project activity (with related calculation approach also being included in the PDD)</li> <li>- More appropriate descriptions of monitoring requirements (including data recording and reporting frequencies) for selected monitoring parameters were added "Amount of landfill gas to flares" (LFGflare,y), "Methane fraction in the landfill gas" (wCH4,y), "Temperature of the landfill gas" (T), "Pressure of the landfill gas" (P).</li> </ul>
PRC-0648-002	20/04/2015 (prior-approval track)	<ul style="list-style-type: none"> <li>- Full revision of the applied monitoring and calculation approaches for determining baseline emissions (including addition of appropriate approaches for determining baseline emissions for by the project's electricity generation component) by following applicable monitoring and calculation approaches and requirement as per the applied CDM baseline and monitoring methodology ACM0001 (version 15.0) + applicable methodological tools.</li> </ul>

#### B.2.6. Changes to project design

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Not applicable for the considered monitoring period. There are no permanent changes to the design of the project activity encompassed by the considered monitoring period that are to be submitted with this Monitoring Report as part of the request for issuance (post-registration change – issuance track).

It is however relevant to note that permanent changes to the design of the project activity were previously approved under PRC-0648-001 and PRC-0648-002 (not in the context of the verification assessment for the considered monitoring period) as changes applicable/valid for monitoring period(s) prior to the considered monitoring period (thus not the context of the verification assessment for the considered monitoring period) as follows:



Ref of PRC processes so far encompassed by the project activity	Approval date	Description of the post-registration change(s) under the category “Permanent changes to the design of the project activity”
PRC-0648-001	31/10/2012 (issuance track)	<ul style="list-style-type: none"> <li>- <i>Consumption of electricity sourced by captive off-grid electricity generator (fuelled by diesel):</i> The project activity design was modified to include the installation and use of a captive off-grid electricity generator (powered by diesel) in order to meet the electricity requirements of the project activity whenever supply of grid electricity to the project activity is temporarily interrupted. This is outlined in the revised version of the PDD (version 7.1, dated 2012-09-27).</li> <li>- <i>Use of fossil fuel Liquefied Petroleum Gas (LPG) as start-up fuel for igniting the high temperature enclose flares:</i> Differently than earlier planned at the time of the original project design, LPG has been used as start-up fuel for igniting the flares since the start of operations of the project activity. This is also outlined in the revised version of the PDD (version 7.1, dated 2012-09-27).</li> </ul>
PRC-0648-002	20/04/2015 (prior-approval track)	<ul style="list-style-type: none"> <li>- Planned implementation of a new electricity generation facility using collected LFG as gaseous fuel for electricity generation as part of the project activity. The change in the project design (of which implementation is currently expected to be concluded in May 2015) is addressed by changing the version of the CDM baseline and monitoring methodology ACM0001, which is applied by the project activity: the application of ACM0001 is changed from version 3 to its current latest version (version 15.0). Applicable methodological tools (as referred by ACM0001 (version 15.0) are also applied in the context of the revision of the PDD. The main reason for the replacement of the applied CDM baseline and monitoring methodology is the fact that potential adverse impacts of the planned post-registration change in the project design over (i) the previously demonstrated additionality for the project activity and (ii) the previously performed identification of the baseline scenario are both analysed/addressed through the application of the “Simplified procedure to identify the baseline scenario and demonstrate additionality” of ACM0001 (version 15.0). This simplified approach is not available in previous versions of ACM0001. While version 15.0 of ACM0001 + applicable methodological tools include different monitoring requirements and GHG calculation approaches (when compared to the previously applied version of ACM0001 (version 3)), the monitoring plan from the registered PDD is also revised accordingly. Furthermore, Corrections (in information that does not affect the project design) are also performed in order to address the need of inclusion of new fixed (ex-ante determined) parameters as required by ACM0001 (version 15.0) + applicable methodological tools.</li> </ul>

## SECTION C. Description of monitoring system

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### C.1. INSTRUMENTATION

Figure shows a schematic instrumentation diagram of the project’s monitoring system as per the configuration available during the monitoring period.

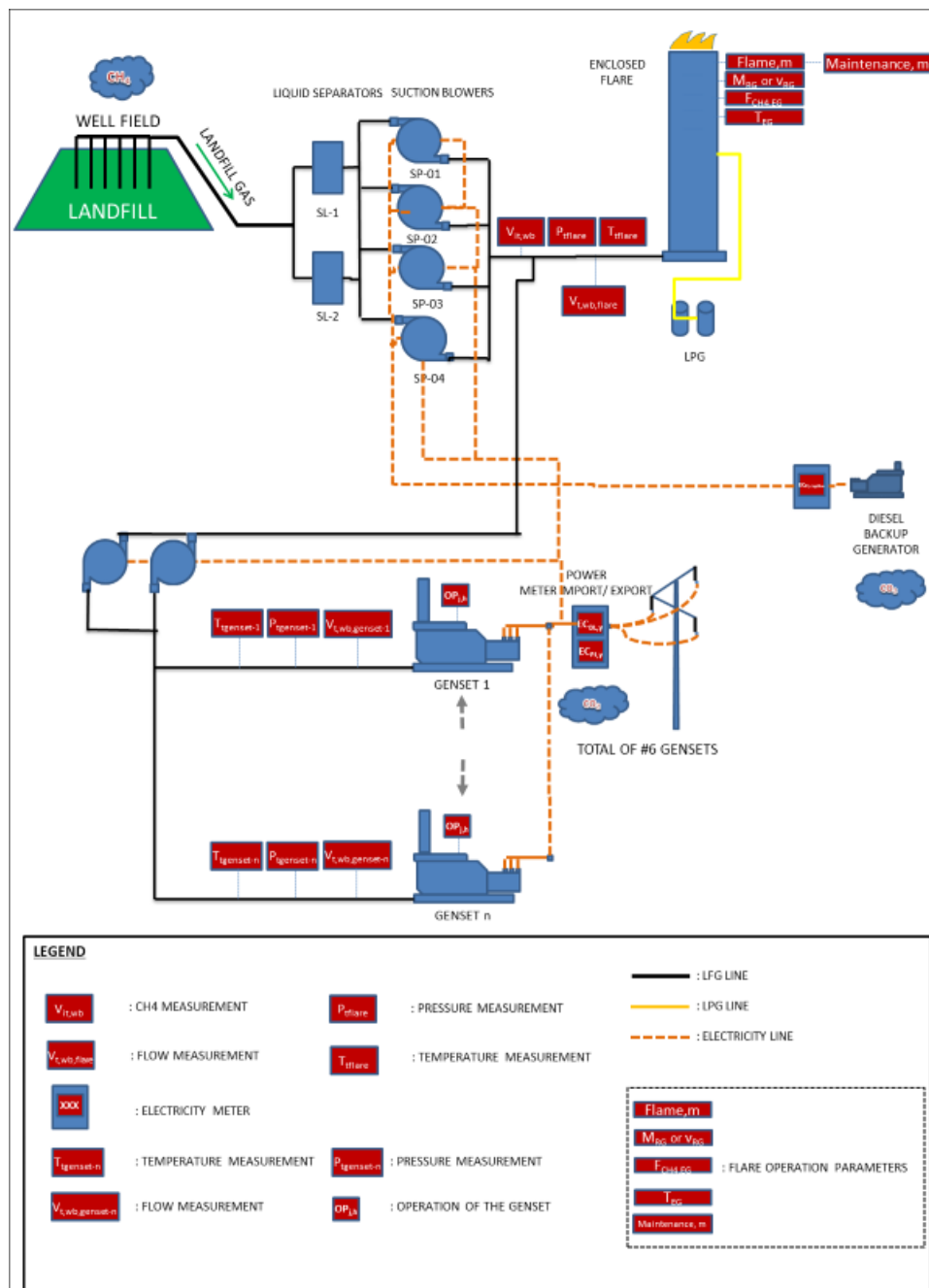


Figure 1: Schematic instrumentation diagram of the project's monitoring system valid for the considered monitoring period

*Project's LFG collection and destruction infrastructure (incl. the LFG flaring facility):*

As part of the project activity, the following monitoring instruments/equipment<sup>6</sup> are installed along the main LFG distribution pipeline (in its final section) within the project's LFG destruction facility (between the installed centrifugal blowers and the enclosed flare):

- One thermal mass flow meter  $\pm 1\%$  (Company internal instrument ID. FIT-01). This measurement unit measures the flow of LFG collected by the project activity which is sent to the installed flare for combustion.

<sup>6</sup> Each of the instruments installed might have several backup units used and changed according to maintenance/calibration requirements. Details of the equipment used are presented in section D.2.

- One LFG pressure sensor (company internal instrument ID. PIT-02). This instrument set measures LFG pressure in the section between the centrifugal blowers and the high temperature enclosed flare in the LFG collection pipeline.
- One LFG temperature sensor (company internal instrument ID. TIT-02). This instrument set measures the LFG temperature in the LFG collection pipeline in the section between the centrifugal blowers and the high temperature enclosed.
- One continuous CH<sub>4</sub>/O<sub>2</sub> content gas analyzer unit (company internal instrument ID. AG-01). This equipment provides continuous measurement of methane fraction in collected LFG. The LFG sampling point for the AG-01 equipment is located in the main LFG collection pipeline in a section close to the location of the LFG flow meter (in a section located between the centrifugal blowers and the flare). While the project's LFG collection process ensures that most of the humidity of the collected LFG is removed by condensation (in available condensation removal traps) prior of having collected LFG passing through the installed LFG flow meter and the installed CH<sub>4</sub>/O<sub>2</sub> content gas analyzer unit, flow of collected LFG being sent to the flare and CH<sub>4</sub> fraction of collected LFG can thus be regarded as measured under the same basis/conditions in terms of moisture.
- Two thermocouples (Company internal instrument ID. TT-04 and TT-05) that measure the temperature in the exhaust gas of the flare. Such measurements are considered in order to assure the operation of flare as per the operation conditions defined by the flare manufacturer. Measurements from the thermocouple TT-04 are only required to be considered whenever the flare operates with flow of LFG higher than 3,000 Nm<sup>3</sup>/h. Measurements from the thermocouple TT-05 are only required to be considered whenever the flare operates with flow of LFG up to 3,000 Nm<sup>3</sup>/h. The thermocouples are located in the upper section of the installed flare and are only used to monitor the flare temperature from an operational point of view and in order to ensure that high flare combustion efficiency is achieved.
- One UV flame detector. For every minute that flame is detected in the flare, its operational status is considered as "On" and emission reductions are thus accounted for such given minute.
- LFG sample collecting points are available in the upper section of the flare stack in order to have samples of LFG regularly collected in order to determine (based on measurements regularly performed by independent 3<sup>rd</sup> party inspection service company) the residual methane content in the exhaust gas of the flare. As defined in the monitoring plan of the PDD, such periodical measurements of residual methane content in the exhaust gas of the flare (monitoring parameter "Mass flow of methane in the exhaust gas of the flare(s) on a dry basis at reference conditions in the time period  $t'$  ( $F_{CH_4,EG,t}$ ) are required to be periodically measured for determining applicable values for flare efficiency (in terms of combustion of methane) in the context of the determination of emission reductions achieved by the project activity. Further details about the monitoring parameter  $F_{CH_4,EG,t}$  are made available in sections D.2 and E.2. For the considered monitoring period, related measurements, which are required to be performed biannually (2 times per year) were performed by the independent 3<sup>rd</sup> party inspection service company BIOAGRI Ambiental Ltda / Mérieux NutriSciences Brasil.

*Project's electricity generation infrastructure:*

As part of the project activity, the following instruments/equipment are installed as part of the project's electricity generation infrastructure:

- Six LFG flow meter sets of differential pressure type (each set comprised by an Annubar element and a pressure signal processing and data transmitting element) to measure flow

of LFG which is sent to each individual engine-generator sets of the project's electricity generation infrastructure (1 flow meter for each individual engine-generator set). These measurement set units measure the flow of collected LFG that is sent to each engine-generator set to be utilized as gaseous fuel for electricity generation.

- Six LFG pressure sensors to measure pressure of the LFG which is sent each individual engine-generator sets of the project's electricity generation infrastructure (1 pressure sensor for each individual engine-generator set).
- Six LFG temperature sensors to measure temperature of LFG which is sent each individual engine-generator sets of the project's electricity generation infrastructure (1 temperature sensor for each individual engine-generator set).
- One digital bi-directional electricity meter to measure the amount of net electricity generated by the project's electricity generation infrastructure that is exported through the local electricity grid. This electricity meter is installed in a power substation that is located 22 km from the project activity site. The bi-directional electricity meter also measures the amount of grid-sourced electricity imported by the project activity (whenever the project's electricity generation infrastructure is not under operational status).

The electricity demand of the project activity has been entirely met by electricity generated by the project activity (whenever the project's electricity generation infrastructure is under operation). During time periods when the project's electricity generation infrastructure is not under operation (temporary interruptions), electricity demand of the project activity has been met by imports of grid electricity through the same dedicated transmission line which is used for exporting electricity generated by the project activity.

A backup off-grid captive diesel electricity generator (fueled by diesel) is also used as an electricity supply source to the project activity whenever there are temporary interruptions on the supply of grid-sourced electricity to the project activity<sup>7</sup>. The internal electricity supply distribution line which is connected uniquely to such backup electricity generator is also equipped with two electricity meters. These electricity meters are used to monitor the amount of electricity generated by this backup electricity generator and consumed by the project activity. Details about the electricity meters and related monitoring procedures are described in section D.2 (under details for the monitoring parameter "Quantity of electricity generated in captive diesel backup generator during the year  $y$ " ( $EC_{PJ,captive,y}$ )).

## C.2. DATA ACQUISITION, STORAGE AND MANAGEMENT SYSTEM

As part of the monitoring process for the project activity, all continuous measurements of LFG related monitoring parameters (including measurements of temperature of exhaust gas of the flare and status of the flare) and also monitoring of operation status of the project's electricity generation infrastructure were recorded/reported every minute during the considered monitoring period in an installed data acquisition unit and archiving solution (database) designed and configured by Biotechnogas S.r.l.<sup>8</sup>

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<sup>7</sup> The installed backup off-grid backup electricity generator (fuelled by diesel) is equipped with automatic switching and control system which ensures its start of operation immediately right after any interruption in the supply of grid-sourced electricity to the project activity.

<sup>8</sup> Biotechnogas S.r.l. is an Italy headquartered organization specialized in the design, installation and operation of biogas destruction and/or utilization infrastructure. Solutions developed by the organization includes the design, installation, configuration and training for related data acquisition and archiving solutions (database). Details about Biotechnogas S.r.l. products, services and expertise/experience are available online: <http://www.biotechnogas.com>

As part of the operation of the project activity, monitoring data has been recorded by the utilized data acquisition and archiving infrastructure (database). Recorded LFG related monitoring data (+ measurement records for temperature of temperature of exhaust gas of the flare, status of the flare, and operational status of each one of the installed engine-generator sets consuming LFG) are regarded as “*raw data*” for processing emission reduction calculations valid for the considered monitoring period. As part of the implemented monitoring procedure for the project activity, such “*raw data*” is exported into MS-Excel spreadsheet format for generating the emission reduction calculation spreadsheets which are enclosed to this Monitoring Report.

The project’s operational staff for both the LFG destruction and electricity generation infrastructure are trained for all related operation, maintenance and safety procedures. Related training certificates for operational staff were issued and are kept achieved. All relevant operational events (emergency, failures, maintenance, etc.) for both the LFG destruction and electricity generation infrastructure are registered in operation workbooks. All performed maintenance and/or repair events applicable for the critical pieces of equipment for both project components (flare, centrifugal blowers, CH<sub>4</sub>/O<sub>2</sub> content gas analyzer unit, air compressor, engine-generator modular package sets, control systems, etc.) are also registered in the project’s operation workbooks.

Records and documented evidences for performed calibration events in monitoring instruments/equipment are also registered in workbooks. The calibration certificates and registries for all performed calibration events are also kept in files. Calibration procedures are performed in accordance with applicable recommendation and requirements as established by equipment manufacturers and are also under conformance with applicable CDM requirements. The project’s maintenance manual also includes related calibration procedures, requirements and instructions.

### C.3. MANAGERIAL RESPONSIBILITIES

Operation of the whole project activity under compliance with all applicable CDM requirements is the responsibility of the CDM Operational Manager of Companhia Riograndense de Valorização de Resíduos S/A. (CRVR S.A.) The CDM Project Manager of CRVR S.A. (who directly reports to the vice-president of the organization), is in charge of all validation and verification related activities (including development of PDD, Monitoring Reports and supporting documentation). The CDM Operational Manager is assisted/supported by hired technical consultants from the hired CDM technical consultancy/advisory service company UniCarbo – Energia and Biogás Ltda. The CDM Project Manager is responsible for ensuring the correct application of the monitoring plan.

Under an operational perspective, the CDM operations manager and CDM supervisor are in charge of performing all field monitoring activities and ensuring appropriate monitoring data logging and recording (always with assistance/support from by hired technical consultants from UniCarbo – Energia and Biogás Ltda.). They are also responsible for the performance of related calibration events as well as all applicable planned or unplanned maintenance and repair events.

Preventative maintenance events are executed by field technicians in order to ensure that monitoring instruments/equipment are fully operating. The technical team of Biotérmica Energia S.A. is also in charge of partial operation of the CDM monitoring plan for the project’s electricity generation infrastructure and it is supervised by the CDM Project Manager of CRVR S.A.

Figure 2 shows the organizational chart for the project activity.

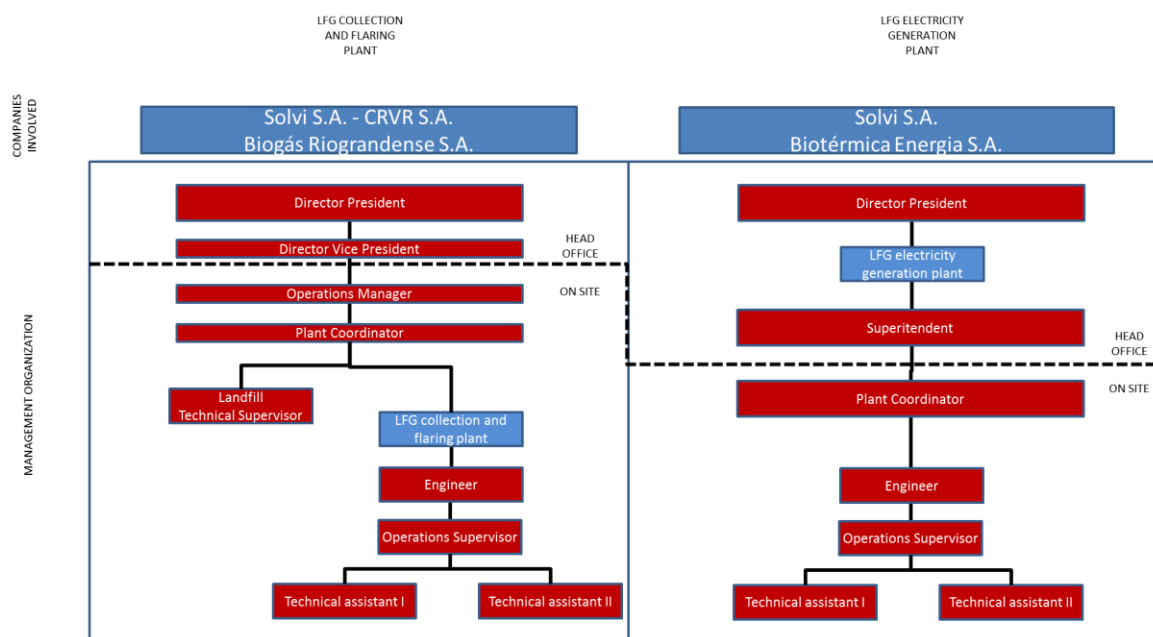


Figure 2: Management organization for the project activity

## SECTION D. Data and parameters

### D.1. Data and parameters fixed ex ante

Data/Parameter	$OX_{top\_layer}$
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline.
Source of data	The PDD refers to the default value as per the CDM baseline and monitoring methodology ACM0001 (version 15.0). The value is consistent with how oxidation is accounted for in the methodological tool "Emissions from solid waste disposal sites" (version 06.0.1).
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 15.0)
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	$GWP_{CH_4}$
Unit	$tCO_2/tCH_4$
Description	Global Warming Potential of $CH_4$

Source of data	<p>The PDD refers to the “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: <a href="http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14">www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14</a></p> <p>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”.</p>
Value(s) applied	25
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

<b>Data/Parameter</b>	<b><math>R_u</math></b>
Unit	$\text{Pa.m}^3/\text{kmol.K}$
Description	Universal ideal gases constant
Source of data	The PDD refers to the default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0).
Value(s) applied	8,314
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

<b>Data/Parameter</b>	<b><math>MM_k</math></b>
Unit	$\text{kg/kmol}$
Description	Molecular mass of gas $k$
Source of data	The PDD refers to the default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0).

