ARCADIS TETRAPLAN

Imagine the result

São João Landfill Gas to Energy Project (SJ)

Monitoring Report – Version 01
4th Verification
Monitoring Period: 01/01/2008 to 31/03/2008

São Paulo, April 1st 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
April 1st, 2008

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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 will also produce 20 MW of electricity from January 25th 2008 on (by the time of the 4th Verification, the power house was finished, but not fully operting).

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 will be cooled down when transported from the landfill, resulting in a condensate. This will be drained to condensate shafts, to be placed nearby the gas pipes. Once in the degassing station, the gas will be measured and sent to a flaring system. Biogás will install chillers in order to remove moisture in July/2007 – the chiller was already acquired. 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 will be 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 will be used for transportation of the landfill gas from the landfill to the flares. These blowers will be 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.

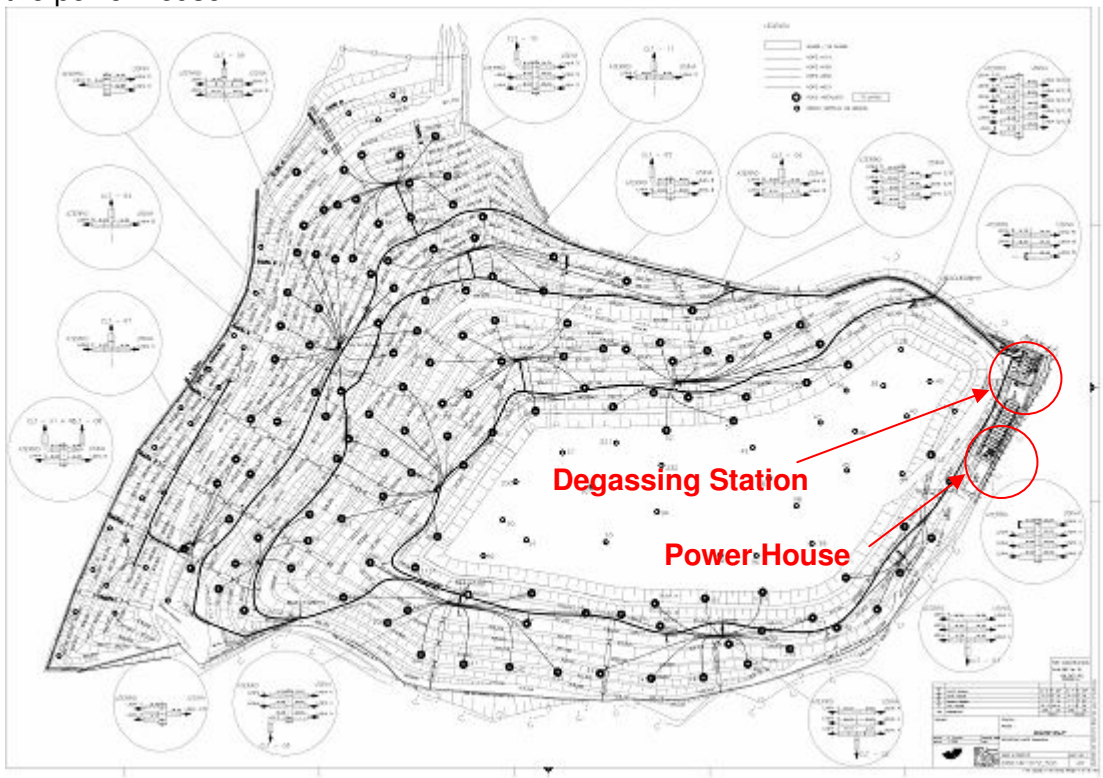

Figure 1.1: SJ Lay-out

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

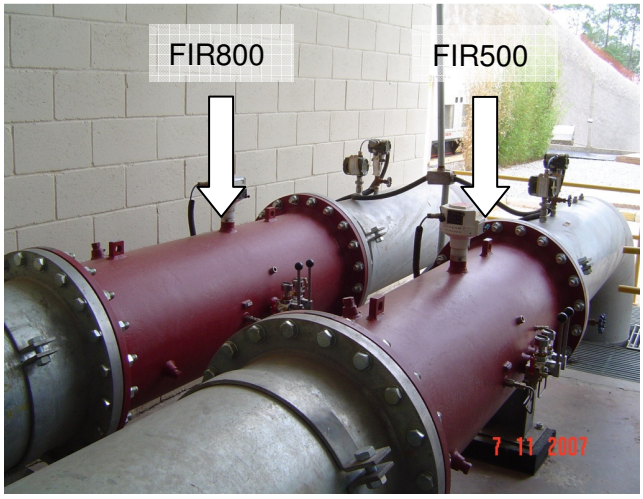

Figure 1.8: FIR500 and FIR800

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 16 gas engines installed with an individual capacity of 1.4 MW. Electricity produced is sent to the substation located next to the power house and then to the distribution grid. An electricity-meter 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 nor 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 01/01/2008 to 31/03/2008.

