ARCADIS TETRAPLAN

Imagine the result

Bandeirantes Landfill Gas to Energy Project (BLFGE)

Monitoring Report – Version 01
13th Verification
Monitoring Period: 01/07/2009 to 30/09/2009

São Paulo, October 05th 2009

Clean Development Mechanism

Monitoring Report – Version 01

Bandeirantes Landfill Gas to Energy Project (BLFGE)

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Biogás Energia Ambiental SA

São Paulo
October 05th 2009

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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

1.1. Title and Registration Number of the Project Activity

Bandeirantes Landfill Gas to Energy Project (BLFGE), Registration Number 0164

OBS: 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.

1.2. Short Description of the Project Activity:

Bandeirantes Landfill Gas to Energy Project (BLFGE) is a project designed to explore the landfill gas produced in Bandeirantes 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. Bandeirantes Landfill Gas to Energy Project (BLFGE)'s goal is to explore the gas produced in Bandeirantes landfill, using it to generate electricity.

1.3. Real Project Implementation

Bandeirantes landfill is divided into 5 cells, named AS-1, AS-2, AS-3, AS-4 and AS-5. The former 3 are the oldest ones, which operated from 1978 until 1995. Bandeirantes Landfill Gas to Energy Project (BLFGE) has since its start been extracting gas from the newest cells, where there is still waste being disposed. Three main units can be detached: the substation, the degassing stations and the power plant.

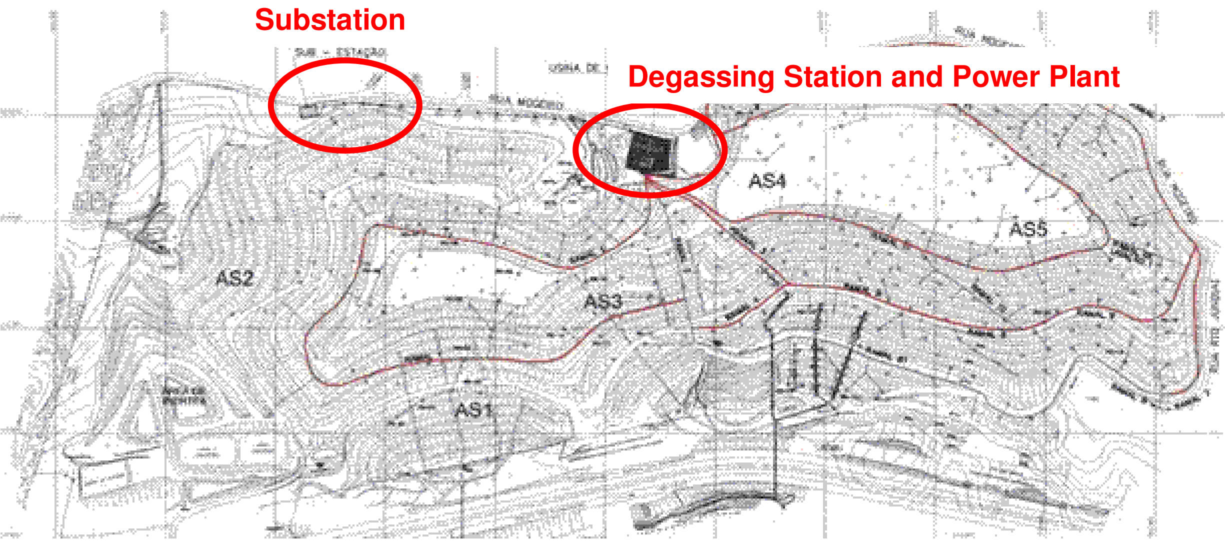

Figure 1-1. Bandeirantes Landfill Cells

The degassing stations are responsible for extracting the landfill gas from the landfill and transport it 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 stations 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.

Figure 1-2. Degassing Station (A) and Power Plant (B)

The landfill gas cools down when transported from the landfill, resulting in a condensate. This is drained to condensate shafts, placed nearby the gas pipes. Once in the degassing stations, the landfill gas has to be cooled again 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 4^{o}C to avoid further condensation.

Considering demoisturing is fundamental for the energy generation, as per the reasons mentioned in the previous paragraph, a demister has been installed for extra-safety reasons. The demister is a stainless steel high density filter which separates liquid particles (small amounts of condensate) from the landfill gas. This liquid is to be drained off to a condensate shaft as well.