Value(s) applied	<p>As outlined in the PDD, for considered gases <math>k</math> that are greenhouse gases (GHGs), the values in the table below are applied for <math>MM_i</math>. The “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” establishes the following:</p> <p><i>“The determination of the molecular mass of the gaseous stream (<math>MM_{t,db}</math>) requires measuring the volumetric fraction of all gases (<math>k</math>) in the considered gaseous stream. However as a simplification, only the volumetric fraction of gases <math>k</math> 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.”</i></p> <p>ACM0001 (version 15.0) 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 (<math>CH_4</math> in the particular case of the project activity) should be considered and the difference to 100% is just considered as pure nitrogen.</p> <table> <tr> <th>Compound</th> <th>Structure</th> <th>Molecular mass (kg/mol)</th> </tr> <tr> <td>Nitrogen</td> <td><math>N_2</math></td> <td>28.01</td> </tr> </table>	Compound	Structure	Molecular mass (kg/mol)	Nitrogen	$N_2$	28.01
Compound	Structure	Molecular mass (kg/mol)					
Nitrogen	$N_2$	28.01					
Choice of data or measurement methods and procedures	-						
Purpose of data/parameter	Calculation of baseline emissions						
Additional comments	-						

Data/Parameter	MM <sub>i</sub>								
Unit	kg/kmol								
Description	Molecular mass of greenhouse gas <i>i</i>								
Source of data	The PDD refers to the default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0).								
Value(s) applied	As outlined in the PDD, the following value of molecular mass is applicable for CH <sub>4</sub> (the only GHG which is considered): <table><tr><td>Compound</td><td>Structure</td><td>Molecular mass (kg/mol)</td></tr><tr><td>Methane</td><td>CH<sub>4</sub></td><td>16.04</td></tr></table>			Compound	Structure	Molecular mass (kg/mol)	Methane	CH <sub>4</sub>	16.04
Compound	Structure	Molecular mass (kg/mol)							
Methane	CH <sub>4</sub>	16.04							
Choice of data or measurement methods and procedures	-								
Purpose of data/parameter	Calculation of baseline emissions								
Additional comments	-								

<b>Data/Parameter</b>	<b><math>P_n</math></b>
Unit	Pa



Description	Total pressure at normal conditions
Source of data	The PDD refers to the default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0).
Value(s) applied	101,325
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	In accordance with the PDD, since measurements of LFG flow are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), the ex-ante determined parameters Temperature at normal conditions ( $T_n$ ) and Total pressure at normal conditions ( $P_n$ ) are not considered.

<b>Data/Parameter</b>	<b>MM<sub>H2O</sub></b>
Unit	kg/kmol
Description	Molecular mass of water
Source of data	The PDD refers to the default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0).
Value(s) applied	18.0152
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

<b>Data/Parameter</b>	<b>T<sub>n</sub></b>
Unit	K
Description	Temperature at normal conditions
Source of data	The PDD refers to the default value as per the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 02.0.0).
Value(s) applied	273.15
Choice of data or measurement methods and procedures	-

Purpose of data/parameter	Calculation of baseline emissions
Additional comments	In accordance with the PDD, since measurements of LFG flow are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), the ex-ante determined parameters Temperature at normal conditions ( $T_n$ ) and Total pressure at normal conditions ( $P_n$ ) are not considered.

<b>Data/Parameter</b>	<b><math>TDL_{grid,y}</math></b>
Unit	Dimensionless
Description	Average technical transmission and distribution losses for providing electricity to the grid and/or for grid sourced electricity consumed by the project activity
Source of data	The PDD refers to the applicable default values as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01).
Value(s) applied	3% (for generated electricity exported through the electricity grid the project activity is connected to ( $TDL_{grid,export,y}$ )) 20% (for electricity imported by the project activity through the electricity grid the project activity is connected to ( $TDL_{grid,import,y}$ ))

Choice of data or measurement methods and procedures	<p>The “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01) defines, as alternative, default value of 20% for project consumption sources (applicable for determination of project emissions due to consumption of grid-sourced electricity by the project activity) and default value of 3% for baseline electricity consumption sources (applicable for the determination of baseline emissions for electricity generation by the project activity). The selection of these default values are under conformance with applicable guidance of ACM0001 (version 15.0).</p> <p>While transmission and distribution sources applicable for both grid-sourced electricity to be consumed by the project activity and for electricity generation by the project activity (equivalent to electricity consumption of baseline electricity consumption sources when applying the underlying tool) do not fit under Scenario B and/or Scenario C (case II) of the such tool, the selected 20% value for <math>TDL_{grid,import,y}</math> and 3% values for <math>TDL_{grid,export,y}</math> are thus under conformance with applicable guidance of the tool.</p> <p>The selection of 20% value for <math>TDL_{grid,import,y}</math> and 3% values for <math>TDL_{grid,export,y}</math> meets applicable guidance for Scenarios A and C (cases I and III) of the Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01) (whichever of these scenarios are applicable for the particular case of the project activity, where, as per the tool, in the case of doubts, case C.III should be identified as a conservative approach).</p> <p>It is relevant to note that as per the project design, the amount of electricity to be consumed by the project activity (project electricity consumption sources) to which scenario C of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01) refers is smaller than the so-called electricity consumption of baseline electricity consumption sources (<math>EC_{BL,k,y}</math>) as per such tool (where <math>EC_{BL,k,y}</math> in the tool is equivalent to the amount of electricity generated using LFG in year y (<math>EG_{PJ,y}</math>) as defined by ACM0001 (version 15.0)). In summary, the project activity generates more electricity than it requires for its operation, with the largest amount of generated electricity being exported through the electricity grid the project activity is connected to. Under these particular conditions, also considering the 3% default value for electricity imported by the project activity (through the electricity grid the project activity is connected to) in thesis would represent an acceptable alternative. However, as a conservative approach, the generic 20% default value of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01) applicable for project consumption sources is selected. This approach results in higher project emissions, thus reducing emission reductions to be achieved by the project activity accordingly.</p>
Purpose of data/parameter	Calculation of both baseline emissions and project emissions (due to generation of electricity that is exported through the electricity grid and the consumption of grid-sourced electricity by the project activity).
Additional comments	-

Data/Parameter	WBM
Unit	%
Description	Weighting of build margin emissions factor

Source of data	The PDD refers to the applicable default value as per the “Tool to calculate the emission factor for an electricity system” (version 4.0). The selected value is valid for the whole 2 <sup>nd</sup> 7-year renewable crediting period.
Value(s) applied	0.75 (75%)
Choice of data or measurement methods and procedures	The applicable value valid for 2 <sup>nd</sup> crediting period as per the “Tool to calculate the emission factor for an electricity system” (Version 4.0) is selected.
Purpose of data/parameter	Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity).
Additional comments	-

<b>Data/Parameter</b>	<b>W<sub>OM</sub></b>
Unit	%
Description	Weighting of operating margin emissions factor
Source of data	The PDD refers to the applicable default value as per the “Tool to calculate the emission factor for an electricity system” (version 4.0). The selected value is valid for the whole 2 <sup>nd</sup> 7-year renewable crediting period.
Value(s) applied	0.25 (25%)
Choice of data or measurement methods and procedures	The applicable value for the 2 <sup>nd</sup> crediting period as per the “Tool to calculate the emission factor for an electricity system” (version 4.0) is selected.
Purpose of data/parameter	Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity).
Additional comments	-

<b>Data/Parameter</b>	<b>EF<sub>grid,BM,y</sub></b>
Unit	tCO <sub>2</sub> /MWh
Description	Build margin CO2 emission factor in year y
Source of data	As outlined in the PDD, data is ex-ante determined as per applicable guidance of the “Tool to calculate the emission factor for an electricity system” and value is valid for the whole 2 <sup>nd</sup> 7-year crediting period. The selected value is the value calculated by the DNA of Brazil and valid for year 2014 (EF <sub>grid,BM,2014</sub> ).
Value(s) applied	0.2963
Choice of data or measurement methods and procedures	Data is determined as per applicable guidance of the “Tool to calculate the emission factor for an electricity system” valid for 2 <sup>nd</sup> crediting period.

Purpose of data/parameter	Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity) and baseline emissions (due to the displacement of an equivalent amount of electricity generated by the project's electricity generation infrastructure which would otherwise be generated by existing grid-connected power plants (and addition of new power generation units) within the National Electricity Grid of Brazil).
Additional comments	-

Data/Parameter	SPEC <sub>flare</sub>																	
Unit	°C (for temperature values) Nm <sup>3</sup> /h (for LFG flow values) Number of days (for maintenance schedule interval values)																	
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval.																	
Source of data	The PDD refers to data as per the flare manufacturer. Data is used as a reference for later ex-post determination of values of flare efficiency (η <sub>flare,m</sub> ) for each individual high temperature enclosed flare in the context of determination of baseline emissions.																	
Value(s) applied	<table><tr><th>SPEC<sub>flare</sub></th><th>Min.</th><th>Max.</th></tr><tr><td>Operational LFG flow (for continuous operation):</td><td>300 Nm<sup>3</sup>/h</td><td>8,100 Nm<sup>3</sup>/h</td></tr><tr><td>Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH<sub>4</sub> 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 (every 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>			SPEC <sub>flare</sub>	Min.	Max.	Operational LFG flow (for continuous operation):	300 Nm <sup>3</sup> /h	8,100 Nm <sup>3</sup> /h	Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH <sub>4</sub> destruction efficiency):	500 °C	1,000 °C	Required minimum frequency for inspection and maintenance service (incl. inspection in the conditions of the flare isolation ceramics revetment material):	Min. every year (every 365 days)		Required/recommended minimum frequency for replacement of the flare isolation ceramics revetment material:	after 10 years of regular and appropriate operation	
SPEC <sub>flare</sub>	Min.	Max.																
Operational LFG flow (for continuous operation):	300 Nm <sup>3</sup> /h	8,100 Nm <sup>3</sup> /h																
Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH <sub>4</sub> destruction efficiency):	500 °C	1,000 °C																
Required minimum frequency for inspection and maintenance service (incl. inspection in the conditions of the flare isolation ceramics revetment material):	Min. every year (every 365 days)																	
Required/recommended minimum frequency for replacement of the flare isolation ceramics revetment material:	after 10 years of regular and appropriate operation																	

Choice of data or measurement methods and procedures	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 <sub>flare</sub> . During the 2 <sup>nd</sup> 7-year crediting period, ex-ante selected data will be compared against monitored data related to the operation of the flare, including: a) Minimum and maximum monitoring records for data regarding inlet LFG flow rate, (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.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	All flare specification and operation details/requirements are based on information provided by the equipment manufacturer.

<b>Data/Parameter</b>	<b>PP<sub>CP,Diesel-generator</sub></b>
Unit	MW
Description	Rated capacity of the installed captive backup electricity generators fuelled by diesel
Source of data	Nameplate capacity of the installed captive generator as per manufacturer's specifications or catalogue references
Value(s) applied	0.144 The power generation unit is composed by a MWM International diesel powered engine (model 6.10.TCA) (215 HP of power output), and a brushless electricity generator set of 180 kVA of nameplate power generation capacity and nameplate power factor of 0.8.
Choice of data or measurement methods and procedures	Specifications of the installed captive backup electricity generators.
Purpose of data/parameter	Calculation of project emissions (due to the consumption of electricity sourced by captive off-grid electricity generator by the project activity).
Additional comments	The ex-ante determined default value for PP <sub>CP,Diesel-generator</sub> will only be used in case alternative approach 4 (as outlined in the PDD) is used for the determination of Project emissions due to the consumption of electricity sourced by backup captive off-grid electricity generators (fuelled by Diesel) (PE <sub>EC,captive,y</sub> ). While for the considered monitoring period alternative approach 2 was selected for the determination of PE <sub>EC,captive,y</sub> , the ex-ante determined parameter PP <sub>CP,Diesel-generator</sub> was thus not used in the context of calculation of emission reductions for the considered monitoring period.

<b>Data/Parameter</b>	<b>TDL<sub>captive,y</sub></b>
Unit	-
Description	Average technical transmission and distribution losses for electricity sourced by the captive electricity generator
Source of data	Applicable default as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01).
Value(s) applied	0
Choice of data or measurement methods and procedures	-
Purpose of data/parameter	Calculation of project emissions (due to the consumption of electricity sourced by captive off-grid electricity generator by the project activity).
Additional comments	The ex-ante determined default value for TDL <sub>captive,y</sub> will only be used in case alternative approach 1 or approach 2 is used for the determination of Project emissions due to the consumption of electricity sourced by backup captive off-grid electricity generators (fuelled by Diesel) ( $PE_{EC,captive,y}$ ).

<b>Data/Parameter</b>	<b>EF<sub>EL,captive,y</sub></b>
Unit	tCO <sub>2</sub> /MWh
Description	CO <sub>2</sub> emission factor for electricity sourced by the captive off-grid electricity generators
Source of data	Applicable default as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01) (in case the <i>Alternative approach 2</i> is selected (by following option B2 of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”).
Value(s) applied	1.3
Choice of data or measurement methods and procedures	Data is determined as per applicable guidance of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01).
Purpose of data/parameter	Calculation of project emissions (due to the consumption of electricity sourced by captive off-grid electricity generator by the project activity).
Additional comments	The ex-ante determined default value for EF <sub>EL,captive,y</sub> will only be used in case alternative approach 2 (as outlined in the PDD) is used for the determination of Project emissions due to the consumption of electricity sourced by backup captive off-grid electricity generators (fuelled by Diesel) ( $PE_{EC,captive,y}$ ).

Ex-ante determined parameters not used in the context of ex-post determination and calculation of emission reductions achieved by the project activity:

The following ex-ante determined parameters (that are also included in the PDD) are not used for the purpose of ex-post determination of baseline emissions and project emissions achieved by the project activity during the considered monitoring period:

- Efficiency of the LFG capture system that will be installed in the project activity ( $\eta_{PJ}$ )
- Default value for model correction factor to account for model uncertainties ( $\phi_{\text{default}}$ )
- Oxidation factor (reflecting the amount of methane from the considered SWDS that is oxidized in the soil (or other material covering the waste)) (OX)
- Fraction of methane in the SWDS gas (volume fraction) (F)
- Fraction of degradable organic carbon (DOC) in MSW that decomposes in the considered SWDS ( $\text{DOC}_{f,\text{default}}$ )
- Methane correction factor ( $\text{MCF}_{\text{default}}$ )
- Fraction of degradable organic carbon in the waste type  $j$  (weight fraction) ( $\text{DOC}_j$ )
- Decay rate for the waste type  $j$  ( $k_j$ )
- Weight fraction of the waste type  $j$  ( $W_j$ )

As also outlined in the PDD, data for the above-listed parameters are used only in the context of ex-ante estimation of annual accumulated values for the “Amount of methane in the LFG which is destroyed or utilized by the project activity” ( $F_{\text{CH}_4,PJ,y}$ ) (in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2<sup>nd</sup> 7-year renewable crediting period). Due to that, details for the above-listed parameters are not included in this Section as they are not relevant in the context of determination of emission reductions achieved by the project activity during the considered monitoring period. Relevant details for such not reported parameters are included in Section B.6.2 of the PDD.

## D.2. Data and parameters monitored

Data/Parameter	Management of SWDS
Unit	Dimensionless
Description	Management of the SWDS
Measured/calculated/default	As per the adopted monitoring procedure for the project activity, the management of the CRR landfill is yearly compared against the previously conceived original construction and operational design for the CRR landfill in order to confirm that the overall management and operation for the landfill (including relevant aspects related to landfilling practice) were not deliberately modified with the unique aim to intentionally increase the generation of methane at the landfill. By performing the checking annually, it is monitored whether any practice aiming to increase methane generation in the landfill has occurred or promoted. As required by ACM0001 (version 15.0), any change in the management of the CRR landfill after the implementation of the project activity should be justified by referring to applicable technical or regulatory specifications.



Source of data	<p>An initial technical evaluation was performed by the independent 3<sup>rd</sup> party engineering company GSA Engenharia Ltda. The findings for the performed evaluations are reported in a declaration document issued by such company that is dated 04/06/2018. This initial evaluation covers the period from 01/12/2007 (date when the project activity started to operate) to 04/06/2018 (issuance date of the declaration document for the performed evaluation).</p> <p>As per the applicable monitoring procedure, a sequential technical evaluation was also performed by the independent 3<sup>rd</sup> party engineering company GSA Engenharia Ltda. in March 2019. The findings for such performed technical evaluations are reported in the declaration documents issued by GSA Engenharia Ltda. that is dated 08/03/2019.</p> <p>As part of the performed evaluation, the current configuration and operational conditions of the CRR landfill were compared against the previously conceived design and operational conditions of the landfill prior of the occurred implementation of the project activity on the basis of different sources and assessments including inter alia:</p> <ul style="list-style-type: none"> <li>- The original design documents of the landfill (as described in the documentation required for all phases of the environmental licensing and operational permitting for the CRR landfill);</li> <li>- Applicable local or national regulations;</li> <li>- Expertise and experience of the technical team of GSA Engenharia Ltda. with the CRR landfill. Since the start of operation of the CRR landfill members of the technical team of GSA Engenharia Ltda. have been directly involved with performance of regular technical inspections at the CRR landfill as part of different technical evaluations, including the continuously performed assessment of geotechnical stability monitoring for the landfill cells. Such regular assessment of geotechnical stability for the landfill cells are required by the competent environmental authority from Rio Grande do Sul State (Fundação Estadual de Proteção Ambiental - FEPAM) where the demonstration of sufficient geotechnical stability of the landfill cells are regarded as prerequisite for the operational permitting of the CRR landfill.</li> </ul>
Value(s) of monitored parameter	<p>As outlined in the issued internal technical evaluation/declaration reports dated 04/06/2018 and 08/03/2019, the previously conceived original design of the CRR landfill (dated prior to the implementation of the project activity) is confirmed not to being deliberately modified during the period from 01/12/2007 (date when the project activity started to operate) until 08/03/2019 (date of issuance of the report for the latest performed technical evaluation). Furthermore, no modification in the previously conceived original design of the CRR landfill has occurred or was promoted during the period. Both issued technical reports confirms that no practice to increase methane generation at the CRR landfill have occurred or have been promoted (when compared to management and MSW landfilling practices prior to implementation of the project activity). Aspects, conditions and circumstances related to management of the landfill (e.g. waste disposal, waste covering, waste compacting, management of leachate, draining of rainwater, etc.) were not changed with an aim to increase methane generation on site.</p> <p>It is relevant to note that MSW management business (collection and disposal of MSW) in Brazil (and in most of the developing countries) has its own economics, dynamics, politics and related regulations. That makes MSW disposal activity for the CRR landfill and other similar landfills in Brazil completely independent from the CDM mechanism and/or revenues of</p>

	<p>commercialization of CERs generated by project-based destruction of methane in landfills.</p> <p>In the particular case of the CRR landfill, it is important to note that this landfill was designed and has operated inter alia as per terms and conditions for solid waste disposal contracts established with the different municipalities and private companies. The design and operation of the landfill is also under conformance with terms and conditions for the environmental licensing that were previously defined and are regularly monitored by the competent environmental authority from Rio Grande do Sul State (FEPAM).</p> <p>Currently, there is still no climate change of waste management policy in Brazil which would provide an incentive or a mandate to have MSW being disposed in landfills with better/improved LFG collection / destruction systems (such as the project's LFG collection and destruction system currently implemented at the CRR landfill).</p>
Monitoring equipment	Not applicable. No measuring equipment is used for monitoring management of the CRR landfill.
Measuring/reading/recording frequency	Annual checking is performed.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A. (private entity) in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	As required by ACM0001 (version 15.0), any change in the management of the landfill after the implementation of the project activity will 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).

