ARCADIS TETRAPLAN

Imagine the result

São João Landfill Gas to Energy Project (SJ)

Monitoring Report – Version 01
11th Verification
Monitoring Period: 01/10/2009 to 31/12/2009

São Paulo, January 15st 2010

Clean Development Mechanism

Monitoring Report – Version 01

São João Landfill Gas to Energy Project (SJ)

11th Verification
Monitoring Period: 01/10/2009 to 31/12/2009

Biogás Energia Ambiental SA

São Paulo
January 15st, 2010

ARCADIS TETRAPLAN

Table of Contents

List of Figures

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 destroys the methane previously released to the atmosphere. The project also has installed a total capacity of 25.6 MW (24.64 MW operative capacity). The electricity generated is transported via a transmission line of 30 km until the connection to the Brazilian Grid, where the electricity is indeed exported to the grid.

The degassing station is responsible for extracting the landfill gas from the landfill and transport it to the flares and 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 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 location of the power house.

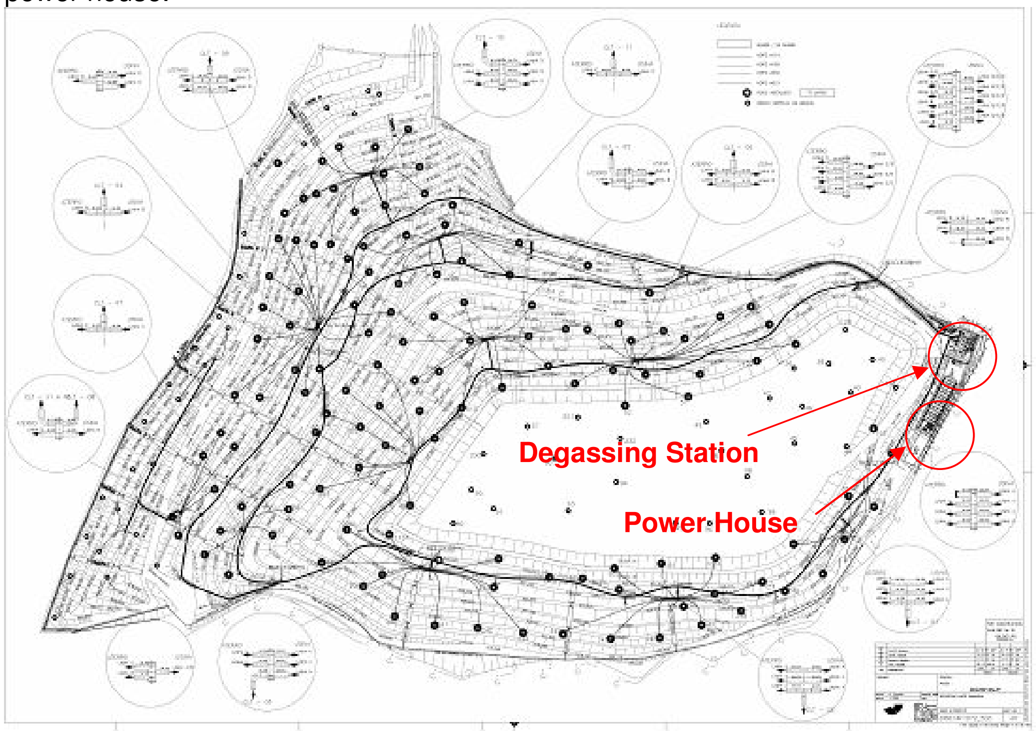


Figure 1-1: SJ Lay-out

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 power house (tags: FIR500 and FIR800, respectively).

While the power house was not installed, SJ generated electricity through a diesel engine installed in the degassing station. The electricity produced was registered continuously by the PLC and the diesel consumed was registered via the contract between Biogás and the diesel supplier. This equipment is in stand-by now, as the electricity consumed by the Degassing Station is supplied by the Power House; however, during electricity black-outs the generator is turned on in order to supply electricity to the Station (this source of project emissions was considered in the calculation of ERs).

The pictures below presents the above mentioned installed equipment. The lay-outs of the degassing station and the power house, locating of the measuring equipment are presented in item 2.2 – Monitoring Equipments.

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 a nominal capacity of 1.6 MW each (operative capacity of 1.54 MW each), achieving a total installed capacity of 25.6 MW (operative capacity of 24.64 MW). Electricity produced is sent to the substation located next to the power house and transported via a transmission line of 30 km until the connection to the Brazilian Electric Grid. Two electricity-meters are installed to measure the net quantity of electricity exported to the grid, one for each bar, and there is another measuring point at the substation connected to the grid – this substation measures the electricity which is indeed exported, discounting the transmission looses.

The pictures below presents the gas engines installed in the Power House, the substation, the electricity-meter and the transmission line from São João Landfill to the connection to the Brazilian Electric Grid.

Figure 1-14: Gas engine

Figure 1-15: Substation

Figure 1-16: Electricity-meter

Figure 1-17: Transmission Line (green collored)

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.

- The application of a new monitoring plan, as approved by the EB in 18/02/2008, including, among others:
    - The use of a diesel generator to supply the project's electric needs from the beginning of the project's operation until January/2008, when the power house entered into operation. This source of project emission was considered in the calculation of emission reduction. However, this project emission source is in stand-by now as the electricity generated in the power house is used to supply the project's internal needs – the diesel generator is only turned on during black-outs of electricity generation;

    - 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.

- The project was implemented installing 25.6 MW for electricity generation (16 engines of 1.6 MW each; operative capacity of 1.54 MW) and a transmission line of around 30 km length. Due to looses in the transmission line, the electricity which is indeed exported to the grid is below 20 MW, which is in accordance with the PDD's premises.

1.4. Monitoring Period

The monitoring period is from 01/10/2009 to 31/12/2009.

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

No major changes were identified.

