Monitoring report form

(Version 05.1)

MONITORING REPORT		
Title of the project activity	Central de Resíduos do Recreio Landfill Gas Project (CRRLGP)	
UNFCCC reference number of the project activity	0648	
Version number of the monitoring report	4.0	
Completion date of the monitoring report	23/06/2017	
Monitoring period number and duration of this monitoring period	Monitoring period: #10 01/01/2016 - 31/07/2016	
Project participant(s)	Companhia Riograndense de Valorização de Resíduos S/A Biogas Riograndense Ltda. Belektron d.o.o.	
Host Party	Brazil	
Sectoral scope(s)	13 - Waste handling and disposal	
Selected methodology(ies)	ACM0001 - “Flaring or use of landfill gas” (version 15.0)	
Selected standardized baseline(s)	Not applicable	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	253,743 tCO_2e	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	-	202,458 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and 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^2 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[1]. 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.[2], 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_2) 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_4) 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_2) 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

[1] The expected total operation lifetime for the CRR landfill of 22 years is established in the landfill's Operating License of no. 41/2014-DL.

[2] As outlined in the PDD, as a result of an occurred corporate mergering process between the waste management companies/enterprises SIL Soluções Ambientais Ltda. and Solvi Group S.A., the CRR landfill is since12/09/2012 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[3].

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 revised version of the PDD valid for 2nd 7-year crediting period of the project activity (PDD version 9.2, dated 16/06/2017, herein after termed "PDD" [4]).

Emission Reductions (ER) achieved during the 10th monitoring period from 01/01/2016 to 31/07/2016 are reported as **202,458** tCO_2e**.**

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 participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Brazil (host)	Companhia Riograndense de Valorização de Resíduos S/A	No

[3] 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 Biogas Riograndense Ltda. 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 Biogas Riograndense Ltda. 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 Biogas Riograndense Ltda., Biotérmica Energia S.A. is mostly owned by Solvi Group (www.solvi.com).

[4] The revised version of the PDD (PDD version 9.2, dated 16/06/2017) includes permanent post-registration changes (PRCs) under the category "Corrections (in information that do not affect the project design)". The revised version of the PDD has its validation opinion and its request of approval submitted as part of the verification assessment for the monitoring period encompassed by this Monitoring Report.

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Brazil (host)	Biogás Riograndense Ltda.	No
United Kingdom of Great Britain and Northern Ireland	Belektron d.o.o.	No

A.4. Reference of applied methodology and standardized baseline

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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[5]:

- "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_2 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 of project activity

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

[5] 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 2nd 7-year crediting period. This methodological tool is not applied for the ex-post determination of emission reductions achieved by the project activity.

A.6. Contact information of responsible persons/entities

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Completion date for the application of the CDM-MR-FORM: 25/03/2017 (date of the initial version of this Monitoring Report).

Responsible entity / person:

Mr. Nuno Barbosa
nuno@unicarbo.com.br
UniCarbo Energia e Biogás Ltda.
São Paulo, Brazil

UniCarbo Energia e Biogás Ltda. is a CDM consulting and advisory services company hired by the project participant Biogas Riograndense Ltda. UniCarbo Energia e Biogás Ltda. is not a project participant.

SECTION B. Implementation of project activity

B.1. Description of implemented registered 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^3/h capacity and total capacity of 20,100 Nm^3/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[6]. The flare has a declared maximum LFG flow operational capacity of 8,100 Nm^3/h.

- 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.

[6] The pilot flame system for the installed high temperature enclosed flare is fuelled by LPG which is sourced (when under operation) by 2 LPG cylinders with 45 kg of LPG each.

- Electricity generation insfrastructure 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 registered monitoring plan, applied methodology or applied standardized baseline

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Not applicable.

B.2.2. Corrections

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The following corrections in information (that do not affect the project design) were performed in the currently registered version of the PDD (as reflected in the revised version of the PDD (version 9.2, dated 16/06/2017)):

Corrections (in information that do not affect the project design):

- 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" ($TDL_{grid,y}$) 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 $TDL_{grid,import,y}$, the added 3% missing default value is termed as $TDL_{grid,export,y}$. Texts in Sections B.6.1 and B.6.3 are adjusted accordingly.

- Calculations of ex-ante estimates of emission reductions to be achieved by the project activity during the 2nd 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 $TDL_{grid,y}$ (value applicable for generated electricity exported through the electricity grid the project activity is connected to).

- The formula for the determination of baseline emissions of methane ($BE_{CH4,y}$) 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 2nd 7-year crediting period as reported in Section B.6.3 are corrected accordingly.

- 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).

The revised version of the PDD has its validation opinion and its request of approval submitted as part of the verification assessment for the monitoring period encompassed by this Monitoring Report.

B.2.3. Changes to start date of crediting period

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Not applicable.

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

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Not applicable.

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

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Not applicable.

B.2.6. Changes to project design of registered project activity

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Not applicable.

B.2.7. Types of changes specific to afforestation or reforestation project activity

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Not applicable.

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.

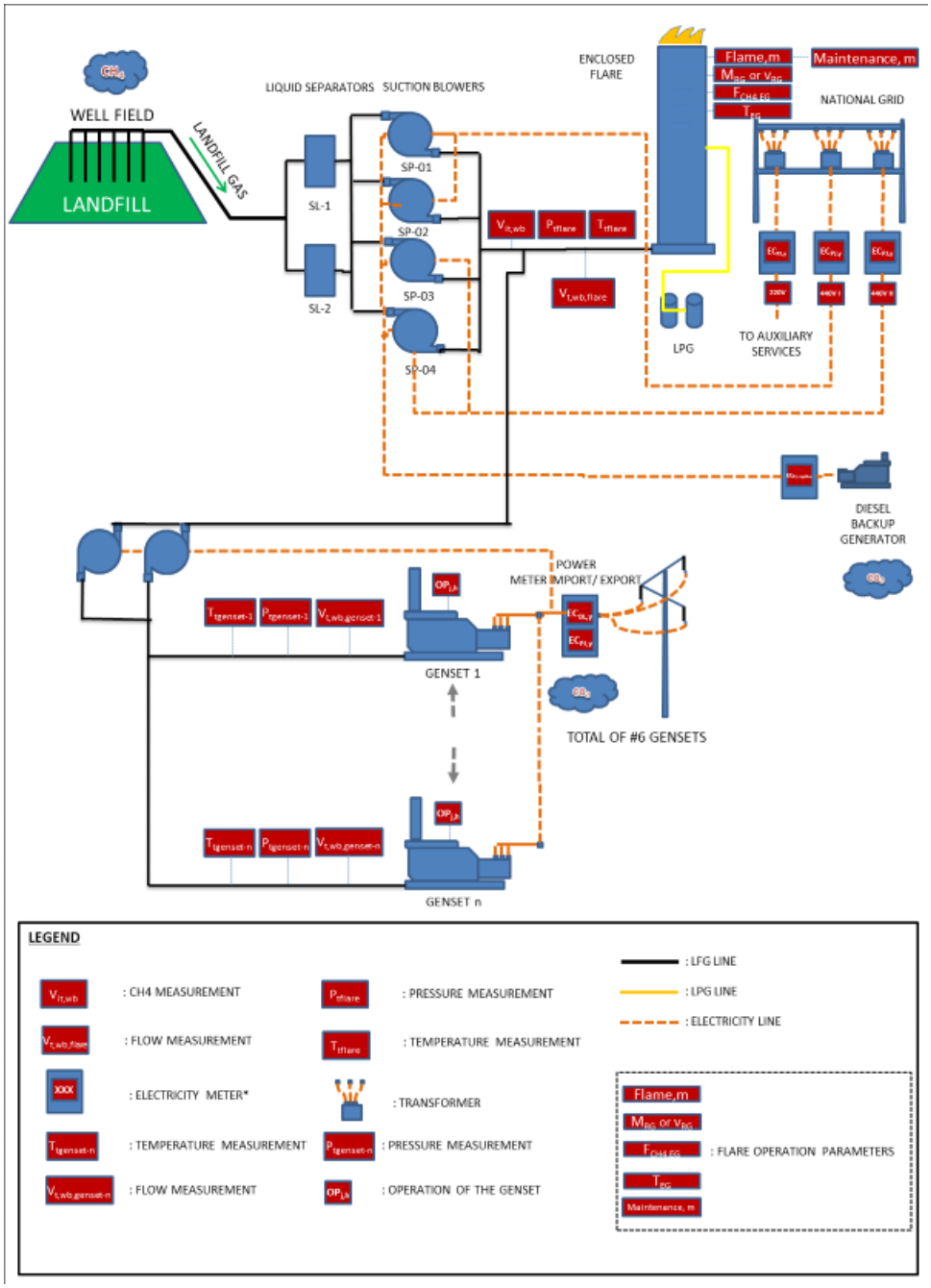

Figure 1: Schematic instrumentation diagram of the project's monitoring system valid for the period from 01/01/2016 to 06/01/2016 within the considered monitoring period