<b>Data/Parameter</b>	$V_{t,wb,j}$
Unit	m <sup>3</sup> wet gas/h
Description	Volumetric flow of LFG stream in time interval $t$ on a wet basis for $j$ (where $j$ is the LFG delivery pipeline to each item of electricity generation and LFG delivery pipeline to the flare(s))
Measured/calculated/default	Continuously measured by seven LFG flow meters (one flow meter for the high temperature enclosed flare and six flow meters sets for the engine-generator sets of the electricity generation infrastructure (one individual flow meter for each engine generator set)).
Source of data	Continuous measurements performed by seven installed LFG flow meters

	are recorded in the project's acquisition system with an every-minute frequency.
Value(s) of monitored parameter	<p>The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include all records of measurement data of LFG flow sent to the installed high temperature enclosed flare and LFG flow sent to each individual engine-generator set of the electricity generation infrastructure during the considered monitoring period. Measurement data is recorded and reported with an every-minute frequency.</p> <p>While measurements are performed by installed seven LFG flow meters (one flow meter for the high temperature enclosed flare and one flow meter for each individual engine-generator set of the electricity generation infrastructure), the monitoring parameter <math>V_{t,wb}</math> is thus measured, recorded and reported on the basis of the following sub-parameters:</p> <ul style="list-style-type: none"> <li>- <math>V_{t,wb,flare}</math>: Volumetric flow of LFG to the Flare</li> <li>- <math>V_{t,wb,genset-1}</math>: Volumetric flow of LFG to the engine-generator set 1</li> <li>- <math>V_{t,wb,genset-2}</math>: Volumetric flow of LFG to the engine-generator set 2</li> <li>- <math>V_{t,wb,genset-3}</math>: Volumetric flow of LFG to the engine-generator set 3</li> <li>- <math>V_{t,wb,genset-4}</math>: Volumetric flow of LFG to the engine-generator set 4</li> <li>- <math>V_{t,wb,genset-5}</math>: Volumetric flow of LFG to the engine-generator set 5</li> <li>- <math>V_{t,wb,genset-6}</math>: Volumetric flow of LFG to the engine-generator set 6</li> </ul>

Monitoring equipment	<p>Measurements of LFG flow sent to the flare are performed by a LFG flow meter installed in an independent section of the LFG pipeline (located between the centrifugal blowers and the installed high temperature enclosed flare).</p> <p>Measurements of LFG flow sent to each one of the six engine-generator sets of the project's electricity generation infrastructure have been performed by six LFG flow meters which are installed in independent sections of the LFG pipeline close to each one of the six engine-generator modular package sets (for each engine-generator set, the LFG flow meter is installed next to the set). It is thus ensured that flow of LFG sent to the flare and flow of LFG sent to each element of project's electricity generation infrastructure (each engine-generator set) is independently and continuously measured.</p> <p><i>Specifications and calibration details for the LFG flow meters used during the considered monitoring period for measuring the flow of LFG sent to the flare:</i></p> <p><i>LFG flow meter used for measuring <math>V_{t,wb,flare}</math> (Flare):</i>  The specifications of the LFG flow meter of thermal mass type utilized during the considered monitoring period are given below:</p> <ul style="list-style-type: none"> <li>- Manufacturer: Fluid Components International (FCI)</li> <li>- Model: ST98</li> <li>- Accuracy: <math>\pm 1\%</math></li> <li>- Serial number (S/N): 294032</li> <li>- Calibration frequency and maintenance requirements: Every 18 months (minimum).</li> <li>- Calibration events valid for the considered monitoring period: <ul style="list-style-type: none"> <li>- Calibration event performed on 06/02/2018, valid until 05/08/2019. Calibration Certificate Number 2214/2018, issued by Hirsá Sistemas de Automação e Controle Ltda.</li> </ul> </li> </ul> <p><i>Specifications and calibration details for the LFG flow meters used for measuring the flow of LFG sent to the engine-generator sets of the project's electricity generation infrastructure:</i></p> <p>6 LFG flow meter sets (each one incl. a measurement element (annubar) and a pressure signal processing + data transmission unit) are installed for measuring LFG flow to the engine-generator sets:</p> <p><i>LFG flow meter used for measuring <math>V_{t,wb,genset-1}</math> (engine-generator set 1):</i></p> <p><i>Measurement element (annubar):</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: Rosemount Inc.</li> <li>- Model: 485 Annubar</li> <li>- Serial number (S/N): 0148661</li> <li>- Accuracy: <math>\pm 1\%</math></li> <li>- Calibration frequency and maintenance requirements: no regular calibration is required for the annubar element as per declaration of the equipment manufacturer. Anyhow, by taking into account the application for the installed element, the regional technical representative of the annubar element recommends the performance of a dimensional checking (metrology analysis) in the element every 5 years in order to confirm the dimensional integrity of the instrument (this is a required condition for its proper functioning).</li> </ul> <p><i>Pressure signal processing + data transmission unit:</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: ABB S.p.A.</li> <li>- Model: 2600T</li> <li>- Serial number (S/N): 3K646614027630</li> <li>- Accuracy: <math>\pm 1\%</math></li> </ul>
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- Calibration frequency and maintenance requirements: Every 2 years (minimum).
- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 06/06/2017 (Calibration Certificate TRP-0270157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).
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*LFG flow meter used for measuring  $V_{t,wb, genset-2}$  (engine-generator set 2):*

*Measurement element (annubar):*

- Manufacturer: Rosemount Inc.
- Model: 485 Annubar
- Serial number (S/N): 0148659
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: no regular calibration is required for the annubar element as per declaration of the equipment manufacturer. Anyhow, by taking into account the application for the installed element, the regional technical representative of the annubar element recommends the performance of a dimensional checking (metrology analysis) in the element every 5 years in order to confirm the dimensional integrity of the instrument (this is a required condition for its proper functioning).

*Pressure signal processing + data transmission unit:*

- Manufacturer: ABB S.p.A.
- Model: 2600T
- Serial number (S/N): 3K646614027628
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: Every 2 years (minimum).
- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 06/06/2017 (Calibration Certificate TRP-0470157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG flow meter used for measuring  $V_{t,wb, genset-3}$  (engine-generator set 3):*

*Measurement element (annubar):*

- Manufacturer: Rosemount Inc.
- Model: 485 Annubar
- Serial number (S/N): 0148658
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: no regular calibration is required for the annubar element as per declaration of the equipment manufacturer. by taking into account the application for the installed element, the regional technical representative of the annubar element recommends the performance of a dimensional checking (metrology analysis) in the element every 5 years in order to confirm the dimensional integrity of the instrument (this is a required condition for its proper functioning).

*Pressure signal processing + data transmission unit:*

- Manufacturer: ABB S.p.A.
- Model: 2600T
- Serial number (S/N): 3K646614027627
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: Every 2 years (minimum).
- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 06/06/2017

(Calibration Certificate TRP-0670157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG flow meter used for measuring  $V_{t,wb, genset-4}$  (engine-generator set 4):*

*Measurement element (annubar):*

- Manufacturer: Rosemount Inc.
- Model: 485 Annubar
- Serial number (S/N): 0148656
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: no regular calibration is required for the annubar element as per declaration of the equipment manufacturer. Anyhow, by taking into account the application for the installed element, the regional technical representative of the annubar element recommends the performance of a dimensional checking (metrology analysis) in the element every 5 years in order to confirm the dimensional integrity of the instrument (this is a required condition for its proper functioning).

*Pressure signal processing + data transmission unit:*

- Manufacturer: ABB S.p.A.
- Model: 2600T
- Serial number (S/N): 3K646614027625
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: Every 2 years (minimum).
- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 06/06/2017 (Calibration Certificate TRP-0870157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG flow meter used for measuring  $V_{t,wb, genset-5}$  (engine-generator set 5):*

*Measurement element (annubar):*

- Manufacturer: Rosemount Inc.
- Model: 485 Annubar
- Serial number (S/N): 0148657
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: no regular calibration is required for the annubar element as per declaration of the equipment manufacturer. Anyhow, by taking into account the application for the installed element, the regional technical representative of the annubar element recommends the performance of a dimensional checking (metrology analysis) in the element every 5 years in order to confirm the dimensional integrity of the instrument (this is a required condition for its proper functioning).

*Pressure signal processing + data transmission unit:*

- Manufacturer: ABB S.p.A.
- Model: 2600T
- Serial number (S/N): 3K646614027626
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: Every 2 years (minimum).
- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 06/06/2017 (Calibration Certificate TRP-1070157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG flow meter used for measuring  $V_{t,wb, genset-6}$  (engine-generator set 6):*

*Measurement element (annubar):*

	<ul style="list-style-type: none"> <li>- Manufacturer: Rosemount Inc.</li> <li>- Model: 485 Annubar</li> <li>- Serial number (S/N): 0148660</li> <li>- Accuracy: <math>\pm 1\%</math></li> <li>- Calibration frequency and maintenance requirements: no regular calibration is required for the annubar element as per declaration of the equipment manufacturer. Anyhow, by taking into account the application for the installed element, the regional technical representative of the annubar element recommends the performance of a dimensional checking (metrology analysis) in the element every 5 years in order to confirm the dimensional integrity of the instrument (this is a required condition for its proper functioning).</li> </ul> <p><i>Pressure signal processing + data transmission unit:</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: ABB S.p.A.</li> <li>- Model: 2600T</li> <li>- Serial number (S/N): 3K646614027629</li> <li>- Accuracy: <math>\pm 1\%</math></li> <li>- Calibration frequency and maintenance requirements: Every 2 years (minimum).</li> <li>- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 07/06/2017 (Calibration Certificate TRP-1270157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 06/06/2019 (2 years).</li> </ul>
Measuring/reading/recording frequency	Continuous measurements are recorded and reported with an every-minute frequency.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	<p>Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer.</p> <p>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A and Biotérmica Energia S.A. in accordance with detailed working instructions that are included in the companies' quality management and control (QA/QC) and environmental management system (EMS).</p>
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	<p>The design of the LFG flow meters used for measuring the flow of LFG sent to the flare during the considered monitoring period ensures that measurement data is automatically converted and recorded in normal cubic meters per hour (<math>\text{Nm}^3/\text{h}</math>).</p> <p>Due to that, as further explained in Section D.1, measurements of LFG pressure and LFG temperature are not required for determining values of the calculation parameter <math>V_{t,wb,n,flare}</math> in the context of calculation of achieved emission reductions. Reported values of <math>V_{t,wb,flare}</math> are thus equivalent to values of <math>V_{t,wb,n,flare}</math> and are thus directly used for the determination of the amount of methane in the LFG flared by the project activity (<math>F_{CH_4,flared,y}</math>) as per Option C of the applicable methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (measurements of volume flow in a wet basis) (as outlined in the monthly emission reduction calculation spreadsheets enclosed to this Monitoring Report).</p> <p>For the particular case of the LFG flow meter sets used for continuously measuring the flow of LFG sent to each one of the engine-generator sets, while such instrument sets do not automatically convert measurements in normal cubic meter per hour (<math>\text{Nm}^3/\text{h}</math>), measurements of LFG pressure and</p>

	LFG temperature (monitoring parameters “Temperature of the LFG stream in time interval $t$ ” ( $T_t$ ) and “Pressure of the LFG stream in time interval $t$ ” ( $P_t$ ) respectively) are considered for converting measurements of $V_{t,wb, genset-n}$ into in normal cubic meter per hour ( $Nm^3/h$ ) ( $V_{t,wb, genset-n}$ ) (where $n = 1, 2, 3, 4, 5$ and $6$ ) in the context of the determination of values for the calculation parameters $V_{t,wb,n, genset-n}$ (where $n = 1, 2, 3, 4, 5$ and $6$ ) as outlined in the monthly emission reduction calculation spreadsheets enclosed to this Monitoring Report).
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Data/Parameter	$V_{CH_4,t,wb,j}$
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 for $j$ (where $j$ is the LFG delivery pipeline to each item of electricity generation and LFG delivery pipeline to the flare(s))
Measured/calculated/default	Continuously measured by continuous $CH_4/O_2$ content gas analyzer.
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments ( $CH_4/O_2$ content gas analyser) (with continuous measurements being electronically recorded).
Value(s) of monitored parameter	The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include measurement data for $V_{CH_4,t,wb,j}$ that are recorded and reported with an every-minute frequency.
Monitoring equipment	<p><i>Continuous <math>CH_4/O_2</math> content gas analyzer unit:</i></p> <p>Specifications of the installed continuous <math>CH_4/O_2</math> content gas analyzer are described below:</p> <ul style="list-style-type: none"> <li>- CRVR's instrument/equipment internal ID reference: AG-01</li> <li>- Manufacturer: Siemens AG</li> <li>- Model: Ultramat 23</li> <li>- Accuracy: <math>\pm 1\%</math></li> <li>- Serial number (S/N): N1-C8-283</li> <li>- Calibration frequency and maintenance requirements<sup>9</sup>: At least every six months.</li> <li>- Calibration events valid for the considered monitoring period: Calibration event dated 22/05/2018 (Calibration Certificate Number 2825/1 – 18, issued by Fazit – Controle e Automação de Processos Industriais Ltda.), valid until 21/11/2018 (6 months). and calibration event dated 20/11/2018, valid until 19/05/2019 (Calibration Certificate Number 3687-18-1, issued by Fazit – Controle e Automação de Processos Industriais Ltda.)</li> </ul>
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.

<sup>9</sup> The calibration frequencies adopted for the installed LFG flow meters,  $CH_4/O_2$  content gas analyzer units, LFG pressure sensors and LFG temperature sensors are all as per the recommendations of related equipment/instrument manufacturers. The PDD and ACM0001 (version 15.0) do not specify any frequency for the calibration of such equipment/instruments. Moreover, the PDD and ACM0001 (version 15.0) do not specify any accuracy or other specification requirement for such instruments/equipment either.



Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer.  Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

Data/Parameter	$T_t$
Unit	K
Description	Temperature of the LFG stream in time interval $t$
Measured/calculated/default	Continuously measured by different LFG temperature sensors installed along the LFG pipeline of the project activity within the flaring facility and electricity generation infrastructure. Measurements are primarily recorded and reported in °C. Recorded/reported data is converted into Kelvin and data is also reported in this unit, thus meeting the related monitoring requirement as per the PDD.
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (LFG temperature sensors) (with recordable electronic signal).
Value(s) of monitored parameter	<p>The monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) include measurement data for <math>T_t</math> that are recorded and reported with an every-minute frequency.</p> <p>While measurements are performed by installed 7 LFG temperature sensors installed along the LFG pipeline of the project activity within the flaring facility and electricity generation infrastructure (one temperature sensor for the high temperature enclosed flare and one temperature sensor set for each individual engine-generator set of the electricity generation infrastructure), the monitoring parameter <math>T_t</math> is thus measured, recorded and reported on the basis of the following sub-parameters:</p> <ul style="list-style-type: none"> <li>- <math>T_{t\text{flare}}</math>: Temperature of the LFG sent to the Flare</li> <li>- <math>T_{t\text{genset-1}}</math>: Temperature of the LFG sent to the engine-generator set 1</li> <li>- <math>T_{t\text{genset-2}}</math>: Temperature of the LFG sent to the engine-generator set 2</li> <li>- <math>T_{t\text{genset-3}}</math>: Temperature of the LFG sent to the engine-generator set 3</li> <li>- <math>T_{t\text{genset-4}}</math>: Temperature of the LFG sent to the engine-generator set 4</li> <li>- <math>T_{t\text{genset-5}}</math>: Temperature of the LFG sent to the engine-generator set 5</li> <li>- <math>T_{t\text{genset-6}}</math>: Temperature of the LFG sent to the engine-generator set 6</li> </ul>

Monitoring equipment	<p>Measurements of temperature of LFG which is sent to the flare are performed by installed LFG temperature sensor that is installed in the main LFG pipeline within the flaring facility in a section between the centrifugal blowers and the high temperature enclosed flare.</p> <p>Measurements of temperature of LFG which is sent to each one of the 6 engine-generator sets of the project's electricity generation infrastructure are performed by 6 LFG temperature sensor sets with each one being installed in an independent section of the LFG pipeline for each engine-generator modular package set prior next to the engine-generator set within the electricity generation infrastructure. It is thus ensured that the temperature of LFG which is sent to the flare and to each element of project's electricity generation infrastructure (each engine-generator set) is independently and continuously measured.</p> <p><i>LFG temperature sensors used for measuring <math>T_{tflare}</math> (Flare):</i></p> <p>The specifications of the LFG temperature sensor set utilized during the considered monitoring period are as follows;</p> <ul style="list-style-type: none"> <li>- Instrument type: (data transmitter + sensor element (RTD))</li> <li>- CRVRs instrument/equipment internal ID reference: TIT-02</li> <li>- Manufacturer: <ul style="list-style-type: none"> <li>o Data transmitter: SMAR Equipamentos Ind. Ltda.</li> <li>o Sensor element: Consistec Controles e Sistemas de Automação Ltda.</li> </ul> </li> <li>- Model: TT301 with a RTD PT100 sensor (respectively)</li> <li>- Accuracy: <math>\pm 0.2^{\circ}\text{C}</math> for the data transmitter and <math>\pm 1.0^{\circ}\text{C}</math> for the sensor</li> <li>- Serial number (S/N): 57235 (data transmitter) and 110813 (sensor element)</li> <li>- Calibration frequency and maintenance requirements: Annual</li> <li>- Calibration events valid for the considered monitoring period (data transmitter + sensor element set): Calibration event dated 08/06/2017, valid until 07/06/2018 (Calibration Certificate Number 8239/2017, issued by SGS do Brasil Ltda.) and calibration event dated 07/06/2018, valid until 06/06/2019 (Calibration Certificate Number 5489/2018, issued by SGS do Brasil Ltda.).</li> </ul> <p><i>LFG temperature sensor sets used for measuring <math>T_{tgenset-n}</math> (engine-generator sets):</i></p> <p><i>LFG temperature sensor set used for measuring <math>T_{tgenset-1}</math> (engine-generator set 1):</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: Elsi s.r.l.</li> <li>- Model: Y1-SEM203/P</li> <li>- Serial number (S/N): E14PT0680</li> <li>- Accuracy: <math>\pm 0.5^{\circ}\text{C}</math></li> <li>- Calibration frequency and maintenance requirements: Every 2 years</li> <li>- Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 15/05/2016 (Calibration Certificate TER-0170157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event dated 06/06/2017 (Calibration Certificate TER-0170157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).</li> </ul> <p><i>LFG temperature sensor used for measuring <math>T_{tgenset-2}</math> (engine-generator set 2):</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: Elsi s.r.l.</li> <li>- Model: Y1-SEM203/P</li> <li>- Serial number (S/N): E14PT0678</li> <li>- Accuracy: <math>\pm 0.5^{\circ}\text{C}</math></li> <li>- Calibration frequency and maintenance requirements: Every 2 years</li> </ul>
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- Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 15/05/2016 (Calibration Certificate TER-0270157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event dated 06/06/2017 (Calibration Certificate TER-0270157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG temperature sensor used for measuring  $T_{\text{igenset-3}}$   
(engine-generator set 3):*