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

This monitoring report was developed and reviewed by:

Cintia Philippi Salles
ARCADIS Tetraplan S/A
Avenida Nove de Julho, 5966 – Térreo
São Paulo – SP
Brazil
CEP: 01406-200
Phone/Fax: + 55 (11) 3060-8457
http://www.tetraplan.com.br
cintia.salles@tetraplan.com.br

Júlio César do Prado
Biogás Energia Ambiental
Estrada do Sapopemba, 23.235
São Paulo – SP
Brazil
CEP: 08310-130
Phone/Fax: + 55 (11) 6734-8862
http://www.biogas-ambiental.com.br
julio@biogas-ambiental.com.br

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:

PDD 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
1 - $LFG_{Total, y}$	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.
2 - $LFG_{Flare, y}$	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.
3 - $LFG_{Electricity, y}$	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 PLC, using continuous readings of temperature and pressure transmitters connected to each flow-meter

PDD 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
4 - 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.
5 - $w_{CH4,y}$	Methane fraction in the landfill gas	%	M	Continuously	100%	E	During the crediting period and two years after	Measured by continuous gas quality analyzer.
6	Regulatory requirements relating to landfill gas projects	Test	N/A	-	100%	E/P		
7 - 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 electricity meters. Data will be kept for two years after the end of the crediting period.
8 - 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.
7 - 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.

PDD 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:

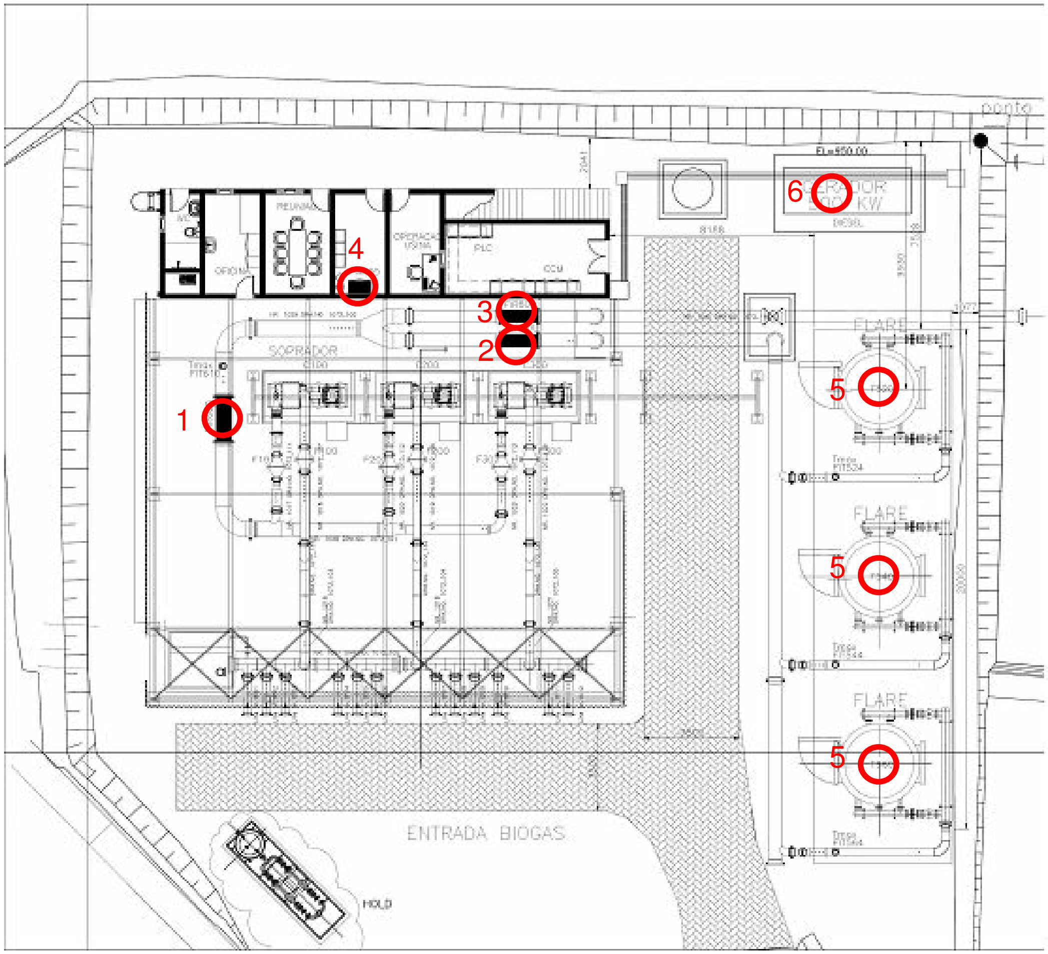


Figure 2-1. Lay-out of the Degassing Station

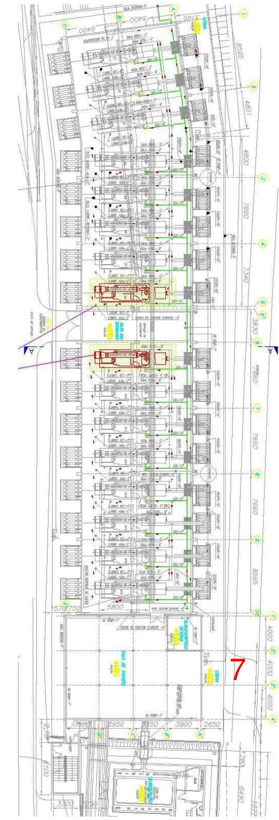


Figure 2-2. Lay-out the Power House

Methodology ID	Equipment Number	Equipment	Location	TAG	Manufacturer	Model	Range	Serial Number	Error (%)
$LFG_{Total, y}$	1	Turbine Flow-meter [3]	Main Line	FIR600	Instromet	SM-RI-X-K	1,300–25,000 m^3/h	10508423	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	10508421	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	10508422	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 (all thermocouples) (2) N/A	(1) 0-1500°C (all thermocouples) (2) N/A	N/A	N/A
$w_{CH4, y}$	4	Methane Analyzer	Analysis Room	A100	NUK-Emerson-Rosemount	Binos 100	0-100%	120171639018	1.000
EG_y [4]	7	Electricity Meters	Substation	N/A	Merlin Gerin	Power Logic - CM 4000	240V/300V - 96mA MAX.	0032004234	1.0
EC_y	6	Electricity Meter	Diesel Generator	N/A	Siemens	MMG 144	0-100 MWh	00400243415	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).

