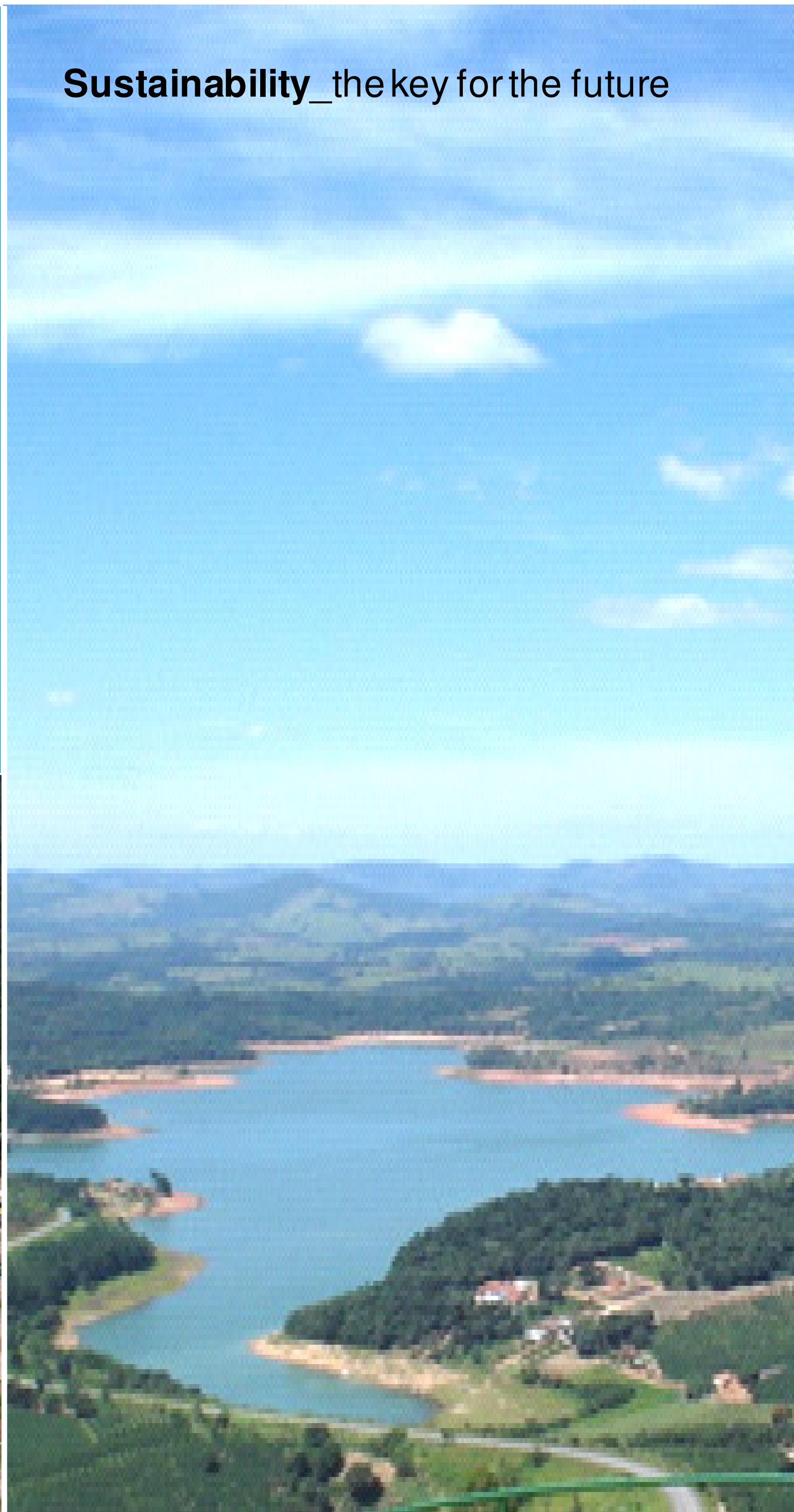
Imagine the result



São João Landfill Gas to Energy Project (SJ)

Monitoring Report – Version 01
5th Verification
Monitoring Period: 01/04/2008 to 30/06/2008

São Paulo, July 2nd 2008

Clean Development Mechanism

Monitoring Report – Version 01

São João Landfill Gas to Energy Project (SJ)

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Biogás Energia Ambiental SA

São Paulo
July 2nd, 2008

ARCADIS TETRAPLAN

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Glossary

CDM	Clean Development Mechanism
CDM-EB	Clean Development Mechanism Executive Board
PDD	Project Design Document
CER	Certified Emission Reduction
GHG	Greenhouse Gas
GWP	Global Warming Potential
CH_4	Methane
EF	Grid CO_2 Electricity Emission Factor

1. General Project Activity Information

São João Landfill Gas to Energy Project (SJ), Registration Number 0373

The presentation of values in this Monitoring Report, including those used for emission reductions, are in international standard format e.g 1,000 representing one thousand and 1.0 representing one.

1.1. Short Description of the Project Activity:

São João Landfill Gas to Energy Project (SJ) is a project designed to explore the landfill gas produced in São João landfill, one of the biggest landfills in Brazil. This landfill is located in the metropolitan region of São Paulo, Brazil's biggest city and financial center of the country. With an estimated population of around 10 million citizens in 2000, São Paulo generates nearly 15,000 tons of waste daily. São João Landfill Gas to Energy Project (SJ)'s goal is to explore the gas produced in São João landfill, using it to generate electricity.

1.2. Real Project Implementation

The SJ includes high density polyethylene pipes connected to the landfill wells; blowers to extract the gas from the landfill; facilities for gas treatment, such as heat exchangers, chillers; and the flares, which will destroy the methane previously released to the atmosphere. The project also has installed a total capacity of 22.4 MW for electricity generation (3.2 MW in stand-by) from January 25th 2008 on (by the time of the 4th Verification, the power house was finished and fully operating, however the automatic monitoring of the electricity exported hasn't being finished – thus Emission Reduction from the electricity exported were not considered in this version of the monitoring report).

The degassing station will be responsible for extracting the landfill gas from the landfill and transport it to the flares and, in the future, to the gas engines in the power plant. During the transportation, the gas goes through a treatment to allow its use as fuel for energy generation. Other functions of the degassing station are: drying landfill gas by gas coolers; and measuring and analyzing the quantity and quality of the landfill gas for safety, process and operating purposes.

The landfill gas is cooled down when transported from the landfill, resulting in a condensate. This is be drained to condensate shafts, to be placed nearby the gas pipes. Once in the degassing station, the gas is be measured and sent to a flaring system. Biogás has chillers installed in order to remove moisture. This is a very important step in the gas treatment process, since the condensate, which contains silicium components, could block the gas pipes and also damage the gas engines, due to the silicium. After this step, the gas is heated again through a second heat exchanger, or economizer, to a temperature of around 25ºC, far enough from the dew point of 4ºC to avoid further condensation.

Blowers are used for transportation of the landfill gas from the landfill to the flares. These blowers are equipped with all the necessary safety equipment, including a noise reducing housing.

The figure below presents the installation of all collecting equipment from SJ, the location of the degassing station and the future location of the power house.

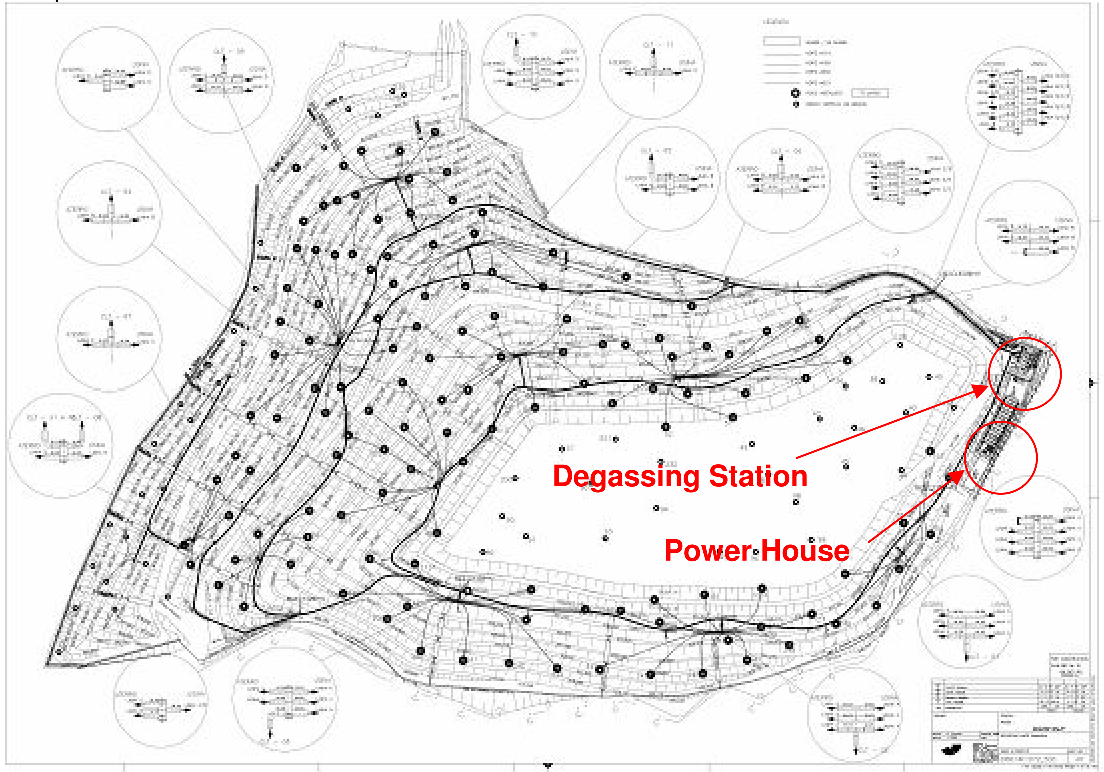

Figure 1-1: SJ Lay-out

Figure 1-2: Degassing Station (1) and Power House (2)

The pictures below illustrate the collecting system of the SJ project.