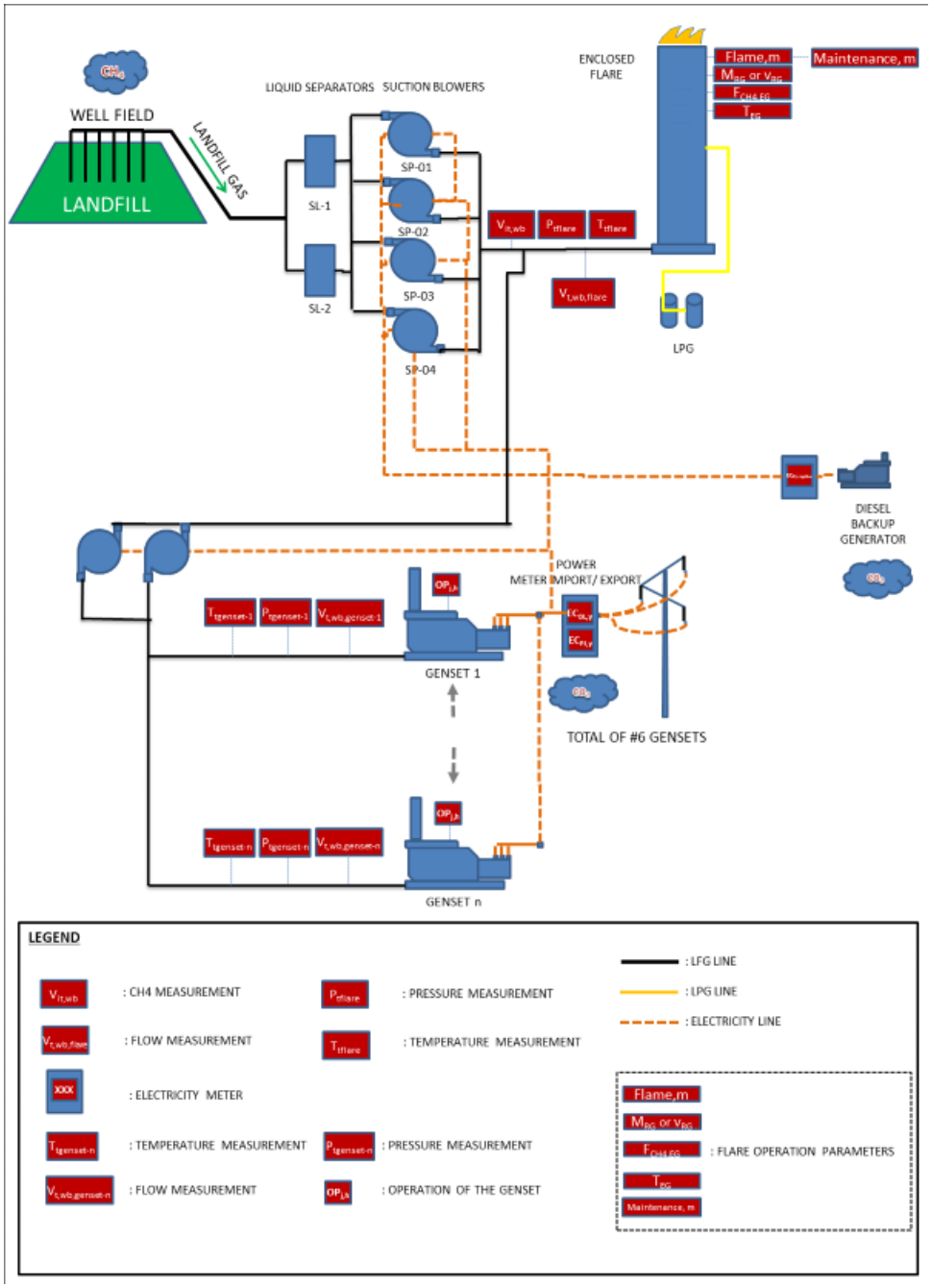

Figure 2: Schematic instrumentation diagram of the project's monitoring system valid for the period from 06/01/2016 to 31/07/2016 within the considered monitoring period

Project's LFG collection and destruction infrastructure (incl. the LFG flaring facility):
As part of the project activity, the following monitoring instruments/equipment[7] 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 model ST98, manufactured by Fluid Components International (FCI), with accuracy of ±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.

[7] 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 coupled to one pressure data transmitter set model Sitrans P / Z Series. The instrument set (sensor + data transmitter unit) is manufactured by Siemens A.G (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. The instrument set has accuracy of ± 0.5%.

- One LFG temperature sensor coupled to a temperature data transmitter set model TT301 manufactured by SMAR Equipamentos Ind. Ltda. The data transmitter unit has accuracy ± 0.2 ºC. The LFG temperature sensor is a PT100 thermo-resistance RTD sensor manufactured by Consistec Controles e Sistemas de Automação Industrial Ltda. (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. The sensor has accuracy of ± 1ºC.

- One continuous CH_4/O_2 content gas analyzer unit, manufactured by Siemens AG, model Ultramat 23, with accuracy of ±1%. (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_4/O_2 content gas analyzer unit, flow of collected LFG being sent to the flare and CH_4 fraction of collected LFG can thus be regarded as measured under the same basis/conditions in terms of moisture.

- Two thermocouple and temperature transmitters (Company internal instrument ID. TT-04 and TT-05) that measure the temperature in the exhaust gas of the flare (T_{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^3/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^3/h. Both thermocouples TT-04 and TT-05 are the model ATC-204, type N manufactured by Ecil Met Tec Ltda. The installed thermocouple has accuracy of ±0.75%. Spare units (with identical specifications) are kept for both installed thermocouples. 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, manufactured by Honeywell Analytics Ltd., model C7061A. 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 3rd 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*" ($\mathbf{F_{CH4,EG,t}}$)) 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 $\mathbf{F_{CH4,EG,t}}$ 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 3rd 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 facility:

- 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). The annubar element in each measurement set is of model Rosemount 485 Annubar (manufactured by Rosemount Inc.), with accuracy of ±1%. The pressure signal processing and data transmitting element in each measurement set is of model 2600T, (manufactured by ABB SpA.) with accuracy of ±1%. 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). All installed six LFG pressure sensors are of model 2600T, (manufactured by ABB S.p.A.), with accuracy of ±1%.

- 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). The installed LFG temperature sensors are of model Y1-SEM203/P (manufactured by Elsi s.r.l.), with accuracy of ± 0.5 ºC.

- 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. The installed electricity meter is of model ION 8650, manufactured by Schneider Electric with accuracy of ±0.2%. 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).

Since 06/01/2016, 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.

It is relevant to note that since 25/06/2015 (date of starting of operations of the project's electricity generation infrastructure), the electricity demand of the whole project activity could technically have been fully met by electricity generated in the project's new electricity generation facility (except during temporary interruptions in operation of such facility). However, due to reasons and aspects related to the commercialization of electricity generated by the project activity, until 06/01/2016, all generated electricity was exported through a dedicated transmission line connected to a substation located close to the facility. Until 06/01/2016, while most of grid-sourced electricity consumed by the project activity was supplied through the previously existent main electrical wiring installation sourcing grid electricity to the project site, there were indeed limited events when the project's electricity generation facility was not under operation and this project component had the electricity demand for ancillary systems being temporarily met by electricity sourced by the high voltage transmission line it is connected to.

During the 6-day length period from 01/01/2016 to 06/01/2016 within the considered monitoring period, continuous supply of grid-sourced electricity to the project's LFG flaring facility was made through 3 independent internal power distribution lines which are each one connected to an individual power transformer. These 3 power transformers have internal identification as "440V I", "440V II" and "220V". There are 2 electricity meters installed in the 3 independent electricity distribution lines (1 power distribution line connected to each power transformer). The electricity supply internal distribution line connected to the power transformer "440V I" supplies grid-sourced electricity to the project's centrifugal blower with internal TAG/ID "SP-01" and "SP-02". The electricity supply internal distribution line which is connected power transformer "440V II" supplies grid-sourced electricity to the project's centrifugal blowers with internal TAG/ID "SP-03" and "SP-04". Finally, the electricity supply internal distribution line which is connected to the power transformer "220V", supplies grid-sourced electricity to the project's plant control/monitoring equipment's. From 06/01/2016 onwards, supply of grid-sourced electricity was made through the same dedicated transmission line which is used for exporting electricity generated by the project activity. During the 6-day length period from 01/01/2016 to 06/01/2016 within the considered monitoring period The sum of the highest applicable accumulated measurement values of grid-sourced electricity consumption (in each internal grid-sourced electricity distribution line) (as displayed and recorded in the 2 installed electricity meters installed in each one of the 3 existent internal grid-sourced electricity supply distribution lines) is considered for the purpose of monitoring the total consumption of grid-sourced electricity by the project activity. Details about the 6 electricity meters used for measurement of consumption of grid-sourced electricity by the project activity and related monitoring procedures are described in section D.2 (under details for the monitoring parameter "Amount of grid electricity consumed by the project activity during the year *y*" ($EC_{PJ,grid,y}$)).

A backup off-grid captive diesel electricity generator (fuelled 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[8]. 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, during the share of the considered monitoring period from 01/01/2016 to 25/05/2016, 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 component are recorded/reported every minute in an installed data acquisition unit of manufacturer/model Chessell 5000B[9]. Since 25/05/2016 all continuous measurements of LFG

[8] 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.

[9] The following is applicable for the installed data acquisition unit Chessell 5000B:
"The equipment is designed for maximum security of data and for flexible functionality. It has 16 Mbyte of non-volatile Flash memory for historical data storage with a logging and archiving strategy that protects the data from loss or tampering".
(…)
Auditor Features: Auditor features on the 5000B have been specifically designed to protect data - providing comprehensive data security and traceability. These feature are designed for industries where data security is of utmost importance - from Pharmaceutical to Heat Treatment - Auditor Features keep valuable and critical data safe.

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 Biotecnogas S.r.l.[10]

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_4/O_2 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 Biogas Riograndense Ltda. The CDM Project Manager of Biogas Riograndense Ltda. (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

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Secure Audit: Secure, embedded, time-stamped audit trail to record operator details, time, date and all actions taken."
Further specification details about this equipment is available online:
http://www.eurotherm.net.au/recorder/5000/5000b1.php

[10] Biotecnogas 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 Biotecnogas S.r.l. products, services and expertise/experience are available online: http://www.biotecnogas.com

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 supervisioned by the CDM Project Manager of Biogas Riograndense Ltda.

Figure 2 shows the organizational chart for the project activity.