- Manufacturer: Elsi s.r.l.
- Model: Y1-SEM203/P
- Serial number (S/N): E14PT0677
- Accuracy:  $\pm 0.5^{\circ}\text{C}$
- Calibration frequency and maintenance requirements: Every 2 years
- Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 15/05/2016 (Calibration Certificate TER-0370157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event dated 06/06/2017 (Calibration Certificate TER-0370157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG temperature sensor used for measuring  $T_{\text{igenset-4}}$   
(engine-generator set 4):*

- Manufacturer: Elsi s.r.l.
- Model: Y1-SEM203/P
- Serial number (S/N): E14PT0675
- Accuracy:  $\pm 0.5^{\circ}\text{C}$
- Calibration frequency and maintenance requirements: Every 2 years
- Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 15/05/2016 (Calibration Certificate TER-0470157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event dated 06/06/2017 (Calibration Certificate TER-0470157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG temperature sensor used for measuring  $T_{\text{igenset-5}}$   
(engine-generator set 5):*

- Manufacturer: Elsi s.r.l.
- Model: Y1-SEM203/P
- Serial number (S/N): E14PT0676
- Accuracy:  $\pm 0.5^{\circ}\text{C}$
- Calibration frequency and maintenance requirements: Every 2 years
- Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 15/05/2016 (Calibration Certificate TER-0570157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event dated 06/06/2017 (Calibration Certificate TER-0570157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG temperature sensor used for measuring  $T_{\text{igenset-6}}$   
(engine-generator set 6):*

- Manufacturer: Elsi s.r.l.
- Model: Y1-SEM203/P
- Serial number (S/N): E14PT0679
- Accuracy:  $\pm 0.5^{\circ}\text{C}$
- Calibration frequency and maintenance requirements: Every 2 years
- Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 15/05/2016 (Calibration

	Certificate TER-0670157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event dated 07/06/2017 (Calibration Certificate TER-0670157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 06/06/2019 (2 years).
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of their manufacturer.  Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A and Biotérmica Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	$T_{flare}$ is only used for the determination of $\eta_{flare,calc,y}$ . An increase in the reported value for this parameter results in reduction the calculated flare efficiency value, thus negatively affecting the reported value for achieved emission reductions during the considered monitoring period. Thus, the applied conservative deduction factor during the above-mentioned period within the considered monitoring period is of +1.2 °C.

<b>Data/Parameter</b>	<b><math>P_t</math></b>
Unit	Pa
Description	Pressure of the LFG stream in time interval $t$
Measured/calculated/default	Continuously measured by LFG pressure sensors (each one encompassing pressure signal processing + data transmission unit) installed along the LFG pipeline of the project activity within the flaring and electricity generation infrastructure. Measurements of pressure of LFG are primarily recorded and reported in mbar. Recorded/reported data is converted into Pascal and data is also reported in this unit, thus meeting the related monitoring requirement as per the PDD.
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (pressure sensors) (with recordable electronic signal).
Value(s) of monitored parameter	The monthly emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) includes measurement data for $P_t$ that are recorded and reported with an every-minute frequency.  While measurements are performed by installed 7 LFG pressure sensors installed along the LFG pipeline of the project activity within the flaring and electricity generation infrastructure (one pressure sensor for the high temperature enclosed flare and one pressure sensor for each individual engine-generator set of the electricity generation infrastructure), the monitoring parameter $P_t$ is thus measured, recorded and reported on the

	<p>basis of the following sub-parameters:</p> <ul style="list-style-type: none"> <li>- <math>P_{tflare}</math>: Pressure of the LFG sent to the Flare</li> <li>- <math>P_{tgenset-1}</math>: Pressure of the LFG sent to the engine-generator set 1</li> <li>- <math>P_{tgenset-2}</math>: Pressure of the LFG sent to the engine-generator set 2</li> <li>- <math>P_{tgenset-3}</math>: Pressure of the LFG sent to the engine-generator set 3</li> <li>- <math>P_{tgenset-4}</math>: Pressure of the LFG sent to the engine-generator set 4</li> <li>- <math>P_{tgenset-5}</math>: Pressure of the LFG sent to the engine-generator set 5</li> <li>- <math>P_{tgenset-6}</math>: Pressure of the LFG sent to the engine-generator set 6</li> </ul>
Monitoring equipment	<p>Measurements of pressure of LFG which is sent to the flare are performed by installed LFG pressure sensor that is installed in the main LFG pipeline within the flaring facility in a section between the centrifugal blowers and the high temperature enclosed flare.</p> <p>Measurements of pressure of LFG which is sent to each one of the 6 engine-generator sets of the project's electricity generation infrastructure are performed by 6 LFG pressure sensors with each one being installed in an independent section of the LFG pipeline for each engine-generator modular package set prior next to the engine-generator set within the electricity generation infrastructure. It is thus ensured that the pressure of LFG which is sent to the flare and to each element of project's electricity generation infrastructure (each engine-generator set) is independently and continuously measured.</p> <p><i>LFG pressure sensor (encompassing pressure signal processing + data transmission unit) used for measuring <math>P_{tflare}</math> (Flare):</i></p> <p>The specifications of the LFG pressure sensor utilized during the considered monitoring period are as follows:</p> <ul style="list-style-type: none"> <li>- CRVR's instrument/equipment internal ID reference: PIT-02</li> <li>- Manufacturer: SMAR Equipamentos Ind. Ltda.</li> <li>- Model: LD301</li> <li>- Serial Number: 249692</li> <li>- Accuracy: <math>\pm 0.1\%</math></li> <li>- Calibration frequency and maintenance requirements: Annual</li> <li>- Calibration events valid for the monitoring period: Calibration event dated 08/06/2017, valid until 07/06/2018 (Calibration Certificate Number 8237/2017) and calibration event dated 07/06/2018, valid until 06/06/2019 (Calibration Certificate Number 5491/2018, issued by SGS do Brasil Ltda.).</li> </ul> <p>The calibration events were performed by the calibration/inspection service company SGS do Brasil Ltda.</p> <p><i>LFG pressure sensors (each one encompassing pressure signal processing + data transmission unit) used for measuring <math>P_{tgenset-n}</math> (engine-generator sets):</i></p> <p><i>LFG pressure sensor used for measuring <math>P_{tgenset-1}</math> (engine-generator set 1):</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: ABB S.p.A.</li> <li>- Model: 2600T</li> <li>- Serial number (S/N): 3K646614027622</li> <li>- Accuracy: <math>\pm 1\%</math></li> <li>- Calibration frequency and maintenance requirements: Every 2 years (minimum).</li> <li>- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 15/05/2016 (Calibration Certificate TRP-0170157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event performed on 06/06/2017 (Calibration Certificate TRP-0170157/17, issued by CEIME - Comércio e Metrologia Ltda.),</li> </ul>

valid until 05/06/2019 (2 years).

*LFG pressure sensor used for measuring  $P_{tgenset-2}$  (engine-generator set 2):*

- Manufacturer: ABB S.p.A.
- Model: 2600T
- Serial number (S/N): 3K646614027620
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: Every 2 years (minimum).
- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 15/05/2016 (Calibration Certificate TRP-0270157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event performed on 06/06/2017 (Calibration Certificate TRP-0370157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG pressure sensor used for measuring  $P_{tgenset-3}$  (engine-generator set 3):*

- Manufacturer: ABB S.p.A.
- Model: 2600T
- Serial number (S/N): 3K646614027619
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: Every 2 years (minimum).
- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 15/05/2016 (Calibration Certificate TRP-0370157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event performed on 06/06/2017 (Calibration Certificate TRP-0570157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG pressure sensor used for measuring  $P_{tgenset-4}$  (engine-generator set 4):*

- Manufacturer: ABB S.p.A..
- Model: 2600T
- Serial number (S/N): 3K646614027617
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: Every 2 years (minimum).
- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 15/05/2016 (Calibration Certificate TRP-0470157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event performed on 06/06/2017 (Calibration Certificate TRP-0770157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

*LFG pressure sensor used for measuring  $P_{tgenset-5}$  (engine-generator set 5):*

- Manufacturer: ABB S.p.A.
- Model: 2600T
- Serial number (S/N): 3K646614027618
- Accuracy:  $\pm 1\%$
- Calibration frequency and maintenance requirements: Every 2 years (minimum).
- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 15/05/2016 (Calibration Certificate TRP-0570157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event performed on 06/06/2017 (Calibration Certificate TRP-0970157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 05/06/2019 (2 years).

	<p><i>LFG pressure sensor used for measuring <math>P_{\text{igenset-6}}</math> (engine-generator set 6):</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: ABB S.p.A.</li> <li>- Model: 2600T</li> <li>- Serial number (S/N): 3K646614027621</li> <li>- Accuracy: <math>\pm 1\%</math></li> <li>- Calibration frequency and maintenance requirements: Every 2 years (minimum).</li> <li>- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 15/05/2016 (Calibration Certificate TRP-0670157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years) and calibration event performed on 07/06/2017 (Calibration Certificate TRP-1170157/17, issued by CEIME - Comércio e Metrologia Ltda.), valid until 06/06/2019 (2 years).</li> </ul>
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	<p>Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.</p> <p>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A and Biotérmica Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).</p>
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	<p><math>P_{\text{tflare}}</math> is only used for the determination of <math>\eta_{\text{flare,calc,y}}</math>. An increase in the reported value for this parameter results in reduction the calculated flare efficiency value, thus negatively affecting the reported value for achieved emission reductions during the considered monitoring period. Thus, the applied conservative deduction factor during the above-mentioned period within the considered monitoring period is of +0.1%.</p>

<b>Data/Parameter</b>	<b><math>EC_{PJ,grid,y}</math></b>		
Unit	MWh		
Description	Amount of grid electricity consumed by the project activity during the year $y$		
Measured/calculated/default	Continuously measured by bi-directional electricity meter.		
Source of data	During the whole considered monitoring period, consumption of grid-sourced electricity by the project activity was measured continuously by the same electricity meter which measures electricity generated by the project activity. While consumption of grid-sourced electricity is measured and registered in kWh, monitoring data is converted and reported in MWh in order to meet data reporting requirement as per the monitoring plan from the PDD.		
Value(s) of monitored parameter	<p>Monthly records of grid-sourced electricity consumption valid for the considered monitoring period:</p> <table border="1"> <tr> <td>Month</td> <td>Total amount of</td> </tr> </table>	Month	Total amount of
Month	Total amount of		

	<table> <tr> <th></th><th>consumed grid electricity (MWh)</th></tr> <tr> <td>Jun. 2018</td><td>0.951</td></tr> <tr> <td>Jul. 2018</td><td>0.987</td></tr> <tr> <td>Aug. 2018</td><td>0.613</td></tr> <tr> <td>Sep. 2018</td><td>1.020</td></tr> <tr> <td>Oct. 2018</td><td>2.400</td></tr> <tr> <td>Nov. 2018</td><td>1.657</td></tr> <tr> <td>Dec. 2018</td><td>1.183</td></tr> <tr> <td>Jan. 2019</td><td>2.111</td></tr> </table>		consumed grid electricity (MWh)	Jun. 2018	0.951	Jul. 2018	0.987	Aug. 2018	0.613	Sep. 2018	1.020	Oct. 2018	2.400	Nov. 2018	1.657	Dec. 2018	1.183	Jan. 2019	2.111
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Monitoring equipment	<p><i>Specification of the bi-directional electricity meter (located in the power substation that the project's electricity generation infrastructure is connected to) which is operated and maintained by the local electricity transmission/distribution company name Companhia Estadual de Distribuição de Energia Elétrica – CEEE-D:</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: Schneider Electric</li> <li>- Model: ION 8650</li> <li>- Serial Number: RSARELUBREC01P</li> <li>- Accuracy: <math>\pm 0.2\%</math>.</li> <li>- Calibration frequency and maintenance requirements: Every 5 years</li> <li>- Dates for performed calibration events valid for the considered monitoring period: Calibration event performed on 14/11/2013, valid 13/11/2018 (5 years) and calibration event performed on 20/08/2018, valid until 19/08/2023 (5 years).</li> </ul>																		
Measuring/reading/recording frequency	Continuous measurements performed by installed electricity meter are automatically transmitted, aggregated and recorded every hour by the Brazilian Chamber of Electric Energy Commercialization (CCEE) h. Accumulated measurement records are reported every month.																		
Calculation method (if applicable)	Not applicable.																		
QA/QC procedures	<p>Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.</p> <p>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).</p>																		
Purpose of data/parameter	Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity).																		
Additional comments	-																		

<b>Data/Parameter</b>	<b>EC<sub>BL,y</sub></b>
Unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year y
Measured/calculated/	Measured as part of the operation of the project activity by applying



default	appropriate electricity meter(s).																		
Source of data	Installed electricity meter that is maintained by the local electricity transmission/distribution company name Companhia Estadual de Distribuição de Energia Elétrica – CEEE-D, with related electricity measurement being performed, recorded and transmitted under conformance with requirements and rules of the Brazilian Chamber of Electric Energy Commercialization (CCEE) <sup>10</sup> .																		
Value(s) of monitored parameter	<p>Monthly records of electricity generated by the project activity valid for the considered monitoring period:</p> <table border="1"> <thead> <tr> <th>Month</th><th>Amount of electricity generated using LFG (MWh)</th></tr> </thead> <tbody> <tr> <td>Jun. 2018</td><td>5,275.201</td></tr> <tr> <td>Jul. 2018</td><td>5,194.483</td></tr> <tr> <td>Aug. 2018</td><td>5,495.608</td></tr> <tr> <td>Sep. 2018</td><td>4,836.310</td></tr> <tr> <td>Oct. 2018</td><td>5,196.852</td></tr> <tr> <td>Nov. 2018</td><td>5,153.727</td></tr> <tr> <td>Dec. 2018</td><td>5,236.517</td></tr> <tr> <td>Jan. 2019</td><td>4,699.624</td></tr> </tbody> </table>	Month	Amount of electricity generated using LFG (MWh)	Jun. 2018	5,275.201	Jul. 2018	5,194.483	Aug. 2018	5,495.608	Sep. 2018	4,836.310	Oct. 2018	5,196.852	Nov. 2018	5,153.727	Dec. 2018	5,236.517	Jan. 2019	4,699.624
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Calculation method (if applicable)	Not applicable.																		
QA/QC procedures	Data from the installed electricity meter is used by CCEE as the basis for remunerating Biotérmica Energia S.A. in the context of commercialization of generated electricity that is exported through the National Electricity Grid of Brazil.																		

<sup>10</sup> The Brazilian Chamber of Electric Energy Commercialization (CCEE) was created under the Federal Law 10,848, of March 2004 as a private and not-for profit institution with the responsibilities of administrating both regulated and free contracting environments for electricity generation under direct regulation and inspection of the Brazilian National Regulatory Agency for Electricity (ANEEL). CCEE has inter alia the main attribution of keeping records of the electricity contracting and acquire online measuring data of all market agents in the Brazilian interconnected electricity system.

	<p>Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer as per the procedures and practices undertaken of both by CCEE and CEEE-D.</p> <p>Also under conformance with procedures and practices from both by CCEE and CEEE-D, Companhia Riograndense de Valorização de Resíduos S/A and Biotérmica Energia S.A. do not have any control over the installed electricity meter. Data records made available by CCEE are regularly collected and archived by Companhia Riograndense de Valorização de Resíduos S/A.</p> <p>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A and Biotérmica Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).</p>
Purpose of data/parameter	Calculation of baseline emissions (due to the displacement of an equivalent amount of electricity generated by the project's electricity generation infrastructure which would otherwise be generated by existing grid-connected power plants (and addition of new power generation units) within the National Electricity Grid of Brazil).
Additional comments	Monitoring records for the considered monitoring period are cross-checked against electricity sale receipts/invoices issued by Biotérmica Energia S.A. for the purchasers of electricity generated by the project activity as per applicable rules in Brazil.