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 Power House's operation and the monitoring of electricity exported and methane sento to the power house parameters.

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.
$LFG_{Flare, y}$	Total amount of landfill gas flared	Nm^3	M	Continuously	100%	E / P	During the crediting period and two years after	Until 31/05/2007, measurements were made by one flow meter. From 01/06/2007 on, the measurements began to be made by two flow meters – the first one located in the main line and the second one located in a particular line connected to a mini-blower. Data will be aggregated monthly and yearly. Normal cubic meters represent the gas volume in cubic meters at STP.
$LFG_{Electricity, y}$	Total amount of landfill gas combusted in power	Nm^3	M	Continuously	100%	E / P	During the crediting period and two years	Measured by 4 flow meters. Data will be aggregated monthly and yearly.

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
	plant						after	Normal cubic meters represent the gas volume in cubic meters at STP.
FE	Flare/combustion efficiency, determined by methane content in the exhaust gas	%	M / C	Quarterly, monthly if unstable	N/A	E	During the crediting period and two years after	Periodic measurement of methane content of flare exhaust gas.
$w_{CH4, y}$	Methane fraction in the landfill gas	%	M	Continuously	100%	E	During the crediting period and two years after	Measured to determine the density of methane D_{CH4}.
T	Temperature of the landfill gas	℃	M	Continuously	100%	E	During the crediting period and two years after	Measured to determine the density of methane D_{CH4}.
p	Pressure of the landfill gas	Pa	M	Continuously	100%	E	During the crediting period and two years after	Measured to determine the density of methane D_{CH4}.
	Regulatory requirements relating to landfill gas projects	Test	N/A	Annually	100%	E	During the crediting period and two years after	Required for any changes to the adjustment factor (AF) or directly $MD_{reg,y}$
EG_y[1]	Net Electricity Exported to the Grid	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. Double check by receipt of sales.
CEF_y[1]	Emission Factor	tCO_2/MWh	C	Yearly	100%	E	During the crediting period and two years	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.

[1] Monitoring parameters as per methodology ACM0002 – version 03 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
EF	CO_2 emission intensity diesel generator	tCO_2e/MWh	E	Every new version of the "Tool to calculate project emissions from electricity consumption"	100%	E/P	During the crediting period and two years	The diesel CO_2 emission factor was 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:

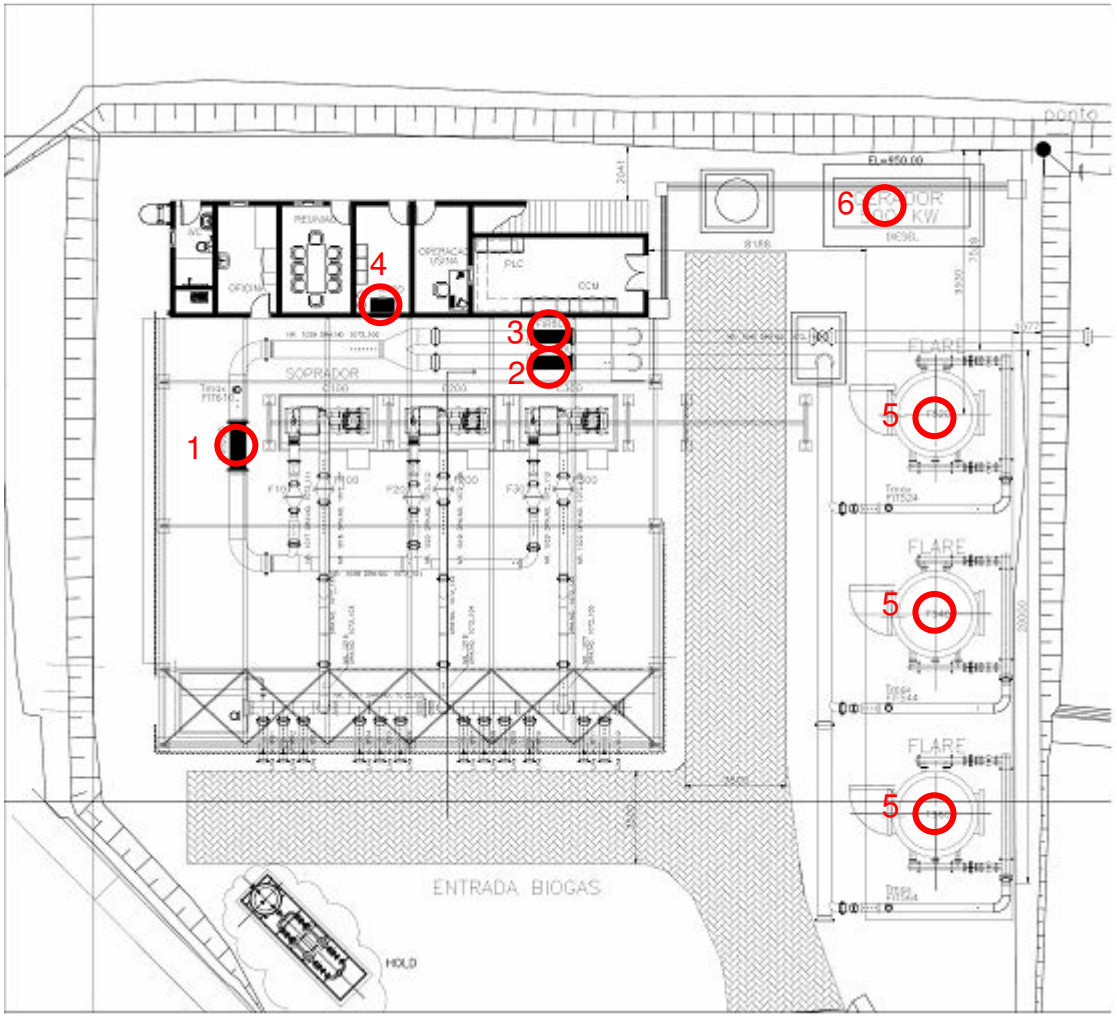


Figure 2.1. Lay-out of the Degassing Station

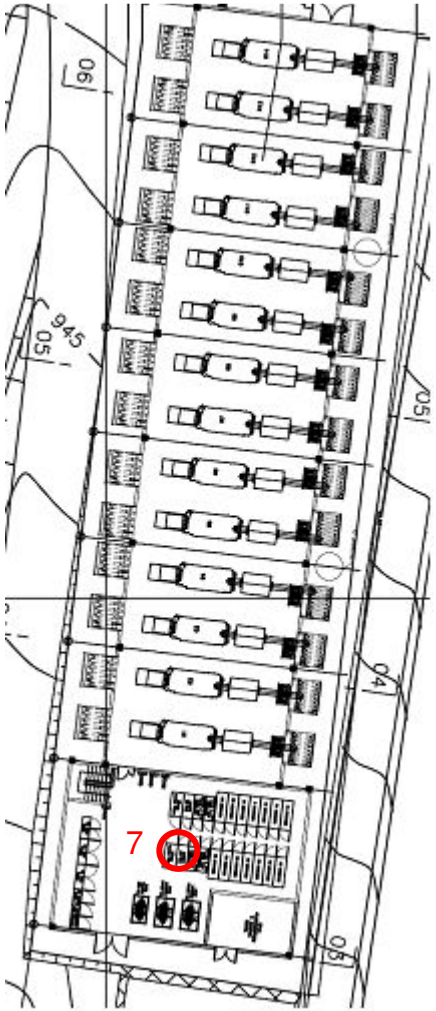


Figure 2.2. Lay-out of the Power House

Methodology ID	Equipment Number	Equipment	Location	TAG	Manufacturer	Model	Range	Error (%)
$LFG_{Total, y}$	1	Turbine Flow-meter	Main Line	FIR600	Instromet	SM-RI-X-K	1,300–25,000 m^3/h	0.600
$LFG_{Flare, y}$	2	Turbine Flow-meters	Line to Flares	FIR500	Instromet	SM-RI-X-K	800–16,000 m^3/h	0.600
$LFG_{Electricity, y}$	3	Turbine Flow-meter	Line to the Power House	FIR800	Instromet	SM-RI-X-K	800–16,000 m^3/h	0.772
FE	5	Chromatographer – analysis made by a Third Party	Flares F520, F540 and F560	N/A	N/A	N/A	N/A	N/A
$w_{CH4, y}$	4	Methane Analyzer	Analysis Room	A100	Fisher & Rosemount	Binos 100	0-100%	1.000
T	1	Temperature Transmitter[2]	FIR600	TT600	Instromet	333	0-150°C	0.050
	2		FIR500	TT500	Instromet	333		0.050
	3		FIR800	TT800	Instromet	333		0.050
p	1	Pressure Transmitter[2]	FIR600	PT500	Instromet	PT-100	0-400 mbar	0.010
	2		FIR500	PT600	Instromet	PT-100		0.010
	3		FIR800	PT800	Instromet	PT-100		-
EG_y	7	Electricity Meter	Substation	N/A	Merlin Gerin	Power Logic - CM 4000	240V/300V - 96mA MAX.	1.000
EC_y	6	Electricity Meter	Diesel Generator	N/A	Siemens	MMG 144	0-100 MWh	0.500