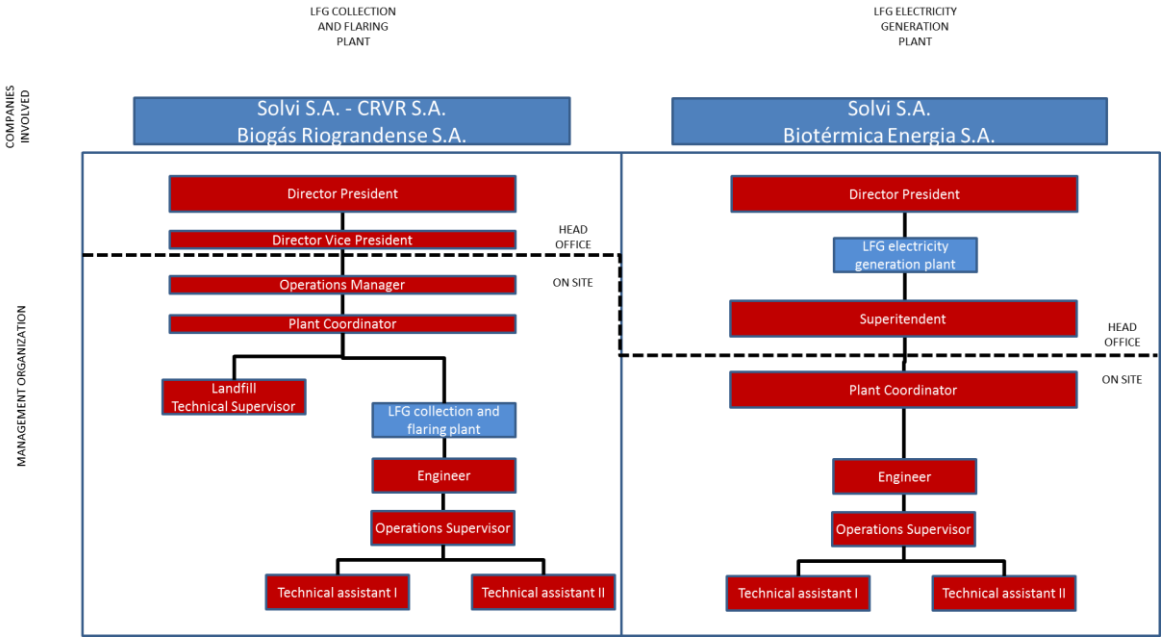


Figure 3: Management organization for the project activity

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

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	Calculation of baseline emissions
Additional comments	**-**

Data/parameter:	**GWP_{CH4}**
Unit	tCO_2/tCH_4
Description	Global Warming Potential of CH_4
Source of data	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: www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html#table-2-14 The applied value is also in accordance with the "Standard for application of the global warming potential to clean development mechanism project activities and programmes of activities for the second commitment period of the Kyoto Protocol".
Value(s) applied)	25
Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comments	**-**

Data/parameter:	**R_u**
Unit	Pa.m^3/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	Calculation of baseline emissions
Additional comments	**-**

Data/parameter:	**MM_k**
Unit	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)	As outlined in the PDD, for considered gases *k* that are greenhouse gases (GHGs), the values in the table below are applied for MM_i. The "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" establishes 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 considered gaseous stream. However as a simplification, only the volumetric fraction of gases k that are greenhouse gases and are considered in the emission reduction calculation in the underlying methodology must be monitored and the difference to 100% may be considered as pure nitrogen. The simplification is not acceptable if it is differently specified in the underlying methodology.*" ACM0001 (version 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 considered and the difference to 100% is just considered as pure nitrogen.
Choice of data or measurement methods and procedures	-

Compound	Structure	Molecular mass (kg/mol)
Nitrogen	N_2	28.01

Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	**MM_i**
Unit	kg/kmol
Description	Molecular mass of greenhouse gas *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_4 (the only GHG which is considered):

Compound	Structure	Molecular mass (kg/mol)
Methane	CH_4	16.04

Choice of data or measurement methods and procedures	-
Purpose of data	Calculation of baseline emissions
Additional comments	-

Data/parameter:	**P_n**
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	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.

Data/parameter:	**MM_{H2O}**
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	Calculation of baseline emissions
Additional comments	**-**

Data/parameter:	**T_n**
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	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.

Data/parameter:	**$TDL_{grid,y}$**
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	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). 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 underlaying tool) do not fit under Scenario B and/or Scenario C (case II) of the such tool, the selected 20% value for $TDL_{grid,import,y}$ and 3% values for $TDL_{grid,export,y}$ are thus under conformance with applicable guidance of the tool. The selection of 20% value for $TDL_{grid,import,y}$ and 3% values for $TDL_{grid,export,y}$ 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). 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 ($EC_{BL,k,y}$) as per such tool (where $EC_{BL,k,y}$ in the tool is equivalent to the net amount of electricity generated using LFG in year y ($EG_{PJ,y}$) 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.
Purpose of data	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:	**w_{BM}**
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 2nd 7-year renewable crediting period.
Value(s) applied)	0.75 (75%)
Choice of data or measurement methods and procedures	The applicable value valid for 2nd crediting period as per the "Tool to calculate the emission factor for an electricity system" (Version 4.0) is selected.
Purpose of data	Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity).
Additional comments	-

Data/parameter:	w_{OM}
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 2nd 7-year renewable crediting period.
Value(s) applied)	0.25 (25%)
Choice of data or measurement methods and procedures	The applicable value for the 2nd crediting period as per the "Tool to calculate the emission factor for an electricity system" (version 4.0) is selected.
Purpose of data	Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity).
Additional comments	-

Data/parameter:	$EF_{grid,BM,y}$
Unit	tCO_2/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 2nd 7-year crediting period. The selected value is the value calculated by the DNA of Brazil and valid for year 2014 ($EF_{grid,BM,2014}$).
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 2nd crediting period.
Purpose of data	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:	**$SPEC_{flare}$**
Unit	°C (for temperature values) Nm^3/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 ($\eta_{flare,m}$) for each individual high temperature enclosed flare in the context of determination of baseline emissions.
Value(s) applied)	

$SPEC_{flare}$	Min.	Max.
Operational LFG flow (for continuous operation):	300 Nm^3/h	8,100 Nm^3/h
Required temperature of the exhaust gas of the flare (to ensure LFG destruction (combustion) under high CH_4 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 $SPEC_{flare}$. During the 2nd 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	Calculation of baseline emissions
Additional comments	All flare specification and operation details/requirements are based on information provided by the equipment manufacturer.

Data/parameter:	$PP_{CP,Diesel\text{-}generator}$
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	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 $PP_{CP,Diesel\text{-}generator}$ 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) ($PE_{EC,captive,y}$). While for the considered monitoring period alternative approach 2 was selected for the determination of $PE_{EC,captive,y}$, the ex-ante determined parameter $PP_{CP,Diesel\text{-}generator}$ was thus not used in the context of calculation of emission reductions for the considered monitoring period.

Data/parameter:	$TDL_{captive,y}$
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	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 $TDL_{captive,y}$ 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) ($PE_{EC,captive,y}$).

Data/parameter:	**$EF_{EL,captive,y}$**
Unit	tCO_2/MWh
Description	CO_2 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 *Alternative approach 2* 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	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 $EF_{EL,captive,y}$ 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 (η_{PJ})
- Default value for model correction factor to account for model uncertainties ($\varphi_{default}$)
- 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 ($DOC_{f,default}$)
- Methane correction factor ($MCF_{default}$)
- Fraction of degradable organic carbon in the waste type j (weight fraction) (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" ($F_{CH4,PJ,y}$) (in the context of ex-ante estimation of emission reductions to be achieved by the project activity during the 2nd 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	An initial technical evaluation was performed by the independent 3rd 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 05/01/2016. This initial evaluation covers the period from 01/12/2007 (date when the project activity started to operate) to 05/01/2016 (issuance date of the declaration document for the performed evaluation). As per the applicable monitoring procedure, a second technical evaluation was performed also by the independent 3rd party engineering company GSA Engenharia Ltda. In the beginning of year 2017 (one year after the performance of the initial evaluation). The findings for such performed second technical evaluation are reported in a declaration document issued by GSA Engenharia Ltda. that is dated 04/01/2017. As part of the performed annual technical evaluations, 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: - 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); - Applicable local or national regulations; - 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.
Value(s) of monitored parameter	As outlined in both issued internal technical evaluation/declaration reports dated 05/01/2016 and 04/01/2017, 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 04/01/2017 (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. 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 commercialization of CERs generated by project based destruction of methane in landfills. In the particular case of the CRR landfill, it is important to note that this landfill was designed and it 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). 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).
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 Biogas Riograndense Ltda. (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:	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).

Data/parameter:	**$V_{t,wb,j}$**
Unit	m^3 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	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. 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 $V_{t,wb}$ is thus measured, recorded and reported on the basis of the following sub-parameters: - $V_{t,wb,flare}$: Volumetric flow of LFG to the Flare - $V_{t,wb,genset-1}$: Volumetric flow of LFG to the engine-generator set 1 - $V_{t,wb,genset-2}$: Volumetric flow of LFG to the engine-generator set 2 - $V_{t,wb,genset-3}$: Volumetric flow of LFG to the engine-generator set 3 - $V_{t,wb,genset-4}$: Volumetric flow of LFG to the engine-generator set 4 - $V_{t,wb,genset-5}$: Volumetric flow of LFG to the engine-generator set 5 - $V_{t,wb,genset-6}$: Volumetric flow of LFG to the engine-generator set 6

Monitoring equipment	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). 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. *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:* *LFG flow meter used for measuring $V_{t,wb,flare}$ (Flare):* The specifications of the LFG flow meter of thermal mass type utilized during the considered monitoring period are given below: - instrument/equipment internal ID reference: FIT-01 - Manufacturer: Fluid Components International (FCI) - Model: ST98 - Accuracy: ±1% - Serial number (S/N): 294032 - Calibration frequency and maintenance requirements[11]: Every 18 months (minimum). - Calibration events valid for the considered monitoring period: Calibration event dated 27/08/2015, valid until 26/02/2017. Calibration Certificate Number 0101/2015. The calibration event of the LFG flow meter used for measuring $V_{t,wb,flare}$ was performed by the calibration/inspection service company Hirsa Sistemas de Automação e Controle Ltda. *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:* 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: *LFG flow meter used for measuring $V_{t,wb,genset-1}$ (engine-generator set 1):* *Measurement element (annubar):* - Manufacturer: Rosemount Inc. - Model: 485 Annubar - Serial number (S/N): 0148661 - Accuracy: ±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

[11] 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.

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): 3K646614027630
- Accuracy: ±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 19/09/2014 by ABB S.p.A., valid until 18/09/2016 (2 years) and calibration event performed on 15/05/2016 (Calibration Certificate TRP-0770157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years).