Figure 1-3: Wellhead

Figure 1-4: Wellhead and Collection Pipeline

Figure 1-5: Transmission Pipeline

Figure 1-6: Gas entrance in the Degassing Station

On the pressure side of the degassing station, all kinds of gas analyzing and gas measuring instruments are present. These instruments are very important for safety, process and operating purposes. SJ counts, actually, with three turbine flow-meters: one measures the total gas collected (tag FIR600) and the other two measures the gas sent to the flaring system and to the future power house (tags: FIR500 and FIR800, respectively).

While the power house has not been installed, SJ generates electricity through a diesel engine installed in the degassing station. The electricity produced is registered continuously by the PLC and the diesel consumed is registered via the contract between Biogás and the diesel supplier.

The pictures below presents the above mentioned installed equipment and the lay-out of the degassing station locating of the measuring equipment.

Figure 1-7: FIR600

Figure 1-8: FIR500 and FIR800

Figure 1-9: Flares F520, F540 and F560

Figure 1-10: Blower

Figure 1-11: Detail of the blower

Figure 1-12: Chiller

Figure 1-13: Methane Analyser A400

The Power House's construction was finished in January 2008. There are 14 gas engines installed with a nominal capacity of 1.6 MW each, achieving a total installed capacity of 22.4 MW – 3.2 MW (or 2 engines) in stand-by. Electricity produced is sent to the substation located next to the power house and then to the distribution grid. An electricity-meter is installed to measure the quantity of electricity exported to the grid.

The pictures below presents the gas engines installed in the Power House, the substation and the electricity-meter.

Figure 1-14: Gas engine

Figure 1-15: Substation

Figure 1-16: Electricity-meter

1.3. Changes against the PDD

From the registered PDD, the following changes were presented:

- The operation of the project only with flares. The project began to generate electricity only on January 2008.
- While the power house was not finished, the electricity supplied to SJ was produced by a diesel generator. This source of project emission was considered in the calculation of emission reduction, according with the revised Monitoring Plan approved by the EB;
- differently from Annex 4 – Monitoring Plan, 3 (three) flow-meters were installed instead of the 2 (two) mentioned: the first to measure the total flow, the second to measure the gas sent to the flares and the third to measure the methane sent to the power house, according with the revised Monitoring Plan approved by the EB;
- Starting date of the project activity was moved from 30/06/2006 to 22/05/2007 due to the bureaucratic process of Environmental Licensing and due to the negotiation aiming the electricity sale (PPA), which delayed the start of the project's civil works.

1.4. Monitoring Period

The monitoring period is from 01/04/2008 to 30/06/2008.

1.5. Methodology applied to the project activity

1.5.1. Baseline methodology

The baseline applied to this project activity is **ACM0001 – version 2: "Consolidated baseline methodology for landfill gas project activities".**

1.5.2. Monitoring methodology

The monitoring methodology applied to this project activity is **ACM0001 – version 2: "Consolidated monitoring methodology for landfill gas project activities".**

1.6. Changes since last verification

The major change since the last verification was the beginning of the electricity geneation and the monitoring of the parameters of methane sen to the power house.

1.7. Person(s) responsible for the preparation and submission of the monitoring report

This monitoring report was developed and reviewed by:

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2. Monitoring of the Project Activity

2.1. Monitoring Plan

The Monitoring Plan was developed based on **version 02** of the **"Consolidated monitoring methodology for landfill gas project activities" – ACM0001**. A review of this plan was submitted and approved. The data to be collected or used to monitor emissions from the project activity, and how this data will be archived are presented below:

Methodology ID	Data variable	Data Unit	Measured (M) Calculated (C) Estimated (E)	Recording frequency	Proportion of data to be monitored	Data archivement: Electronic (E) Paper (P)	For how long is archived data kept?	Comment
$LFG_{Total, y}$	Total amount of landfill gas captured	Nm^3	M	Continuously	100%	E / P	During the crediting period and two years after	Measured by a flow meter. Data will be aggregated monthly and yearly. Normal cubic meters represent the gas volume in cubic meters at STP [1]. Data will be kept for two years after the end of the crediting period.
$LFG_{Flare, y}$	Total amount of landfill gas flared	Nm^3	M	Continuously	100%	E / P	During the crediting period and two years after	Measured by a flow meter. Data will be aggregated monthly and yearly. Normal cubic meters represent the gas volume in cubic meters at STP. Data will be kept for two years after the end of the crediting period.
$LFG_{Electricity, y}$	Total amount of landfill gas combusted in power plant	Nm^3	M	Continuously	100%	E / P	During the crediting period and two years after	Measured by a flow meter. Data will be aggregated monthly and yearly. Normal cubic meters represent the gas volume in cubic meters at STP. Data will be kept for two years after the end of the crediting period.

[1] The conversion of m^3 to Nm^3 is made automatically by the flow-meter, using continuous readings of temperature and pressure transmitters connected to each flow-meter

Methodology ID	Data variable	Data Unit	Measured (M) Calculated (C) Estimated (E)	Recording frequency	Proportion of data to be monitored	Data archivement: Electronic (E) Paper (P)	For how long is archived data kept?	Comment
FE	Flare combustion efficiency. Determined by the operation hours (1) and the methane content in the exhaust gas (2)	%	M / C	(1) continuously, (2) quarterly, monthly if unstable	N/A	E	During the crediting period and two years after	(1) Continuous measurement of operation time of flare (e.g. with temperature). (2) Periodic measurement of methane content of flare exhaust gas. Data will be kept for two years after the end of the crediting period.
$w_{CH4,y}$	Methane fraction in the landfill gas	%	M	Continuously	100%	E	During the crediting period and two years after	Measured by continuous gas quality analyzer.
	Regulatory requirements relating to landfill gas projects	Test	N/A	-	100%	E/P		
EG_y[2]	Net quantity of electricity displaced during the year	MWh	M	Continuously	100%	E	During the crediting period and two years	The net quantity of electricity displaced will be measured by an electricity meter. Data will be kept for two years after the end of the crediting period.
CEF_y[2]	Emission Factor	tCO_2/MWh	C	Once at project start and then at each baseline renewal	100%	E	During the crediting period and two years	CO_2e emission intensity of the electricity being generated by the grid will be determined through an approved baseline methodology, which is ACM0002 version 5. This data will be updated at the baseline renewal, in accordance with the considered methodology.
EC_y	Electricity consumed from the diesel generator	MWh	M	Continuously	100%	E	During the crediting period and two years	During the construction of the power house, SJ will consume electricity from a diesel generator, measured by an electricity-meter. Data will be kept for two years after the end of the crediting period.
EF_y	CO_2 emission intensity	tCO_2e/MWh	E	Every new version	100%	E/P	During the crediting	The diesel CO_2 emission factor was

[2] Monitoring parameters as per methodology ACM0002 – version 05 to calculate emission reductions due to the displacement of fóssil-fuel based energy in the Brazilian S-SE-CO Grid.

Methodology ID	Data variable	Data Unit	Measured (M) Calculated (C) Estimated (E)	Recording frequency	Proportion of data to be monitored	Data archivement: Electronic (E) Paper (P)	For how long is archived data kept?	Comment
	diesel generator			of the "Tool to calculate project emissions from electricity consumption"			period and two years	adopted as a conservative default emission factor, based on the "Tool to calculate project emissions from electricity consumption".

The variables EC_y and EF_y were included as part of the revision of the Monitoring Plan in order to calculate Project Emissions from the Diesel Electricity Consumption.

2.2. Monitoring Equipment

The following equipment were installed in the Degassing Station and in the Power House, as per the revised Monitoring Plan:

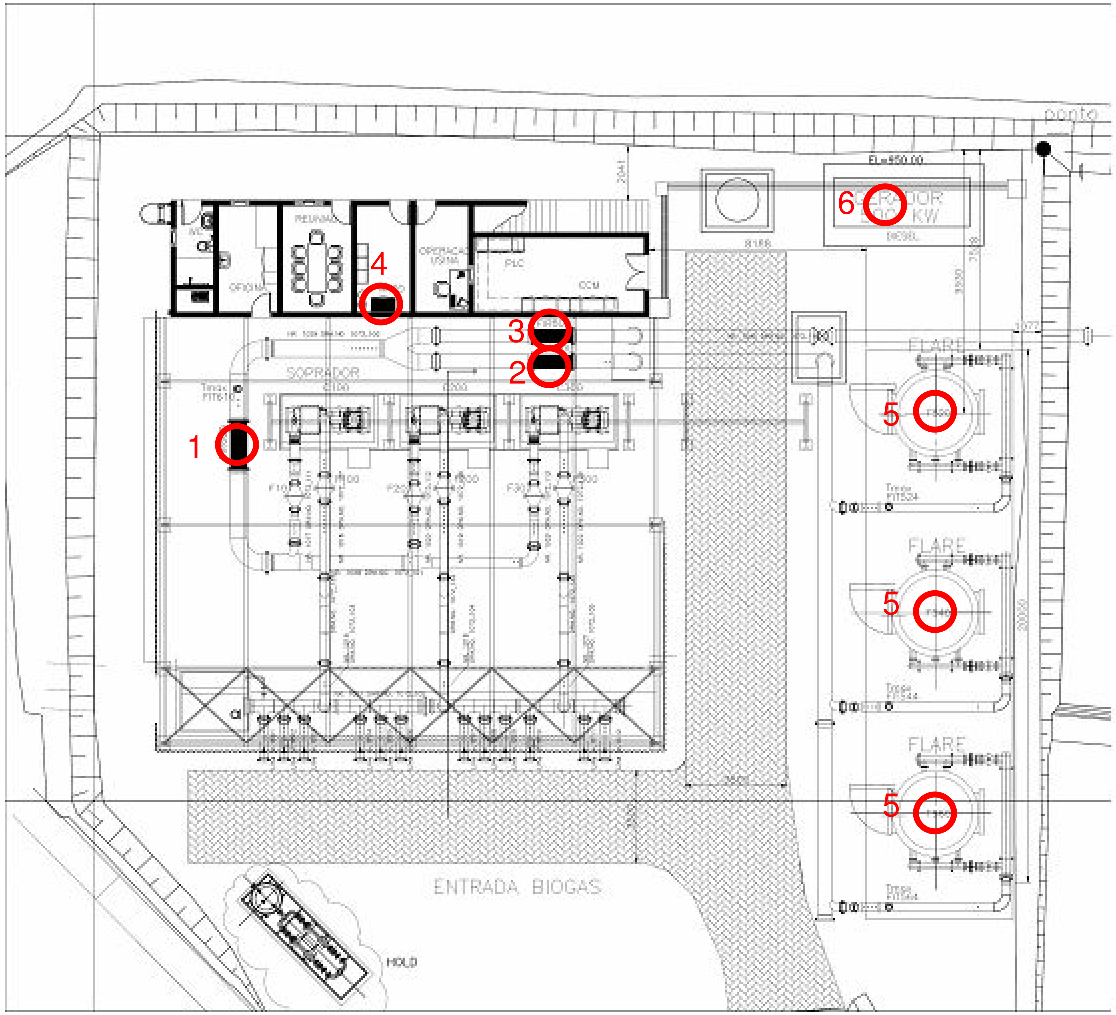


Figure 2-1. Lay-out of the Degassing Station

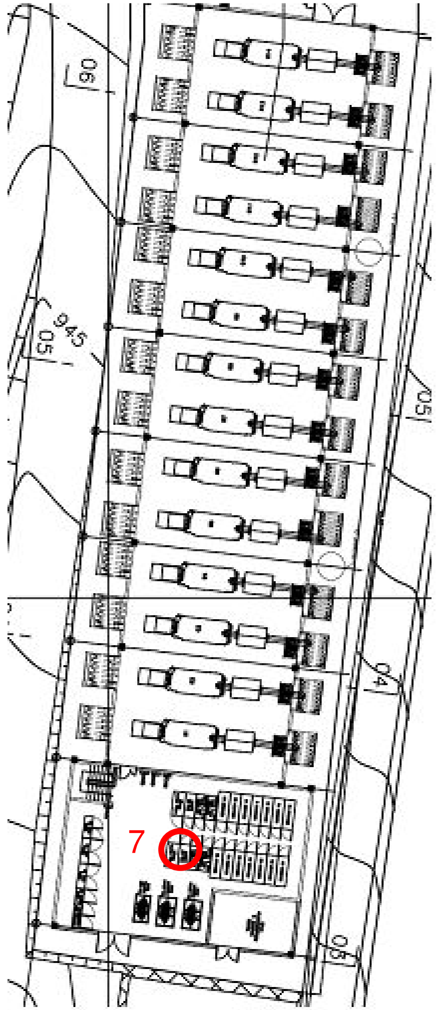


Figure 2-2. Lay-out of the Power House

Methodology ID	Equipment Number	Equipment	Location	TAG	Manufacturer	Model	Range	Error (%)
$LFG_{Total, y}$	1	Turbine Flow-meter [3]	Main Line	FIR600	Instromet	SM-RI-X-K	1,300–25,000 m^3/h	0.480
$LFG_{Flare, y}$	2	Turbine Flow-meters [3]	Line to Flares	FIR500	Instromet	SM-RI-X-K	800–16,000 m^3/h	0.980
$LFG_{Electricity, y}$	3	Turbine Flow-meter [3]	Line to the Power House	FIR800	Instromet	SM-RI-X-K	800–16,000 m^3/h	1.280
FE	5	(1) Temperature transmitters (thermocouples) (2) Chromatographer – analysis made by a Third Party	Flares F520, F540 and F560	(1) TAC520, TAC540 and TAC560 (2) N/A	(1) Jumo (all thermocouples) (2) N/A	(1) type "S" L750 (2) N/A	(1) 0-1500°C (2) N/A	N/A
$w_{CH4, y}$	4	Methane Analyzer	Analysis Room	A100	Fisher & Rosemount	Binos 100	0-100%	1.000
EG_y	7	Electricity Meter	Substation	N/A	Merlin Gerin	Power Logic - CM 4000	240V/300V - 96mA MAX.	0.2
EC_y	6	Electricity Meter	Diesel Generator	N/A	Siemens	MMG 144	0-100 MWh	0.500

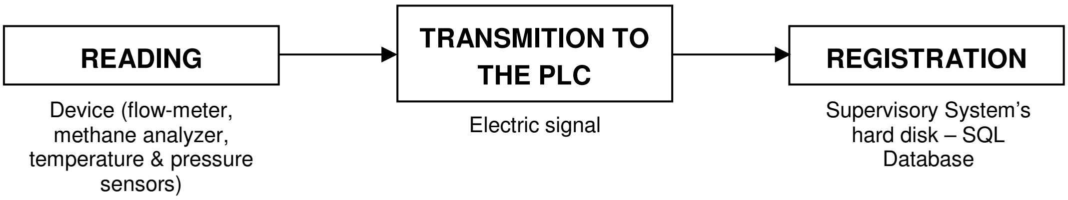
[3] The Turbine flow-meters installed are connected to a pressure and temperature transmitters, which allows the device to use those variables to make the conversion automatically to Nm^3. Thus, readings from pressure and temperature were not monitored; however the erros from the transmitters were discounted from the final calculation (refer to 4.3).

2.2.1. Data Acquisition

All variables monitored are controlled by an electrical control system. This control system is provided with a PLC (Programmable Logical Computer). All the measured process signals are processed by the PLC to output signals for the gas-coolers, blowers, flares and gas-engines. Also the system counts on a SCADA system (process visualization on a personal computer). With this system it is possible to control and monitor the installation at a distance, including through the internet.

Figure 2-3. PLC Controlling System panel

For each parameter operationally monitored, the PLC makes a routine of reading / transmitting / registering in the Supervosory's System hard disk as presente in the figure below:



Depending on the paremeter the, the frequency of the PLC's routine may vary, as presented in the table below:

Methodology ID	Equipment TAG	Reading Frequency	Transmition Frequency	Registration Frequency	Comments
$LFG_{Total, y}$	FIR600	Every 5 seconds	Every 5 seconds	Every 5 minutes	- Data accumulated every 1 hour in the Supervisory System's hard disk, in Nm^3, using the readings from the pressure and temperature transmitters; - Every 00:00, the PLC's counter is reseted; - The flow-computer installed in the flow-meter keeps registering the accumulated flow; - Every 3 hours, the accumulated flow (in Nm^3) is manually registered by the operators; - Responsibilties of the routine: PLC (continuously) and plant supervisor (monthly)
$LFG_{Flare, y}$	FIR500	Every 5 seconds	Every 5 seconds	Every 5 minutes)	
$LFG_{Electricity, y}$	FIR800	Every 5 seconds	Every 5 seconds	Every 5 minutes	
FE	(1) TAC520, TAC540 and TAC560 (2) N/A	(1) Every 5 seconds (2) Every 3 months, by a specialized company on gas analysis	(1) Every 5 seconds (2) Every 3 months, by a specialized company on gas analysis	(1) Every 5 minutes (2) Every 3 months, by a specialized company on gas analysis	- Temperatures below 900°C indicates that the flare is running out of the specified combustion temperature range; - A sudden decrease of temperature indicates that the main valve of the flare is closed and no gas is being sent to the flare (please, refer to item 3.1.1) - The flare efficiency analysis is made according with internal procedures from the hired company
$w_{CH4, y}$	A100	Every 5 minutes	Every 5 minutes	Every 5 minutes	- By the end of the day, an average of CH_4 concentration (registered every 5 minutes) is calculated. - Responsibilties of the routine: PLC (continuously) and plant supervisor (monthly)
EG_y	EM100	Every 5 seconds	-	Every 1 hour	- As during this monitoring period the electricity-meter was not connected to the PLC, the readings of electricity exported were made manually by the operators every 1 hour and registered in a sheet
EC_y	N/A	Every 5 seconds	Every 5 seconds	Every 5 minutes	- Responsibilities of the routine: PLC (continuously) and power plant supervisor (monthly)

2.2.2. Involvement of Third Parties

SJ has four third parties involved (directly and indirectly):

- Specialized company on gas analysis, to perform the analysis of methane concentration in the exhaust gas. For this monitoring period, Biogás hired BIOAGRI, a certified national laboratory.
- NEXT Solutions, the company responsible for the automation of the system;
- Van der Wiel, one of Biogás's shareholders, is the only company who has external access to the data registered from the PLC.
- ARCADIS Tetraplan is the company responsible to develop the Monitoring Report and is part of the quality assurance/quality control procedures.

2.3. Quality assurance and quality control measures

2.3.1. Internal Procedures and ISO14001

Biogás counts with the internal procedure PO-005 which objective is to to specify the monitoring procedures made inside the Degassing Station, as gas flows, temperature, pressure, electricity generation and methane concentration.

As presented in item 2.2.1, all parameters monitored inside the Degassing Station have the same reading / transmitting / registration routine and all routines have one person responsible: the plant supervisor.