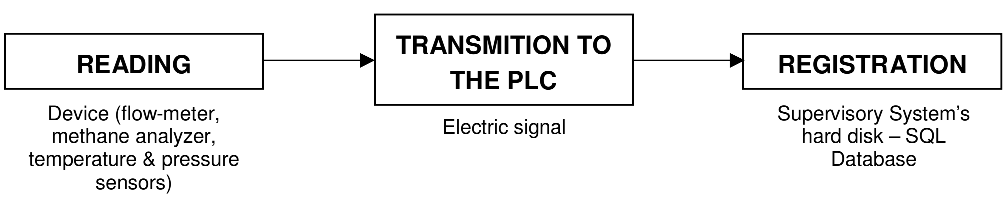
[4] There are two electricity-mters inatalled at SJ – one in each bar. The electricity-meters are from the same manufacturer and are the same model.

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	Continuously	Continuously	Every 5 minutes (instant gas-flow) Every 1 hour (accumulated gas-flow)	- Data of instant gas-flow is registered every 5 minutes in the Supervisory System's hard disk, in Nm^3/h, using the readings from the pressure and temperature transmitters; - Data accumulated every 1 hour is registered 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; - Every 3 hours, the accumulated flow (in Nm^3) is manually registered by the operators; - Every 1 hour, the operators perform a "Print-Screen" of the PLC Controlling System Panel, which presents the operational variables. - Responsibilties of the routine: PLC (continuously) and plant supervisor (monthly)
$LFG_{Flare, y}$	FIR500	Continuously	Continuously	Every 5 minutes (instant gas-flow) Every 1 hour (accumulated gas-flow)	
$LFG_{Electricity, y}$	FIR800	Continuously	Continuously	Every 5 minutes (instant gas-flow) Every 1 hour (accumulated gas-flow)	
FE	(1) TAC520, TAC540 and TAC560 (2) N/A	(1) Continuously (2) Every 3 months, by a specialized company on gas analysis	(1) Continuously (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	Continuously	Continuously	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)

Methodology ID	Equipment TAG	Reading Frequency	Transmition Frequency	Registration Frequency	Comments
EG_y	EM100	Continuously	Continuously	Every 1 hour	- Data accumulated every 1 hour in the Power House's Supervisory System's hard disk, in MWh; - Every 00:00, the PLC's counter is reseted; - Responsibilties of the routine: PLC (continuously) and power plant supervisor (monthly)
EC_y	N/A	Continuously	Continuously	Every 1 hour (accumulated electricity consumption)	- The electricity-meter keeps accumulating the electricity consumed; - When the meter reaches 100 MWh, the count is reseted. - Responsibilities of the routine: PLC (continuously) and 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 CORPLAB, a national certified laboratory.
- NEXT Automations, 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 every 3 hours, 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). Additionally, the operators are oriented to perform a "Print-Screen" of the PLC Controlling System Panel every hour. The picture printed presents all monitoring parameters and is saved in the computer's hard disk.

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

PO-012: Instructionfor Refuelling the Diesel Device

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:

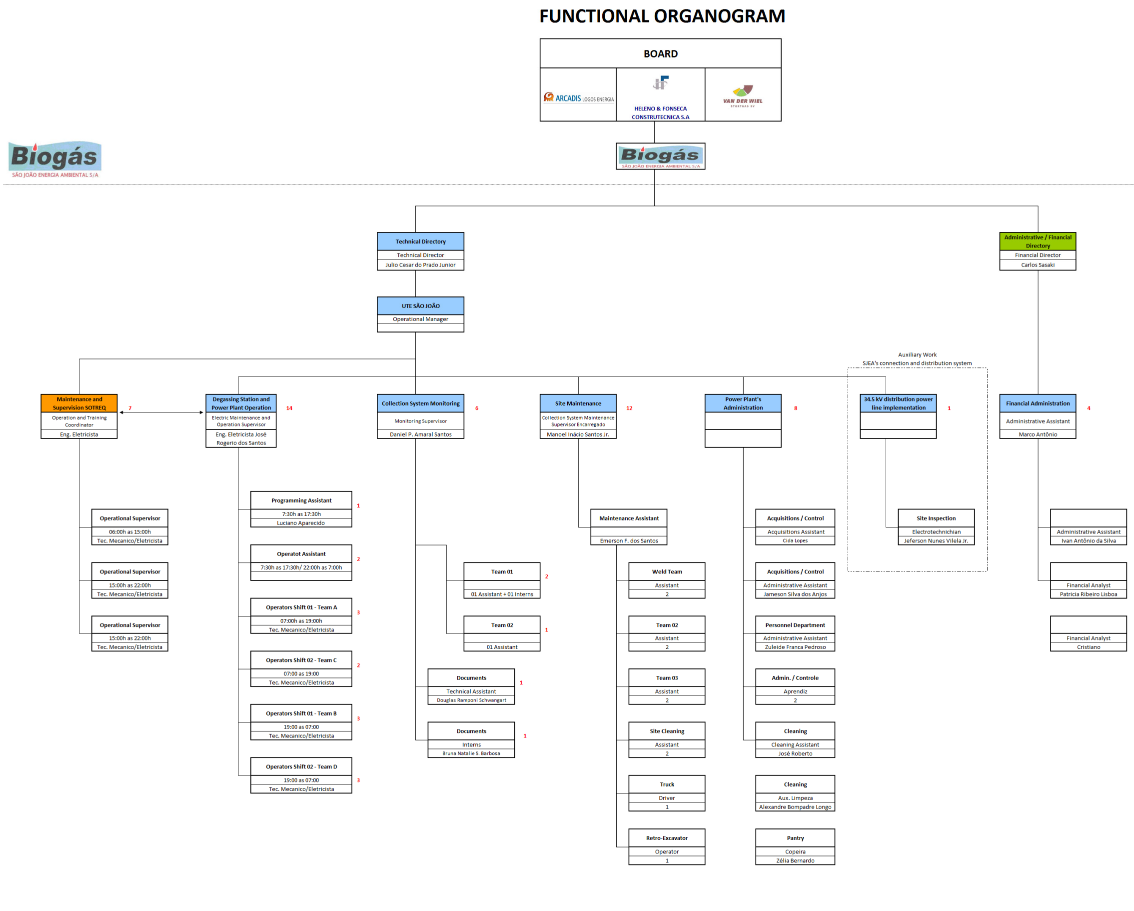


Figure 2-4. General Organogram of SJ

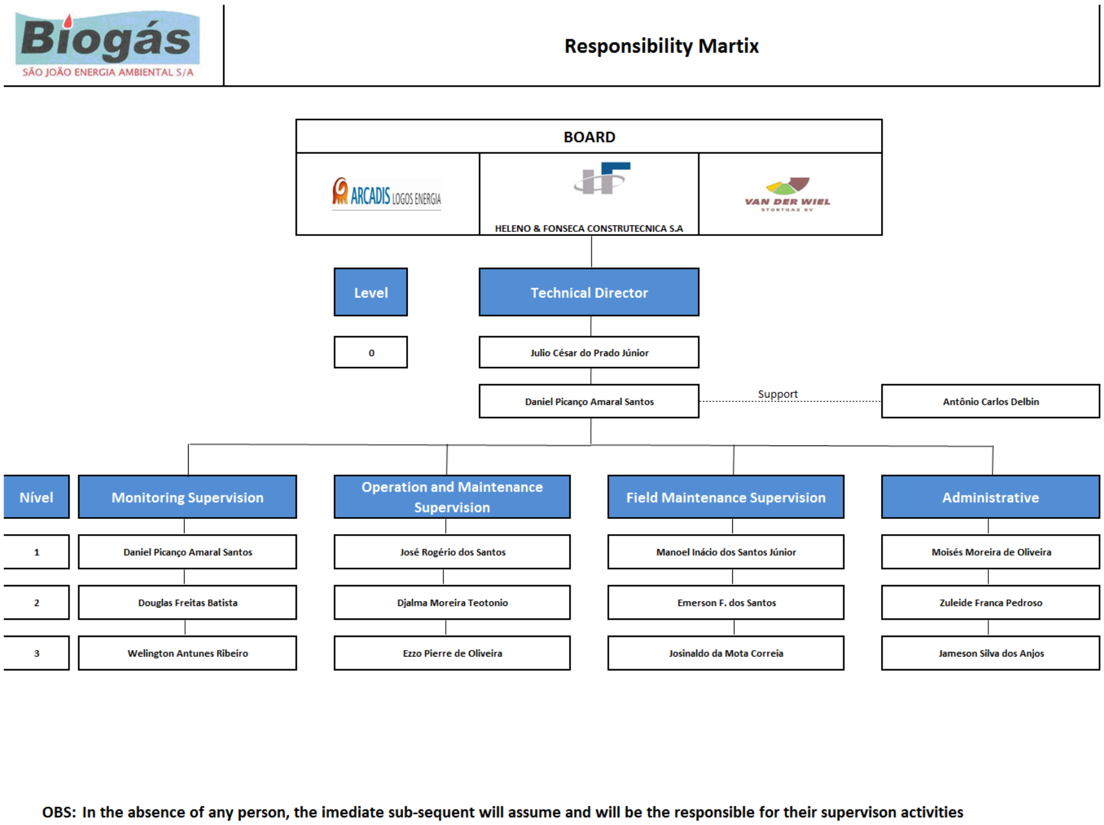


Figure 2-5. Responsibility Matrix of SJ

2.3.3. Trainings

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

For this monitoring period, one new employee (Danilo Maer da Silva – Operator) was hired.

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 regularly 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 SJ 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:

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

As SJ does not diaplace thermal energy, ET_y = 0 and equation 6.1 is updated to:

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

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[5];

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:

[5] 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).

For this monitoring period, Biogás decided to perform 2 analysis of the methane content in the exhaust gas of all flares, all performed by CORPLAB[6]: between 03/08/2009 and 04/08/2009; and between 04/11/2009 and 06/11/2009. The table below presents the methane concentration results.

Flare	August/2009 (Report 0950809)	November/2009 (Report 2241109)
F520	1,0 mg/Nm^3	1,9 mg/Nm^3
F540	0,80 mg/Nm^3	0,9 mg/Nm^3
F560	0,90 mg/Nm^3	1,0 mg/Nm^3

Other parameters used to calculate the flare efficiency were:

Measurement	$Flow_{FIR500}$			$\%_{methane}$		
	F520	F540	F560	F520	F540	F560
August/2009	5,407.03 Nm^3/h	4,351.30 Nm^3/h	4,432.20 Nm^3/h	47.7%	46.3%	47.8%
November/2009	5,211.30 Nm^3/h	4,370.30 Nm^3/h	4,449.60 Nm^3/h	46.2%	45.3%	45.5%

The results were:

Measurement	Flare Efficiency Calculated		
	F520	F540	F560
August/2009	99.9990%	99.9992%	99.9991%
November/2009	99.9981%	99.9991%	99.9990%

In order to adopt a conservative approach, the lowest efficiency calculated through the methane content among the three flares was adopted until the next analysis. The table below resumes the period and the flare efficiency considered.