The blowers are used for transportation of the landfill gas from the landfill to the gas engines, under correct suction and pre-pressure. Capacity and pressure are adjusted through frequency controlled electromotors. Moreover, the blowers are equipped with all the necessary safety equipment, including a noise reducing housing.

Figure 1-3. Compressors (blue) and dryers (metal)

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. After the described treatment, analyzing and measurement, the landfill gas is transported as a fuel to the gas engines. These drive electrical generators in order to generate electrical power. An occasional surplus of the landfill gas can be burned off by the flares.

Figure 1-4. Turbine Flow-meter

Figure 1-5. Generators used to produce electricity

Figure 1-6. Flare used to destroy the surplus gas collected

For electricity generation, a total of 24 Caterpillar engines, nominal capacity of 925 kW, model 3516 A were installed. They will burn the gas and generate energy, which is to be sent to

Eletropaulo's – the electric distributor supplying São Paulo metropolitan region – grid, measured at the substation. This electricity will in fact not be commercialized directly; it will supply Unibanco's branches over São Paulo state.

1.4. Changes against the PDD

A revised Monitoring Plan was approved in order to reconsider the following changes from the previous Monitoring Plan:

- Installation of 4 new flow-meters to measure the gas flow to the power house;
- changes in the gas station's lay-out. This change was necessary in order to adapt the gas station to treat an increase of landfill gas collected (average 17,000 Nm^3/h) – changes were presented in the Monitoring Report from the 4^{th} Verification.

1.5. Monitoring Period

The monitoring period is from 01/07/2009 to 30/09/2009.

1.6. Methodology applied to the project activity

1.6.1. Baseline methodology

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

1.6.2. Monitoring methodology

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

1.7. Changes since last verification

The only change identified since the last verification was concerning the calibration of FIR200, TTF201 and TPF201. According with the calibration schedule of the instruments, for this monitoring period those instruments should have been sent to calibration on 28/07/2009, 09/10/2012 and 17/08/2009 respectivelly. However, instead of sending to calibration Biogás decided to replace these instruments with FIR700 and its respective transmitters, once the auxiliary gas line is not constatly operational. The replacement happened in 03/07/2009.

1.8. 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 to the EB 36th Meeting and approved on 29/01/2008. 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	Measured by a flow meter, located in the gas line. Normal cubic meters represent the gas volume in cubic meters at STP. Data will be aggregated monthly and yearly. After the installation of the mini-blower, the measurements will be made by two flow meters – the first one was presented above and the second one located in a dedicated line connected to a mini-blower. Normal cubic meters represent the gas volume in cubic meters at STP.
$LFG_{Electricity, y}$	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 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
								Normal cubic meters represent the gas volume in cubic meters at STP.
FE	Flare/combustion efficiency, determined by: the operation hours (1) and 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.
$w_{CH4,\ y}$	Methane fraction in the landfill gas	%	M	Continuously	100%	E	During the crediting period and two years after	Measured by continuous gas quality analyzer.
	Regulatory requirements relating to landfill gas projects	Test	N/A	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. BLFGE will measure the total electricity fed into the grid (via an electricity-meter).
EF_y[1]	Emission Factor	tCO_2/MWh	C	At baseline renewal	100%	E	During the crediting period and two years	This data will be updated at the baseline renewal, in accordance with the considered methodology.

2.2. Monitoring Equipment

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

[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.