Every week, the plant supervisor downloads all data registered from the PLC and make a complete check to identify unconformities, such as unread registrations or troubles with the PLC (this unconformities happens mainly due to electricity black-outs). All unconformities raised are promptly compared with operational events, registered by the operators in the Operation Diary. The event is informed to the Production Manager of Biogás, which is responsible for taking the necessary actions to avoid it to happen again.

In order to avoid data loss, the operators are oriented to register all gas flow data manually in proper sheets on a daily basis (0:00 hour), which are verified by the production manager weekly for legibility. Manual records are transferred to an Excel sheet (which is double-checked with a sheet developed by ARCADIS Tetraplan).

Also, the SJ counts with a third-party, non-responsible for the project's monitoring: ARCADIS Tetraplan, which is the responsible for the development of the Monitoring Report. ARCADIS Tetraplan's role in the Project is to assure the quality of the registered data, through a double-check process, and to assure the quality of the calculation of ERs and is in constant contact with the Production Manager of Biogás.

Biogás has, until now, no intention to implent EMS such as ISO 14001 in SJ.

Other procedures developed at SJ are:

PO-001: Procedure about re-starting the plant after an electricity breakdown
PO-002: Calibration of methane analyser
PO-003: Calibration of valve (flare)
PO-004: Service orders and maintenance
PO-005: Procedure of monitoring parameters (including calibration plan)
PO-006: Procedure about internal monitoring of São João
PO-007: Procedure about wokers control
PO-008: Procedure for the elaboration of the monthly operational report
PO-009: Procedure in emergency situations
PO-010: Procedure for data back-up of the supervisory system
PO-011: Procedure for manual data collection

2.3.2. Organizational Structure, responsibilities and competencies

Positions and roles for this CDM project activity are well defined. From the point of view of the plant operation, positions and roles are defined. Duties, personel replacement in the case of non-availability of the supervisor of monitoring and/or the eletrical supervisor and hiring requirements for job positions are determined in documented procedures, as presented in the figures below:

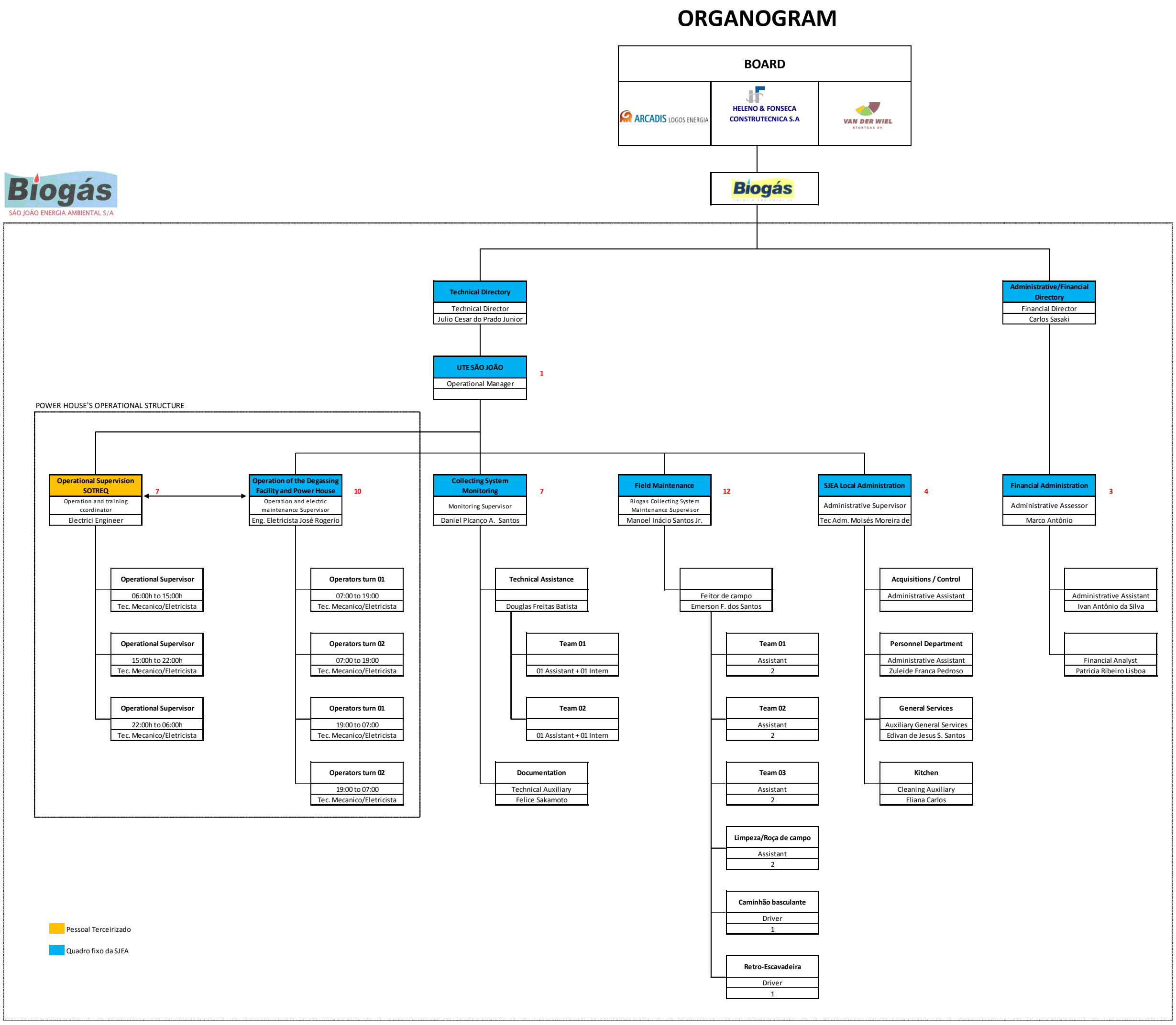


Figure 2-4. General Organogram of SJ

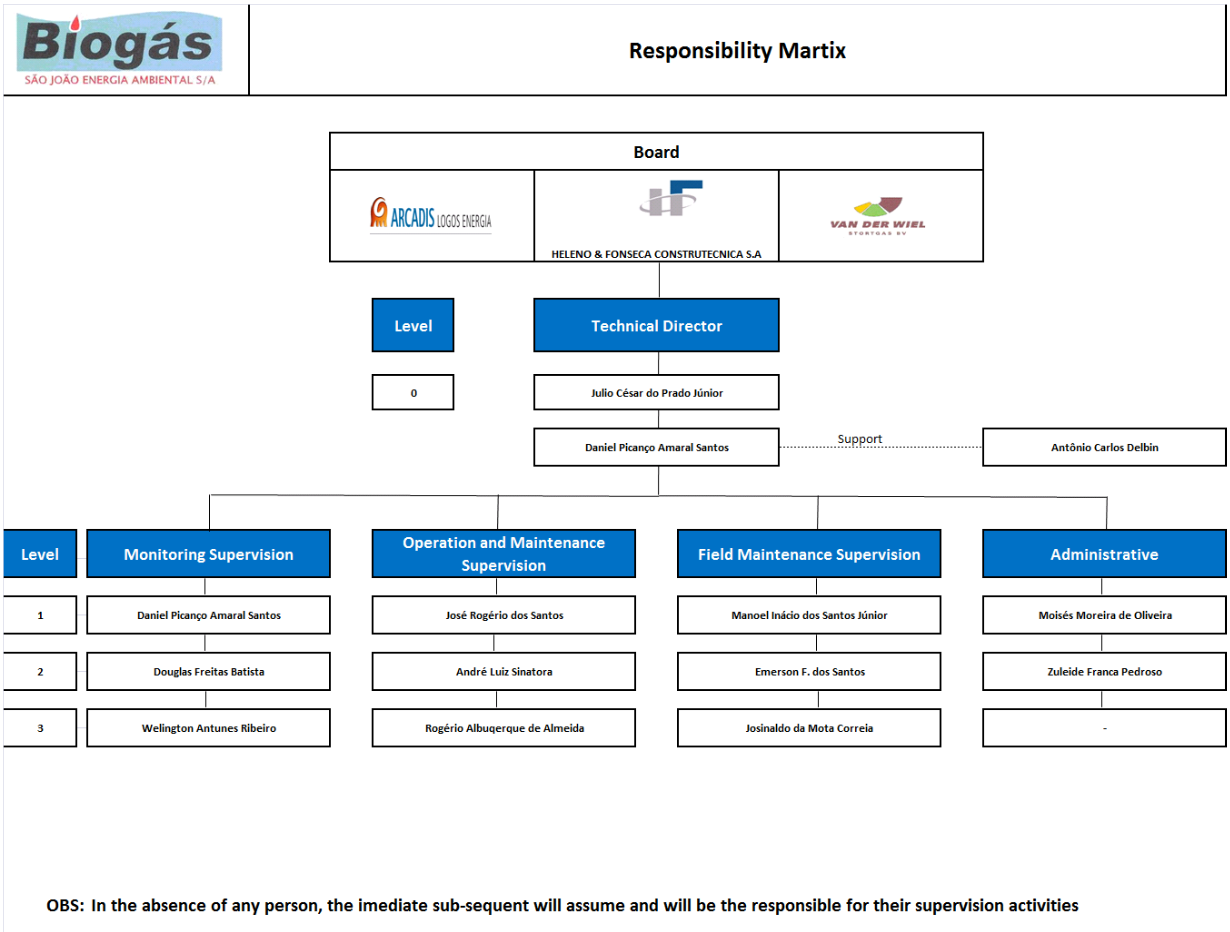


Figure 2-5. Responsibility Matrix of SJ

2.3.3. Trainings

All training was supplied before the project's implementation. The training certificates were presented to the Verification Team.