Period		Flare Efficiency Adopted
From	To	
01/10	02/11/2009	99.9990%
03/11	31/12/2009	99.9981%

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

[6] Due to time constrains Corplarb could not performe the exhaust gas anaylsis for all flares in one day .

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.

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 (Nm³) A	Methane (%) B	*Methane measured FIR600 (Nm³) C = A . B*	Flares Efficiency (%) D	LFG measured FIR500 (Nm³) E	*Methane measured FIR500 (Nm³) F = E . B*	*Methne Destroyed in Flares (Nm³) G = F . D*	LFG measured FIR800 (Nm³) H	*Methane measured FIR800 (Nm³) I = H . B*	Eletricity Exported SJ (MWh) J	Eletricity Consumed (MWh) L
01/10/2009	263,232	47.6465	*125,420.8348*	*99.9990%*	262,713	125,173.5495	125,172.2977	0	0.0000	0.00	1.8045
02/10/2009	262,951	47.9093	*125,977.9834*	*99.9990%*	262,439	125,732.6878	125,731.4304	0	0.0000	0.00	5.0904
03/10/2009	261,520	47.7309	*124,825.8496*	*99.9990%*	143,727	68,602.1906	68,601.5045	117,119	55,901.9527	186.81	1.1128
04/10/2009	253,045	48.6097	*123,004.4153*	*99.9990%*	72,865	35,419.4579	35,419.1037	179,615	87,310.3126	296.30	0.0000
05/10/2009	265,988	47.6510	*126,745.9418*	*99.9990%*	72,364	34,482.1696	34,481.8247	192,963	91,948.7991	313.85	0.0000
06/10/2009	261,261	47.1920	*123,294.2911*	*99.9990%*	58,176	27,454.4179	27,454.1433	201,613	95,145.2069	326.10	0.0710
07/10/2009	272,775	46.9107	*127,960.6619*	*99.9990%*	61,251	28,733.2728	28,732.9854	206,465	96,854.1767	326.75	0.1842
08/10/2009	279,336	46.4440	*129,734.8118*	*99.9990%*	70,014	32,517.3021	32,516.9769	208,584	96,874.7529	328.90	0.0000
09/10/2009	271,401	47.3218	*128,431.8384*	*99.9990%*	65,650	31,066.7617	31,066.4510	205,043	97,030.0383	326.87	0.0000
10/10/2009	266,939	47.7354	*127,424.3994*	*99.9990%*	79,922	38,151.0863	38,150.7047	186,153	88,860.8791	299.58	0.0000
11/10/2009	263,334	48.3888	*127,424.1625*	*99.9990%*	86,658	41,932.7663	41,932.3469	175,700	85,019.1216	285.06	0.0000
12/10/2009	264,986	47.4559	*125,751.4911*	*99.9990%*	101,011	47,935.6791	47,935.1997	162,939	77,324.1689	262.99	0.0000

DATE	COLLECTING SYSTEM				FLARING SYSTEM			ELECTRICITY GENERATION			
	LFG measured FIR600 (Nm³)	Methane (%)	*Methane measured FIR600 (Nm³)*	Flares Efficiency (%)	LFG measured FIR500 (Nm³)	*Methane measured FIR500 (Nm³)*	*Methne Destroyed in Flares (Nm³)*	LFG measured FIR800 (Nm³)	*Methane measured FIR800 (Nm³)*	Eletricity Exported SJ (MWh)	Eletricity Consumed (MWh)
	A	B	*C = A . B*	D	E	*F = E . B*	*G = F . D*	H	*I = H . B*	J	L
13/10/2009	268,068	46.6548	*125,066.5892*	*99.9990%*	88,770	41,415.4659	41,415.0517	178,315	83,192.5066	286.58	0.0000
14/10/2009	266,880	47.1430	*125,815.2384*	*99.9990%*	95,966	45,241.2513	45,240.7988	169,882	80,087.4712	273.30	0.0000
15/10/2009	271,922	46.0809	*125,304.1048*	*99.9990%*	73,581	33,906.7870	33,906.4479	197,491	91,005.6302	315.39	0.0000
16/10/2009	272,527	46.0194	*125,415.2902*	*99.9990%*	47,158	21,701.8286	21,701.6115	224,735	103,421.6985	358.46	0.0000
17/10/2009	271,529	46.8559	*127,227.3567*	*99.9990%*	60,155	28,186.1666	28,185.8847	210,663	98,708.0446	339.18	0.0000
18/10/2009	270,639	47.3541	*128,158.6626*	*99.9990%*	75,008	35,519.3633	35,519.0081	194,625	92,162.9171	314.74	0.0000
19/10/2009	270,482	47.2263	*127,738.6407*	*99.9990%*	74,635	35,247.3490	35,246.9965	195,018	92,099.7857	305.37	0.0000
20/10/2009	271,611	47.1006	*127,930.4106*	*99.9990%*	52,453	24,705.6777	24,705.4306	218,473	102,902.0938	354.76	0.0000
21/10/2009	273,302	46.5611	*127,252.4175*	*99.9990%*	65,128	30,324.3132	30,324.0099	197,414	91,918.1299	313.55	0.0000
22/10/2009	272,102	46.3156	*126,025.6739*	*99.9990%*	77,662	35,969.6212	35,969.2615	236,980	109,758.7088	382.42	0.0000
23/10/2009	264,777	47.0135	*124,480.9348*	*99.9990%*	31,170	14,654.1079	14,653.9613	233,090	109,583.7671	378.61	0.0000
24/10/2009	264,464	46.9958	*124,286.9725*	*99.9990%*	44,020	20,687.5511	20,687.3442	219,789	103,291.5988	356.65	0.0000
25/10/2009	266,772	46.2232	*123,310.5551*	*99.9990%*	25,797	11,924.1989	11,924.0796	240,455	111,145.9955	388.30	0.0000
26/10/2009	271,759	46.0656	*125,187.4139*	*99.9990%*	32,331	14,893.4691	14,893.3201	238,803	110,006.0347	381.67	0.0000
27/10/2009	278,814	45.9045	*127,988.1726*	*99.9990%*	32,712	15,016.2800	15,016.1298	245,495	112,693.2522	389.41	0.0000
28/10/2009	274,327	46.6656	*128,016.3405*	*99.9990%*	18,088	8,440.8737	8,440.7892	250,808	117,041.0580	401.61	0.0000
29/10/2009	273,216	46.8902	*128,111.5288*	*99.9990%*	24,077	11,289.7534	11,289.6405	247,066	115,849.7415	399.79	0.0000
30/10/2009	269,705	47.0583	*126,918.5880*	*99.9990%*	18,484	8,698.2561	8,698.1691	249,966	117,629.7501	405.99	0.0000
31/10/2009	270,630	46.7024	*126,390.7051*	*99.9990%*	18,388	8,587.6373	8,587.5514	251,421	117,419.6411	405.27	0.0000
01/11/2009	266,277	46.8003	*124,618.4348*	*99.9990%*	18,381	8,602.3631	8,602.2770	246,141	115,194.7264	397.02	0.0000