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: ±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: ±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 19/09/2014 by ABB S.p.A., valid until 18/09/2016 (2 years) and calibration event performed on 15/05/2016 (Calibration Certificate TRP-0870157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (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: ±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: ±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 19/09/2014 by ABB S.p.A., valid until 18/09/2016 (2 years) and calibration event performed on 15/05/2016 (Calibration Certificate TRP-0970157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (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: ±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: ±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 19/09/2014 by ABB S.p.A., valid until 18/09/2016 (2 years) and calibration event performed on 15/05/2016 (Calibration Certificate TRP-1070157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (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: ±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: ±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 19/09/2014 by ABB S.p.A., valid until 18/09/2016 (2 years) and calibration event performed on 15/05/2016 (Calibration Certificate TRP-1170157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years). *LFG flow meter used for measuring $V_{t,wb,genset-6}$ (engine-generator set 6):* *Measurement element (annubar):* - Manufacturer: Rosemount Inc. - Model: 485 Annubar - Serial number (S/N): 0148660 - Accuracy: ±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): 3K646614027629 - Accuracy: ±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 19/09/2014 by ABB S.p.A., valid until 18/09/2016 (2 years) and calibration event performed on 15/05/2016 (Calibration Certificate TRP-1270157/16, issued by CEIME - Comércio e Metrologia Ltda.), valid until 14/05/2018 (2 years).
Measuring/reading/recording frequency:	Continuous measurements are recorded and reported with an every-minute frequency.
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 Biogas Riograndense

	Ltda. 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).
Purpose of data:	Calculation of baseline emissions
Additional comments:	The design of the LFG flow meter 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 (Nm^3/h). 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 $V_{t,wb,n,flare}$ in the context of calculation of achieved emission reductions. Reported values of $V_{t,wb,flare}$ are thus equivalent to values of $V_{t,wb,n,flare}$ and are thus directly used for the determination of the amount of methane in the LFG flared by the project activity ($F_{CH4,flared,y}$) 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). 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 (Nm^3/h), measurements of LFG pressure and 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).

Data/parameter:	**$v_{CH4,t,wb,j}$**
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 $v_{CH4,t,wb,j}$ that are recorded and reported with an every-minute frequency.

Monitoring equipment	*Continuous CH_4/O_2 content gas analyzer unit:* Specifications of the continuous CH_4/O_2 content gas analyzer utilized during the considered monitoring period are described below: - instrument/equipment internal ID reference: AG-01 - Manufacturer: Siemens AG - Model: Ultramat 23 - Accuracy: ±1% - Serial number (S/N): N1-C8-283 - Calibration frequency and maintenance requirements: At least every six months. - Calibration events valid for the considered monitoring period: Calibration event dated 29/10/2015, valid until 28/04/2016 (Calibration Certificate Number 551/2015), calibration event dated 05/04/2016, valid until 04/10/2016 (Calibration Certificate 296/2016) and calibration event dated 23/08/2016, valid until 22/02/2017 (Calibration Certificate Number 432/2016). Both calibration events were performed by the calibration/inspection service company ISOCELL Comércio de Instrumentação Ltda.
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 Biogas Riograndense Ltda. 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:	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 ^oC. 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	The monthly emission reduction calculation spreadsheets (that are enclosed

parameter	to this Monitoring Report) include measurement data for T_t that are recorded and reported with an every-minute frequency. 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 T_t is thus measured, recorded and reported on the basis of the following sub-parameters: - T_{tflare}: Temperature of the LFG sent to the Flare - $T_{tgenset-1}$: Temperature of the LFG sent to the engine-generator set 1 - $T_{tgenset-2}$: Temperature of the LFG sent to the engine-generator set 2 - $T_{tgenset-3}$: Temperature of the LFG sent to the engine-generator set 3 - $T_{tgenset-4}$: Temperature of the LFG sent to the engine-generator set 4 - $T_{tgenset-5}$: Temperature of the LFG sent to the engine-generator set 5 - $T_{tgenset-6}$: Temperature of the LFG sent to the engine-generator set 6

Monitoring equipment	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. 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. *LFG temperature sensors used for measuring T_{tflare} (Flare):* The specifications of the LFG temperature sensor utilized during the considered monitoring period are as follows; - Instrument type: (data transmitter + sensor element (RTD)) - instrument/equipment internal ID reference: TIT-02 - Manufacturer: o Data transmitter: SMAR Equipamentos Ind. Ltda. o Sensor element: Consistec Controles e Sistemas de Automação Ltda. - Model: TT301 with a RTD PT100 sensor (respectively) - Accuracy: ± 0.2ºC for the data transmitter and ± 1.0ºC for the sensor - Serial number (S/N): 62274 (data transmitter) and 110813 (sensor element) - Calibration frequency and maintenance requirements: Annual - Calibration events valid for the considered monitoring period (data transmitter + sensor element set): Calibration event dated 28/09/2015, valid until 27/09/2016 (Calibration Certificate Number 9184/2015, issued by SGS do Brasil Ltda.). The calibration event was performed by the calibration/inspection service company SGS do Brasil Ltda. *LFG temperature sensor sets used for measuring $T_{tgenset-n}$ (engine-generator sets):* *LFG temperature sensor set used for measuring $T_{tgenset-1}$ (engine-generator set 1):* - Manufacturer: Elsi s.r.l. - Model: Y1-SEM203/P - Serial number (S/N): E14PT0680 - Accuracy: ± 0.5 ºC - Calibration frequency and maintenance requirements: Every 2 years - Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 24/07/2014 (Calibration Certificate EL14/0530, issued by Elsi s.r.l.), valid until 23/07/2016 (2 years) and 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). *LFG temperature sensor used for measuring $T_{tgenset-2}$ (engine-generator set 2):* - Manufacturer: Elsi s.r.l. - Model: Y1-SEM203/P - Serial number (S/N): E14PT0678 - Accuracy: ± 0.5 ºC - Calibration frequency and maintenance requirements: Every 2 years

	- Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 24/07/2014 (Calibration Certificate EL14/0528, issued by Elsi s.r.l.), valid until 23/07/2016 (2 years) and calibration event dated 15/05/2016 (Calibration Certificate TER-0270157/16), valid until 14/07/2018 (2 years). *LFG temperature sensor used for measuring $T_{tgenset-3}$ (engine-generator set 3):* - Manufacturer: Elsi s.r.l. - Model: Y1-SEM203/P - Serial number (S/N): E14PT0677 - Accuracy: ± 0.5 ºC - Calibration frequency and maintenance requirements: Every 2 years - Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 24/07/2014 (Calibration Certificate EL14/0527, issued by Elsi s.r.l.), valid until 23/07/2016 (2 years) and 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). *LFG temperature sensor used for measuring $T_{tgenset-4}$ (engine-generator set 4):* - Manufacturer: Elsi s.r.l. - Model: Y1-SEM203/P - Serial number (S/N): E14PT0675 - Accuracy: ± 0.5 ºC - Calibration frequency and maintenance requirements: Every 2 years - Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 24/07/2014 (Calibration Certificate EL14/0525, issued by Elsi s.r.l.), valid until 23/07/2016 (2 years) and 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). *LFG temperature sensor used for measuring $T_{tgenset-5}$ (engine-generator set 5):* - Manufacturer: Elsi s.r.l. - Model: Y1-SEM203/P - Serial number (S/N): E14PT0676 - Accuracy: ± 0.5 ºC - Calibration frequency and maintenance requirements: Every 2 years - Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 09/10/2014 (Calibration Certificate EL14/0598, issued by Elsi s.r.l.), valid until 08/10/2016 (2 years) and 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). *LFG temperature sensor used for measuring $T_{tgenset-6}$ (engine-generator set 6):* - Manufacturer: Elsi s.r.l. - Model: Y1-SEM203/P - Serial number (S/N): E14PT0679 - Accuracy: ± 0.5 ºC - Calibration frequency and maintenance requirements: Every 2 years - Dates for performed calibration events valid for the considered monitoring period: Calibration event dated 24/07/2014 (Calibration Certificate EL14/0529, issued by Elsi s.r.l.), valid until 23/07/2016 (2 years) and 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).

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 Biogas Riograndense Ltda. 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:	Calculation of baseline emissions
Additional comments:	-

Data/parameter:	**P_t**
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 basis of the following sub-parameters: - P_{tflare}: Pressure of the LFG sent to the Flare - $P_{tgenset-1}$: Pressure of the LFG sent to the engine-generator set 1 - $P_{tgenset-2}$: Pressure of the LFG sent to the engine-generator set 2 - $P_{tgenset-3}$: Pressure of the LFG sent to the engine-generator set 3 - $P_{tgenset-4}$: Pressure of the LFG sent to the engine-generator set 4 - $P_{tgenset-5}$: Pressure of the LFG sent to the engine-generator set 5 - $P_{tgenset-6}$: Pressure of the LFG sent to the engine-generator set 6

Monitoring equipment	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. 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. *LFG pressure sensors used for measuring P_{tflare} (Flare):* The specifications of the LFG pressure sensor utilized during the considered monitoring period are as follows; - instrument/equipment internal ID reference: PIT-02 - Manufacturer: Siemens A.G - Model: Sitrans P / Z Series - Serial Number:. / N1-E704-9211231 - Accuracy: ±0.5% - Calibration frequency and maintenance requirements: Annual - Calibration events valid for the monitoring period: Calibration event dated 28/09/2015, valid until 27/09/2016 (Calibration Certificate Number 9188/2015). The calibration event was performed by the calibration/inspection service company SGS do Brasil Ltda. *LFG pressure sensors (each one encompassing pressure signal processing + data transmission unit) used for measuring $P_{tgenset-n}$ (engine-generator sets):* *LFG pressure sensor used for measuring $P_{tgenset-1}$ (engine-generator set 1):* - Manufacturer: ABB S.p.A. - Model: 2600T - Serial number (S/N): 3K646614027622 - Accuracy: ±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 23/09/2014 by ABB S.p.A., valid until 22/09/2016 (2 years) and 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). *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: ±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 22/09/2014 by ABB S.p.A., valid until 21/09/2016 (2 years) and 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). *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: ±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 22/09/2014 by ABB S.p.A., valid until 21/09/2016 (2 years) and 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). *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: ±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 23/09/2014 by ABB S.p.A., valid until 22/09/2016 (2 years) and 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). *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: ±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 23/09/2014 by ABB S.p.A., valid until 22/09/2016 (2 years) and 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). *LFG pressure sensor used for measuring $P_{tgenset-6}$ (engine-generator set 6):* - Manufacturer: ABB s.p.a. - Model:2600T - Serial number (S/N): 3K646614027621 - Accuracy: ±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 23/09/2014 by ABB S.p.A., valid until 22/09/2016 (2 years) and 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).
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 manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Biogas Riograndense Ltda. 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:	Calculation of baseline emissions
Additional comments:	-

Data/parameter:	**$EC_{PJ,grid,y}$**
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	Measurement records from installed electricity meters. By taking into account the layout of the main electrical wiring installation sourcing grid electricity to the project site (through different power transformers), consumption of grid-sourced electricity by the project activity during the period from 01/01/2016 to 06/01/2016 within the considered monitoring was measured continuously by a set of 6 electronic electricity meters (with readings being accumulated)[12]. From 06/01/2016 onwards, while imports of grid-sourced electricity have been made through the same dedicated transmission line which is used for exporting electricity generated by the project activity, measurements of grid electricity consumed by the project activity have thus been made by the same electricity meter which is used for measuring electricity generated by the project activity.