Data/Parameter	$EF_{grid,OM,y} = EF_{grid,OM-DD,y}$
Unit	tCO <sub>2</sub> /MWh
Description	Operation margin CO <sub>2</sub> emission factor in year $y$ = Dispatch data analysis operating margin CO <sub>2</sub> emission factor in year $y$
Measured/calculated/default	Calculated (based on official monthly values as calculated and published by the DNA of Brazil).
Source of data	<p>Selected average values of <math>EF_{grid,OM,y} = EF_{grid,OM-DD,y}</math> valid for all months of years 2017 and 2018 that are encompassed by the considered monitoring period are calculated by the DNA of Brazil and are made public available at the website of the DNA of Brazil:</p> <p><a href="http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/fatoresdeemissao/emissao_despacho.html">http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/clima/fatoresdeemissao/emissao_despacho.html</a></p>
Value(s) of monitored parameter	<p>Average values of operation margin CO<sub>2</sub> emission factor for the National Electricity Grid of Brazil for all months of years 2018 and 2019 that are encompassed by the considered monitoring period (from 01/06/2018 to 31/01/2019) are summarized below:</p> <ul style="list-style-type: none"> <li>- 01/06/2018 to 31/12/2018: 0.5390 tCO<sub>2</sub>/MWh (official average annual value for year 2017),</li> <li>- 01/01/2019 to 31/01/2019 0.5652 tCO<sub>2</sub>/MWh (official average monthly value for the month of January 2018)</li> </ul>

Monitoring equipment	Not applicable
Measuring/reading/recording frequency	Values are updated annually.
Calculation method (if applicable)	Values applicable for the months of years 2018 and 2019 encompassed by the considered monitoring period were calculated by the DNA of Brazil as per applicable guidance of the calculation method “dispatch data analysis operating margin CO <sub>2</sub> emission factor” of the “Tool to calculate the emission factor for an electricity system”.
QA/QC procedures	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A in accordance with detailed working instructions that are included in the company’s quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity) and baseline emissions (due to the displacement of an equivalent amount of electricity generated by the project’s electricity generation infrastructure which would otherwise be generated by existing grid-connected power plants (and addition of new power generation units) within the National Electricity Grid of Brazil).
Additional comments	-

<b>Data/Parameter</b>	<b>Op<sub>j,h</sub></b>
Unit	-
Description	Operation of the equipment that consumes LFG (engine-generator sets of the electricity generation infrastructure).
Measured/calculated/default	<p>For each equipment unit <i>j</i> using the LFG monitor that the plant is operating in hour <i>h</i> by the monitoring any one or more of the following three parameters:</p> <p>(a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer’s specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD;</p> <p>(b) Flame. Flame detection system is used to ensure that the equipment is in operation;</p> <p>(c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnaces. This option is not applicable to brick kilns.</p> <p>Op<sub>j,h</sub> = 0 when:</p> <p>(a) One of more temperature measurements are missing or below the minimum threshold in hour <i>h</i> (instantaneous measurements are made at least every minute);</p> <p>(b) Flame is not detected continuously in hour <i>h</i> (instantaneous measurements are made at least every minute);</p> <p>(c) No products are generated in the hour <i>h</i>. Otherwise, Op<sub>j,h</sub> = 1</p>
Source of data	The electronic control system for each engine-generator set of the project’s electricity generation infrastructure continuously monitor operational status of the set (engine-generator set running “on” or not-running “off”).
Value(s) of monitored	Records for every-minute operational status of the set (engine-generator set

parameter	<p>running (“on”) = 1 or not-running (“off”) = 0) are made available in the monthly emission reduction calculation spreadsheets valid for the considered monitoring period).</p> <p>While the operational status for each individual engine-generator set consuming LFG is independently monitored since 25/06/2015, the monitoring parameter <math>Op_{j,h}</math> is recorded and reported on the basis of the following sub-parameters:</p> <ul style="list-style-type: none"> <li>- <math>Op_{genset-1,h,y}</math>: Operation of the engine-generator 1</li> <li>- <math>Op_{genset-2,h,y}</math>: Operation of the engine-generator 2</li> <li>- <math>Op_{genset-3,h,y}</math>: Operation of the engine-generator 3</li> <li>- <math>Op_{genset-4,h,y}</math>: Operation of the engine-generator 4</li> <li>- <math>Op_{genset-5,h,y}</math>: Operation of the engine-generator 5</li> <li>- <math>Op_{genset-6,h,y}</math>: Operation of the engine-generator 6</li> </ul>
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	Values are reported on a minute basis.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A and Biotérmica Energia S.A. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation baseline emissions (due to the displacement of an equivalent amount of electricity generated by the project's electricity generation infrastructure which would otherwise be generated by existing grid-connected power plants (and addition of new power generation units) within the National Electricity Grid of Brazil).
Additional comments	-

<b>Data/Parameter</b>	<b><math>F_{CH_4,EG,t}</math></b>
Unit	kg
Description	Mass flow of methane in the exhaust gas of the flare(s) on a dry basis at reference conditions in the time period $t$
Measured/calculated/default	Measurements performed by a third party accredited entity.
Source of data	<p>Related measurements were performed by the independent third party inspection services company “BIOAGRI Ambiental Ltda / Mérieux NutriSciences Brasil”</p> <p>Biannual measurements of mass flow of methane in the exhaust gas are performed on the basis of measurements of <math>CH_4</math> concentration in a collected gas sample + measurements of speed of exhaust gas in the upper section of the flare with one hour of duration each.</p> <p>Measurements are performed by following applicable guidance and requirements of the following standards/methods:</p> <p>US-EPA Method 18 – Measurement of Gaseous Organic Compound</p>

	<p>Emission by Gas Chromatography (available online: <a href="https://www.epa.gov/emc/method-18-volatile-organic-compounds-gas-chromatography">https://www.epa.gov/emc/method-18-volatile-organic-compounds-gas-chromatography</a>);</p> <p>CETESB L9.221 - "Pipelines and chimneys in stationary emission sources- Sampling points determination procedure) (available online: <a href="http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.221.pdf">http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.221.pdf</a>)</p> <p>CETESB L9.222 - "Pipelines and chimneys in stationary emission sources – Determination of speed and outflow of gases) (available online: <a href="http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.222.pdf">http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.222.pdf</a>)</p> <p>CETESB L9.223 - "Pipelines and chimneys in stationary emission sources – Determination of dry molecular mass and the excess of the air flow gas" (available online: <a href="http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.223.pdf">http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.223.pdf</a>).</p> <p>CETESB L9.224 - "Pipelines and chimneys in stationary emission sources – Determination of humidity of effluents" (available online: <a href="http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.224.pdf">http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.224.pdf</a>).</p>				
Value(s) of monitored parameter	<p>For the determination of values of <math>F_{CH_4,EG,t}</math>, average of the accumulated mass of methane measured during one hour measurements are considered (average of every-minute measurements).</p> <p>The table below summarizes the performed biannual determination of <math>F_{CH_4,EG,t}</math> for the installed flare valid for the considered monitoring period:</p> <table border="1" data-bbox="750 1019 1220 1142"> <thead> <tr> <th>Measurements performed on 02/10/2017 (kg)</th><th>Measurements performed on 26/03/2018 (kg)</th></tr> </thead> <tbody> <tr> <td>1.0440</td><td>0.1624</td></tr> </tbody> </table>	Measurements performed on 02/10/2017 (kg)	Measurements performed on 26/03/2018 (kg)	1.0440	0.1624
Measurements performed on 02/10/2017 (kg)	Measurements performed on 26/03/2018 (kg)				
1.0440	0.1624				

Monitoring equipment	<p>Measurements were performed by the independent 3<sup>rd</sup> party inspection service company "BIOAGRI Ambiental Ltda / Mérieux NutriSciences Brasil" using an appropriated chromatographer and a pitot tube with the following specifications:</p> <p><i>Specifications of the utilized chromatographer:</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: Varian Analytical Instruments (Varian, Inc.)</li> <li>- Model: 3900</li> <li>- S/N: 101129</li> <li>- Accuracy: <math>\pm 0.005\%</math></li> <li>- Calibration frequency and maintenance requirements: Every 2 years</li> <li>- Calibration events valid for the considered monitoring period: Calibration event dated 18/04/2017 (Calibration Certificate number 12583/2017, issued by Radchrom Analítica Ltda.) and calibration event dated 05/10/2017 (Calibration Certificate number TGS-025/17, issued by Energética Industria e Comércio Ltda.).</li> </ul> <p><i>Specifications of the utilized Pitot tube:</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: APEX Instruments</li> <li>- Type: S</li> <li>- S/N: the instrument does not have a Serial Number</li> <li>- Accuracy: <math>\pm 1.0\%</math></li> <li>- Calibration frequency and maintenance requirements: Every 6 months</li> <li>- Calibration events valid for the considered monitoring period: Calibration event dated 31/08/2017 (Calibration Certificate number 565/2017/IPAA, issued by Companhia Ambiental do Estado de São Paulo (CETESB)) and calibration event dated 23/02/2018 (Calibration Certificate number 097/2018/IPAA, issued by Companhia Ambiental do Estado de São Paulo (CETESB)).</li> </ul>
Measuring/reading/recording frequency	Biannual
Calculation method (if applicable)	-
QA/QC procedures	<p>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).</p> <p>BIOAGRI Ambiental Ltda / Mérieux NutriSciences Brasil is an independent third party inspections services company specialized in inspections and testing of air emissions from stationary sources accredited by the Instituto Nacional de Metrologia, Qualidade e Tecnologia (INMETRO) (the Brazilian national authority for metrology and certification affairs), which is responsible for the regulation of operation of inspection entities and labs.</p>
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	<p>As demonstrated in the flare efficiency calculation spreadsheet (which is enclosed to this Monitoring Report), the average flow rate to the flare during the period in which measurements for <math>F_{CH_4,EG,t}</math> were made are greater than the average flow rate observed for the previous six months as required by the methodological tool "Project emissions from flaring" (version 02.0.0) for the application of its Option B.1.</p> <p>The flare efficiency calculation spreadsheet also calculates the average flow rate of LFG sent to the flare during the 6 months prior to each measurement</p>

	<p>event performed by “BIOAGRI Ambiental Ltda / Mérieux NutriSciences Brasil” in order to demonstrate that related average value is lower than the average flow rate of LFG sent to the flare during each one of considered 1-hour period when measurement events for <math>F_{CH_4,EG}</math> were performed.</p> <p>Among the standards of which guidance and requirements were followed as part of performed biannual determination of <math>F_{CH_4,EG,t}</math> for the installed flare within the considered monitoring period, the US-EPA Method 18 – Measurement of Gaseous Organic Compound Emission by Gas Chromatography has been widely internationally recognized and/or accepted by different national and international organizations as a standard for performance of emission measurements from stationary emission sources in a wide range of industries (e.g. The California Air Resources Board (CARB), Scottish Environment Protection Agency (SEPA). Different agencies in the United States (USA) and in other countries require or recommend that determination of concentration of VOC portion in landfill gas is to be performed by applying US-EPA Method 18. The US-EPA Method 18 is also referred in the most popular and acknowledged pollution control handbooks and guides (i.e. Pollution Control Handbook for Oil and Gas Engineering, 2016, published by John Wiley &amp; Sons, Inc. – USA, US-EPA Guidance for evaluating landfill gas emissions from closed or abandoned facilities, SEPA Guidance for monitoring landfill gas engine emissions, Pollution Prevention and Abatement Handbook 1998 – The World Bank Group, etc.).</p> <p>The technical test/evaluation reports for the performed biannual determination of <math>F_{CH_4,EG,t}</math> for the installed flare within the considered monitoring period (reports issued by the independent 3<sup>rd</sup> party inspection service company “BIOAGRI Ambiental Ltda / Mérieux NutriSciences Brasil”) also refer to methods recommended by the environmental authority of São Paulo State in Brazil. Compliance with these methods has also been acknowledged as best practice for performance of air emission measurements by different environmental regulatory agencies in Brazil.</p>
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Data/Parameter	$T_{EG,m}$
Unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute <i>m</i>
Measured/calculated/default	Continuously measured by thermocouples installed in the upper section of the flare
Source of data	Measured as part of the operation of the project activity by applying appropriate monitoring instruments (thermocouples) (with recordable electronic signal).
Value(s) of monitored parameter	Values for the installed high temperature enclosed flare are reported in the monthly emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report). Measurement data is recorded and reported with an every-minute frequency.

Monitoring equipment	<p>Two identical thermocouples were used simultaneously during the considered monitoring period. Their specifications are as follows;</p> <ul style="list-style-type: none"> <li>- Instrument/equipment internal ID reference: TT-04 and TT-05</li> <li>- Manufacturer: ECIL Met Tec Ltda.</li> <li>- Model: ATC-204, type N</li> <li>- Accuracy: <math>\pm 0.75\%</math></li> <li>- Calibration frequency and maintenance requirements: Every 2 years</li> <li>- Calibration events valid for the monitoring period:</li> </ul> <table border="1"> <thead> <tr> <th>Instrument</th><th>Calibration certificate</th><th>Calibration event date</th><th>Validity of the performed calibration event</th></tr> </thead> <tbody> <tr> <td>TT-04</td><td>4682/2018</td><td>27/03/2018</td><td>26/03/2020</td></tr> <tr> <td>TT-05</td><td>4701/2018</td><td>28/03/2018</td><td>27/03/2020</td></tr> </tbody> </table> <p>Both calibration events were performed by the calibration/inspection service company SGS do Brasil Ltda.</p>	Instrument	Calibration certificate	Calibration event date	Validity of the performed calibration event	TT-04	4682/2018	27/03/2018	26/03/2020	TT-05	4701/2018	28/03/2018	27/03/2020
Instrument	Calibration certificate	Calibration event date	Validity of the performed calibration event										
TT-04	4682/2018	27/03/2018	26/03/2020										
TT-05	4701/2018	28/03/2018	27/03/2020										
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.												
Calculation method (if applicable)	-												
QA/QC procedures	<p>Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.</p> <p>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).</p>												
Purpose of data/parameter	Calculation of baseline emissions.												
Additional comments	<p>Measurements outside the operational temperature specified/recommended by the manufacturer may indicate that the flare is not functioning correctly and may require maintenance. Unexpected changes such as a sudden increase/drop in temperature can occur for different reasons. As part of the monitoring procedure, these events are 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.</p>												

Data/Parameter	Flame <sub>m</sub>
Unit	Flame status "on" or flame status "off"
Description	Flame detection of flare in the minute <i>m</i>
Measured/calculated/default	Continuously measured by Ultra violet (UV) flame detector
Source of data	Whenever flame is detected in the flare, flame status "on" or "1" value is attributed. Whenever no flame is detected in the flare, flame status "off" or "0" is attributed.



Value(s) of monitored parameter	Values for the installed high temperature enclosed flare are reported in the monthly emission reduction calculation spreadsheets (that is enclosed to this Monitoring Report). Measurement data is recorded and reported with an every-minute frequency.
Monitoring equipment	<p><i>Specifications and calibration details for the installed/utilized UV Flame detector:</i></p> <ul style="list-style-type: none"> <li>- Manufacturer: Honeywell Analytics Ltd.</li> <li>- Model: C7061A Dynamic Self-Check Ultra-Violet Flame Detector</li> <li>- Serial Number: 1037 1</li> <li>- Calibration frequency: No calibration is required as the equipment has a self-checking function.</li> </ul>
Measuring/reading/recording frequency	Continuously measurements are recorded/reported every minute.
Calculation method (if applicable)	Not applicable
QA/QC procedures	<p>Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.</p> <p>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).</p>
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	-

<b>Data/Parameter</b>	<b>Maintenance<sub>y</sub></b>
Unit	Calendar dates
Description	Maintenance events completed in year <i>y</i> as monitored by the project participants.
Measured/calculated/default	-
Source of data	Maintenance logs
Value(s) of monitored parameter	<p>The following relevant maintenance events (inspection and maintenance services) are applicable for the installed high temperature enclosed flare during the considered monitoring period:</p> <ul style="list-style-type: none"> <li>- 07/04/2018: General inspection/maintenance service on the Flare (incl. inspection of the condition of the flare isolation ceramics revetment material, checking of conditions of the LPG supply valve for pilot flame, checking of condition/function of the air inlet dumpers, checking of the conditions of the thermocouples, checking of the condition of the UV flame detector, checking of the condition of the flame arrester valve, checking of the conditions of the LPG injectors, checking of painting conditions).</li> <li>- 17/07/2017: General inspection/maintenance service on the Flare (incl. inspection of the condition of the flare isolation ceramics revetment material, checking of conditions of the LPG supply valve</li> </ul>

	<p>for pilot flame, checking of condition/function of the air inlet dumpers, checking of the conditions of the thermocouples, checking of the condition of the UV flame detector, checking of the condition of the flame arrester valve, checking of the conditions of the LFG injectors, checking of painting conditions).</p> <p>As per the applied maintenance practice for the project activity, general inspection/maintenance services on the flare are opportunely performed during planned or unplanned interruptions of operation of the flare within a time interval between 2 performed inspection/maintenance services events never higher than 6 months.</p> <p>The expected lifetime for the isolation ceramics revetment material for the flare is of at least 10 years (as established in details for the ex-ante determined parameter "Manufacturer's flare specifications for temperature, flow rate and maintenance schedule interval" (<math>SPEC_{flare}</math>)).</p> <p>After the project's commissioning, the isolation ceramics revetment material of the installed high temperature enclosed flare was initially replaced on October 2014 and more recently on April 2018.</p> <p>Performed maintenance and overhauling services in the flare are performed under by specialized technical service team under conformance with maintenance requirements for the flare (as established by equipment manufacturer) and as required by the ex-ante determined parameter <math>SPEC_{flare}</math>. Further details about the parameter <math>SPEC_{flare}</math> are included in Section D.1.</p>
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	Not applicable.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	The maintenance event logs and documentation for the whole project activity are recorded as per requirement of the company's quality and control (QA/QC) and environmental management (EMS) system that is implemented for activities undertaken at the CRR landfill.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	<p>Monitoring of this parameter is required for the case of enclosed flare and the project participant selects Option B to determine flare efficiency.</p> <p>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 (<math>SPEC_{flare}</math>).</p>

<b>Data/Parameter</b>	<b><math>FC_{LPG,y}</math></b>
Unit	ton
Description	Quantity of LPG consumed by the project activity in year $y$
Measured/calculated/default	Measured.

Source of data	Monitored values of $FC_{LPG,y}$ are based on measurements performed by the local LPG distribution company Liquigás Distribuidora S.A.
Value(s) of monitored parameter	No LPG was consumed during the considered monitoring period.
Monitoring equipment	Not applicable as no LPG was consumed during the considered monitoring period.
Measuring/reading/recording frequency	Amount of LPG is measured upon the supply of cylinders of LPG with 45 kg capacity each, and cross checked with LPG purchasing receipts.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	<p>The amount of consumed LPG is cross-checked with internal records of cost expenditures for fuel LPG as per the internal financial/accounting management system of Companhia Riograndense de Valorização de Resíduos S/A.</p> <p>Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.</p> <p>Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Companhia Riograndense de Valorização de Resíduos S/A in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).</p>
Purpose of data/parameter	Calculation of project emissions (due to consumption of LPG by the project activity).
Additional comments	-

<b>Data/Parameter</b>	<b><math>NCV_{LPG,y}</math></b>
Unit	GJ/ton LPG
Description	Net calorific value of the fuel LPG in year y
Measured/calculated/default	Default value is selected.
Source of data	<p>National default value as per the Brazilian National Energetic Balance Report for year 2018 (Balanço Energético Nacional (BEN) – 2018) / Table VIII.9 – Specific Mass and Heating Values (Higher Heating Value). This annual report is the latest issued version. This official document was published by the public entity Empresas de Pesquisas Energéticas (EPE). While created and established in accordance with the Federal Law 10.847 of 15/03/2004, the EPE is a governmental entity that undertakes energy planning related investigation and research services.</p> <p>The BEN-2018 report is available online:  <a href="http://epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2018">http://epe.gov.br/pt/publicacoes-dados-abertos/publicacoes/balanco-energetico-nacional-2018</a></p> <p>Reported value in kcal/kg is converted into GJ/ton.</p>
Value(s) of monitored	46.5

parameter	
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	In accordance with the PDD, as national default value is considered, an every year monitoring frequency is thus applied.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of project emissions (due to consumption of LPG by the project activity)
Additional comments	-

<b>Data/Parameter</b>	<b>EF<sub>CO<sub>2</sub>,LPG,y</sub></b>
Unit	tCO <sub>2</sub> /GJ LPG
Description	CO <sub>2</sub> emission factor of fuel LPG in year y
Measured/calculated/default	Default value is selected.
Source of data	Value is selected as per 2006 IPCC Guidelines on National GHG Inventories (applicable value at upper limit of uncertainty at 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy)).
Value(s) of monitored parameter	0.0656
Monitoring equipment	Not applicable.
Measuring/reading/recording frequency	In accordance with the PDD, as IPCC default value is considered, an every year monitoring frequency is thus applied.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS).
Purpose of data/parameter	Calculation of project emissions (due to consumption of LPG by the project activity)
Additional comments	-

Data/Parameter	$p_{H_2O,t,Sat}$																								
Unit	Pa																								
Description	Saturation pressure of H <sub>2</sub> O at temperature $T_t$ in time interval $t$																								
Measured/calculated/default	Default values as per selected literature.																								
Source of data	Data selected as per the literature " <i>Fundamentals of Classical Thermodynamics</i> ". Authors: Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4 <sup>th</sup> Edition. Published by John Wiley & Sons, Inc.																								
Value(s) of monitored parameter	$p_{H_2O,t,Sat}$ is determined as a function of temperature of LFG ( $T_t$ ) by the equation: $p_{H_2O,t,sat} = 1,031.3 * e^{(0.049 * T_t)}$ , with a correlation coefficient of $R^2 = 0.998$ . Further details are presented below in "Calculation Method".																								
Monitoring equipment	Not applicable.																								
Measuring/reading/recording frequency	Not applicable																								
Calculation method (if applicable)	<p>The Absolute Vapor Pressure of Water was obtained from the mentioned literature and is presented in the following table within the range of interest for the required calculations:</p> <table border="1"> <thead> <tr> <th>Temperature</th><th><math>p_{H_2O,t,Sat}</math></th></tr> <tr> <th>°C</th><th>Pa</th></tr> </thead> <tbody> <tr><td>30</td><td>4,246</td></tr> <tr><td>35</td><td>5,628</td></tr> <tr><td>40</td><td>7,384</td></tr> <tr><td>45</td><td>9,593</td></tr> <tr><td>50</td><td>12,349</td></tr> <tr><td>55</td><td>15,758</td></tr> <tr><td>60</td><td>19,940</td></tr> <tr><td>65</td><td>25,030</td></tr> <tr><td>70</td><td>31,190</td></tr> <tr><td>75</td><td>38,580</td></tr> </tbody> </table> <p>The following graphic represents the above data and the regression calculated to adjust data:</p>	Temperature	$p_{H_2O,t,Sat}$	°C	Pa	30	4,246	35	5,628	40	7,384	45	9,593	50	12,349	55	15,758	60	19,940	65	25,030	70	31,190	75	38,580
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	<p>As <math>p_{H_2O,t,Sat}</math> is a function of temperature and best represented by an exponential function, the exponential regression method is applied to the above data and the following equation is obtained:</p> $p_{H_2O,t,sat} = 1,031.3 * e^{(0.049 * Tt)}$ <p>This equation represents the above data with a correlation coefficient of <math>R^2 = 0.998</math>.</p> <p>Thus, by applying the above equation, <math>p_{H_2O,t,sat}</math> is determined as a function of the temperature.</p>
QA/QC procedures	Not applicable.
Purpose of data/parameter	Calculation of baseline emissions.
Additional comments	It is important to note that $p_{H_2O,t,Sat}$ is only used in the context of the determination of the methane mass flow in the residual gas (in a dry basis) for each minute $m$ of the two time periods in year $y$ during which the flare efficiency is measured (parameter $F_{CH_4,RG,t}$ ). The calculations of every-minute values of $p_{H_2O,t,Sat}$ for the 2 time periods during which the flare efficiency is measured is thus presented only in the flare efficiency calculation spreadsheet.