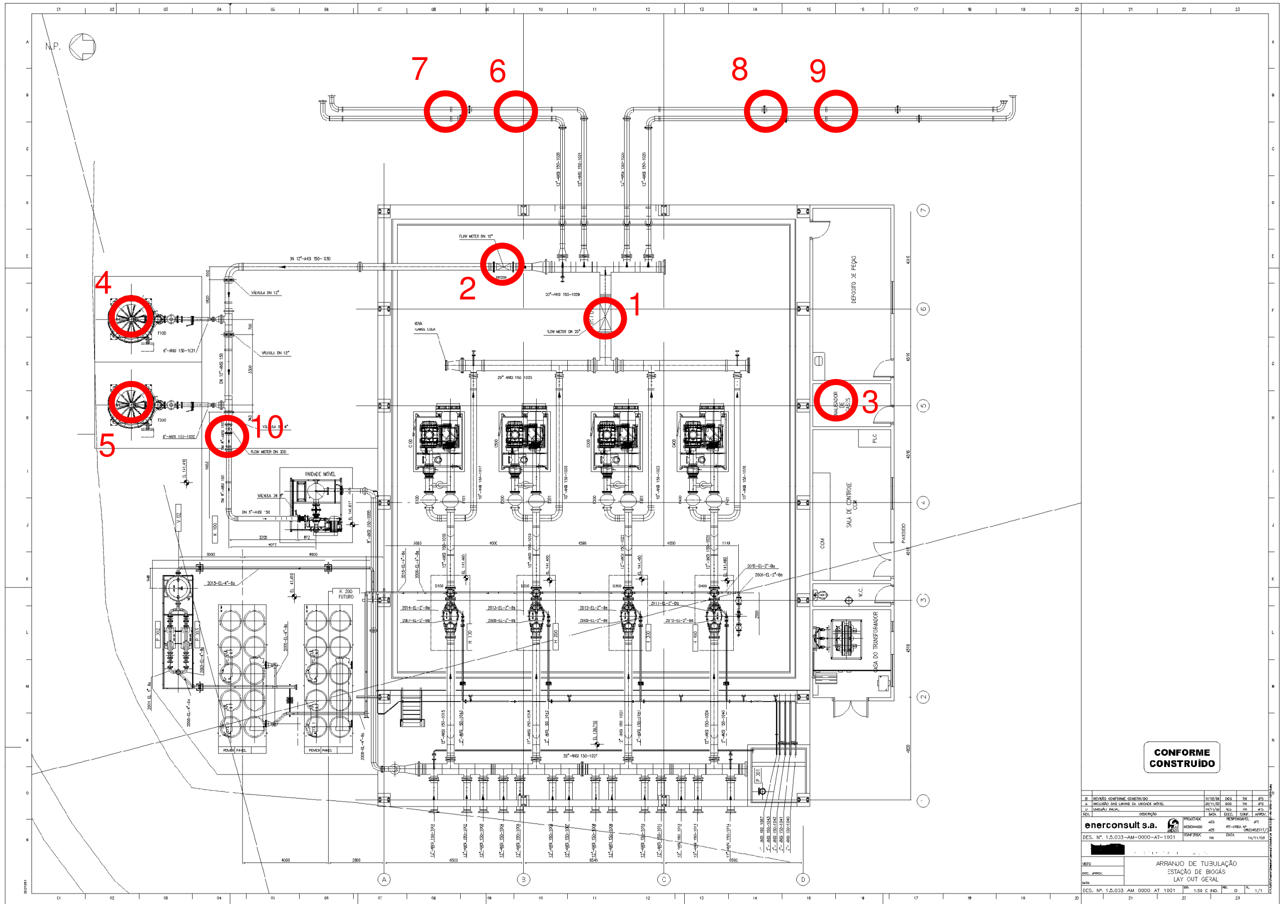

Figure 2-1. Lay-out of the Degassing Station

Due to the replacement of FIR200 by FIR700 (please, refer to 1.7), the table of the instruments with its information are divided in two parts:

PART 01 – from 01/07/2009 to 02/07/2009

Method. ID	Equipment Number	Equipment	Location	TAG	Manufacturer	Model	Range	Error (%)
$LFG_{Total, y}$	1	Turbine Flow-meter [2]	Main Line	FIR100	Instromet	SM-RI-X-K	800-16,000 m^3/h	0.600
$LFG_{Flare, y}$	2 10	Turbine Flow-meters [2]	Line to Flare F100 Auxiliary Line	FIR200 FIR700	Instromet Incontrol	SM-RI-X-K VTGEX-200	320-6,500 m^3/h 250-2,500 m^3/h	0.300 0.890
$LFG_{Electricity, y}$	6 7 8 9	Turbine Flow-meters [2]	Line to the Power House Line to the Power House Line to the Power House Line to the Power House	FIR300 FIR400 FIR500 FIR600	Incontrol Incontrol Incontrol Incontrol	VTGEX-200 VTGEX-200 VTGEX-200 VTGEX-200	170-8,156 m^3/h 170-8,156 m^3/h 170-8,156 m^3/h 170-8,156 m^3/h	0.772 0.596 0.632 0.811
FE_{F100}	4	(1) Thermocouple (2) Chromatographer – analysis made by a Third Party	Flare F100	(1) TAC520 (2)N/A	(1) Jumo (2) N/A	(1) type "S" L750 (2) N/A	(1) 0-1,600°C (2) N/A	N/A
FE_{F200}	5	(1) Thermocouple (2) Chromatographer – analysis made by a Third Party	Flare F200	(1) TAC570 (2)N/A	(1) Jumo (2) N/A	(1) type "S" L750 (2) N/A	(1) 0-1,600°C (2) N/A	N/A
$w_{CH4, y}$	3	Methane Analyzer	Analysis Room	A100	Rosemount-NUK	Binos 100	0-100%	1.000
EG_y		Electricity Meter	Substation	N/A	Merlin Gerin	Power Logic - CM 4000	240V/300V - 96mA MAX.	1.000