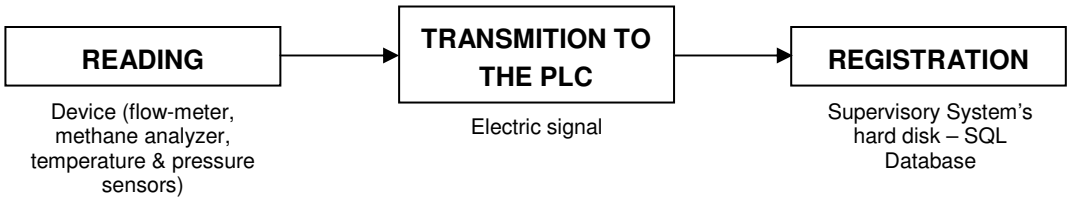
[2] The Turbine flow-meters installed are connected to a pressure and temperature transmitters, which allows the device to use those variables to make the conversion automatically to Nm^3. Thus, readings from pressure and temperature were not considered and the erros from the transmitters were discounted 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 Supervosory System's hard disk, in Nm^3; - 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	N/A	Every 3 months, by a specialized company on gas analysis	Every 3 months, by a specialized company on gas analysis	Every 3 months, by a specialized company on gas analysis	- 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)
T	TT600 TT500 TT800	Every 5 seconds Every 5 seconds Every 5 seconds	Every 5 seconds Every 5 seconds Every 5 seconds	Every 5 minutes Every 5 minutes Every 5 minutes	- The temperature readings are not transmitted and registered in by PLC because the flow-meters make the conversion to Nm^3 automatically.
p	PT600 PT500 PT800	Every 5 seconds Every 5 seconds Every 5 seconds	Every 5 seconds Every 5 seconds Every 5 seconds	Every 5 minutes Every 5 minutes Every 5 minutes	- The pressure readings are not transmitted and registered by the PLC because the flow-meters make the conversion to Nm^3 automatically.
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

Methodology ID	Equipment TAG	Reading Frequency	Transmition Frequency	Registration Frequency	Comments
					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 Sotreq's 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.

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:

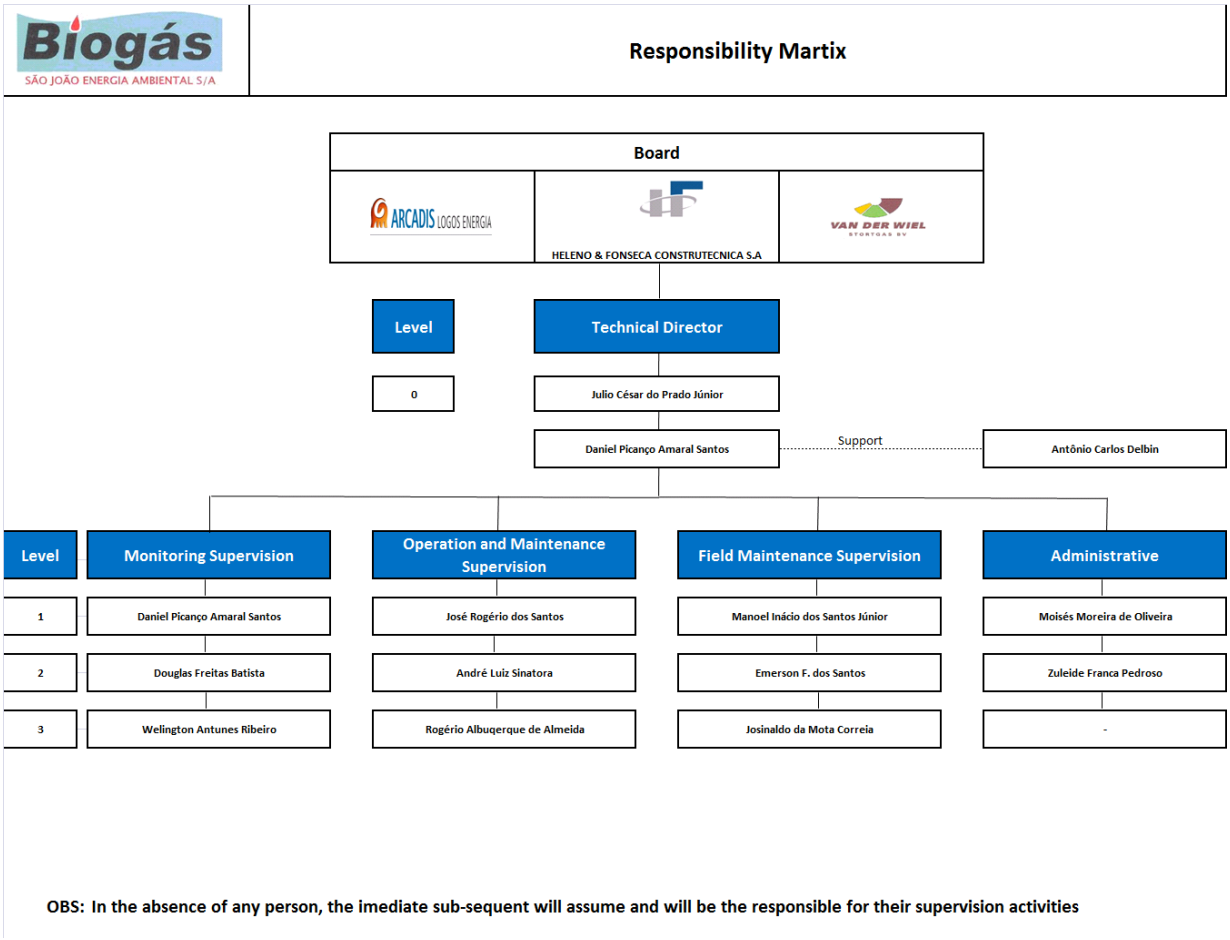


Figure 2.4. General Organogram and Responsibility Matrix of SJ

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 Supervosory 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:

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

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:

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

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:

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

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:

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

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

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:

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

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

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

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

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[3];

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:

[3] 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 11/10/2007 and on 04/01/2008.

Flare	October/2007	January/2008
F520	5.19 mg/Nm^3	1.45 mg/Nm^3
F540	4.51 mg/Nm^3	3.19 mg/Nm^3
F560	4.33 mg/Nm^3	1.61 mg/Nm^3

Other parameters used to calculate the flare efficiency were:

Measurement	$Flow_{FIR500}$			$\%_{methane}$		
	F520	F540	F560	F520	F540	F560
October/2007	5,000 Nm^3/h	4,892 Nm^3/h	4,750 Nm^3/h	54.2%	54.6%	55.5%
January/2008	5,000 Nm^3/h	4,902 Nm^3/h	5,000 Nm^3/h	55.8%	56.1%	56.9%

The results were:

Measurement	Flare Efficiency Calculated		
	F520	F540	F560
October/2007	99.9950%	99.9957%	99.9959%
January/2008	99.9986%	99.9970%	99.9985%

The flare efficiency adopted from 01/01/2008 to 03/01/2008 is 99.9950% and the flare efficiency adopted from 04/01/2008 to 31/03/2008 was 99.9985% (the lowest efficiencies calculated).

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
01/01/2008	323,119	54.6607	176,619.1072	99.9950%	321,412	175,686.0490	175,677.2646	0	0.0000	0	2.1283
02/01/2008	313,456	55.2964	173,329.8835	99.9950%	312,560	172,834.4278	172,825.7860	0	0.0000	0	2.0949
03/01/2008	307,203	56.2562	172,820.7340	99.9950%	305,664	171,954.9511	171,946.3533	0	0.0000	0	2.0878
04/01/2008	309,085	56.2371	173,820.4405	99.9970%	308,067	173,247.9468	173,242.7493	0	0.0000	0	2.0827
05/01/2008	312,463	56.0468	175,125.5126	99.9970%	311,688	174,691.1499	174,685.9091	0	0.0000	0	1.9947
06/01/2008	312,004	55.9123	174,448.6124	99.9970%	311,217	174,008.5826	174,003.3623	0	0.0000	0	2.0041
07/01/2008	313,528	55.0052	172,456.7034	99.9970%	312,623	171,958.9063	171,953.7475	0	0.0000	0	2.0414
08/01/2008	289,587	55.3577	160,308.7026	99.9970%	287,383	159,088.6189	159,083.8462	0	0.0000	0	1.9915
09/01/2008	312,540	54.5552	170,506.8220	99.9970%	310,906	169,615.3901	169,610.3016	0	0.0000	0	2.2736
10/01/2008	312,846	54.3734	170,105.0069	99.9970%	311,455	169,348.6729	169,343.5924	0	0.0000	0	2.2688
11/01/2008	306,836	53.9671	165,590.4909	99.9970%	305,792	165,027.0744	165,022.1235	0	0.0000	0	2.2023
12/01/2008	296,656	53.9063	159,916.2733	99.9970%	295,670	159,384.7572	159,379.9756	0	0.0000	0	2.0835
13/01/2008	310,688	54.6626	169,830.1386	99.9970%	309,675	169,276.4065	169,271.3282	0	0.0000	0	2.2664
14/01/2008	307,187	55.0776	169,191.2271	99.9970%	306,162	168,626.6817	168,621.6228	0	0.0000	0	2.1004
15/01/2008	302,057	55.1234	166,504.0883	99.9970%	301,071	165,960.5716	165,955.5927	0	0.0000	0	2.0186
16/01/2008	306,459	54.9460	168,386.9621	99.9970%	305,473	167,845.1945	167,840.1591	0	0.0000	0	2.0384
17/01/2008	306,262	55.1229	168,820.4959	99.9970%	305,232	168,252.7301	168,247.6825	0	0.0000	0	2.0470
18/01/2008	304,937	55.5798	169,483.3747	99.9970%	303,851	168,879.7780	168,874.7116	0	0.0000	0	2.0547