[12] Since 25/06/2015 the project activity was connected to the electricity grid through 2 mains points:

- the previously existent main electrical wiring installation sourcing grid electricity to the project site (through different power transformers connected to the local electricity distribution network). Most of grid-sourced electricity consumed by the project activity during the considered monitoring period was supplied through this point.
- a 22 km new high voltage transmission line that was built as part of the project activity that connects the project's electricity generation component to a power substation located in the region of the project site. This high voltage transmission line is primarily used to export electricity generated by the project activity. Bi-directional electricity meters installed in the power substation and are utilized for measuring amount of exported electricity (with related meter specifications and monitoring details being described under details for the monitoring parameter "Amount of electricity generated using LFG by the project activity in year *y*" ($EC_{BL,y}$).

During the 6-day period from 01/01/2016 to 06/01/2016 within the considered monitoring period, while most of grid-sourced electricity consumed by the project activity was supplied through the previously existent main electrical wiring installation sourcing grid electricity to the project site, there were indeed limited events when the project's electricity generation facility was not under operation and this project component had the electricity demand for ancillary systems being temporarily met by electricity sourced by the high voltage transmission line it is connected to.

<table>
<tr><td></td><td>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.</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>Monthly records of grid-sourced electricity consumption valid for the considered monitoring period:

<table>
<tr><th>Month</th><th>Amount of grid-sourced electricity consumed through the electricity grid connection within the LFG flaring infrastructure (MWh)</th><th>Amount of grid-sourced electricity consumed through the electricity grid connection within the project's electricity generation infrastructure (MWh)</th><th>Combined (total) amount of grid-sourced electricity consumed by the whole project activity (MWh)</th></tr>
<tr><td>Jan. 2016</td><td>1.100</td><td>2,664</td><td>3.764</td></tr>
<tr><td>Feb. 2016</td><td>-</td><td>3,396</td><td>3.396</td></tr>
<tr><td>Mar. 2016</td><td>-</td><td>2,810</td><td>2.810</td></tr>
<tr><td>Apr. 2016</td><td>-</td><td>1,367</td><td>1.367</td></tr>
<tr><td>May 2016</td><td>-</td><td>2,011</td><td>2.011</td></tr>
<tr><td>Jun. 2016</td><td>-</td><td>305</td><td>0.305</td></tr>
<tr><td>Jul. 2016</td><td>-</td><td>1,406</td><td>1.406</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td>Monitoring equipment</td><td>Grid-sourced electricity consumed by the whole project activity during the 6-day period from 01/01/2016 to 06/01/2016 within the considered monitoring period was measured separately for each one of the three installed power transformers which supply grid-sourced electricity to the project site. The electricity meters are identified as “220 V”, “440V I” and “440 VII”.

Specification for the installed electricity meters from which measurements were considered for the period from 01/01/2016 to 06/01/2016:
- Manufacturer: Ello Sistemas Eletrônicos Ltda.
- Model:
- 2106 D (electricity meter with serial number (S/N) 901193798)
- 2106 (electricity meters with serial number (S/N) 901193720 and 901193721)
- Accuracy: ±1%
- Calibration frequency and maintenance requirements: Every 5 years
- Calibration events valid for the monitoring period:

<table>
<tr><th colspan="2">Instrument</th><th colspan="3">Calibration events</th></tr>
<tr><th>TAG</th><th>Serial Number</th><th>Number of the calibration certificate</th><th>Calibration event date</th><th>Validity of the performed calibration event</th></tr>
<tr><td>220V</td><td>901193798</td><td>E1757/2014</td><td>22/10/2014</td><td>21/10/2019</td></tr>
<tr><td>440V I</td><td>900192720</td><td>E1756/2014</td><td>22/10/2014</td><td>21/10/2019</td></tr>
<tr><td>440V II</td><td>900192721</td><td>E1755/2014</td><td>22/10/2014</td><td>21/10/2019</td></tr>
</table>

All calibration events were performed by the calibration/inspection service company LABELO - Laboratórios Especializados em Eletroeletrônica Calibração e Ensaios.

From 06/01/2016 onwards, measurements of grid-sourced electricity consumed by the project activity have been made by the same electricity meter which measures electricity generated by the project activity. Specification details for this meter are included in the applicable table for the monitoring parameter “Amount of electricity generated using LFG by the project activity in year y” ($EC_{BL,y}$) and also below:

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:

- Manufacturer: Schneider Electric
- Model: ION 8650
- Serial Number: RSARELUBREC01P
- Accuracy: ±0.2%.
- Calibration frequency and maintenance requirements: Every 5 years
- Dates for performed calibration events valid for the considered monitoring period: 14/11/2013
- Validity of the performed calibration event: valid until 13/11/2018 (5 years)</td></tr>
<tr><td>Measuring/reading/recording frequency:</td><td>For the period of 01/01/2016 to 06/01/2016 continuous measurements are recorded and reported every week. Reported monthly values are aggregated</td></tr>
</table>

	on the basis of weekly recorded values. From 06/01/2016 onwards continuous measurements performed by installed electricity meter are automatically transmitted, aggregated and recorded/reported hourly by the Brazilian Chamber of Electric Energy Commercialization (CCEE). Accumulated measurement records are reported every month.
Calculation method (if applicable):	Not applicable.
QA/QC procedures:	Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Biogas Riograndense Ltda. 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:	Calculation of project emissions (due to consumption of grid-sourced electricity by the project activity).
Additional comments:	-

Data/parameter:	**$EC_{BL,y}$**
Unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year *y*
Measured/calculated/default	Measured as part of the operation of the project activity by applying 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)[13].
Value(s) of monitored parameter	Monthly records of electricity generated by the project activity valid for the considered monitoring period:

Month	Amount of electricity generated using LFG (MWh)
Jan. 2016	5,012.895
Feb. 2016	4,787.101
Mar. 2016	5,223.815
Apr. 2016	5,216.656

[13] 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.

	<table><tr><td>May 2016</td><td>4,950.549</td></tr><tr><td>Jun. 2016</td><td>4,572.547</td></tr><tr><td>Jul. 2016</td><td>5,381.606</td></tr></table>
Monitoring equipment	*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:* - Manufacturer: Schneider Electric - Model: ION 8650 - Serial Number: RSARELUBREC01P - Accuracy: ±0.2%. - Calibration frequency and maintenance requirements: Every 5 years - Dates for performed calibration events valid for the considered monitoring period: 14/11/2013 - Validity of the performed calibration event: valid until 13/11/2018 (5 years)
Measuring/reading/recording frequency:	Continuous measurements performed by installed electricity meter are automatically transmitted, aggregated and recorded/reported hourly by the Brazilian Chamber of Electric Energy Commercialization (CCEE). Accumulated measurement records are reported every month.
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. 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. Also under conformance with procedures and practices from both by CCEE and CEEE-D, Biogas Riograndense Ltda. 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 Biogas Riograndense Ltda.. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Biogas Riograndense Ltda. 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:	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_2/MWh
Description	Operation margin CO_2 emission factor in year *y* = Dispatch data analysis operating margin CO_2 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	Value for year 2016 is selected and applied for the determination of the CO_2 emission factor for grid-sourced electricity in the context of the determination of both baseline and project emissions during the considered monitoring period. Selected values for year 2016 is the average of monthly official values as calculated and currently made available (published) by the DNA of Brazil. Monthly official values are made available online: http://www.mct.gov.br/upd_blob/0240/240983.html
Value(s) of monitored parameter	0.6228 tCO_2/MWh
Monitoring equipment	Not applicable
Measuring/reading/recording frequency:	Values are calculated annually.
Calculation method (if applicable):	Value applicable for year 2016 was calculated by the DNA of Brazil as per applicable guidance of the calculation method "dispatch data analysis operating margin CO_2 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 Biogas Riograndense Ltda. 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:	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:	**$Op_{j,h}$**
Unit	-
Description	Operation of the equipment that consumes LFG (engine-generator sets of the electricity generation infrastructure).
Measured/calculated/default	For each equipment unit *j* using the LFG monitor that the plant is operating in

	hour h by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnances. This option is not applicable to brick kilns. $Op_{j,h}$=0 when: (a) One of more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute); (c) No products are generated in the hour h. Otherwise, $Op_{j,h}$=1
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 parameter	Records for every-minute operational status of the set (engine-generator set running ("on") = 1 or not-running ("off") = 0) are made available in the monthly emission reduction calculation spreadsheets valid for the considered monitoring period). While the operational status for each individual engine-generator set consuming LFG is independently monitored since 25/06/2015, the monitoring parameter $Op_{j,h}$ is recorded and reported on the basis of the following sub-parameters: - $Op_{genset-1,h,y}$: Operation of the engine-generator 1 - $Op_{genset-2,h,y}$: Operation of the engine-generator 2 - $Op_{genset-3,h,y}$: Operation of the engine-generator 3 - $Op_{genset-4,h,y}$: Operation of the engine-generator 4 - $Op_{genset-5,h,y}$: Operation of the engine-generator 5 - $Op_{genset-6,h,y}$: Operation of the engine-generator 6
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 Biogas Riograndense Ltda. 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:	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:	-