[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 monitored; however the erros from the transmitters were discounted from the final calculation.

PART 02 – from 03/07/2009 to 30/09/2009

Method. ID	Equipment Number	Equipment	Location	TAG	Manufacturer	Model	Range	Error (%)
$LFG_{Total, y}$	1	Turbine Flow-meter[2]	Main Line	FIR100	Instromet	SM-RI-X-K	800-16,000 m3/h	0.600
$LFG_{Flare, y}$	2 10	Turbine Flow-meters[2]	Line to Flare F100 Auxiliary Line	FIR200 FIR700	Instromet N/A[3]	VTGEX-200 N/A	250-2,500 m3/h N/A	0.890 N/A
$LFG_{Electricity, y}$	6 7 8 9	Turbine Flow-meters[2]	Line to the Power House Line to the Power House Line to the Power House Line to the Power House	FIR300 FIR400 FIR500 FIR600	Incontrol Incontrol Incontrol Incontrol	VTGEX-200 VTGEX-200 VTGEX-200 VTGEX-200	170-8,156 m3/h 170-8,156 m3/h 170-8,156 m3/h 170-8,156 m3/h	0.772 0.596 0.632 0.811
FE_{F100}	4	(1) Thermocouple (2) Chromatographer – analysis made by a Third Party	Flare F100	(1) TAC520 (2)N/A	(1) Jumo (2) N/A	(1) type "S" L750 (2) N/A	(1) 0-1,600oC (2) N/A	N/A
FE_{F200}	5	(1) Thermocouple (2) Chromatographer – analysis made by a Third Party	Flare F200	(1) TAC570 (2)N/A	(1) Jumo (2) N/A	(1) type "S" L750 (2) N/A	(1) 0-1,600oC (2) N/A	N/A
$w_{CH4, y}$	3	Methane Analyzer	Analysis Room	A100	Rosemount-NUK	Binos 100	0-100%	1.000
EG_y		Electricity Meter	Substation	N/A	Merlin Gerin	Power Logic - CM 4000	240V/300V - 96mA MAX.	1.000

[3] From 03/07/2009 on, the auxiliary line was deactivated and FIR700 was removed and replaced FIR200.

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 2-2. 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 presented in the figure below:

READING → **TRANSMITION TO THE PLC** → **REGISTRATION**

READING	TRANSMITION TO THE PLC	REGISTRATION
Device (flow-meter, methane analyzer, temperature & pressure sensors)	Electric signal	Supervisory System's hard disk – SQL Database

Depending on the paremeter, 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
$LFG_{Total, y}$	FIR100	Continuously	Continuously	Every 5 minutes	- Data accumulated every 1 hour is registered in the SQL's database, 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 00:00, the accumulated flow (in Nm^3) is manually registered by the operators; - Every 3 hours, the operators perfom the "Print-Screen" of the controlling system panel; - Responsibilties of the routine: PLC (continuously) and plant supervisor (monthly)
$LFG_{Flare, y}$	FIR200 FIR700	Continuously Continuously	Continuously Continuously	Every 5 minutes Every 5 minutes	
$LFG_{Electricity, y}$	FIR300 FIR400 FIR500 FIR600	Continuously Continuously Continuously Continuously	Continuously Continuously Continuously Continuously	Every 5 minutes Every 5 minutes Every 5 minutes Every 5 minutes	
FE_{F100}	(1) TAC520 (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 methane analysis in the exhaust gas is made according with internal procedures from the hired company
FE_{F200}	(1) TAC570 (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	
$w_{CH4, y}$	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	N/A	Continuously	Continuously	Every 15 minutes	- Sotreq's PLC registers the accumulated electricity sent to the grid every 00:00. Data is compared with Eletropaulo's invoices. - Responsibilities of the routine: PLC (continuously) and Sotreq's plant supervisor (monthly)