For this monitoring period, the following employers were hired:

Name	Position
Robson Draghi Faldin	Maintenance and Operation Electricist
Eduardo de Oliveira Silva	Maintenance and Operation Electricist
João de Almeida	Maintenance and Operation Mechanic
Ronildo Martins Ramos	Maintenance and Operation Mechanic

All training was supplied to this new employers, evidenced by the Training Certificates.

2.3.4. Data Protection Measures

As all data registered in the Supervisory System's hard disk is subjected to sabotage and technical failure, Biogás developed the following actions to protect the monitoring system:

- The PLC is not connected to the Internet, thus the risk of virus is minimized;
- Only defined persons have access to the data base of the system;
- Antivirus programmes are installed at the system;
- Data backup:
  - A weekly CD backup of the Supervosory System's hard disk;
  - A weekly backup of the Supervosory System's hard disk is made by the server of Heleno & Fonseca (one of Biogás shareholders);
  - Van der Wiel (another Biogás shareholder) has radio access to the Supervisory System;
  - ARCADIS Tetraplan downloads every week the primary data for the elaboration of the monitoring report.

3. Application of GHG determination methods

3.1. Calculation of Emission Reductions

According with baseline methodology ACM0001 – version 02, Emission Reductions are calculated as follows:

$$ER_y = (MD_{project,\,y} - MD_{reg,\,y}) \times GWP_{CH4} + EG_y \times CEF + ET_y \times CEF_{thermal,\,y} \qquad (1)$$

Where:

ER_y = Emission reduction achieved by the project activity during a given year y (tCO_2e);
$MD_{project,\,y}$ = Amount of methane actually destroyed/combusted during the year y (tCH_4);
$MD_{reg,\,y}$ = Amount of methane that would have been destroyed/combusted during the year y in the absence of the project activity (tCH_4);
GWP_{CH4} = Global Warming Potential value for methane (tCO_2e/tCH_4);
EG_y = Net quantity of electricity displaced during the year y (MWh)
$CEF_{electricity,\,y}$ = CO_2 emissions intensity of the electricity displaced (tCO_2e/MWh)
ET_y = Quantity of thermal energy displaced during the year y (TJ)
$CEF_{thermal,\,y}$ = CO_2 emissions intensity of the thermal energy displaced (tCO_2e/TJ).

$MD_{project,\,y}$ is calculated as the sum of methane flow destroyed in the flares, in the power house and in the heat generation, as follows:

$$MD_{project,\,y} = MD_{flared,\,y} + MD_{electricity,\,y} + MD_{thermal,\,y} \qquad (2)$$

Where:

$MD_{flared,\,y}$ = quantity of methane destroyed in the flares in year y (tCH_4)
$MD_{electricity,\,y}$ = quantity of methane destroyed by the generation of electricity y (tCH_4);
$MD_{thermal,\,y}$ = quantity of methane destroyed for the generation of thermal energy in year y (tCH_4)

As the BLFGE does not use the methane to generate thermal energy, $MD_{thermal,\,y} = 0$.

$MD_{flared,\,y}$ is calculated as follows:

$$MD_{flared,\,y} = LFG_{flared,\,y} \times w_{CH4} \times D_{CH4} \times FE \qquad (3)$$

Where:

$MD_{flared,y}$ = Quantity of methane destroyed by flaring (tCH_4);
$LFG_{flare,y}$ = Quantity of landfill gas flared during the year measured in cubic meters (Nm^3);
$w_{CH4,y}$ = Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (m^3_{CH4}/m^3LFG)
FE = Flare efficiency (%);

D_{CH4} = Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3_{CH4});

$MD_{electricity,\ y}$ is calculated as follows:

$$MD_{electricity,\ y} = LFG_{electricity,\ y} \times w_{CH4} \times D_{CH4} \quad (4)$$

Where:

$MD_{electricity,y}$ = Quantity of methane destroyed by generation of electricity (tCH_4);
$LFG_{flare,y}$ = quantity of landfill gas fed into electricity generator (Nm^3);
$w_{CH4,y}$ = Average methane fraction of the landfill gas as measured during the year and expressed as a fraction (m^3_{CH4}/m^3LFG)
D_{CH4} = Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3_{CH4});

Thus, $MD_{project,\ y}$ is equal to:

$$MD_{project,\ y} = \left(LFG_{flared,\ y} \times w_{CH4} \times D_{CH4} \times FE\right) + \left(LFG_{electricity,\ y} \times w_{CH4} \times D_{CH4}\right) \quad (5.1)$$

$$MD_{project,\ y} = w_{CH4} \times D_{CH4} \times \left(LFG_{flared,\ y} \times FE + LFG_{electricity,\ y}\right) \quad (5.2)$$

The amount of methane that would have been destroyed/combusted during the year *y* in the absence of the project activity ($MD_{reg,\ y}$) is calculated adopting an "Adjustment Factor" (AF), as no regulatory or contractual requirements specifying a quantity of methane destruction exists. As will be presented below, the *AF* adopted for the 1st Crediting Period is equal to 20% of total gas collected. Thus, equation (1) is updated to:

$$ER_y = \left(MD_{project,\ y} - 0.2 \times MD_{project,\ y}\right) \times GWP_{CH4} + EG_y \times CEF \quad (6.1)$$

$$ER_y = \left(0.8 \times MD_{project,\ y}\right) \times GWP_{CH4} + EG_y \times CEF \quad (6.2)$$

Additionally, electricity consumption from the diesel generator times a conservative diesel CO_2 emission factor was subtracted from equation 6.2, resulting in:

$$ER_y = \left(0.8 \times MD_{project,\ y}\right) \times GWP_{CH4} + EG_y \times CEF - EC_y \times EF \quad (6.3)$$

Where:

EC_y = Electricity consumed from the diesel generator (MWh);
EF = Diesel CO_2 emission factor, based on a conservative value (tCO_2/MWh);

A detailed step-by-step of the calculation is presented in item 4.9.

3.1.1. Calculation of FE – Flare Efficiency

To calculate the Flare Efficiency, the following formulae were applied, based on the mass-balance (an Excel spreadsheet was evidenced to the Verification Team):

a) Calculate the volume of CH_4 sent to flares F_i ($Flow_{methane}$), measured by FIR500:

$$Flow_{methane} = Flow_{FIR500} \times \frac{\%_{methane}}{100}$$, where:

- $Flow_{methane}$ = methane flow sent to the flare Fi (Nm^3/h);
- $Flow_{FIRi}$ = total flow measured by the flow-meter FIR500 sent to the flare F_i (Nm^3/h);
- % methane = methane measured by the gas analyzer (%);

b) Calculate the volume of other gases (residual gases) sent to flares ($Flow_{remaining}$):

$$Flow_{remaining} = Flow_{FIR500} - Flow_{methane}$$, where:

- $Flow_{remaining}$ = flow of residual gases sent to the flare F_i (Nm^3/h);

c) Calculate the total flow entering the flare F_i ($Flow_{Total}$):

$$Flow_{Total} = Flow_{methane} + (Flow_{methane} \times air_{ratio}) + Flow_{remaining}$$,

where:

- $Flow_{total}$ = total gas sent to the flare F_i (Nm^3/h);
- air_{ratio} = theoretical air ratio[4];

d) Calculate the mass of methane in the exhaust gas ($M_{methane}$):

$$M_{methane} = Flow_{Total} \times \frac{CH_{4,eg}}{1000}$$, where:

- $M_{methane}$ = amount of methane remaining in the exhaust gas (g), calculated using the result of the analysis;
- $CH_{4,eg}$ = methane concentration in the exhaust gas (mg/Nm^3) – data acquired from the analysis form the specialized company;

e) Calculate the Flare Efficiency (FE):

$$FE = \frac{(Flow_{methane} \times 0.7168) - \frac{M_{methane}}{1000}}{(Flow_{methane} \times 0.7168)} \times 100$$, where:

[4] Air_{ratio} is equal to 5, as reccomended by Hoffstetter, the flare manufacturer.

- FE = Flare Efficiency (%);
- 0.7168 = density of methane, at STP (kg/Nm^3).

BIOAGRI made two analysis of the methane content in the exhaust gas of the flares F520, F540 and F560 on 04/01/2008 and on 04/04/2008.

Flare	January/2008	April/2008
F520	1.45 mg/Nm^3	1.11 mg/Nm^3
F540	3.19 mg/Nm^3	1.14 mg/Nm^3
F560	1.61 mg/Nm^3	1.20 mg/Nm^3

Other parameters used to calculate the flare efficiency were:

Measurement	$Flow_{FIR500}$			$\%_{methane}$		
	F520	F540	F560	F520	F540	F560
January/2008	4,725 Nm^3/h	4,902 Nm^3/h	5,000 Nm^3/h	55.8%	56.1%	56.9%
April/2008	4,709 Nm^3/h	4,866 Nm^3/h	4,754 Nm^3/h	52.9 %	53.3 %	54.1%

The results were:

Measurement	Flare Efficiency Calculated		
	F520	F540	F560
January/2008	99.9986%	99.9970%	99.9985%
April/2008	99.9989%	99.9989%	99.9989%

The flare efficiency adopted from 01/04/2008 to 03/04/2008 is 99.9970% and the flare efficiency adopted from 04/04/2008 to 30/06/2008 was 99.9989% (the lowest efficiencies calculated).