<b>Data/Parameter</b>	<b>EC<sub>PJ,captive,y</sub></b>																		
Unit	MWh																		
Description	Quantity of electricity generated in captive diesel backup generator during the year $y$																		
Measured/calculated/default	Measurements by the project participants.																		
Source of data	Electricity meters. While consumption of electricity sourced by the captive off-grid electricity generator is measured and registered in kWh, data is converted and also reported in MWh in order to meet data reporting requirement as per the monitoring plan from the PDD.																		
Value(s) of monitored parameter	<p>Monthly records of captive diesel sourced electricity consumption valid for the considered monitoring period:</p> <table border="1"> <thead> <tr> <th>Month</th><th>Amount of consumed diesel backup sourced electricity (MWh)</th></tr> </thead> <tbody> <tr><td>Jun. 2018</td><td>0.180</td></tr> <tr><td>Jul. 2018</td><td>0.463</td></tr> <tr><td>Aug. 2018</td><td>0</td></tr> <tr><td>Sep. 2018</td><td>1.032</td></tr> <tr><td>Oct. 2018</td><td>0.151</td></tr> <tr><td>Nov. 2018</td><td>0.046</td></tr> <tr><td>Dec. 2018</td><td>0.300</td></tr> <tr><td>Jan. 2019</td><td>0.230</td></tr> </tbody> </table>	Month	Amount of consumed diesel backup sourced electricity (MWh)	Jun. 2018	0.180	Jul. 2018	0.463	Aug. 2018	0	Sep. 2018	1.032	Oct. 2018	0.151	Nov. 2018	0.046	Dec. 2018	0.300	Jan. 2019	0.230
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Monitoring equipment	<p>There are 2 electricity meters to measure the amount of electricity sourced by the installed captive off-grid backup electricity generator, (fuelled by diesel). The highest measurement value from the set of meters is considered in the context of the determination of related project emissions. The installed electricity meters have the following specifications:</p> <ul style="list-style-type: none"> <li>- Manufacturer: Ello Sistemas Eletrônicos Ltda.</li> <li>- Model: 2106</li> <li>- Serial Number: 00008150 and 00045288</li> <li>- Accuracy: <math>\pm 1\%</math></li> <li>- Calibration frequency and maintenance requirements: 5 years</li> <li>- Calibration events valid for the monitoring period:</li> </ul>																		
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00045288	E0685/2016	25/03/2016	24/03/2021																
<p>Both calibration events were performed by LABELO - Laboratórios Especializados em Eletroeletrônica Calibração e Ensaios.</p>																			
<p>Both installed electricity meters are under operation since 08/02/2012. The installed instruments are made in Brazil and are of construction and design approved by the Brazilian Metrology authority INMETRO<sup>11</sup>. As part the manufacturing process and commercialization approvals valid for the installed electricity meters, such meters are not any longer required to be individually calibrated by the equipment manufacturer prior to be made available to commercialization and later utilization. The manufacturing, calibration, verification and testing procedures applicable for the installed electricity meters are regulated by the INMETRO's Decree No. 431 (dated 04/12/2007)<sup>12</sup>. This decree is currently replaced by the more recently passed INMETRO's Decree No. 587 (dated 05/11/2012)<sup>13</sup>. By taking into account the design and construction technology currently commonly applied for electronic electricity meters for active and reactive power, both Decree No. 431 and Decree No. 587 establish that homologated electronic electricity meters manufactured in Brazil in controlled production batches are to be calibrated, verified and tested on a sampling basis (by applying specific calibration, testing and verification procedures which are approved and prescribed by INMETRO).</p>																			
<p>Besides of the applicable calibration, verification and testing procedures under responsibility of the instrument manufacturer, as indicated in the</p>																			

<sup>11</sup> Information confirming the approval of the applied manufacturing and testing/verification procedures for the electricity meter model 2106 (manufactured by Ello Sistemas Eletrônicos Ltda.) is available online: <http://www.inmetro.gov.br/pam/pdf/PAM004192.pdf>

<sup>12</sup> The INMETRO's Decree No. 431 is available online: <http://www.inmetro.gov.br/rtac/pdf/RTAC001248.pdf>

<sup>13</sup> The INMETRO's Decree No. 587 is available online: <http://www.inmetro.gov.br/legislacao/rtac/pdf/RTAC001929.pdf>

	<p>operation and commissioning manual/report for the installed captive off-grid electricity generator<sup>14</sup> issued by 5EC Engenharia Ltda., the installed electricity meters S/N 00008150 and 00045288 were also tested and approved as part of the related commissioning work performed by 5EC Engenharia Ltda. Results of performed field verifications in the instruments are presented in the operation and commissioning manual/report for the installed captive off-grid electricity generator.</p> <p>By taking into account above-presented information and also by considering that the electricity meters are to be calibrated at least every 5 years (as declared in the service and operation manual for the installed electricity meters<sup>15</sup>), the installed instruments are under conformance with applicable calibration requirements.</p>
Measuring/reading/recording frequency	The reading of each meter is recorded manually every month and converted (reported) to spreadsheets.
Calculation method (if applicable)	Not applicable.
QA/QC procedures	
Purpose of data/parameter	Data is used for the determination of project emissions.
Additional comments	During the present monitoring period the values registered by the two meters are exactly the same.

The following monitoring parameters (which are also included in the monitoring plan of the PDD) were not monitored as the methodological options for which they are applicable were not selected as the monitoring or calculation approaches for the determination of baseline emissions and/or project emissions achieved by the project activity during the considered monitoring period:

- Volumetric flow of LFG stream in time interval  $t$  on a dry basis for  $j$  (where  $j$  is the LFG delivery pipeline to each item of electricity generation and LFG delivery pipeline to the flare(s)) ( $V_{t,db,j}$ )
- Volumetric fraction of  $CH_4$  in the collected LFG in time interval  $t$  on a dry basis for  $j$  (where  $j$  is the LFG delivery pipeline to each item of electricity generation and LFG delivery pipeline to the flare(s)) ( $V_{CH_4,t,db,j}$ )
- Mass flow of the LFG stream in time interval  $t$  on dry basis for  $j$  (where  $j$  is the LFG delivery pipeline to each item of electricity generation and LFG delivery pipeline to the flare(s)) ( $M_{t,db,j}$ )
- Quantity of fuel Diesel combusted by the captive off-grid electricity generator ( $FC_{Diesel,y}$ )
- Net calorific value of the fuel Diesel in year  $y$  ( $NCV_{Diesel,y}$ )
- $CO_2$  emission factor of fuel Diesel in year  $y$  ( $EF_{CO_2,Diesel,y}$ )
- Quantity of electricity generated in captive diesel backup generator during the year  $y$  ( $EG_{Diesel-Generator,y}$ )

<sup>14</sup> The operation and commissioning manual/report for the installed equipment package of the captive off-grid electricity generator (fuelled by diesel) is titled "SCQB SMCEE Manual de Oper. e Manut. - GERADOR ass PP". The results of the performed measurement tests in the installed electricity meters are presented under Section "Relatório de Verificação Inicial" of the manual/report.

<sup>15</sup> The service and operation manual for the installed electricity meter 2106 model manufactured by Ello Sistemas Eletrônicos Ltda. is available online: [http://www.elonet.com.br/downloads/man2106\\_002.pdf](http://www.elonet.com.br/downloads/man2106_002.pdf)



Moreover, the monitoring parameters “Tariff of the electricity exported” (Tariff of electricity exported) and “Total investment to implement the project and total cost to operate the project” (CAPEX and OPEX) from the monitoring plan of the PDD were also not monitored during the considered period. As per ACM0001 (version 15.0), both parameters are only to be monitored “*At the first issuance request after each phase of the project is fully implemented*”. While both parameters were monitored and presented in the Monitoring Report for the previous 9<sup>th</sup> monitoring period (which was the first monitoring period after the implementation of the project’s electricity generation infrastructure (project’s phase 2)) and since there are no other phases of the project activity to be implemented, monitoring of Tariff of electricity exported and CAPEX and OPEX is no longer necessary.

### D.3. Implementation of sampling plan

>>

Not applicable.

## SECTION E. Calculation of emission reductions or net anthropogenic removals

### E.1. Calculation of baseline emissions or baseline net removals

>>

Baseline emissions ( $BE_y$ ) are determined (in  $tCO_2e$ ) as follows:

$$BE_y = BE_{CH_4,y} + BE_{EC,y}$$

Where:

$BE_{CH_4,y}$  Baseline emissions of methane from the SWDS<sup>16</sup>.

$BE_{EC,y}$  Baseline emissions associated with electricity generation in year  $y$  (in  $tCO_2/yr$ ).

#### Determination of baseline emissions associated with electricity generation ( $BE_{EC,y}$ )

Baseline emissions associated with electricity generation ( $BE_{EC,y}$ ) is determined as follows:

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

Where:

$EC_{BL,y}$  Amount of electricity generated using LFG in year  $y$  (in MWh). As per the applied monitoring procedure, monthly records of net electricity generated by the project activity (using collected LFG as gaseous fuel) for the considered monitoring period are summarized below:

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<sup>16</sup> SWDS = Solid Waste Disposal Site. For the case of the project activity, the SWDS is the CRR landfill.

Month	Amount of electricity generated using LFG (kWh)
Jun. 2018	5,275.201
Jul. 2018	5,194.483
Aug. 2018	5,495.608
Sep. 2018	4,836.310
Oct. 2018	5,196.852
Nov. 2018	5,153.727
Dec. 2018	5,236.517
Jan. 2019	4,699.624

Additional monitoring details about the monitoring parameter  $EC_{BL,y}$  are included in Section D.2.

$EF_{EL,grid,y}$  Emission factor for grid sourced electricity in year  $y$  (in  $tCO_2/MWh$ ).  $EF_{EL,grid,y}$  is determined as the combined margin emission factor ( $EF_{grid,CM,y}$ ) that is calculated as the weighted average of the operating margin and build margin emission factors. To weight these two factors, the default values applicable to both for the 2<sup>nd</sup> crediting period are applied. The combined margin emission factor is thus obtained as follows:

$$EF_{EL,grid,y} = EF_{grid,CM,y} = w_{OM} * EF_{grid,OM,y} + w_{BM} * EF_{grid,BM,y}$$

Where:

$w_{OM}$  Weighting of operating margin emissions factor.  $w_{OM}$  is ex-ante selected as 0.25. Further details about the ex-ante selected parameter  $w_{OM}$  are included in Section D.1 and in the PDD.

$w_{BM}$  Weighting of operating margin emissions factor.  $w_{BM}$  is ex-ante selected as 0.75. Further details about the ex-ante selected parameter  $w_{BM}$  are included in Section D.1 and in the PDD.

$EF_{grid,OM,y}$  Operating margin  $CO_2$  emission factor in year  $y$  (in  $tCO_2/MWh$ ). Selected values for the monitoring parameter  $EF_{grid,OM,y} = EF_{grid,OM-DD,y}$  represent the official annual average value for year 2018 and the official average monthly value for January 2019 as calculated and published by the DNA of Brazil. Values are summarized below:

Period	Operating margin emission factor ( $tCO_2/MWh$ )
01/06/2018 to 31/12/2018	0.5390
01/01/2019 to 31/01/2019	0.5652

Further details about the monitoring parameter  $EF_{grid,OM}$  are included in Section D.2.

$EF_{grid,BM,y}$  Build margin CO<sub>2</sub> emission factor in year  $y$ .  $EF_{grid,BM}$  is ex-ante determined as 0.2963 tCO<sub>2</sub>/MWh. Further details about the ex-ante determined parameter  $EF_{grid,BM}$  are included in Section D.1.

For the considered monitoring period,  $EF_{EL,grid,y}$  is thus calculated as follows:

Month	Monthly values of $EF_{EL,grid,y}$ (tCO <sub>2</sub> /MWh)
June 2018 – December 2018	0.3570
Jan. 2019	0.3635

$TDL_{grid,y}$  Average technical transmission and/or distribution losses for providing electricity to the grid and/or for grid sourced electricity consumed by the project activity. For the particular case of determination of  $BE_{EC,y}$ ,  $TDL_{grid,y}$  is ex-ante determined as being 3% ( $TDL_{grid,export,y}$ ).

Baseline emissions associated with electricity generation in year  $y$  ( $BE_{EC,y}$ ) for the considered monitoring period are calculated and reported as 15,136 tCO<sub>2</sub>. All related calculation are presented in an emission reduction calculation spreadsheet that is enclosed to the Monitoring Report.

*Determination of baseline emissions of methane from the SWDS ( $BE_{CH4,y}$ ):*

Baseline emissions of methane from the SWDS ( $BE_{CH4,y}$ ) are determined as follows:

$BE_{CH4,y}$  Baseline emissions of methane from the SWDS<sup>17</sup>. As established by both ACM0001 (version 15.0) and the PDD, the determination of  $BE_{CH4,y}$  is based on the amount of methane that is actually captured and combusted (through destruction of collected LFG in the flare and utilization of collected LFG as gaseous fuel for electricity generation) by the project activity. As established by both ACM0001 (version 15.0) and the PDD, the amount of methane that, in the absence of the project activity (baseline scenario), would be otherwise captured and destroyed in the landfill (by the pre-project previously existent conventional LFG destruction system) is also taken into account. In addition, the effect of methane oxidation (that, as per ACM0001 (version 15.0) is assumed as existing in the baseline and not in the project scenario) is also taken into account.  $BE_{CH4,y}$  is thus 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 in the LFG that would be oxidized in the top layer of the SWDS in the baseline scenario.  $OX_{top\_layer}$  is ex-ante determined as 10%. Further details about the selection of the value for  $OX_{top\_layer}$  is included in Section D.1 and in the PDD.

$GWP_{CH4,y}$  Global warming potential of CH<sub>4</sub>.  $GWP_{CH4}$  is ex-ante determined as 25. Further details about the selection of the value for  $GWP_{CH4}$  is included in Section D.1 and in the PDD.

<sup>17</sup> SWDS = Solid Waste Disposal Site. For the case of the project activity, the SWDS is the CRR landfill.

$F_{CH_4,BL,y}$ 

Amount of methane in the LFG that would be flared in the baseline scenario (absence of project activity). As outlined in Section B.6.1 of the PDD,  $F_{CH_4,BL,y}$  is calculated as follows:

$$F_{CH_4,BL,y} = 0.2 * F_{CH_4,PJ,capt,y}$$

Where:

 $F_{CH_4,PJ,capt,y}$ 

Amount of methane collected by the project activity. In the particular case of the project activity and for the considered monitoring period, while collected LFG was sent for combustion in both the high temperature enclosed flare and in the engine-generator sets of the project's electricity generation infrastructure,  $F_{CH_4,PJ,capt,y}$  is thus determined as follows for such period:

$$F_{CH_4,PJ,capt,y} = F_{CH_4,sent,flare,y} + F_{CH_4,EL,y}$$

Where:

 $F_{CH_4,EL,y}$ 

Amount of methane in the LFG which is used for electricity generation in year  $y$  (in  $tCH_4/yr$ ). Details for the determination of every-minute values for  $F_{CH_4,EL,y}$  are presented below (under "*Determination of every-minute values for the calculation parameters  $F_{CH_4,sent,flare,y}$  and  $F_{CH_4,EL,y}$* ").

For the considered monitoring period, the accumulated value for  $F_{CH_4,BL,y}$  is calculated and reported as 2,763  $tCH_4$ . All related calculation are presented in the monthly emission reduction calculation spreadsheets that are enclosed to the Monitoring Report.

 $F_{CH_4,PJ,y}$ 

Amount of methane in the LFG which is flared and/or used in the project activity. In the particular case of the project activity,  $F_{CH_4,PJ,y}$  is determined as follows:

$$F_{CH_4,PJ,y} = F_{CH_4,flared,y} + F_{CH_4,EL,y}$$

Where:

 $F_{CH_4,EL,y}$ 

Amount of methane in the LFG which is used for electricity generation in year  $y$  (in  $tCH_4/yr$ ). Details for the determination of every-minute values for  $F_{CH_4,EL,y}$  for each individual engine-generator during the the considered monitoring period are presented below (under "*Determination of every-minute values for the calculation parameters  $F_{CH_4,sent,flare,y}$  and  $F_{CH_4,EL,y}$* ").

 $F_{CH_4,flared,y}$ 

Amount of methane in the LFG flared by the project activity (in  $tCH_4$ ) during the whole monitoring period. In accordance with calculation guidance included in the PDD and by following applicable guidance of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", for each individual flare every-

minute values for  $F_{CH4,flared,y}$  are determined as the difference between the amount of methane supplied to the flare and residual methane emissions from combustion of LFG in the flare, as follows:

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

Where:

$F_{CH4,sent\_flare,y}$  Amount of methane in the LFG which is sent to the flare.

Details for the determination of every-minute values for  $F_{CH4,sent\_flare,y}$  for each individual flare are presented below (under “*Determination of every-minute values for the calculation parameters  $F_{CH4,sent\_flare,y}$  and  $F_{CH4,EL,y}$* ”).