DATE	COLLECTING SYSTEM				FLARING SYSTEM			ELECTRICITY GENERATION			
	LFG measured FIR600 (Nm^3)	Methane (%)	*Methane measured FIR600 (Nm^3)*	Flares Efficiency (%)	LFG measured FIR500 (Nm^3)	*Methane measured FIR500 (Nm^3)*	*Methne Destroyed in Flares (Nm^3)*	LFG measured FIR800 (Nm^3)	*Methane measured FIR800 (Nm^3)*	Eletricity Exported SJ (MWh)	Eletricity Consumed (MWh)
	A	B	*C = A . B*	D	E	*F = E . B*	*G = F . D*	H	*I = H . B*	J	L
02/11/2009	266,184	46.8173	*124,620.1618*	*99.9990%*	32,443	15,188.9366	15,188.7847	233,100	109,131.1263	375.10	0.0000
03/11/2009	264,750	46.1326	*122,136.0585*	*99.9981%*	38,683	17,845.4736	17,845.1345	225,391	103,978.7284	364.61	0.0000
04/11/2009	268,211	45.4291	*121,845.8434*	*99.9981%*	41,468	18,838.5391	18,838.1811	221,051	100,421.4798	353.14	0.0000
05/11/2009	267,167	45.2038	*120,769.6363*	*99.9981%*	25,541	11,545.5025	11,545.2831	240,441	108,688.4687	384.94	0.0000
06/11/2009	262,797	45.6121	*119,867.2304*	*99.9981%*	29,414	13,416.3430	13,416.0880	230,989	105,358.9336	374.91	0.0000
07/11/2009	258,903	45.5309	*117,880.8660*	*99.9981%*	33,045	15,045.6859	15,045.4000	222,917	101,496.1163	362.86	0.0000
08/11/2009	256,560	45.4600	*116,632.1760*	*99.9981%*	8,650	3,932.2900	3,932.2152	246,128	111,889.7888	397.69	0.0000
09/11/2009	264,255	45.9923	*121,536.9523*	*99.9981%*	12,351	5,680.5089	5,680.4009	243,760	112,110.8304	398.81	0.0000
10/11/2009	256,931	47.5583	*122,192.0157*	*99.9981%*	42,137	20,039.6408	20,039.2600	210,037	99,890.0265	349.97	0.4473
11/11/2009	273,354	46.8229	*127,992.2700*	*99.9981%*	187,038	87,576.6157	87,574.9517	85,746	40,148.7638	140.78	3.5593
12/11/2009	263,014	47.5680	*125,110.4995*	*99.9981%*	1,441	685.4548	685.4417	258,013	122,731.6238	430.46	0.0000
13/11/2009	264,773	47.1489	*124,837.5569*	*99.9981%*	0	0.0000	0.0000	264,383	124,653.6762	437.26	0.0000
14/11/2009	265,647	47.0604	*125,014.5407*	*99.9981%*	3,366	1,584.0530	1,584.0229	261,443	123,036.1215	429.82	0.0000
15/11/2009	265,763	46.9673	*124,821.7054*	*99.9981%*	18,960	8,905.0000	8,904.8308	244,556	114,861.3501	403.80	0.0000
16/11/2009	267,399	46.9673	*125,590.0905*	*99.9981%*	13,907	6,531.7424	6,531.6182	248,704	116,809.5537	408.51	0.0000
17/11/2009	267,574	46.9621	*125,658.3694*	*99.9981%*	7,585	3,562.0752	3,562.0075	258,558	121,424.2665	420.44	0.0000
18/11/2009	267,550	47.3305	*126,632.7527*	*99.9981%*	32,479	15,372.4730	15,372.1809	231,571	109,603.7121	374.18	0.0000
19/11/2009	261,739	47.7954	*125,099.2020*	*99.9981%*	47,627	22,763.5151	22,763.0825	213,521	102,053.2160	350.28	0.0000
20/11/2009	266,526	46.8170	*124,779.4774*	*99.9981%*	38,958	18,238.9668	18,238.6202	227,064	106,304.5528	368.46	0.0000
21/11/2009	265,764	46.9468	*124,767.6935*	*99.9981%*	20,437	9,594.5175	9,594.3352	245,024	115,030.9272	395.80	0.0000