Monitoring of the operation time of the flares is made continuously by the PLC and every 5 minutes the instantaniouslly flare temperature is registered by the supervisory system. In order to guarantee the real destruction of the gas, the flares are equipped with an automatic system which can detects the existence of flame. The following operational procedure is applied:

- a signal of gas being collected is sent to the PLC, which sends a signal to a solenoid valve;
- the valve is opened and a small amount of gas is delivered to an ignition burner;
- the ignition burner ignites the gas;
- an UV-sond (part of the ignition burner) verifies the existence of an stable flame – if not, the flare is stopped;
- if the stable flame detection is succesfull, the UV-sond sends a signal to the PLC, which then opens the main valve, located in the entrance of the flare;
- the main burner is ignited and gas begans to be destroyed;

- after a few seconds, the ignition burner is switched off and UV-sond begans to monitor the existence of flame in the flare – if no flame is detected, the flare will be automatically stopped by a signal sent from the UV-sond to the PLC;

According with the manufacturer, if the temperature of the flare is higher than 1,350°C, the flare will be stopped automatically and if the temperature is below 900°C an alarm is indicating the operator that the flare is running out of the specified combustion temperature range.

If temperature decreases significantly from one registration to another (5 minutes interval), it means that the main valve is closed – the flare is stopped and no gas is being burned. It can be confirmed that no gas is being burned by the instant reading of gas flow from the three thermal-mass flow-meters, installed right before the flares entrances.

Moreover, the flares are equipped with an hour-meter, which measures the accumulated operating hours of the flares. Despite of not being registered by SJ's computer supervisory system, Van der Wiel, one of Biogás shareholders, makes the registration of these accumulated operating hours of the flares every 00:01 via a CARS, a system which allows Van der Wiel to have total access to the PLC of SJ. This evidence was submitted to the Verification Team.

4. Monitored and Calculated Data

4.1. Table presenting the monitored data

For the whole monitoring period, the following table presents all measured data and the calculation of methane destroyed.

DATE	COLLECTING SYSTEM				FLARING SYSTEM			ELECTRICITY GENERATION			
	LFG measured FIR600 (Nm^3) A	Methane (%) B	*Methane measured FIR600 (Nm^3) C = A . B*	Flares Efficiency (%) D	LFG measured FIR500 (Nm^3) E	*Methane measured FIR500 (Nm^3) F = E . B*	*Methne Destroyed in Flares (Nm^3) G = F . D*	LFG measured FIR800 (Nm^3) H	*Methane measured FIR800 (Nm^3) I = H . B*	Eletricity Exported (MWh) J	Eletricity Consumed (MWh) K
01/04/2008	296,734	52.7593	*156,554.7812*	99.9970%	69,972	*36,916.7373*	*175,677.2646*	36,915.6297	*225,760*	0	0
02/04/2008	297,815	52.0000	*154,863.8000*	99.9970%	49,907	*25,951.6400*	*172,825.7860*	25,950.8614	*247,106*	0	0
03/04/2008	296,451	52.8677	*156,726.8253*	99.9970%	87,169	*46,084.2454*	*171,946.3533*	46,082.8628	*208,558*	0	0
04/04/2008	289,317	53.9604	*156,116.6104*	99.9989%	105,799	*57,089.5635*	*173,242.7493*	57,088.9355	*182,407*	0	0
05/04/2008	301,059	53.9557	*162,438.4908*	99.9989%	135,253	*72,976.7029*	*174,685.9091*	72,975.9001	*164,641*	0	0
06/04/2008	309,460	53.4797	*165,498.2796*	99.9989%	87,146	*46,605.4193*	*174,003.3623*	46,604.9066	*221,181*	0	0
07/04/2008	307,494	53.5437	*164,643.6648*	99.9989%	88,310	*47,284.4414*	*171,953.7475*	47,283.9212	*218,037*	0	0
08/04/2008	301,139	53.1024	*159,912.0363*	99.9989%	70,313	*37,337.8905*	*159,083.8462*	37,337.4797	*229,840*	0	0
09/04/2008	300,390	53.5533	*160,868.7578*	99.9989%	69,342	*37,134.9292*	*169,610.3016*	37,134.5207	*230,064*	0	0
10/04/2008	305,959	52.9212	*161,917.1743*	99.9989%	70,401	*37,257.0540*	*169,343.5924*	37,256.6441	*234,598*	0	0
11/04/2008	308,365	52.7884	*162,780.9496*	99.9989%	70,948	*37,452.3140*	*165,022.1235*	37,451.9020	*236,429*	0	0
12/04/2008	309,354	52.1815	*161,425.5575*	99.9989%	68,481	*35,734.4130*	*159,379.9756*	35,734.0199	*239,942*	0	0
13/04/2008	302,675	52.5706	*159,118.0635*	99.9989%	90,455	*47,552.7362*	*169,271.3282*	47,552.2131	*211,130*	0	0
14/04/2008	310,277	51.9487	*161,184.8678*	99.9989%	83,341	*43,294.5660*	*168,621.6228*	43,294.0897	*225,872*	0	0
15/04/2008	266,698	53.7590	*143,374.1778*	99.9989%	73,915	*39,735.9648*	*165,955.5927*	39,735.5277	*191,842*	0	0
16/04/2008	311,102	52.2541	*162,563.5501*	99.9989%	58,370	*30,500.7181*	*167,840.1591*	30,500.3825	*251,881*	0	0
17/04/2008	309,483	51.9555	*160,793.4400*	99.9989%	56,722	*29,470.1987*	*168,247.6825*	29,469.8745	*251,872*	0	0
18/04/2008	296,577	52.5972	*155,991.1978*	99.9989%	81,287	*42,754.6859*	*168,874.7116*	42,754.2155	*214,179*	0	0

DATE	COLLECTING SYSTEM				FLARING SYSTEM			ELECTRICITY GENERATION			
	LFG measured FIR600 (Nm^3) A	Methane (%) B	*Methane measured FIR600 (Nm^3) C = A . B*	Flares Efficiency (%) D	LFG measured FIR500 (Nm^3) E	*Methane measured FIR500 (Nm^3) F = E . B*	*Methne Destroyed in Flares (Nm^3) G = F . D*	LFG measured FIR800 (Nm^3) H	*Methane measured FIR800 (Nm^3) I = H . B*	Eletricity Exported (MWh) J	Eletricity Consumed (MWh) K
19/04/2008	293,687	52.8282	*155,149.5557*	99.9989%	98,144	*51,847.7086*	*168,557.2607*	51,847.1382	*194,278*	0	0
20/04/2008	290,574	53.1126	*154,331.4063*	99.9989%	100,474	*53,364.3537*	*169,154.5498*	53,363.7666	*188,835*	0	0
21/04/2008	275,292	53.6458	*147,682.5957*	99.9989%	117,987	*63,295.0700*	*159,049.6419*	63,294.3737	*153,052*	0	0
22/04/2008	298,070	52.3454	*156,025.9337*	99.9989%	91,574	*47,934.7765*	*169,156.7209*	47,934.2492	*205,283*	0	0
23/04/2008	302,164	51.5090	*155,641.6547*	99.9989%	87,651	*45,148.1535*	*150,979.7624*	45,147.6568	*213,343*	0	0
24/04/2008	266,136	52.6867	*140,218.2759*	99.9989%	124,139	*65,404.7425*	*138,577.2881*	65,404.0230	*135,950*	0	0
25/04/2008	284,194	52.4471	*149,051.5113*	99.9989%	120,426	*63,159.9446*	*150,090.3274*	63,159.2498	*162,585*	0	0
26/04/2008	292,312	51.4658	*150,440.7092*	99.9989%	130,205	*67,011.0448*	*140,157.4431*	67,010.3076	*160,812*	0	0
27/04/2008	294,409	51.0407	*150,268.4144*	99.9989%	140,780	*71,855.0974*	*160,453.0648*	71,854.3069	*152,280*	0	0
28/04/2008	290,588	50.8662	*147,811.0732*	99.9989%	123,800	*62,972.3556*	*153,257.8103*	62,971.6629	*165,504*	0	0
29/04/2008	294,796	51.0434	*150,473.9014*	99.9989%	99,145	*50,606.9789*	*166,098.9301*	50,606.4222	*194,470*	0	0
30/04/2008	290,022	53.2560	*154,454.1163*	99.9989%	95,680	*50,955.3408*	*170,649.8817*	50,954.7802	*193,150*	0	0
01/05/2008	285,543	52.6865	*150,442.6126*	99.9989%	98,230	*51,753.9489*	*169,656.6697*	51,753.3796	*186,087*	0	0
02/05/2008	282,678	53.5791	*151,456.3282*	99.9989%	87,708	*46,993.1570*	*117,706.1116*	46,992.6400	*193,808*	0	0
03/05/2008	277,697	53.2659	*147,917.8063*	99.9989%	67,014	*35,695.6102*	*161,293.4087*	35,695.2175	*209,626*	0	0
04/05/2008	278,819	52.9464	*147,624.6230*	99.9989%	69,763	*36,936.9970*	*164,952.4133*	36,936.5906	*207,984*	0	0
05/05/2008	273,740	53.1442	*145,476.9330*	99.9989%	62,764	*33,355.4256*	*160,964.6150*	33,355.0586	*209,967*	0	0
06/05/2008	280,709	52.3791	*147,032.8478*	99.9989%	71,346	*37,370.3926*	*166,382.1422*	37,369.9815	*208,295*	0	0
07/05/2008	285,724	52.0169	*148,624.7673*	99.9989%	71,489	*37,186.3616*	*164,099.5866*	37,185.9525	*213,153*	0	0
08/05/2008	289,194	51.9482	*150,231.0775*	99.9989%	82,679	*42,950.2522*	*164,092.6009*	42,949.7797	*205,362*	0	0
09/05/2008	294,851	51.5718	*152,059.9680*	99.9989%	176,909	*91,235.1556*	*168,011.7907*	91,234.1520	*117,014*	0	0
10/05/2008	308,933	50.9139	*157,289.8386*	99.9989%	116,456	*59,292.2913*	*168,852.7191*	59,291.6390	*191,378*	0	0
11/05/2008	306,853	51.1637	*156,997.3483*	99.9989%	108,555	*55,540.7545*	*162,644.0687*	55,540.1435	*197,446*	0	0
12/05/2008	298,541	51.0169	*152,306.3634*	99.9989%	119,763	*61,099.3699*	*150,552.2938*	61,098.6978	*177,724*	0	0
13/05/2008	292,746	51.1506	*149,741.3354*	99.9989%	110,045	*56,288.6777*	*140,893.2089*	56,288.0585	*181,607*	0	0
14/05/2008	286,168	51.1891	*146,486.8236*	99.9989%	88,091	*45,092.9900*	*114,905.0896*	45,092.4939	*197,103*	0	0
15/05/2008	289,576	51.0234	*147,751.5207*	99.9989%	87,380	*44,584.2469*	*166,782.2830*	44,583.7564	*201,349*	0	0