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19/01/2008	307,891	54.9471	169,177.1756	99.9970%	306,772	168,562.3176	168,557.2607	0	0.0000	0	2.1192
20/01/2008	308,243	55.0519	169,693.6281	99.9970%	307,273	169,159.6246	169,154.5498	0	0.0000	0	2.0820
21/01/2008	287,363	55.5505	159,631.5833	99.9970%	286,324	159,054.4136	159,049.6419	0	0.0000	0	1.9724
22/01/2008	313,169	54.1982	169,731.9609	99.9970%	312,117	169,161.7958	169,156.7209	0	0.0000	0	2.1734
23/01/2008	270,180	56.1088	151,594.7558	99.9970%	269,092	150,984.2920	150,979.7624	0	0.0000	0	1.9506
24/01/2008	238,566	58.2875	139,054.1572	99.9970%	237,755	138,581.4456	138,577.2881	0	0.0000	0	2.0216
25/01/2008	266,680	56.4642	150,578.7285	99.9970%	265,823	150,094.8303	150,090.3274	0	0.0000	0	2.1139
26/01/2008	241,259	58.2674	140,575.3465	99.9970%	240,549	140,161.6480	140,157.4431	0	0.0000	0	1.4637
27/01/2008	289,952	55.4454	160,765.0462	99.9970%	289,398	160,457.8786	160,453.0648	0	0.0000	0	2.0122
28/01/2008	273,175	56.2107	153,553.5797	99.9970%	272,657	153,262.4082	153,257.8103	0	0.0000	0	2.0679
29/01/2008	297,594	55.8913	166,329.1553	99.9970%	297,191	166,103.9133	166,098.9301	0	0.0000	0	2.0491
30/01/2008	303,600	56.2954	170,912.8344	99.9970%	303,142	170,655.0014	170,649.8817	0	0.0000	0	2.2430
31/01/2008	306,318	55.4733	169,924.7030	99.9970%	305,844	169,661.7596	169,656.6697	0	0.0000	0	2.1593
01/02/2008	206,715	57.0318	117,893.2853	99.9970%	206,393	117,709.6429	117,706.1116	0	0.0000	0	1.7829
02/02/2008	289,183	55.8365	161,469.6657	99.9970%	288,876	161,298.2477	161,293.4087	0	0.0000	0	2.4052
03/02/2008	304,821	54.1723	165,128.5465	99.9970%	304,505	164,957.3621	164,952.4133	0	0.0000	0	2.3452
04/02/2008	294,241	54.7707	161,157.8553	99.9970%	293,897	160,969.4441	160,964.6150	0	0.0000	0	2.4242
05/02/2008	304,133	54.7791	166,601.3202	99.9970%	303,742	166,387.1339	166,382.1422	0	0.0000	0	2.3461
06/02/2008	299,402	54.8951	164,357.0273	99.9970%	298,942	164,104.5098	164,099.5866	0	0.0000	0	2.3156
07/02/2008	297,828	55.1861	164,359.6579	99.9970%	297,353	164,097.5239	164,092.6009	0	0.0000	0	2.3471
08/02/2008	308,648	54.5065	168,233.2221	99.9970%	308,251	168,016.8313	168,011.7907	0	0.0000	0	2.4786
09/02/2008	311,814	54.2184	169,060.5617	99.9970%	311,440	168,857.7849	168,852.7191	0	0.0000	0	2.5337
10/02/2008	301,189	54.1054	162,959.5132	99.9970%	300,615	162,648.9482	162,644.0687	0	0.0000	0	2.2970
11/02/2008	278,287	54.2088	150,856.0432	99.9970%	277,735	150,556.8106	150,552.2938	0	0.0000	0	2.0588
12/02/2008	258,638	54.5930	141,198.2433	99.9970%	258,087	140,897.4359	140,893.2089	0	0.0000	0	1.8776
13/02/2008	205,277	56.1329	115,227.9331	99.9970%	204,708	114,908.5369	114,905.0896	0	0.0000	0	1.6337
14/02/2008	309,117	54.0354	167,032.6074	99.9970%	308,663	166,787.2867	166,782.2830	0	0.0000	0	2.3798