Data/parameter:	**$F_{CH4,EG,t}$**
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	Related measurements were performed by the independent third party inspection services company "BIOAGRI Ambiental Ltda / Mérieux NutriSciences Brasil" Biannual measurements of mass flow of methane in the exhaust gas are performed on the basis of measurements of CH_4 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. Measurements are performed as per applicable guidance of the following standards: US-EPA Method 18 – Measurement of Gaseous Organic Compound Emission by Gas Chromatography (available online: https://www3.epa.gov/ttnemc01/promgate/m-18.pdf); CETESB L9.221 - "Pipelines and chimneys in stationary emission sources-Sampling points determination procedure) (available online: http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.221.pdf) CETESB L9.222 - "Pipelines and chimneys in stationary emission sources – Determination of speed and outflow of gases) (available online: http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.222.pdf) 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: http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.223.pdf) CETESB L9.224 - "Pipelines and chimneys in stationary emission sources – Determination of humidity of effluents" (available online: http://www.esaat.com.br/docs/met_cetesb/CETESB-L9.224.pdf)
Value(s) of monitored parameter	For the determination of values of $F_{CH4,EG,t}$, average of the accumulated mass of methane measured during one hour measurements are considered (average of every-minute measurements). The table below summarizes the performed biannual determination of $F_{CH4,EG,t}$ for the installed flare valid for the considered monitoring period: Measurements performed on 01/02/2016 (kg): 25.700 Measurements performed on 01/08/2016 (kg): 0.2437

Monitoring equipment	Measurements were performed by the independent 3rd party inspection service company "BIOAGRI Ambiental Ltda / Mérieux NutriSciences Brasil" using an appropriated chromatographer and a pitot tube with the following specifications: *Specifications of the utilized chromatographer:* - Manufacturer: Varian Analytical Instruments (Varian, Inc.) - Model: 3900 - S/N: 101129 - Accuracy: ±0.005% - Calibration frequency and maintenance requirements: Every 2 years - Calibration events valid for the considered monitoring period: Calibration event dated 18/08/2015 (Calibration Certificate number 15671/2015, issued by Radchrom Analítica Ltda.), valid until 17/08/2016 and calibration event dated 05/07/2016 (Calibration Certificate number 13474/2016, issued by Radchrom Analítica Ltda.), valid until 04/07/2017. *Specifications of the utilized Pitot tube:* - Manufacturer: APEX Instruments - Type: S - S/N: the instrument does not have a Serial Number - Accuracy: ±1.0% - Calibration frequency and maintenance requirements: Every 6 months - Calibration events valid for the considered monitoring period: Calibration event dated 29/10/2015 (Calibration Certificate number IPAA 647/2015, issued by Companhia Ambiental do Estado de São Paulo (CETESB)), valid until 28/04/2016 and calibration event dated 21/04/2016 (Calibration Certificate number IPAA 328/2016, issued by Companhia Ambiental do Estado de São Paulo (CETESB)), valid until 20/10/2016.
Measuring/reading/recording frequency:	Biannual
Calculation method (if applicable):	-
QA/QC procedures:	Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Biogas Riograndense Ltda. in accordance with detailed working instructions that are included in the company's quality management and control (QA/QC) and environmental management system (EMS). 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.
Purpose of data:	Calculation of baseline emissions
Additional comments:	-

<table>
<tr><td>Data/parameter:</td><td>$T_{EG,m}$</td></tr>
<tr><td>Unit</td><td>^{o}C</td></tr>
<tr><td>Description</td><td>Temperature in the exhaust gas of the enclosed flare in minute m</td></tr>
<tr><td>Measured/calculated/default</td><td>Continuously measured by thermocouples installed in the upper section of the flare</td></tr>
<tr><td>Source of data</td><td>Measured as part of the operation of the project activity by applying appropriate monitoring instruments (thermocouples) (with recordable electronic signal).</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>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.</td></tr>
<tr><td>Monitoring equipment</td><td>Two identical equipment were used simultaneously during the considered monitoring period. Their specifications are as follows;
- Instrument/equipment internal ID reference: TT-04 and TT-05
- Manufacturer: ECIL Met Tec Ltda.
- Model: ATC-204, type N
- Accuracy: ±0.75%
- Calibration frequency and maintenance requirements: Every 2 years
- Calibration events valid for the monitoring period:

<table>
<tr><th rowspan="2">Instrument
TAG</th><th rowspan="2">Calibration certificate</th><th rowspan="2">Calibration event date</th><th rowspan="2">Validity of the performed calibration event</th></tr>
<tr></tr>
<tr><td>TT-04</td><td>10412/15</td><td>26/11/2015</td><td>25/11/2017</td></tr>
<tr><td>TT-05</td><td>10413/15</td><td>26/11/2015</td><td>25/11/2017</td></tr>
</table>

Both calibration events were performed by the calibration/inspection service company SGS do Brasil Ltda.</td></tr>
<tr><td>Measuring/reading/recording frequency:</td><td>Continuously measurements are recorded/reported every minute.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>-</td></tr>
<tr><td>QA/QC procedures:</td><td>Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer.

Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Biogas Riograndense Ltda. in accordance with detailed working instructions that are included in the company’s quality management and control (QA/QC) and environmental management system (EMS).</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments:</td><td>Measurements outside the operational temperature specified/recommended by the manufacturer may indicate that the flare is not functioning correctly</td></tr>
</table>

	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.

Data/parameter:	**$Flame_m$**
Unit	Flame status "*on*" or flame status "*off*"
Description	Flame detection of flare in the minute *m*
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	*Specifications and calibration details for the installed/utilized UV Flame detector:* - Manufacturer: Honeywell Analytics Ltd. - Model: C7061A Dynamic Self-Check Ultra-Violet Flame Detector - Serial Number: 1037 1 - Calibration frequency: No calibration is required as the equipment has a self-checking function.
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 manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Biogas Riograndense Ltda. 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:	Calculation of baseline emissions
Additional comments:	Not applicable.

Data/parameter:	**$Maintenance_y$**
Unit	Calendar dates
Description	Maintenance events completed in year *y* as monitored by the project participants.

Measured/calculated/default	-
Source of data	Maintenance logs
Value(s) of monitored parameter	The following relevant maintenance events (inspection and maintenance services) are applicable for the flare during the considered monitoring period: - 07/12/2015: 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 LFG injectors, checking of painting conditions). - 15/05/2016: 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 LFG injectors, checking of painting conditions). 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. 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" ($SPEC_{flare}$)). After the project's commissioning, the isolation ceramics revetment material of the installed high temperature enclosed flare was replaced on 22-23 October 2014. 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 $SPEC_{flare}$. Further details about the parameter $SPEC_{flare}$ are included in Section D.1.
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:	Calculation of baseline emissions

Additional comments:	Monitoring of this parameter is required for the case of enclosed flare and the project participant selects Option B to determine flare efficiency. These dates are required so that they can be compared to the maintenance schedule to check that maintenance events were completed within the minimum time between maintenance events specified by the manufacturer ($SPEC_{flare}$).

Data/parameter:	**$FC_{LPG,y}$**
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	<table><tr><th colspan="2">LPG purchasing receipt</th><th rowspan="2">Reported amount of purchased LPG[14]</th></tr><tr><th>Number</th><th>Date</th></tr><tr><td>001</td><td>22/07/2015</td><td>2 * 45 kg = 90 kg</td></tr><tr><td>129</td><td>18/07/2016</td><td>1 * 45 kg = 45 kg</td></tr></table> As per the adopted monitoring procedure, the total amount of LPG consumed by the project activity during the considered monitoring period was measured as 135 kg (0.135 ton). LPG was consumed for lighting/igniting the flare (flare pilot).

[14] LPG supply is based on supply of filled LPG cylinders with 45 kg of net mass of LPG.

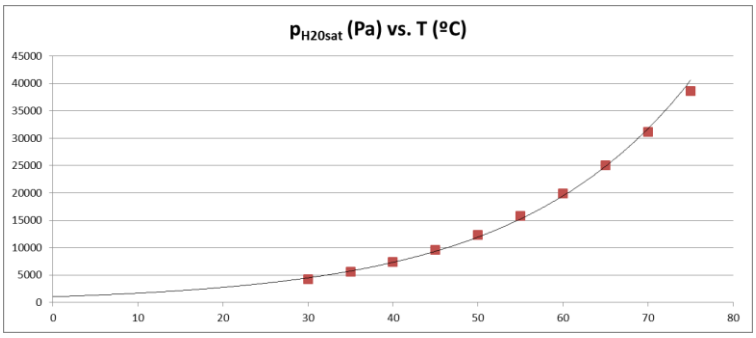
Monitoring equipment	LPG consumption was monitored based on monitoring of the quantity of purchased LPG cylinders for which the amount of LPG filled are checked and monitored by the LPG distribution company Liquigás Distribuidora S.A. at the LPG filling station / distributor warehouse through the use of appropriate weight scale. Specifications for the weight scale used for the monitoring/checking the amount of LPG filled in the LPG cylinders supplied are summarized below: *Specifications of the weight scale for measurements of FC_{LPG}:* - Manufacturer: Mettler-Toledo Inc. - Model: IND560 - Capacity: max. 250 kg - Accuracy: 13 grams - Serial Number: 10562590 - Calibration events valid for the monitoring: calibration events dated 08/06/2015 and 08/06/2016, both issued by the Instituto Nacional de Metrologia, Qualidade e Tecnologia (INMETRO)
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:	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 Biogas Riograndense Ltda. Monitoring equipment/instruments are calibrated and maintained as per instrument specifications and/or recommendations of manufacturer. Procedures related to collection/gathering, recording, storing and reporting of monitoring data for the project activity are performed at Biogas Riograndense Ltda. 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:	Calculation of project emissions (due to consumption of LPG by the project activity).
Additional comments:	-