DATE	COLLECTING SYSTEM				FLARING SYSTEM			ELECTRICITY GENERATION			
	LFG measured FIR600 (Nm^3) A	Methane (%) B	*Methane measured FIR600 (Nm^3) C = A . B*	Flares Efficiency (%) D	LFG measured FIR500 (Nm^3) E	*Methane measured FIR500 (Nm^3) F = E . B*	*Methne Destroyed in Flares (Nm^3) G = F . D*	LFG measured FIR800 (Nm^3) H	*Methane measured FIR800 (Nm^3) I = H . B*	Eletricity Exported (MWh) J	Eletricity Consumed (MWh) K
16/05/2008	297,698	51.0138	*151,867.0623*	99.9989%	62,294	*31,778.5365*	*169,604.0375*	31,778.1869	*230,350*	0	0
17/05/2008	305,837	51.0180	*156,031.9206*	99.9989%	46,786	*23,869.2814*	*165,691.0939*	23,869.0188	*258,417*	0	0
18/05/2008	306,536	50.8984	*156,021.9194*	99.9989%	50,741	*25,826.3571*	*171,962.1193*	25,826.0730	*255,354*	0	0
19/05/2008	303,138	51.0487	*154,748.0082*	99.9989%	50,140	*25,595.8181*	*175,372.9073*	25,595.5365	*252,432*	0	0
20/05/2008	304,308	50.7522	*154,443.0047*	99.9989%	55,819	*28,329.3705*	*175,468.7752*	28,329.0588	*247,882*	0	0
21/05/2008	304,178	50.9886	*155,096.1037*	99.9989%	43,667	*22,265.1919*	*174,622.5220*	22,264.9469	*259,974*	0	0
22/05/2008	304,490	50.6360	*154,181.5564*	99.9989%	27,251	*13,798.8163*	*169,306.4896*	13,798.6645	*276,832*	0	0
23/05/2008	302,622	50.9456	*154,172.5936*	99.9989%	29,988	*15,277.5665*	*147,973.3314*	15,277.3984	*272,190*	0	0
24/05/2008	278,223	50.3335	*140,039.3737*	99.9989%	22,406	*11,277.7240*	*172,533.3160*	11,277.5999	*256,537*	0	0
25/05/2008	297,165	50.6999	*150,662.3578*	99.9989%	17,029	*8,633.6859*	*166,403.8855*	8,633.5909	*276,771*	0	0
26/05/2008	297,188	50.4451	*149,916.7837*	99.9989%	18,531	*9,347.9814*	*91,131.5608*	9,347.8785	*276,157*	0	0
27/05/2008	297,579	50.2971	*149,673.6072*	99.9989%	29,609	*14,892.4683*	*110,839.6163*	14,892.3044	*267,529*	0	0
28/05/2008	282,279	50.8899	*143,651.5008*	99.9989%	44,186	*22,486.2112*	*195,012.7074*	22,485.9638	*237,555*	0	0
29/05/2008	282,737	50.1607	*141,822.8583*	99.9989%	26,518	*13,301.6144*	*196,426.2270*	13,301.4680	*255,092*	0	0
30/05/2008	276,361	50.6406	*139,950.8685*	99.9989%	15,244	*7,719.6530*	*206,631.8530*	7,719.5680	*257,133*	0	0
31/05/2008	267,168	52.1427	*139,308.6087*	99.9989%	458	*238.8135*	*186,226.8155*	238.8108	*266,617*	0	0
01/06/2008	255,297	52.1464	*133,128.1948*	99.9989%	69,972	*36,487.8790*	*219,884.9960*	36,487.4776	*225,773*	492.23	0
02/06/2008	297,257	51.3340	*152,593.9083*	99.9989%	49,907	*25,619.2593*	*207,030.3494*	25,618.9774	*247,120*	498.20	0
03/06/2008	268,872	51.3024	*137,937.7889*	99.9989%	87,169	*44,719.7890*	*55,751.0680*	44,719.2970	*208,570*	485.64	0
04/06/2008	292,324	51.9572	*151,883.3653*	99.9989%	105,799	*54,970.1980*	*145,287.6409*	54,969.5933	*182,408*	484.06	0
05/06/2008	275,024	52.2160	*143,606.5318*	99.9989%	135,253	*70,623.7064*	*160,465.7606*	70,622.9295	*164,642*	482.91	0
06/06/2008	251,466	52.4507	*131,895.6772*	99.9989%	87,146	*45,708.6870*	*164,937.3682*	45,708.1842	*221,181*	453.98	0
07/06/2008	298,351	51.2527	*152,912.9429*	99.9989%	88,310	*45,261.2593*	*168,183.8110*	45,260.7614	*218,038*	475.45	0
08/06/2008	299,146	51.1405	*152,984.7601*	99.9989%	70,313	*35,958.4197*	*158,066.8919*	35,958.0241	*229,841*	490.00	0
09/06/2008	284,437	50.6399	*144,038.6123*	99.9989%	69,342	*35,114.7194*	*166,227.5476*	35,114.3331	*230,065*	485.44	0
10/06/2008	286,944	50.7463	*145,613.4630*	99.9989%	70,401	*35,725.9026*	*136,283.4645*	35,725.5096	*234,598*	489.56	0
11/06/2008	266,482	51.8204	*138,092.0383*	99.9989%	70,948	*36,765.5373*	*108,401.2100*	36,765.1328	*236,430*	489.91	0

DATE	COLLECTING SYSTEM				FLARING SYSTEM			ELECTRICITY GENERATION			
	LFG measured FIR600 (Nm^3) A	Methane (%) B	*Methane measured FIR600 (Nm^3) C = A . B*	Flares Efficiency (%) D	LFG measured FIR500 (Nm^3) E	*Methane measured FIR500 (Nm^3) F = E . B*	*Methne Destroyed in Flares (Nm^3) G = F . D*	LFG measured FIR800 (Nm^3) H	*Methane measured FIR800 (Nm^3) I = H . B*	Eletricity Exported (MWh) J	Eletricity Consumed (MWh) K
12/06/2008	279,812	52.0306	*145,587.8624*	99.9989%	68,481	*35,631.0751*	*104,252.5978*	35,630.6831	*239,943*	496.61	0
13/06/2008	286,391	51.8663	*148,540.4152*	99.9989%	90,455	*46,915.6616*	*104,978.2177*	46,915.1455	*211,130*	498.66	0
14/06/2008	301,896	50.9423	*153,792.7660*	99.9989%	83,341	*42,455.8222*	*98,908.8024*	42,455.3551	*225,873*	495.11	0
15/06/2008	304,662	50.1049	*152,650.5904*	99.9989%	73,915	*37,035.0368*	*90,954.5416*	37,034.6294	*191,842*	482.66	0
16/06/2008	286,139	51.1286	*146,298.8647*	99.9989%	58,370	*29,843.7638*	*94,087.4369*	29,843.4355	*251,882*	490.81	0
17/06/2008	272,371	51.5215	*140,329.6247*	99.9989%	56,722	*29,224.0252*	*57,747.4143*	29,223.7037	*251,872*	493.77	0
18/06/2008	275,093	50.8727	*139,947.2366*	99.9989%	81,287	*41,352.8916*	*45,881.0338*	41,352.4367	*214,180*	467.05	0
19/06/2008	283,931	50.6207	*143,727.8597*	99.9989%	98,144	*49,681.1798*	*34,034.0316*	49,680.6333	*194,279*	468.98	0
20/06/2008	278,825	50.7773	*141,579.8067*	99.9989%	100,474	*51,017.9844*	*23,160.9667*	51,017.4232	*188,836*	488.34	0
21/06/2008	273,042	50.9798	*139,196.2655*	99.9989%	117,987	*60,149.5366*	*10,716.4581*	60,148.8749	*153,052*	476.53	0
22/06/2008	257,512	51.6180	*132,922.5441*	99.9989%	91,574	*47,268.6673*	*16,416.5119*	47,268.1473	*205,283*	497.34	0
23/06/2008	268,969	51.0520	*137,314.0538*	99.9989%	87,651	*44,747.5885*	*16,621.4153*	44,747.0962	*213,343*	497.31	0
24/06/2008	234,123	52.3725	*122,616.0681*	99.9989%	124,139	*65,014.6977*	*24,432.5899*	65,013.9825	*135,951*	461.90	0
25/06/2008	282,011	49.9464	*140,854.3421*	99.9989%	120,426	*60,148.4516*	*25,988.5471*	60,147.7899	*162,585*	468.69	0
26/06/2008	277,345	50.0739	*138,877.4579*	99.9989%	130,205	*65,198.7214*	*24,361.6379*	65,198.0042	*160,813*	477.32	0
27/06/2008	283,292	50.8576	*144,075.5121*	99.9989%	140,780	*71,597.3292*	*26,149.0755*	71,596.5416	*152,281*	472.26	0
28/06/2008	258,651	52.1899	*134,989.6982*	99.9989%	123,800	*64,611.0962*	*28,829.7456*	64,610.3854	*165,504*	487.92	0
29/06/2008	256,459	52.3270	*134,197.3009*	99.9989%	99,145	*51,879.6041*	*32,464.1414*	51,879.0334	*194,470*	475.93	0
30/06/2008	254,315	52.4194	*161,724.2805*	99.9989%	95,680	*50,154.8819*	*34,034.0316*	50,154.3301	*193,150*	431.05	0

Obs: the calculation of *methane measured* and *methane destroyed* was conservatively made, using Excel tool “ROUND DOWN” with four decimal rounds.