DATE	COLLECTING SYSTEM				FLARING SYSTEM			ELECTRICITY GENERATION			
	LFG measured FIR600 (Nm^3)	Methane (%)	*Methane measured FIR600 (Nm^3)*	Flares Efficiency (%)	LFG measured FIR500 (Nm^3)	*Methane measured FIR500 (Nm^3)*	*Methne Destroyed in Flares (Nm^3)*	LFG measured FIR800 (Nm^3)	*Methane measured FIR800 (Nm^3)*	Eletricity Exported SJ (MWh)	Eletricity Consumed (MWh)
	A	B	*C = A . B*	D	E	*F = E . B*	*G = F . D*	H	*I = H . B*	J	L
22/11/2009	263,177	47.4892	*124,980.6518*	*99.9981%*	49,362	23,441.6189	23,441.1735	238,458	113,241.7965	390.87	0.0000
23/11/2009	265,592	47.1833	*125,315.0701*	*99.9981%*	28,357	13,379.7683	13,379.5140	236,074	111,387.5036	384.94	0.0000
24/11/2009	261,047	47.6506	*124,390.4617*	*99.9981%*	25,365	12,086.5746	12,086.3449	233,035	111,042.5757	382.79	0.0000
25/11/2009	262,284	47.9152	*125,673.9031*	*99.9981%*	31,001	14,854.1911	14,853.9088	230,938	110,654.4045	376.97	0.0000
26/11/2009	260,892	47.9006	*124,968.8333*	*99.9981%*	7,743	3,708.9434	3,708.8729	249,607	119,563.2506	411.77	0.0000
27/11/2009	259,884	48.4833	*126,000.3393*	*99.9981%*	75,032	36,377.9896	36,377.2984	176,735	85,686.9602	294.00	1.3917
28/11/2009	264,223	47.6798	*125,980.9979*	*99.9981%*	218,575	104,216.1228	104,214.1426	44,891	21,403.9390	70.40	4.4969
29/11/2009	264,123	47.5434	*125,573.0543*	*99.9981%*	20,125	9,568.1092	9,567.9274	243,624	115,827.1328	400.44	0.2785
30/11/2009	259,804	48.5475	*126,128.3469*	*99.9981%*	7,922	3,845.9329	3,845.8598	246,564	119,700.6579	414.49	0.0000
01/12/2009	261,698	48.3204	*126,453.5203*	*99.9981%*	1,570	758.6302	758.6157	260,055	125,659.6162	438.43	0.0000
02/12/2009	258,609	49.1246	*127,040.6368*	*99.9981%*	0	0.0000	0.0000	258,500	126,987.0910	440.26	0.0000
03/12/2009	259,293	48.9722	*126,981.4865*	*99.9981%*	0	0.0000	0.0000	259,164	126,918.3124	440.70	0.0000
04/12/2009	269,884	47.4475	*128,053.2109*	*99.9981%*	598	283.7360	283.7306	263,024	124,798.3124	431.97	0.0000
05/12/2009	280,444	46.1965	*129,555.3124*	*99.9981%*	0	0.0000	0.0000	280,263	129,471.6967	446.38	0.0000
06/12/2009	273,726	47.2437	*129,318.2902*	*99.9981%*	0	0.0000	0.0000	273,445	129,185.5354	442.34	0.0000
07/12/2009	274,838	47.0562	*129,328.3189*	*99.9981%*	0	0.0000	0.0000	274,526	129,181.5036	444.63	0.0000
08/12/2009	267,795	47.9524	*128,414.1295*	*99.9981%*	23,734	11,381.0226	11,380.8063	242,723	116,391.5038	400.34	0.0000
09/12/2009	272,732	47.5170	*129,594.0644*	*99.9981%*	12,218	5,805.6270	5,805.5166	256,152	121,715.7458	419.12	0.0000
10/12/2009	275,985	47.1253	*130,058.7592*	*99.9981%*	2,140	1,008.4814	1,008.4622	269,428	126,968.7532	438.21	0.0000
11/12/2009	270,061	48.1170	*129,945.2513*	*99.9981%*	648	311.7981	311.7921	268,590	129,237.4503	445.72	0.0000