Data/parameter:	**$NCV_{LPG,y}$**
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	National default value as per the Brazilian National Energetic Balance Report for year 2016 (Balanço Energético Nacional (BEN) – 2016) / Table VIII.9 – Specific Mass and Heating Values (Higher Heating Value). This annual report is the latest issued version and it is based on data valid for year 2015. 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. The BEN-2016 report is available online: https://ben.epe.gov.br/BENRelatorioSintese.aspx?anoColeta=2016&anoFimColeta=2015 Reported value in kcal/kg is converted into GJ/ton.
Value(s) of monitored parameter	46.5
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:	Calculation of project emissions (due to consumption of LPG by the project activity)
Additional comments:	-

Data/parameter:	**$EF_{CO2,LPG,y}$**
Unit	tCO_2/GJ LPG
Description	CO_2 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:	Calculation of project emissions (due to consumption of LPG by the project activity)
Additional comments:	-

Data/parameter:	**$p_{H2O,t,Sat}$**
Unit	Pa
Description	Saturation pressure of H_2O 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 "*Fundamentals of Classical Thermodynamics*". Authors: Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 3rd Edition 1986. Published by John Wiley & Sons, Inc.
Value(s) of monitored parameter	$p_{H2O,t,Sat}$ is determined as a function of temperature of LFG (T_t by the equation: $p_{H2O,t,sat} = 1{,}031.3 * e^{(0.049 * Tt)}$, 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):	The Absolute Vapor Pressure of Water was obtained from the mentioned literature and is presented in the following table within the rage of interest for

	the required calculations: | Temperature	$p_{H2O,t,Sat}$
ºC	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 | The following graphic represents the above data and the regression calculated to adjust data:  As $p_{H2O,t,Sat}$ 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: $p_{H2O,t,sat} = 1{,}031.3 * e^{(0.049 * Tt)}$ This equation represents the above data with a correlation coefficient of $R^2 = 0.998$. Thus, by applying the above equation, $p_{H2O,t,sat}$ is determined as a function of the temperature.
QA/QC procedures:	Not applicable.
Purpose of data:	Calculation of baseline emissions.
Additional comments:	It is important to note that $p_{H2O,t,Sat}$ 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 $F_{CH4,RG,t}$). The calculations of every-minute values of $p_{H2O,t,Sat}$ for the 2 time periods during which the flare efficiency is measured is thus presented only in the flare efficiency calculation spreadsheet.

Data/parameter:	**$EC_{PJ,captive,y}$**
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	Monthly records of captive diesel sourced electricity consumption valid for the considered monitoring period:

Month	**Amount of consumed diesel backup sourced electricity (MWh)**
Jan. 2016	0.147
Feb. 2016	0.056
Mar. 2016	0.144
Apr. 2016	0.258
May 2016	0.157
Jun. 2016	0.247
Jul. 2016	0.326

Monitoring equipment

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:

- Manufacturer: Ello Sistemas Eletrônicos Ltda.
- Model: 2106
- Serial Number: 00008150 and 00045288
- Accuracy: ±1%
- Calibration frequency and maintenance requirements: 5 years
- Calibration events valid for the monitoring period:

Instrument	Calibration events		
Serial Number	**Number of the calibration certificate**	**Calibration event date**	**Validity of the performed calibration event**
00008150	E0684/2016	25/03/2016	24/03/2021
00045288	E0685/2016	25/03/2016	24/03/2021

Both calibration events were performed by LABELO - Laboratórios Especializados em Eletroeletrônica Calibração e Ensaios.

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[15]. 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)[16]. This decree is currently replaced by the more recently passed INMETRO's Decree No. 587 (dated 05/11/2012)[17]. 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).

Besides of the applicable calibration, verification and testing procedures under responsibility of the instrument manufacturer, as indicated in the

[15] 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

[16] The INMETRO's Decree No. 431 is available online: http://www.inmetro.gov.br/rtac/pdf/RTAC001248.pdf

[17] The INMETRO's Decree No. 587 is available online:

http://www.inmetro.gov.br/legislacao/rtac/pdf/RTAC001929.pdf

	operation and commissioning manual/report for the installed captive off-grid electricity generator [18] 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. 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 [19]), the installed instruments are under conformance applicable calibration requirements.
Measuring/reading/recording frequency:	The reading of each meter is recorded manually every month, and converted to spreadsheets.
Calculation method (if applicable):	Not applicable.
QA/QC procedures:	
Purpose of data:	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)) ($v_{CH4,t,db,j}$)
- 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* ($EF_{CO2,Diesel,y}$)
- Quantity of electricity generated in captive diesel backup generator during the year *y* ($EG_{Diesel\text{-}Generator,y}$)

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.

[18] 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.

[19] 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

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 9th 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 GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

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

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

Where:

$BE_{CH4,y}$ Baseline emissions of methane from the SWDS[20].

$BE_{EC,y}$ 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:

$EC_{BL,y}$ Net 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:

Month	Amount of electricity generated using LFG (MWh)
Jan. 2016	5,012.895
Fev. 2016	4,787.101

[20] SWDS = Solid Waste Disposal Site. For the case of the project activity, the SWDS is the CRR landfill.

Mar. 2016	5,223.815
Apr. 2016	5,216.656
May 2016	4,950.549
Jun. 2016	4,572.547
Jul. 2016	5,381.606

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 2nd 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*. As per the applied monitoring procedure, the selected values for the monitoring parameter $EF_{grid,OM,y} = EF_{grid,OM-DD,y}$ (0.6228 tCO_2/MWh) represents the official average value for year (vintage) 2016 as calculated and made public available by the DNA of Brazil. Further details about the monitoring parameter $EF_{grid,OM}$ are included in Section D.2.

$EF_{grid,BM,y}$ Build margin CO_2 emission factor in year *y*. $EF_{grid,BM}$ is ex-ante determined as 0.2963 tCO_2/MWh. Further details about the ex-ante determined parameter $EF_{grid,BM}$ are included in Section D.1.

$TDL_{grid,y}$ 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% ($TDL_{grid,export,y}$).

For the considered monitoring period, $EF_{EL,grid,y}$ is thus calculated as 0.3779 tCO_2/MWh.

Baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) for the considered monitoring period are calculated and reported as 13,680 tCO_2. 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[21]. 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_4. 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.

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

$$F_{CH4,BL,y} = 0.2 * F_{CH4,PJ,capt,y}$$

Where:

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

$$F_{CH4,PJ,capt,y} = F_{CH4,sent,flare,y} + F_{CH4,EL,y}$$

Where:

$F_{CH4,EL,y}$ 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 $F_{CH4,EL,y}$ are presented below (under "*Determination of every-minute values*

[21] SWDS = Solid Waste Disposal Site. For the case of the project activity, the SWDS is the CRR landfill.

for the calculation parameters $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$").

For the considered monitoring period, the accumulated value for $F_{CH4,BL,y}$ is calculated and reported as 1,957 tCH_4. All related calculation are presented in the monthly emission reduction calculation spreadsheets that are enclosed to the Monitoring Report.

$F_{CH4,PJ,y}$ Amount of methane in the LFG which is flared and/or used in the project activity. In the particular case of the project activity, $F_{CH4,PJ,y}$ is determined as follows:

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

Where:

$F_{CH4,EL,y}$ 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 $F_{CH4,EL,y}$ for each individual engine-generator set during the considered monitoring period that is encompassed by electricity generation are presented below (under "*Determination of every-minute values for the calculation parameters $F_{CH4,sent\_flare,y}$ and $F_{CH4,EL,y}$"*).

$F_{CH4,flared,y}$ 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)[22] 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^3 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 particular case of the project activity, during the considered monitoring period, volumetric flow of the gaseous stream (LFG) is already measured in Nm^3 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.

$v_{CH4,t,wb}$ Volumetric fraction of CH_4 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 $v_{CH4,t,wb}$ (in m^3 of CH_4 / m^3 of wet LFG) are reported in the monthly emission reduction calculation spreadsheet valid for the considered monitoring period (and enclosed to this Monitoring Report).

[22] 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.*"

Further monitoring details about the monitoring parameter $v_{CH4,t,wb}$ are included in Section D.2.

$\rho_{CH4,n}$ Density of CH_4 in the gaseous stream (LFG) at normal conditions. For the considered monitoring period, value of $\rho_{CH4,n}$ (in kg of CH_4 / m^3 of CH_4) 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:

$\rho_{CH4,n} = (P_n * MM_i) / (R_u * T_n)$

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 $Pa.m^3$ /kmol.K. Further details about the ex-ante determined parameter R_u are presented in Section D.1 and in the PDD.

$\rho_{CH4,n}$ is calculated as 0.7156650 $kgCH_4$ / m^3CH_4 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 m³ 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 $P_{tgenset-n}$ 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.

$v_{CH4,t,wb}$ Volumetric fraction of CH_4 in the gaseous stream in time interval *t* on a wet basis. Further monitoring details about the monitoring parameter $v_{CH4,t,wb}$ are included above and in Section D.2.

$\rho_{CH4,n}$ Density of CH_4 in the gaseous stream (LFG) at normal conditions. $\rho_{CH4,n}$ is calculated as 0.7156650 $kgCH_4$ / m^3CH_4 as reported in the monthly emission reduction calculation spreadsheet valid for the considered monitoring period. Details about the determination of $\rho_{CH4,n}$ are presented above.

Determination of $PE_{flare,y}$:

$PE_{flare,y}$ is determined by following the applicable stepwise guidance of the methodological tool "Project emissions from flaring" (version 2). Every minute values for $PE_{flare,y}$ 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 ($\eta_{flare,m} = \eta_{flare,calc,y}$) as follows:

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

Where:

$F_{CH4,RG,m}$ Methane mass flow in the residual gas of the flare. For each minute *m* of the considered monitoring period, values for $F_{CH4,RG,m}$ 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" ($F_{CH4,sent\_flare,y}$).