A consolidation of methane destroyed and electricity consumed/exported is presented in the table below:

Total Methane Destroyed in Flares (Nm^3), measured by FIR500	**3,865,543.2840**
Total Methane destroyed in the Power House (Nm^3), measured by FIR800	**9,962,604.4155**
Total electricity consumed fro the diesel generator (MWh)	**0.0000**

Total Electricity Exported (MWh)	**14,455.6218**

4.2. Events registered

No special events were registered during this monitoring period.

4.3. Description and consideration of measurement uncertainties and error propagation

The readings from all equipments are subjected to internal errors from a standard value. These errors are measured and described in the Calibration Certificates, in terms of ± % from the standard adopted.

All calibrations usually have an expiration date, however the manufacturers of the flow-meters and pressure-temperature transmitters are Europeans and there are no rule in Europe specifying the calibration periodicity. Biogás decided to adopt a 5 years calibration frequency for every equipment.

The errors and the date of the calibration for each equipment are presented in the table below:

Methodology ID	Equipment	TAG	Error (%)	Date of the last calibration	Date of the next calibration
$LFG_{Total, y}$	Turbine Flow-meter	FIR600	0.480	May/2007	May/2012
$LFG_{Flare, y}$	Turbine Flow-meters	FIR500	0.980	May/2007	May/2012
$LFG_{Electricity, y}$	Turbine Flow-meters	FIR800	1.280	May/2007	May/2012
$w_{CH4, y}$	Methane Analyzer	A100	1.000	May/2007	Weekly, with a standard gas
temperature [5]	Temperature Transmitter	TT600 TT500 TT800	0.020 0.030 0.100	May/2007 May/2007 May/2007	May/2012 May/2012 May/2012
pressure [5]	Pressure Transmitter	PT600 PT500 PT800	0.030 0.010 0.010	May/2007 May/2007 May/2007	May/2012 May/2012 May/2012
EG_y	Electricity Meter	N/A	0.2	Jan/2008[6]	Jan/2013
EC_y	Electricity Meter	N/A	0.500	May/2007	May/2012

Adopting a conservative approach on Emission Reduction calculation, the equivalent error calculated was discounted from the amount of methane calculated for each flow-meter, according with the equations below:

[5] Despite of not being included in the revised Monitoring Plan, pressure and tempreature erros were conidered in the error calculation as they are used to convert the measured flow to Nm^3 (STP conditions)

[6] "Date of the last calibration" from the electricity-meter refers to the date of installation. As stated by the manufacturer, the electricity-meter was delivered calibrated.

$$\varepsilon_{FIR500} = \sqrt{\left(\varepsilon_{Gas\ Flow_{FIR500}}\right)^2 + \left(\varepsilon_{Temperature_{FIR500}}\right)^2 + \left(\varepsilon_{Pressure\ _{FIR500}}\right)^2 + \left(\varepsilon_{Methane\ Analysis}\right)^2}$$

$$\varepsilon_{FIR600} = \sqrt{\left(\varepsilon_{Gas\ Flow_{FIR600}}\right)^2 + \left(\varepsilon_{Temperature_{FIR600}}\right)^2 + \left(\varepsilon_{Pressure\ _{FIR600}}\right)^2 + \left(\varepsilon_{Methane\ Analysis}\right)^2}$$

$$\varepsilon_{FIR800} = \sqrt{\left(\varepsilon_{Gas\ Flow_{FIR800}}\right)^2 + \left(\varepsilon_{Temperature_{FIR800}}\right)^2 + \left(\varepsilon_{Pressure\ _{FIR800}}\right)^2 + \left(\varepsilon_{Methane\ Analysis}\right)^2}$$

4.4. Calculation of $LFG_{flared,\ y}$

The calculation of $LFG_{flared,\ y}$ is the measurement from FIR500 made during the monitoring period, minus the uncertainties of the flow-meters, as follows:

$$LFG_{flared,\ y,\ corrected} = FIR_{500} \times \left(1 - \frac{\varepsilon_{FIR500}}{100}\right)$$

Applying the erros from the table below in the equations previously presented:

$$\varepsilon_{FIR500} = \sqrt{0.980^2 + 0.030^2 + 0.010^2 + 1.000^2} = 1.4005\%$$

4.5. Calculation of $LFG_{electricity,\ y}$

The calculation of $LFG_{electricity,\ y}$ is measurement from FIR800 made during the monitoring period, minus the uncertainties of the flow-meter, as follows:

$$LFG_{electricity,\ y,\ corrected} = FIR_{800} \times \left(1 - \frac{\varepsilon_{FIR800}}{100}\right)$$

Applying the erros from the table below in the equations previously presented:

$$\varepsilon_{FIR800} = \sqrt{1.280^2 + 0.100^2 + 0.010^2 + 1.000^2} = 1.6275\%$$

4.6. Calculation of $EG_{y,\ corrected}$

The calculation of EG_y is the sum of all measurements from the electricity-meter made during the monitoring period, plus the uncertainties of the electricity-meter due to conservativeness, as follows:

$$EC_{y,\ corrected} = \sum EG_y \times \left(1 - \frac{\varepsilon_{EG}}{100}\right)$$

4.7. Calculation of $EC_{y,\ corrected}$

The calculation of EG_y is the sum of all measurements from the electricity-meter made during the monitoring period, plus the uncertainties of the electricity-meter due to conservativeness, as follows:

$$EC_{y,\ corrected} = \sum EC_y \times \left(1 + \frac{\varepsilon_{EC}}{100}\right)$$

4.8. List of default values

- *Global Warming Potential of CH_4 (GWP_{CH4})* = 21 tCO_2e/tCH_4;
- Emission Factor of Diesel Engines = 1.3 tCO_2e/MWh[7]
- *Density of Methane, at STP (D_{CH4})* = 0.0007168 tons/Nm^3
- *AF* = Adjustment Factor (changes in the landfill legislation). For this monitoring period, no changes in the legislation were identified, thus the AF remains as the validated value (20%).

4.9. Table providing the formulas used

	Variable	Description
Flaring System	A_{FIR500} (see the table of consolidated methane destroyed and electricity consumed/exported – last table from item 4.1)	Total methane destroyed in flares, measured by FIR500 (Nm^3)
	B_{FIR500}	Total error from FIR500 (%) – see item 4.4
	$C_{FIR500} = A_{FIR500} . (1-B_{FIR500}/100)$	**Total methane corrected destroyed at the flare (Nm^3)**
Power House	A_{FIR800} (see the table of consolidated methane destroyed and electricity consumed/exported – last table from item 4.1)	Methane flow to the power house measured by FIR800 (Nm^3)
	B_{FIR800}	Total measuring error from FIR800 (%) – see item 4.5
	$C_{FIR800} = A_{FIR800} . (1 – B_{FIR800}/100)$	**Total methane corrected destroyed at the power house (Nm^3)**
CO_2e Methane	$A = C_{FIR500} + C_{FIR800}$	Total methane destroyed in the period (Nm^3)
	B = 0.0007168	Density of Methane at the STPC (tCH_4/Nm^3)
	C = A . B	Total weight of methane destroyed (tCH_4)
	D = 21	CO_2 equivalency (tCO_2e/tCH_4)
	E = C . D	Total equivalent carbon (tCO_2e)
	F = 20%	Adjustment Factor (%)
	G = E . (1-F)	**Total Liquid Carbon (tCO_2e)**
CO_2e Electricity Exported	H (see the table of consolidated methane destroyed and electricity consumed/exported – last table from	Total electricity exported (MWh)

[7] The diesel CO_2 emission factor was adopted as a conservative default emission factor of 1.3 tCO2/MWh, based on the *"Tool to calculate project emissions from electricity consumption (version 01)".*

	item 4.1)	
	I	Electricity-meter error (%)
	J = H . (1 – I/100)	Total electricity corrected (MWh)
	K = 0.2677	Emission Factor (tCO_2e/MWh)
	L = J . K	**Total CO_2e from the electricity exported (tCO_2e)**
CO_2e Electricity Consumed	M (see the table of consolidated methane destroyed and electricity consumed/exported – last table from item 4.1)	Total Electricity Consumed from the Diesel Generator (MWh)
	N	Electricity-meter error (%)
	O = M . (1 + N/100)	Total electricity corrected (MWh)
	P = 1.3	Conservative Diesel CO_2 Emission Factor (tCO_2e/MWh)
	Q = O . P	**Total CO_2e from the electricity consumed (tCO_2e)**
TOTAL	**R = G + L – Q**	**TOTAL CREDITS DURING THE PERIOD (tCO_2e)**

Obs: Cells in red means that the calculation was made using the Excel tool "ROUND DOWN" with zero decimal rounds, in order to assure conservativeness.

Obs: cells in green means that the calculation was made using the Excel tool "ROUND UP" with zero decimal rounds, in order to assure conservativeness.

4.10. GHG emission reductions

	TOTAL
Total CO_2e from methane destroyed	163,900
Total CO_2e from electricity exported	3,831
Total CO_2e from electricity consumed	0
TOTAL CO_2e	**167,731**

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