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15/02/2008	315,608	53.8652	170,002.8804	99.9970%	314,877	169,609.1258	169,604.0375	0	0.0000	0	2.4586
16/02/2008	301,941	54.9576	165,939.5270	99.9970%	301,498	165,696.0648	165,691.0939	0	0.0000	0	2.3885
17/02/2008	315,931	54.5940	172,479.3701	99.9970%	314,993	171,967.2784	171,962.1193	0	0.0000	0	2.7026
18/02/2008	319,695	54.9260	175,595.6757	99.9970%	319,299	175,378.1687	175,372.9073	0	0.0000	0	2.5089
19/02/2008	325,611	53.9530	175,676.9028	99.9970%	325,235	175,474.0395	175,468.7752	0	0.0000	0	2.5909
20/02/2008	325,409	53.7975	175,061.9067	99.9970%	324,602	174,627.7609	174,622.5220	0	0.0000	0	2.6274
21/02/2008	316,147	53.7538	169,941.0260	99.9970%	314,976	169,311.5690	169,306.4896	0	0.0000	0	2.5295
22/02/2008	267,634	55.4062	148,285.8293	99.9970%	267,078	147,977.7708	147,973.3314	0	0.0000	0	1.9155
23/02/2008	314,603	55.4118	174,327.1851	99.9970%	311,375	172,538.4922	172,533.3160	0	0.0000	0	2.2933
24/02/2008	312,102	54.5374	170,212.3161	99.9970%	305,128	166,408.8778	166,403.8855	0	0.0000	0	2.2671
25/02/2008	171,323	54.3738	93,154.8253	99.9970%	167,607	91,134.2949	91,131.5608	0	0.0000	0	2.5118
26/02/2008	173,710	54.2789	94,287.8771	99.9970%	204,210	110,842.9416	110,839.6163	0	0.0000	0	3.8074
27/02/2008	370,400	53.9038	199,659.6752	99.9970%	361,790	195,018.5580	195,012.7074	0	0.0000	0	4.2536
28/02/2008	377,900	53.3899	201,760.4321	99.9970%	367,920	196,432.1200	196,426.2270	0	0.0000	0	1.0508
29/02/2008	361,770	53.9173	195,056.6162	99.9970%	383,250	206,638.0522	206,631.8530	0	0.0000	0	8.3661
01/03/2008	383,740	53.0350	203,516.5090	99.9970%	351,150	186,232.4025	186,226.8155	0	0.0000	0	6.5513
02/03/2008	382,910	52.7571	202,012.2116	99.9970%	416,800	219,891.5928	219,884.9960	0	0.0000	0	6.5250
03/03/2008	363,710	53.4550	194,421.1805	99.9970%	387,310	207,036.5605	207,030.3494	0	0.0000	0	6.7713
04/03/2008	111,018	55.1325	61,206.9988	99.9970%	101,125	55,752.7406	55,751.0680	9,109	5,022.0194	0	7.9359
05/03/2008	291,150	54.6418	159,089.6007	99.9970%	265,899	145,291.9997	145,287.6409	24,466	13,368.6627	0	8.6457
06/03/2008	292,190	55.0388	160,817.8697	99.9970%	291,559	160,470.5748	160,465.7606	0	0.0000	0	5.8502
07/03/2008	305,399	54.1414	165,347.2941	99.9970%	304,651	164,942.3165	164,937.3682	0	0.0000	0	6.2252
08/03/2008	311,388	54.1406	168,587.3315	99.9970%	310,652	168,188.8567	168,183.8110	0	0.0000	0	6.3607
09/03/2008	304,096	54.4836	165,682.4482	99.9970%	290,127	158,071.6341	158,066.8919	13,149	7,164.0485	0	7.5448
10/03/2008	310,046	53.7458	166,636.7030	99.9970%	309,294	166,232.5346	166,227.5476	0	0.0000	0	6.6750
11/03/2008	294,796	53.2777	157,060.5284	99.9970%	255,806	136,287.5532	136,283.4645	38,091	20,294.0087	0	8.5457
12/03/2008	288,587	53.6592	154,853.4755	99.9970%	202,024	108,404.4622	108,401.2100	85,350	45,798.1272	0	9.0168