$PE_{flare,y}$  Project emissions from flaring of the residual gas stream.

Details for the determination of every-minute values for  $PE_{flare,y}$  for each individual flare are presented below (under “*Determination of  $PE_{flare,y}$* ”).

*Determination of every-minute values for the calculation parameters  $F_{CH4,sent\_flare,y}$  and  $F_{CH4,EL,y}$ :*

For the considered monitoring period, Option C of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (where the gaseous stream the tool shall be applied to is the stream of collected LFG that is sent to the flare and to the electricity generation infrastructure)<sup>18</sup> is the selected option for determination of values of  $F_{CH4,sent\_flare,y}$  (applicable for flare) and independent values of  $F_{CH4,EL,y}$  (applicable for each individual engine-generator set of the electricity generation infrastructure (based on the calculation of the sub-parameters  $F_{CH4,EL,y, genset-1}$ ,  $F_{CH4,EL,y, genset-2}$ ,  $F_{CH4,EL,y, genset-3}$ ,  $F_{CH4,EL,y, genset-4}$ ,  $F_{CH4,EL,y, genset-5}$ ,  $F_{CH4,EL,y, genset-6}$ )).

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

By following calculation option C (that is one of the applicable calculation methods the PDD refers to), the mass flow of greenhouse gas  $i$  ( $F_{i,t}$ ) ( $i = CH_4$ ) for the installed flare during the whole considered monitoring period is determined as follows:

$$F_{CH4,sent\_flare,y} = F_{CH4,t} = V_{t,wb,n,flare} * V_{CH4,t,wb,flare} * \rho_{CH4,n}$$

Where:

$V_{t,wb,n,flare}$  Volumetric flow of the gaseous stream (LFG) to the flare in time interval  $t$  on a wet basis at normal conditions. For the considered monitoring period, every-minute values of the calculation parameter  $V_{t,wb,n,flare}$  are measured and reported (in Nm<sup>3</sup> wet gas/h) in the monthly emission reduction calculation spreadsheets valid for the considered monitoring period (and enclosed to this Monitoring Report). While in the

<sup>18</sup> It is relevant to note that the PDD states the following regarding the calculation approach for values of  $F_{CH4,sent\_flare,y}$  and  $F_{CH4,EL,y}$ :

“Applicable guidance of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” will be applied to determine  $F_{CH4,sent\_flare,y}$  and  $F_{CH4,EL,y}$  by using Option 2: Simplified calculation without measurement of the moisture content, and one of the options A, C or D. The selection of the determination option will depend on project conditions and equipment to be installed.”

particular case of the project activity, during the considered monitoring period, volumetric flow of the gaseous stream (LFG) is already measured in Nm<sup>3</sup> of wet gas/h (normal conditions), the following assumption is thus valid:

$V_{t,wb,n,flare}$  is equivalent to  $V_{t,wb,flare}$

Where:

$V_{t,wb,flare}$  Volumetric flow of the gaseous stream (LFG) sent to the flare in time interval  $t$  on a wet basis (in actual conditions)

Note: in accordance with the PDD, since measurements of LFG flow sent to the flare are automatically converted and recorded in normalized cubic meters (by considering standard temperature and pressure (STP) conditions), monitoring of "Pressure of the LFG stream in time interval  $t$ " ( $P_t$ ) and "Temperature of the LFG stream in time interval  $t$ " ( $T_t$ ) are thus not required for the determination of  $V_{t,wb,n,flare}$ . Further monitoring details about the monitoring parameter  $V_{t,wb,flare}$  are included in Section D.2.

$V_{CH_4,t,wb}$  Volumetric fraction of CH<sub>4</sub> in the gaseous stream in time interval  $t$  on a wet basis. As per the applied monitoring procedure, every-minute values of the monitoring parameter  $V_{CH_4,t,wb}$  (in m<sup>3</sup> of CH<sub>4</sub> / m<sup>3</sup> of wet LFG) are reported in the monthly emission reduction calculation spreadsheet valid for the considered monitoring period (and enclosed to this Monitoring Report). Further monitoring details about the monitoring parameter  $V_{CH_4,t,wb}$  are included in Section D.2.

$\rho_{CH_4,n}$  Density of CH<sub>4</sub> in the gaseous stream (LFG) at normal conditions. For the considered monitoring period, value of  $\rho_{CH_4,n}$  (in kg of CH<sub>4</sub> / m<sup>3</sup> of CH<sub>4</sub>) is calculated and reported in the monthly emission reduction calculation spreadsheet valid for the considered monitoring period (and enclosed to this Monitoring Report) as follows:

$$\rho_{CH_4,n} = (P_n * MM_i) / (R_u * T_n)$$

Where:

$P_n$  Absolute pressure at normal conditions.  $P_n$  is ex-ante determined as 101,325 Pa. Further details about the ex-ante determined parameter  $P_n$  are included in Section D.1 and in the PDD.

$T_n$  Temperature at normal conditions.  $T_n$  is ex-ante determined as 273.15 Kelvin. Further details about the ex-ante determined parameter  $T_n$  are included in Section D.1 and in the PDD.

$MM_i$  Molecular mass of greenhouse gas  $i$  ( $i = CH_4$ ).  $MM_i$  ( $i = CH_4$ ) is ex-ante determined as 16.04 kg/mol. Further details about the ex-ante determined parameter  $MM_i$  ( $i = CH_4$ ) are presented in Section D.1 and in the PDD.

$R_u$  Universal ideal gases constant.  $R_u$  is ex-ante determined as 8,314 Pa.m<sup>3</sup> /kmol.K. Further details about the ex-ante determined parameter  $R_u$  are presented in Section D.1 and in the PDD.

$\rho_{CH_4,n}$  is calculated as 0.7156650 kgCH<sub>4</sub> / m<sup>3</sup>CH<sub>4</sub> as reported in the monthly emission reduction calculation spreadsheet valid for the considered monitoring period.

$F_{CH4,EL,y}$  (calculation sub-parameters  $F_{CH4,EL,y,genset-1}$ ,  $F_{CH4,EL,y,genset-2}$ ,  $F_{CH4,EL,y,genset-3}$ ,  $F_{CH4,EL,y,genset-4}$ ,  $F_{CH4,EL,y,genset-5}$ ,  $F_{CH4,EL,y,genset-6}$ ):

By following calculation option C (that is one of the applicable calculation methods the PDD refers to), the mass flow of greenhouse gas  $i$  ( $F_{i,t}$ ) ( $i = CH_4$ ) to each individual engine-generator set of the project's electricity generation infrastructure ( $F_{CH4,EL,y,genset-1}$ ,  $F_{CH4,EL,y,genset-2}$ ,  $F_{CH4,EL,y,genset-3}$ ,  $F_{CH4,EL,y,genset-4}$ ,  $F_{CH4,EL,y,genset-5}$ ,  $F_{CH4,EL,y,genset-6}$ ) is determined as follows:

$$F_{CH4,EL,y,genset-n} = V_{t,wb,n,genset-n} * V_{CH4,t,wb,flare} * \rho_{CH4,n}$$

Where:

$n$  The engine-generator set in question ( $n = 1, 2, 3, 4, 5$  and  $6$ )

$V_{t,wb,n,genset-n}$  Volumetric flow of the gaseous stream (LFG) to the engine-generator set  $n$  in time interval  $t$  on a wet basis at normal conditions. For the considered monitoring period, every-minute values of the calculation parameters  $V_{t,wb,n,genset-n}$  are calculated and reported (in  $Nm^3$  wet gas/h) in the monthly emission reduction calculation spreadsheets valid for the considered monitoring period (and enclosed to the Monitoring Report). While in the particular case of the project activity, during the considered monitoring period, measurements of volumetric flow of the gaseous stream (LFG) sent to each one of the engine-generator sets  $n$  are not processed and recorded in  $Nm^3$  of wet gas/h (normal conditions), values of  $V_{t,wb,n,genset-n}$  valid for each minute encompassed by monitoring period are thus calculated as follows:

Under conformance with related provisions of the PDD, the following equation is used to convert the measured volumetric flow of LFG sent to the engine-generator sets from actual conditions to normal conditions of temperature and pressure:

$$V_{t,wb,n,genset-n} = V_{t,wb,genset-n} * (T_n / T_{tgenset-n}) * (P_{tgenset-n} / P_n)$$

Where:

$V_{t,wb,genset-n}$  Volumetric flow of the gaseous stream (LFG) to the engine-generator set  $n$  in time interval  $t$  on a wet basis at actual conditions. Every-minute values of  $V_{t,wb,genset-n}$  for each engine-generator set  $n$  (where  $n = 1, 2, 3, 4, 5$  and  $6$ ) are reported (in  $m^3$  wet gas/h) in the monthly emission reduction calculation spreadsheets enclosed to the Monitoring Report. Further monitoring details about the sub-parameters  $V_{t,wb,genset-n}$  are included under details for the monitoring parameter  $V_{t,wb,flare}$  in Section D.2.

$T_{tgenset-n}$  Temperature of the gaseous stream in time interval  $t$ . Every-minute values of  $T_{tgenset-n}$  for each engine-generator set  $n$  are reported (in Kelvin) in the monthly emission reduction calculation spreadsheets enclosed to the Monitoring Report. Further monitoring details about the sub-parameters  $T_{tgenset-n}$  are included under details for the monitoring parameter  $T_t$  in Section D.2.

$T_n$  Temperature at normal conditions.  $T_n$  is ex-ante determined as 273.15 Kelvin. Further details about the ex-ante determined parameter  $T_n$  are included in Section D.1 and in the PDD.

$P_{tgenset-n}$  Pressure of the gaseous stream in time interval  $t$ . Every-minute values of  $P_{tgenset-n}$  for each engine-generator set  $n$  are reported (in Pa) in the monthly emission reduction calculation spreadsheets enclosed to the Monitoring Report. Further monitoring details about

the sub-parameters  $P_{\text{tgenset-}n}$  are included under details for the monitoring parameter  $P_t$  in Section D.2.

$P_n$	Absolute pressure at normal conditions. $P_n$ is ex-ante determined as 101,325 Pa. Further details about the ex-ante determined parameter $P_n$ are included in Section D.1 and in the PDD.
$n$	Number of the installed engine-generator set. $n = 1, 2, 3, 4, 5$ and $6$ .

All related calculation are presented in the monthly emission reduction calculation spreadsheets that are enclosed to the Monitoring Report.

$V_{\text{CH}_4,t,\text{wb}}$	Volumetric fraction of $\text{CH}_4$ in the gaseous stream in time interval $t$ on a wet basis. Further monitoring details about the monitoring parameter $v_{\text{CH}_4,t,\text{wb}}$ are included above and in Section D.2.
$\rho_{\text{CH}_4,n}$	Density of $\text{CH}_4$ in the gaseous stream (LFG) at normal conditions. $\rho_{\text{CH}_4,n}$ is calculated as $0.7156650 \text{ kgCH}_4 / \text{m}^3\text{CH}_4$ as reported in the monthly emission reduction calculation spreadsheet valid for the considered monitoring period. Details about the determination of $\rho_{\text{CH}_4,n}$ are presented above.

#### Determination of $PE_{\text{flare},y}$ :

$PE_{\text{flare},y}$  is determined by following the applicable stepwise guidance of the methodological tool “Project emissions from flaring” (version 2). Every minute values for  $PE_{\text{flare},y}$  are determined as a function of every-minute records of mass flow of methane sent to the flare as well as based on calculated values for flare efficiency ( $\eta_{\text{flare},m} = \eta_{\text{flare},\text{calc},y}$ ) as follows:

$$PE_{\text{flare},y} = GWP_{\text{CH}_4} * \sum_{m=1}^{525,600} F_{\text{CH}_4,\text{RG},m} * (1 - \eta_{\text{flare},m}) * 10^{-3}$$

Where:

$F_{\text{CH}_4,\text{RG},m}$	Methane mass flow in the residual gas of the flare. For each minute $m$ of the considered monitoring period, values for $F_{\text{CH}_4,\text{RG},m}$ are equal to every-minute reported measurement records of the calculation sub-parameter “Amount of methane in the LFG which is sent to the flare” ( $F_{\text{CH}_4,\text{sent\_flare},y}$ ).
$\eta_{\text{flare},m}$	Flare efficiency in minute $m$ . For the considered monitoring period, $\eta_{\text{flare},m}$ is calculated based on performed measurements of methane in the exhaust gas of the flare by following applicable guidance as per Option B (Measured flare efficiency) of the methodological tool “Project emissions from flaring” from which the following related guidance of the PDD is applied:

“(…)

#### Option B: Measured flare efficiency:

*For each high temperature enclosed flare installed as part of the project activity, the flare efficiency in the minute  $m$  is determined as a value which is calculated based on performed related measurements ( $\eta_{\text{flare},m} = \eta_{\text{flare},\text{calc},m}$ ) when the following two 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  $T_{\text{EG},m}$ ) and the flow rate LFG to the flare (monitoring parameter  $F_{\text{RG},m}$ ) is within the manufacturer’s specification for the flare ( $\text{SPEC}_{\text{flare}}$ ) in minute  $m$*
- (2) *Flame is detected in the flare in minute  $m$  (monitoring parameter  $\text{Flame}_m$ ).*

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



(...)"

In applying Option B, the project participants chose to determine  $\eta_{\text{flare,calc,m}}$  by applying the guidance of Option B.1 (with related measurements of emission of methane in the exhaust gas of the flare being performed by an accredited independent third party entity (e.g. an independent inspection/analysis service company) on a biannual basis).

In order to calculate the flare efficiency value for the installed flare ( $\eta_{\text{flare,calc,m}}$ ) biannual values for the monitoring parameter "Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period  $t$ " ( $F_{\text{CH}_4,\text{EG},t}$ ) are considered as per the following calculation formula:

Option B.1: Biannual measurement of the flare efficiency":

The calculated flare efficiency  $\eta_{\text{flare,calc,y}}$  for the installed flare is determined as follows:

$$\eta_{\text{flare,calc,y}} = 1 - \frac{1}{2} \sum_{t=1}^2 \left( \frac{F_{\text{CH}_4,\text{EG},t}}{F_{\text{CH}_4,\text{RG},t}} \right)$$

Where:

$F_{\text{CH}_4,\text{EG},t}$  Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period  $t$ . As established by the PDD, for the considered monitoring period,  $F_{\text{CH}_4,\text{EG},t}$  was measured as per appropriate national or international standard during 2 set of measurement events encompassed by the considered monitoring period. 1-hour length biannual measurements of residual methane in the exhaust gas of the flare and measurements of speed of exhaust gas of the flare (for the determination of flow of methane exhaust gas of the flare) were performed by the third party inspection service company BIOAGRI Ambiental Ltda / Mérieux NutriSciences Brasil, an inspection service company which is specialized in emission measurements and air pollution inspections. Further monitoring details for  $F_{\text{CH}_4,\text{EG},t}$  are presented in Section D.2.

$t$  The two time periods in year  $y$  during which the flare efficiency is measured, each a minimum of one hour and separated by at least six months.

$F_{\text{CH}_4,\text{RG},t}$  Mass flow of methane in the residual gas on a dry basis at reference conditions in the time period  $t$ . Details for the determination of every-minute values for  $F_{\text{CH}_4,\text{RG},t}$  are presented below.

*Determination of  $F_{\text{CH}_4,\text{RG},t}$ :*

As per the applicable guidance of the methodological tool "Project emissions from flaring" and also as per the PDD, the methane mass flow in the residual gas (in a dry basis) for each minute  $m$  of the two time periods in year  $y$  during which the flare efficiency is measured shall be calculated by following the applicable guidance of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". Values for the parameter  $F_{\text{CH}_4,\text{RG},t}$  are thus calculated as follows:

$$F_{\text{CH}_4,\text{RG},t} = V_{t,\text{db},n} * v_{\text{CH}_4,t,\text{db}} * \rho_{\text{CH}_4,n}$$

Where:

$\rho_{CH_4,n}$  Density of greenhouse gas  $i$  ( $i = CH_4$ ) in the gaseous stream (LFG) at normal conditions. Further details for the determination of  $\rho_{CH_4,n}$  are presented above under the sub-section “*Determination of every-minute values for the calculation parameter  $F_{CH_4,sent\_flare,y}$* ”.

$v_{CH_4,t,db}$  Volumetric fraction of greenhouse gas  $i$  ( $i = CH_4$ ) in the gaseous stream in a time interval  $t$  on a dry basis. The following is stated in footnote 3 of the methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”:

*“(...) 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 analyzers and dry basis analyzers (...).”*

Thus, every-minute values of  $v_{CH_4,t,db}$  are regarded as equal to every-minute values of the monitoring parameter  $v_{CH_4,t,wb}$  (for which further details are presented above under the sub-section “*Determination of every-minute values for the calculation parameter  $F_{CH_4,sent\_flare,y}$* ”).

$V_{t,db,n,flare}$  Volumetric flow of the gaseous stream (LFG) in time interval  $t$  on a dry basis which is sent to the flare. As per Option B of the applicable methodological “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, the volumetric flow of the gaseous stream on a dry basis which is sent to the flare is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,db,n,flare} = V_{t,wb,n,flare} / (1 + v_{H_2O,t,db})$$

Where:

$V_{t,wb,n,flare}$  Volumetric flow of the gaseous stream (LFG) in time interval  $t$  on a wet basis at normal conditions. Further details of  $V_{t,wb,n}$  are presented above under the sub-section “*Determination of every-minute values for the calculation parameter  $F_{CH_4,sent\_flare,y,flare}$* ”

$v_{H_2O,t,db}$  Volumetric fraction of  $H_2O$  in the gaseous stream in time interval  $t$  on a dry basis. As per applicable guidance of the methodological “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”,  $v_{H_2O,t,db}$  is calculated as follows:

$$v_{H_2O,t,db} = \frac{m_{H_2O,t,db} * MM_{t,db}}{MM_{H_2O}}$$

Where:

$MM_{H_2O}$  Molecular mass of  $H_2O$ .  $MM_{H_2O}$  is ex-ante determined as 18.0152 kg/kmol. Further details about the ex-ante determined parameter  $MM_{H_2O}$  are included in Section D.1 and in the PDD.

$MM_{t,db}$  Molecular mass of the gaseous stream in time interval  $t$  on a dry basis. As per applicable guidance of the methodological “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”,  $MM_{t,db}$  is calculated as follows:

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

Where:

$k$  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.

$V_{k,t,db}$  Volumetric fraction of gas  $k$  in the gaseous stream in time interval  $t$  on a dry basis. Applicable guidance of the methodological “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” states the following:  
*“(…) 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.”*

ACM0001 (version 15.0) 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) should be measured and the difference to 100% is just considered as pure nitrogen. Further details for the determination of the volumetric

fraction of CH<sub>4</sub> in the gaseous stream ( $V_{k,t,db} = V_{CH_4,t,db}$ ) are presented above under the calculation parameter  $V_{CH_4,t,db}$ .

$MM_k$  Molecular mass of gas  $k$  ( $k = CH_4$  and  $N_2$ ). The molecular mass of  $CH_4$  and  $N_2$  are ex-ante determined as 16.04 and 28.01, respectively.  
Further details about the ex-ante determined values for  $MM_k$  are included in Section D.1 and in the PDD.