$\eta_{flare,m}$ Flare efficiency in minute m. For the considered monitoring period, $\eta_{flare,m}$ 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 ($\eta_{flare,m} = \eta_{flare,calc,m}$) 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 $T_{EG,m}$) and the flow rate LFG to the flare (monitoring parameter $F_{RG,m}$) is within the manufacturer's specification for the flare ($SPEC_{flare}$) in minute m*
> *(2) Flame is detected in the flare in minute m (monitoring parameter $Flame_m$).*
>
> *Otherwise $\eta_{flare,m}$ is set as 0%.*
> *(…)"*

In applying Option B, the project participants chose to determine $\eta_{flare,calc,m}$ 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 ($\eta_{flare,calc,m}$) 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" ($F_{CH4,EG,t}$)) are considered as per the following calculation formula:

Option B.1: Biannual measurement of the flare efficiency":
The calculated flare efficiency $\eta_{flare,calc,y}$ for the installed flare is determined as follows:

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

Where:

$F_{CH4,EG,t}$ Mass flow of methane in the exhaust gas of the flare on a dry basis at reference conditions in the time period *t*. As established by the PDD, for the considered monitoring period, $F_{CH4,EG,t}$ 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 $F_{CH4,EG,t}$ 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.

$F_{CH4,RG,t}$ 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 $F_{CH4,RG,t}$ are presented below.

Determination of $F_{CH4,RG,t}$:

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 $F_{CH4,RG,t}$ are thus calculated as follows:

$$F_{CH4,RG,t} = V_{t,db,n} * v_{CH4,t,db} * \rho_{CH4,n}$$

Where:

$\rho_{CH4,n}$ Density of greenhouse gas *i* (*i* = CH_4) in the gaseous stream (LFG) at normal conditions. Further details for the determination of $\rho_{CH4,n}$ are presented above under the sub-section "*Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$*".

$v_{CH4,t,db}$ 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 $v_{CH4,t,db}$ are regarded as equal to every-minute values of the monitoring parameter $v_{CH4,t,wb}$ (for which further details are presented above under the sub-

section "*Determination of every-minute values for the calculation parameter $F_{CH4,sent\_flare,y}$*").

$V_{t,db,n,flare}$ 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:

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

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 $F_{CH4,sent\_flare,y,flare}$*"

$v_{H2O,t,db}$ 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", $v_{H2O,t,db}$ is calculated as follows:

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

Where:

MM_{H2O} Molecular mass of H_2O. MM_{H2O} is ex-ante determined as 18.0152 kg/kmol.
Further details about the ex-ante determined parameter MM_{H2O} 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_4 in the gaseous stream ($V_{k,t,db}$ = $v_{CH4,t,db}$) are presented above under the calculation parameter $v_{CH4,t,db}$.

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.

$m_{H2O,t,db}$ Absolute humidity in the gaseous stream in time interval *t* n 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 ($m_{H2O,t,db} = m_{H2O,t,db,Sat}$), $m_{H2O,t,db}$ is calculated as follows [23]:

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

Where:

MM_{H2O}	Molecular mass of H_2O. MM_{H2O} is ex-ante determined as 18.0152. Further details about the ex-ante determined values for MM_{H2O} are included in Section D.1 and in the PDD.
P_t	Absolute pressure of the gaseous stream in time interval *t*. Further monitoring details for P_t are included in Section D.2.
$MM_{t,db}$	Molecular mass of the gaseous stream in a time interval *t* on a dry basis. Further details for the determination of $MM_{t,db}$ are presented above.
$p_{H2O,t,Sat}$	Saturation pressure of H_2O at temperature T in time *t*.

[23] It is important to note that the simplified approach for the calculation of the absolute humidity of the gaseous stream ($m_{H2O,t,db}$) 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 I is underestimated (applicable for calculating baseline emissions). Conversely, an assumption that the gas stream is dry is conservative for the situation that the greenhouse gas t is overestimated (applicable for calculating project emissions).*"

In this particular case, $m_{H2O,t,db}$ is calculated for the determination of the mass flow of methane in the residual gas on a dry basis during the time period t ($F_{CH4,RG,t}$). While $F_{CH4,RG,t}$ 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.

Further monitoring details about the monitoring parameter $p_{H2O,t,Sat}$ are included in Section D.2.

In summary, for the considered monitoring period, a value of 0.8794056 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 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 $F_{CH4,PJ,y} = F_{CH4,flared,y}$ 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 $F_{CH4,PJ,y} = F_{CH4,flared,y}$ 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 $\eta_{flare,m}$ 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 $SPEC_{flare}$ (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 $F_{CH4,PJ,y} = F_{CH4,flared,y}$ 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 $SPEC_{flare}$ (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 $F_{CH4,PJ,y} = F_{CH4,flared,y} + F_{CH4,EL,y}$ is calculated as 10,565 tCH_4.

For the considered monitoring period, baseline emissions of methane from the SWDS ($BE_{CH4,y}$) are calculated as 188,788 tCO_2e.

The summarized emission reduction calculation spreadsheets (that are enclosed to this Monitoring Report) summarizes the determination of $BE_y = BE_{CH4,y} + BE_{EC,y}$ for the considered monitoring period.

E.2. Calculation of project emissions or actual net GHG removals by sinks

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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_2 emissions from fossil fuel combustion".

Project emissions (PE_y) for the considered monitoring period are determined (in tCO_2e) as follows:

$$PE_y = PE_{EC,grid,y} + PE_{EC,captive,y} + PE_{LPG,y}$$

Where:

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

$PE_{EC,captive,y}$ Project emissions from consumption of electricity generated by a captive off-grid electricity generator fuelled by fossil fuel (diesel) in year *y* (in tCO_2/yr)

$PE_{LPG,y}$ Project emissions due to the consumption of LPG by the project activity in year *y* (in tCO_2/year)

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

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 providing electricity to the grid and/or for grid sourced electricity consumed by the project activity. For the particular case of determination of $PE_{EC,grid,y}$, $TDL_{grid,y}$ is ex-ante selected as 20% ($TDL_{grid,import,y}$). 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)
Jan. 2016	3.764
Feb. 2016	3.396
Mar. 2016	2.810
Apr. 2016	1.367
May 2016	2.011
Jun. 2016	0.305
Jul. 2016	1.406

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 2nd 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*. As per the applied monitoring procedure, the selected value for the monitoring parameter $EF_{grid,OM,y} = EF_{grid,OM-DD,y}$ (0.6228 tCO_2/MWh) represents the official average value for year (vintage) 2016 as calculated and made public available by the DNA of Brazil. Further details about the monitoring parameter $EF_{grid,OM}$ are included in Section D.2.

$EF_{grid,BM,y}$ Build margin CO_2 emission factor in year *y*. Further details about the ex-ante selected parameter $EF_{grid,BM}$ are included in Section D.1 and in the PDD.

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

$PE_{EC,grid,y}$ = 15.059 MWh * (0.25 * 0.6228 tCO_2/MWh + 0.75 * 0.2963 tCO_2/MWh) = 7 tCO_2 (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_2/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)
Jan. 2016	0.147
Feb. 2016	0.056
Mar. 2016	0.144
Apr. 2016	0.258
May 2016	0.157
Jun. 2016	0.247
Jul. 2016	0.326

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_2 emission factor for electricity sourced by the captive off-grid electricity generators $EF_{EL,captive,y}$ is ex-ante determined as 1.3 tCO_2/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:

$PE_{EC,captive,y} = 1.335\ MWh * 1.3\ tCO_2/MWh * (1 + 0) = 2\ tCO_2$ (rounded value)

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_2 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*. As per the adopted monitoring procedure, during the considered monitoring $FC_{LPG,y}$ is determined as

135 kg (0.135 ton) of LPG. Additional monitoring details for the monitoring parameter $FC_{LPG,y}$ are included in Section D.2.

$COEF_{LPG,y}$ CO2 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 CO2 emissions from fossil fuel combustion" as follows:

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

Where:

$EF_{CO2,LPG,y}$ CO_2 emission factor of fuel LPG (in energy basis). As per the applied monitoring procedure, $EF_{CO2,LPG,y}$ is determined as 0.0656 tCO_2/GJ. Further details about the monitoring parameter $EF_{CO2,LPG,y}$ are included in Section D.2.

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

Thus, $COEF_{LPG,y}$ = 0.0656 tCO_2/GJ * 46.5 GJ/ton = 3.05 tCO_2/ton

In summary, $PE_{LPG,y}$ is calculated as follows:

$PE_{LPG,y}$ = 0.135 ton LPG * 3.05 tCO_2/ton LPG = 1 tCO_2 (rounded value)

Project emissions due to the consumption of LPG are thus determined as 1 tCO_2 (rounded value). The summarized emission reduction calculation spreadsheet (that is enclosed to this Monitoring Report) includes all calculations related to the determination of $PE_{LPG,y}$ for the considered monitoring period.

Total project emissions (PE_y) for the considered monitoring period are calculated as 10 tCO_2 (rounded value).

E.3. Calculation of leakage

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Not applicable.

E.4. Summary of calculation of emission reductions or net GHG removals by sinks

Emission reductions achieved by the project activity during the considered monitoring period are determined as the difference between baseline emissions (BE_y) and project emissions (PE_y) determined for such period. Calculations of baseline emissions (BE_y) are presented in Section E.1. Calculations of project emissions (PE_y) are presented in Section E.2. As summarized in the table below, during the monitoring period from 01/01/2016 to 31/07/2016, achieved emission reductions are calculated and reported as 202,458 tCO_2e (rounded value):

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	202,468	10	-	-	202,458	202,458

E.5. Comparison of actual emission reductions or net GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	253,743[24]	202,458

E.6. Remarks on difference from estimated value in registered PDD

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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 213-day monitoring period within year 2016. The following aspects justify and explain 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:

Aspects/conditions which represent 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 2nd 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 "Efficiency of the LFG capture system that will be installed in the project activity" (η_{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

[24] The 253,743 tCO_2e value is calculated as the share of the estimated total emission reductions for year 2016 to be achieved during the 213-day length considered monitoring period within year 2016 (calculated as 434,817 tCO_2e * 213 / 365).

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).

Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	☒ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
Organization name	Companhia Riograndense de Valorização de Resíduos S/A
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Direct fax	
Direct tel.	

Project participant and/or responsible person/ entity	☒ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
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Document information

Version	*Date*	*Description*
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from *F-CDM-MR* to *CDM-MR-FORM*; • Editorial improvement.
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 (EB70, 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).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

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