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13/03/2008	295,763	53.9517	159,569.1664	99.9970%	193,239	104,255.7255	104,252.5978	101,173	54,584.5534	0	8.5909
14/03/2008	296,982	55.2208	163,995.8362	99.9970%	190,112	104,981.3672	104,978.2177	105,464	58,238.0645	0	8.4922
15/03/2008	308,039	55.1320	169,828.0614	99.9970%	179,409	98,911.7698	98,908.8024	127,110	70,078.2852	0	8.8332
16/03/2008	299,560	55.8812	167,397.7227	99.9970%	162,769	90,957.2704	90,954.5416	135,425	75,677.1151	0	8.2204
17/03/2008	312,998	55.7638	174,539.5787	99.9970%	168,730	94,090.2597	94,087.4369	143,130	79,814.7269	0	7.8990
18/03/2008	306,180	54.4454	166,700.9257	99.9970%	106,068	57,749.1468	57,747.4143	198,979	108,334.9124	267.1060	0.0000
19/03/2008	313,478	52.2668	163,844.9193	99.9970%	87,785	45,882.4103	45,881.0338	224,589	117,385.4834	409.4610	0.0000
20/03/2008	310,685	52.0541	161,724.2805	99.9970%	65,384	34,035.0527	34,034.0316	244,439	127,240.5214	451.9170	0.0000
21/03/2008	307,355	52.8178	162,338.1491	99.9970%	43,852	23,161.6616	23,160.9667	262,962	138,890.7432	484.7030	0.0000
22/03/2008	296,947	53.2961	158,261.1700	99.9970%	20,108	10,716.7797	10,716.4581	276,393	147,306.6896	508.8820	0.0000
23/03/2008	314,566	51.8050	162,960.9163	99.9970%	31,690	16,417.0045	16,416.5119	282,216	146,201.9988	513.4840	0.0000
24/03/2008	313,079	51.7978	162,168.0342	99.9970%	32,090	16,621.9140	16,621.4153	280,241	145,158.6726	511.8650	0.0000
25/03/2008	275,820	53.3840	147,243.7488	99.9970%	45,769	24,433.3229	24,432.5899	229,409	122,467.7005	406.8050	0.0000
26/03/2008	308,231	53.2590	164,160.7482	99.9970%	48,798	25,989.3268	25,988.5471	258,592	137,723.5132	477.7240	0.0000
27/03/2008	300,760	53.2034	160,014.5458	99.9970%	45,791	24,362.3688	24,361.6379	254,162	135,222.8255	442.6640	0.0000
28/03/2008	299,331	52.5805	157,389.7364	99.9970%	49,733	26,149.8600	26,149.0755	248,739	130,788.2098	454.0300	0.0000
29/03/2008	297,616	52.5186	156,303.7565	99.9970%	54,896	28,830.6106	28,829.7456	241,827	127,004.1548	508.8820	0.0000
30/03/2008	296,957	52.6672	156,398.9371	99.9970%	61,642	32,465.1154	32,464.1414	234,387	123,445.0700	508.8820	0.0000
31/03/2008	310,685	52.0541	161,724.2805	99.9970%	65,384	34,035.0527	34,034.0316	244,439	127,240.5214	451.9170	0.0000

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

Total Methane Destroyed in Flares (Nm^3), measured by FIR500	**12,543,304.3542**
Total Methane destroyed in the Power House (Nm^3), measured by FIR800	**2,264,450.6282**
Total electricity consumed fro the diesel generator (MWh)	**268.3882**
Total Electricity Exported (MWh)	**6,398.3220**

4.2. Events registered

For this monitoring period, the following events were registered:

- In 26/02/2008 the circuit plate of the flow-meters FIR500, FIR600 and FIR800 was damaged during the engines test. Manual readings of the flows made every 00:00 (accumulated flow) were applied until 03/03/2008, when the circuit plates were replaced.

- In 16/02/2008, two readings of all variables were made from 23:00 to 23:59 due to the end of the Brazilian Summer Time (all clocks needed to delay one hour at 23:59:59). All variables (gas flows and methane concentration) were adjusted to incorporate the readings after the clock delay.

- For this monitoring period, the registrations of the "Net Quantity of Electricirty Exported" were made manually every hour by the operators. This routine will be applied while the electricity-meter is not connected to the PLC. Registrations began on 18/03/2008.

- From 18/03/2008 on, data of electricity consumption from the diesel generator stopped being discounted from ERs calculation as the electricity internal needs have been supplied by the power house.

- In 29/02/2008, the chiller entered in operation, thus an increase of electricity consumption from the diesel generator was detected.

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

Methodology ID	Equipment	TAG	Error (%)	Date of the last calibration	Date of the next calibration
T	Temperature Transmitter[2]	TT600 TT500 TT800	0.020 0.030 0.100	May/2007 May/2007 May/2007	May/2012 May/2012 May/2012
p	Pressure Transmitter[2]	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	1.000	Jan/2008	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:

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

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

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

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:

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

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:

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

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[4]
- *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
Flare F100	A_{FIR500} (see 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 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	$A = C_{FIR500} + C_{FIR800}$	Total methane destroyed in the period (Nm^3)

[4] 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)".*

Methane	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 Dispatched	H (see last table from item 4.1)	Total electricity exported (MWh)
	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 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	175,744
Total CO_2e from electricity exported	1,695
Total CO_2e from electricity consumed	351
TOTAL CO_2e	**177,088**

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