$m_{H_2O,t,db}$  Absolute humidity in the gaseous stream in time interval  $t$  on a dry basis.  
As per Option 2 of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream", by conservatively assuming that the gaseous stream is saturated ( $m_{H_2O,t,db} = m_{H_2O,t,db,Sat}$ ),  $m_{H_2O,t,db}$  is calculated as follows<sup>19</sup>:

$$m_{H_2O,t,db,Sat} = \frac{P_{H_2O,t,Sat} * MM_{H_2O}}{(P_t - P_{H_2O,t,Sat}) * MM_{t,db}}$$

Where:

$MM_{H_2O}$  Molecular mass of H<sub>2</sub>O.  $MM_{H_2O}$  is ex-ante determined as 18.0152. Further details about the ex-ante determined values for  $MM_{H_2O}$  are

<sup>19</sup> It is important to note that the simplified approach for the calculation of the absolute humidity of the gaseous stream ( $m_{H_2O,t,db}$ ) as presented in Option 2 of the methodological "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" shall be applied by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. Footnote 4 of the "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" explicitly states the following:

*"An assumption that the gaseous stream is saturated is conservative for the situation that the mass flow of greenhouse gas  $l$  is underestimated (applicable for calculating baseline emissions). Conversely, an assumption that the gas stream is dry is conservative for the situation that the greenhouse gas  $t$  is overestimated (applicable for calculating project emissions)."*

In this particular case,  $m_{H_2O,t,db}$  is calculated for the determination of the mass flow of methane in the residual gas on a dry basis during the time period  $t$  ( $F_{CH_4,RG,t}$ ). While  $F_{CH_4,RG,t}$  is used for the determination of the parameter  $PE_{flare,y}$  (project emissions from flaring the residual gas), the assumption that the gaseous stream is dry (conservatively applicable for calculating project emissions) would not be conservative in this case as an overestimation of the amount of methane in the residual gas would actually increase the calculated efficiency of the flare, thus resulting in a reduction of  $PE_{flare,y}$  and consequent increment of emission reductions during the considered monitoring period.

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included in Section D.1  
and in the PDD.

$P_t$	<p>Absolute pressure of the gaseous stream in time interval <math>t</math>. Further monitoring details for <math>P_t</math> are included in Section D.2.</p>
$MM_{t,db}$	<p>Molecular mass of the gaseous stream in a time interval <math>t</math> on a dry basis. Further details for the determination of <math>MM_{t,db}</math> are presented above.</p>
$p_{H_2O,t,Sat}$	<p>Saturation pressure of <math>H_2O</math> at temperature <math>T</math> in time <math>t</math>. Further monitoring details about the monitoring parameter <math>p_{H_2O,t,Sat}</math> are included in Section D.2.</p>

In summary, for the considered monitoring period, a value of 0.8994611 was obtained for the parameter  $\eta_{flare,m} = \eta_{flare,calc,y}$ . For every minute encompassed by the considered monitoring period, the validity of the determined value for  $\eta_{flare,m} = \eta_{flare,calc,y}$  is dependent on fully meeting applicable flare operational criteria/requirements as explained below:

*Meeting of applicable flare operational criteria/requirements:*

As per the applied monitoring procedure, compliance with operational and maintenance requirements for the flare, as established by the *ex-ante* determined parameter “Manufacturer’s flare specifications for temperature, flow rate and maintenance schedule interval” ( $SPEC_{flare}$ ), is also considered for the determination and application of the values of  $\eta_{flare,m} = \eta_{flare,calc,y}$  for the determination of  $F_{CH_4,PJ,y} = F_{CH_4,flared,y}$  along the considered monitoring period. This is reflected in the monthly emission reduction spreadsheets. Data records for the monitoring parameter “Flame detection of flare in the minute  $m$ ” ( $Flame_m$ ) are also considered for the determination and application of the values of  $\eta_{flare,m}$  for the determination of values of  $F_{CH_4,PJ,y} = F_{CH_4,flared,y}$  along the considered monitoring period. This is reflected in the monthly emission reduction spreadsheet.

The time the flare has operated is determined by monitoring the flame combustion status/condition by using an UV flame detector (of which status signal (flame status “on” or “off”) is continuously recorded and reported). Moreover, the monitoring requirements related to operational requirements/conditions for the flare (as provided by the manufacturer’s specifications for operating conditions as per the *ex-ante* determined parameter  $SPEC_{flare}$  (min. and max. flow of LFG to the flare + min and max. temperature of exhaust gas of the flare + meeting of maintenance

requirements) are also considered in the context of the application of determined values for  $\eta_{\text{flare},m}$  along the considered monitoring period. As outlined in the monthly emission reduction spreadsheets, for each minute  $m$  within the considered monitoring period when the flare have combusted LFG by not operating in accordance with all the operational criteria/requirements as established by the ex-ante estimated parameter  $\text{SPEC}_{\text{flare}}$  (in terms of LFG flow, temperature of exhaust gas or maintenance practice), no destruction of methane is accounted as part of the calculation values of  $F_{\text{CH}_4,\text{PJ},y} = F_{\text{CH}_4,\text{flared},y}$  achieved by the project activity. The monthly emission reduction calculation spreadsheets enclosed to the Monitoring Report includes the compliance/meeting of all the operational criteria/requirements as established by the ex-ante estimated parameter  $\text{SPEC}_{\text{flare}}$  (in terms of LFG flow, temperature of exhaust gas or maintenance practice) during every single minute of the considered monitoring period.

For the considered monitoring period, the accumulated value for  $F_{\text{CH}_4,\text{PJ},y} = F_{\text{CH}_4,\text{flared},y} + F_{\text{CH}_4,\text{EL},y}$  is calculated as 14,488 tCH<sub>4</sub>.

For the considered monitoring period, baseline emissions of methane from the SWDS ( $\text{BE}_{\text{CH}_4,y}$ ) are calculated as 256,905 tCO<sub>2e</sub>.

The summarized emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) summarizes the determination of  $\text{BE}_y = \text{BE}_{\text{CH}_4,y} + \text{BE}_{\text{EC},y}$  for the considered monitoring period. For the considered monitoring period,  $\text{BE}_y = 272,041$  tCO<sub>2e</sub>

## E.2. Calculation of project emissions or actual net removals

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Despite of encompassing an electricity generation infrastructure using collected LFG as gaseous fuel, the project activity demands consumption of grid-sourced electricity and/or electricity sourced by the installed backup off-grid electricity generator (fuelled by diesel) whenever the project's electricity generation is not under operation. Moreover, Liquefied Petroleum Gas (LPG) is also consumed by the project activity for igniting the flare. As also established in the PDD, project emissions due to consumption of these energy carriers are determined by following the applicable guidance of the "Tool to calculated baseline, project and/or leakage emissions from electricity consumption" and "Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion".

Project emissions ( $\text{PE}_y$ ) for the considered monitoring period are determined (in tCO<sub>2e</sub>) as follows:

$$\text{PE}_y = \text{PE}_{\text{EC},\text{grid},y} + \text{PE}_{\text{EC},\text{captive},y} + \text{PE}_{\text{LPG},y}$$

Where:

$\text{PE}_{\text{EC},\text{grid},y}$	Project emissions due to the consumption of grid electricity due to the project activity in year $y$ (in tCO <sub>2</sub> /year)
$\text{PE}_{\text{EC},\text{captive},y}$	Project emissions from consumption of electricity generated by a captive off-grid electricity generator fuelled by fossil fuel (diesel) in year $y$ (in tCO <sub>2</sub> /yr)
$\text{PE}_{\text{LPG},y}$	Project emissions due to the consumption of LPG by the project activity in year $y$ (in tCO <sub>2</sub> /year)

*Project emissions due to the consumption of grid-sourced electricity by the project activity ( $\text{PE}_{\text{EC},\text{grid},y}$ ):*

Project emissions due to the consumption of grid-sourced electricity by the project activity ( $PE_{EC,grid,y}$ ) are calculated as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01) as follows:

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

Where:

$TDL_{grid,y}$  Average technical transmission and distribution losses for grid sourced electricity consumed by the project activity in year  $y$ .  $TDL_{grid,y}$  is ex-ante selected as 20%. Further details about the ex-ante determined parameter  $TDL_{grid,y}$  are included in Section D.1 and in the PDD.

$EC_{PJ,grid,y}$  Quantity of grid sourced electricity consumed by the project activity in year  $y$  (in MWh). As per the applied monitoring procedure, monthly records of grid-sourced electricity consumption valid for the considered monitoring period are summarized below:

Month	Amount of grid-sourced electricity consumed by the project activity (MWh)
Jun. 2018	0.951
Jul. 2018	0.987
Aug. 2018	0.613
Sep. 2018	1.020
Oct. 2018	2.400
Nov. 2018	1.657
Dec. 2018	1.183
Jan. 2019	2.111

Additional monitoring details about the monitoring parameter  $EC_{PJ,grid,y}$  are included in Section D.2.

$EF_{EL,grid,y}$  Emission factor for grid sourced electricity in year  $y$  (in  $tCO_2/MWh$ ).  $EF_{EL,grid,y}$  is determined as the combined margin emission factor ( $EF_{grid,CM,y}$ ) that is calculated as the weighted average of the operating margin and build margin emission factors. To weight these two factors, the default values applicable to both for the 2<sup>nd</sup> crediting period are applied. The combined margin emission factor is thus obtained as follows:

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

Where:

$w_{OM}$  Weighting of operating margin emissions factor.  $w_{OM}$  is ex-ante selected as 0.25. Further details about the ex-ante selected parameter  $w_{OM}$  are included in Section D.1 and in the PDD.

$w_{BM}$  Weighting of operating margin emissions factor.  $w_{BM}$  is ex-ante selected as 0.75. Further details about the ex-ante selected parameter  $w_{BM}$  are included in Section D.1 and in the PDD.

$EF_{grid,OM,y}$  Operating margin  $CO_2$  emission factor in year  $y$  (in  $tCO_2/MWh$ ). Selected values for the monitoring parameter  $EF_{grid,OM,y} = EF_{grid,OM-DD,y}$

represent the official annual average value for year 2018 and the official average monthly value for January 2019 as calculated and published by the DNA of Brazil. Values are summarized below:

Period	Average operating margin emission factor (tCO <sub>2</sub> /MWh)
01/06/2018 to 31/12/2018	0.5390
01/01/2019 to 31/01/2019	0.5652

Further details about the monitoring parameter  $EF_{grid,OM}$  are included in Section D.2.

$EF_{grid,BM,y}$  Build margin CO<sub>2</sub> emission factor in year  $y$ .  $EF_{grid,BM}$  is ex-ante determined as 0.2963 tCO<sub>2</sub>/MWh. Further details about the ex-ante determined parameter  $EF_{grid,BM}$  are included in Section D.1.

For each month encompassed by the considered monitoring period,  $EF_{EL,grid,y}$  is thus calculated as follows:

Period	Monthly values of $EF_{EL,grid,y}$ (tCO <sub>2</sub> /MWh)
01/06/2018 to 31/12/2018	0.3570
01/01/2019 to 31/01/2019	0.3635

For the considered monitoring period, project emissions due to the consumption of grid-sourced electricity by the project activity ( $PE_{EC,grid,y}$ ) are thus calculated as 9 tCO<sub>2</sub> (rounded value).

The summarized emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) includes all calculations related to the determination of  $PE_{EC,grid,y}$  for the considered monitoring period.

*Project emissions from consumption of electricity generated by a captive off-grid electricity generator fuelled by fossil fuel (diesel) in year  $y$  (in tCO<sub>2</sub>/yr):*

Project emissions from consumption of electricity generated by a captive off-grid electricity generator fuelled by fossil fuel (diesel) in year  $y$  ( $PE_{EC,captive,y}$ ) are calculated by following option B.2 of the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” as follows:

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

Where:

$EC_{PJ,captive,y}$  Amount of electricity sourced by the captive electricity generator (fuelled by diesel) and consumed by the project activity. As per the applied monitoring procedure, monthly measurement records of electricity consumed by the project activity that is supplied by the installed backup off-grid captive electricity generator (fuelled by diesel) and valid for the considered monitoring period are summarized below:



Month	Amount of electricity sourced by the installed back-up off grid electricity generator (fuelled by diesel) (MWh)
Jun. 2018	0.180
Jul. 2018	0.463
Aug. 2018	0
Sep. 2018	1.032
Oct. 2018	0.151
Nov. 2018	0.046
Dec. 2018	0.300
Jan. 2019	0.230

Further monitoring details for  $EC_{PJ,captive,y}$  are presented in Section D.2.

$TDL_{captive,y}$  Average technical transmission and distribution losses for electricity sourced by the captive electricity generator.  
 $TDL_{captive,y}$  is ex-ante determined as zero. Further details about the ex-ante determined parameter  $TDL_{captive,y}$  are included in Section D.1 and in the PDD.

$EF_{EL,captive,y}$  CO<sub>2</sub> emission factor for electricity sourced by the captive off-grid electricity generators  $EF_{EL,captive,y}$  is ex-ante determined as 1.3 tCO<sub>2</sub>/MWh. Further details about the ex-ante determined parameter  $EF_{EL,captive,y}$  are included in Section D.1 and in the PDD.

For the considered monitoring period, project emissions due to the consumption of electricity sourced by the backup captive off-grid electricity generator ( $PE_{EC,captive,y}$ ) are calculated as follows:

$$PE_{EC,captive,y} = 2.402 \text{ MWh} * 1.3 \text{ tCO}_2/\text{MWh} * (1 + 0) = 4 \text{ tCO}_2$$

*Project emissions due to consumption of LPG by the project activity:*

Project emissions due to the consumption of LPG by the project activity ( $PE_{LPG,y}$ ) are calculated as per the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” (version 02) as follows:

$$PE_{LPG,y} = FC_{LPG,y} * COEF_{LPG,y}$$

Where:

$FC_{LPG,y}$  Quantity of LPG consumed by the project activity in year y. No LPG was consumed during the considered monitoring period.

$COEF_{LPG,y}$  CO<sub>2</sub> emission coefficient for LPG. As established in the PDD,  $COEF_{LPG,y}$  is determined by following applicable guidance as per Option B of the “Tool to calculate project or leakage CO<sub>2</sub> emissions from fossil fuel combustion” as follows:

$$COEF_{LPG,y} = NCV_{LPG,y} * EF_{CO2,LPG,y}$$

Where:

$EF_{CO2,LPG,y}$  CO<sub>2</sub> emission factor of fuel LPG (in energy basis). As per the applied monitoring procedure,  $EF_{CO2,LPG,y}$  is determined as 0.0656 tCO<sub>2</sub>/GJ. Further details about the monitoring parameter  $EF_{CO2,LPG,y}$  are included in Section D.2.

NCV<sub>LPG,y</sub> Net calorific value of the fuel LPG. As per the applied monitoring procedure, NCV<sub>LPG,y</sub> is determined as 46.5 GJ/ton for the considered monitoring period. Further details about the monitoring parameter NCV<sub>LPG,y</sub> are included in Section D.2

Thus, COEF<sub>LPG,y</sub> = 0.0656 tCO<sub>2</sub>/GJ \* 46.5 GJ/ton = 3.05 tCO<sub>2</sub>/ton

As no LPG was consumed during the considered monitoring period, project emissions due to the consumption of LPG are thus determined as 0 tCO<sub>2</sub> (rounded value). The summarized emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) includes all calculations related to the determination of PE<sub>LPG,y</sub> for the considered monitoring period.

Total project emissions (PE<sub>y</sub>) for the considered monitoring period are calculated as 13 tCO<sub>2</sub> (rounded value).

### E.3. Calculation of leakage emissions

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Not applicable.

### E.4. Calculation of emission reductions or net anthropogenic removals

Emission reductions achieved by the project activity during the considered monitoring period are determined as the difference between baseline emissions (BE<sub>y</sub>) and project emissions (PE<sub>y</sub>) determined for such period. Calculations of baseline emissions (BE<sub>y</sub>) are presented in Section E.1. Calculations of project emissions (PE<sub>y</sub>) are presented in Section E.2. As summarized in the table below, during the monitoring period from 01/06/2018 to 31/01/2019, achieved emission reductions are calculated and reported as follows:

	Baseline GHG emissions or baseline net GHG removals (t CO <sub>2</sub> e)	Project GHG emissions or actual net GHG removals (t CO <sub>2</sub> e)	Leakage GHG emissions (t CO <sub>2</sub> e)	GHG emission reductions or net anthropogenic GHG removals (t CO <sub>2</sub> e)		
				Before 01/01/2013	From 01/01/2013	Total amount
<b>Total</b>	272,041	13	-	-	272,028	272,028

### E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO <sub>2</sub> e)	Amount estimated ex ante (t CO <sub>2</sub> e)
272,028	339,150 <sup>20</sup>

<sup>20</sup> The 339,150 tCO<sub>2</sub>e value is calculated as the sum of the share of the estimated total emission reductions for year 2018 to be achieved during the 214-day length considered monitoring period within year 2018 (calculated as 501,725 tCO<sub>2</sub>e \* 214 / 365) and the share of the estimated total emission reductions for year 2019 to be achieved during the 31-day length considered monitoring period within year 2019 (calculated as 529,698 tCO<sub>2</sub>e \* 31 / 365)

**E.6. Remarks on increase in achieved emission reductions**

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Achieved emission reductions for the project activity are about ~20% lower than the calculated value of ex-ante estimation of emission reductions as per the PDD that is valid for the considered 245-day monitoring period within years 2018 and 2019. The following aspect justifies and explains the relative difference between such value for ex-ante estimation of emission reductions as per the PDD (calculated as applicable for the considered monitoring period) and emission reductions actually achieved by the project activity during the considered monitoring period:

Aspect/condition which represents a decrease factor of reported emission reductions for the considered monitoring period when compared against the *ex-ante* estimation of emission reduction for the same period in the PDD:

- 1) *Uncertainties associated with the application of First Order Decay (FOD) multi-phased model for estimating the emission reductions in the PDD:*

As outlined in the PDD, like other similar CDM project activities encompassing LFG collection and destruction/utilization, the amount of methane to be generated by decomposition of MSW disposed at the CRR landfill and collected by the project activity was derived by applying the First Order Decay (FOD) model as per the methodological tool "Emission from Solid Waste Disposal Sites" (version 06.0.1) in the context of the determination of ex-ante estimated emission reductions to be achieved during the 2<sup>nd</sup> 7-year renewable crediting period. By taking in account all potential uncertainties associated with the application of such multi-phased decay model, it is reasonable to assume that, in the particular case of the project activity during the considered monitoring period, the application of this model somehow overestimated the amount of LFG to be actually generated and collected by the project activity. In this particular context, it is crucial to note that, while the PDD assumes a LFG collection efficiency of 92.80% (ex-ante determined parameter " $\eta_{PJ}$ ") in the context of the ex-ante estimates of emission reductions, as outlined in Section A.1 and B.2, during the considered monitoring period there were relevant number of LFG collection wells and conventional LFG venting/combustion drains that were not connected to project activity, thus negatively affecting the collection efficiency of LFG generated in the site during the considered period. Besides of minor uncertainty aspects, this particular aspect represents a relevant negative impact over emission reductions achieved during the period (when compared to estimates in the PDD).

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**Document information**

<i>Version</i>	<i>Date</i>	<i>Description</i>
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> <li>• Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN);</li> <li>• Make editorial improvements.</li> </ul>
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> <li>• Include provisions related to delayed submission of a monitoring plan;</li> <li>• Provisions related to the Host Party;</li> <li>• Remove reference to programme of activities;</li> <li>• Overall editorial improvement.</li> </ul>
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> <li>• Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0));</li> <li>• Include provisions related to standardized baselines;</li> <li>• Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1;</li> <li>• Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>;</li> <li>• Editorial improvement.</li> </ul>
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
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