	COLLECTING SYSTEM				FLARING SYSTEM			ELECTRICITY GENERATION			
	LFG measured FIR600 (Nm³)	Methane (%)	*Methane measured FIR600 (Nm³)*	Flares Efficiency (%)	LFG measured FIR500 (Nm³)	*Methane measured FIR500 (Nm³)*	*Methne Destroyed in Flares (Nm³)*	LFG measured FIR800 (Nm³)	*Methane measured FIR800 (Nm³)*	Eletricity Exported SJ (MWh)	Eletricity Consumed (MWh)
DATE	A	B	*C = A . B*	D	E	*F = E . B*	*G = F . D*	H	*I = H . B*	J	L
12/12/2009	267,042	48.0767	*128,384.9812*	*99.9981%*	2,858	1,374.0320	1,374.0058	259,241	124,634.5178	433.63	0.0000
13/12/2009	270,834	47.5631	*128,817.0462*	*99.9981%*	763	362.9064	362.8995	268,879	127,887.1876	442.52	0.0000
14/12/2009	271,293	47.6701	*129,325.6443*	*99.9981%*	8,567	4,083.8974	4,083.8198	262,164	124,973.8409	428.22	0.0000
15/12/2009	275,498	47.6232	*131,200.9635*	*99.9981%*	167,544	79,789.8142	79,788.2981	107,036	50,973.9683	177.11	3.2972
16/12/2009	264,140	48.3447	*127,697.6905*	*99.9981%*	1,675	809.7737	809.7583	259,038	125,231.1439	432.43	0.0000
17/12/2009	261,625	48.3753	*126,561.8786*	*99.9981%*	8,114	3,925.1718	3,925.0972	250,898	121,372.6601	424.43	0.0000
18/12/2009	263,018	47.9138	*126,021.9184*	*99.9981%*	8,494	4,069.7981	4,069.7207	250,966	120,247.3473	421.38	0.0000
19/12/2009	263,278	47.8222	*125,905.3317*	*99.9981%*	27,166	12,991.3788	12,991.1319	235,490	112,616.4987	387.70	0.0000
20/12/2009	256,011	48.2979	*123,647.9367*	*99.9981%*	36,274	17,519.5802	17,519.2473	214,493	103,595.6146	355.75	0.3607
21/12/2009	267,336	47.1281	*125,990.3774*	*99.9981%*	34,915	16,454.7761	16,454.4634	231,733	109,211.3599	379.92	0.0000
22/12/2009	264,775	47.1142	*124,746.6230*	*99.9981%*	61,161	28,815.5158	28,814.9683	238,911	112,561.0063	393.77	0.0000
23/12/2009	263,079	47.5715	*125,150.6264*	*99.9981%*	16,818	8,000.5748	8,000.4227	245,359	116,720.9566	404.64	0.0000
24/12/2009	258,071	48.1107	*124,159.7645*	*99.9981%*	0	0.0000	0.0000	257,440	123,856.1860	429.54	0.0000
25/12/2009	259,289	47.9739	*124,391.0455*	*99.9981%*	0	0.0000	0.0000	257,854	123,702.6201	430.56	0.0000
26/12/2009	261,290	47.4732	*124,042.7242*	*99.9981%*	0	0.0000	0.0000	260,911	123,862.8008	435.02	0.0000
27/12/2009	260,015	47.8590	*124,440.5788*	*99.9981%*	2,560	1,225.1904	1,225.1671	256,108	122,570.7277	427.91	0.0000
28/12/2009	254,984	48.5690	*123,843.1789*	*99.9981%*	6,226	3,023.9059	3,023.8484	238,398	115,787.5246	405.21	0.3807
29/12/2009	265,541	47.4885	*126,101.4377*	*99.9981%*	15,784	7,495.5848	7,495.4423	247,980	117,761.9823	408.71	0.0000
30/12/2009	268,571	47.4968	*127,562.6307*	*99.9981%*	25,552	12,136.3823	12,136.1517	241,752	114,824.4639	398.48	0.0000
31/12/2009	259,793	48.2381	*125,319.2071*	*99.9981%*	952	*459.2267*	*459.2179*	258,387	124,640.9794	430.81	0.0000

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	**1,832,102.1976**
Total Methane destroyed in the Power House (Nm^3), measured by FIR800	**9,709,062.3515**
Total electricity consumed fro the diesel generator (MWh)	**22.4752**
Total Electricity Exported, measured at São João Landfill's substation (MWh)	**33,585.5930**

ERs from the electricity indeed exported are measured at Eletropaulo's substation (based on monthly electricity transaction notes), located around 30 km from São João Landfill. The values measured are lower than the one in the landfill's substation due to looses in the transmission line. The table below presents the electricity measured during the Monitoring Period and the comparison between the one measured in the landfill:

MONTH	Electricity Measured at São João Landfill (MWh)	Electricity Measured at Eletropaulo's Substation (MWh)[7]
October/09	9,704.26	9,315.63
November/09	11,045.50	10,556.38
Dezember/09	12,835.84	12,222.76
TOTAL	**33,585.60**	**32,094.77**

For this monitoring period, the electricity indeed exported (32,094.77 MWh) has not reached the capacity stated in the PDD considering 92 days in the given monitoring period (38,83 MWh, calculated as 154,080[8] MWh / 365 days x 92 days), thus the project is inside the forecasted in the PDD.

[7] Electricity measured based on monthly transaction notes.

4.2. Events registered

No importants events were registered.

[8] Annual electricity displacement, according with the estimatives from the PDD

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	23/05/2007	23/05/2012
$LFG_{Flare, y}$	Turbine Flow-meters	FIR500	0.980	23/05/2007	23/05/2012
$LFG_{Electricity, y}$	Turbine Flow-meters	FIR800	1.280	23/05/2007	23/05/2012
$w_{CH4, y}$	Methane Analyzer	A100	1.000	23/05/2007[9]	Weekly, with a standard gas
temperature [10]	Temperature Transmitter	TT600 TT500 TT800	0.020 0.030 0.100	15/05/2007 15/05/2007 15/05/2007	15/05/2012 15/05/2012 15/05/2012
pressure [10]	Pressure Transmitter	PT600 PT500 PT800	0.030 0.010 0.010	15/05/2007 15/05/2007 15/05/2007	15/05/2012 15/05/2012 15/05/2012
EG_y	Electricity Meter	N/A	1.0	29/10/2007	29/10/2012
EC_y	Electricity Meter	N/A	0.500	23/05/2007[11]	23/05/2012

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:

[9] This date refers to the installation of the Methane Analyzer and, since then, the calibration of the instrument has been made weekly

[10] 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)

[11] "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.

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

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

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

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, minus the uncertainties of the electricity-meter due to conservativeness, as follows:

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

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

The calculation of EC_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[12]
- *S-SE-CO Grid Emission Factor (EF)* = 0.2677 tCO_2e/MWh
- *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	H (see the table of consolidated methane destroyed and electricity	Total electricity exported (MWh)

[12] 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)".*

Exported	consumed/exported – last table from 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.

4.10. GHG emission reductions

	TOTAL
Total CO_2e from methane destroyed	136,768
Total CO_2e from electricity exported	8,505
Total CO_2e from electricity consumed	30
TOTAL CO_2e	**145,243**

The real monitoring emission reduced are less than the estimated in the PDD. The difference between the PDD estimatives and the gas-flow monitored is due to the landfill's poor final layer cover, which increases the gas leakage through the landfill's surface.

VERSION HISTORY

Version	Date	Nature of Revision(s)
01	**15/01/2010**	Initial Adoption

ARCADIS Tetraplan S.A.

Av. Nove de Julho, 5966, térreo,
Jardim Paulista, São Paulo-SP
CEP 01406-200

Fone/fax: +55 (11) 3060 8457
E-mail: tetraplan@tetraplan.com.br

Website: www.tetraplan.com.br
www.arcadis-global.com