2.2.2. Involvement of Third Parties

BFLGE has three third parties involved:

- Specialized company on gas analysis, to perform the analysis of methane concentration in the exhaust gas. For this monitoring period, Biogás hired CORPLAB, a certified national laboratory.

- Sotreq, the company responsible for the electricity production in the power house, using the gas from the landfill. Sotreq's PLC is responsible to monitor the electricity displaced to the local grid.

- 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 SGA IT 4.4.6-26 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. Additionally, the operators are oriented to perform the "Print-Screen" of the control system panel of the PLC. The picture is saved in the computer's hard-disk.

Also, the BLGFE 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.

Moreover, Biogás was certified with ISO 14001 in 21/10/2008, as per raised during the 1st Verification, in March 2006. With this certification, erros will be minimized through reinforecement of the procedures, such as:

- Document Control;
- Data safety measures (backup and sabotage);
- Monitoring Report Preparation (frequency, responsibilities, crosschecking measures, legal binding signature in monitoring reports,etc.);
- Data Spreadsheets;
- Error management (including software errors, material errors, etc.);

2.3.2. Organizational Structure, responsibilities and competencies

Positions and roles for this CDM project activity are well defined, according with the organogram below.

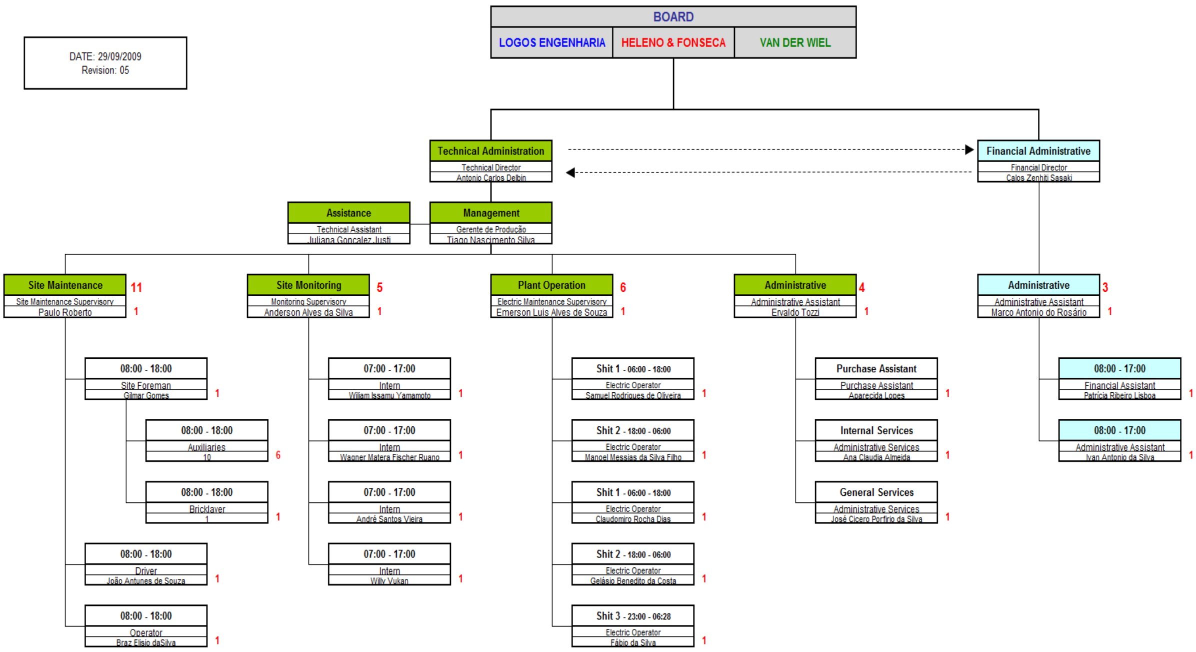

Figure 2-3. General Organogram of Biogás

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:

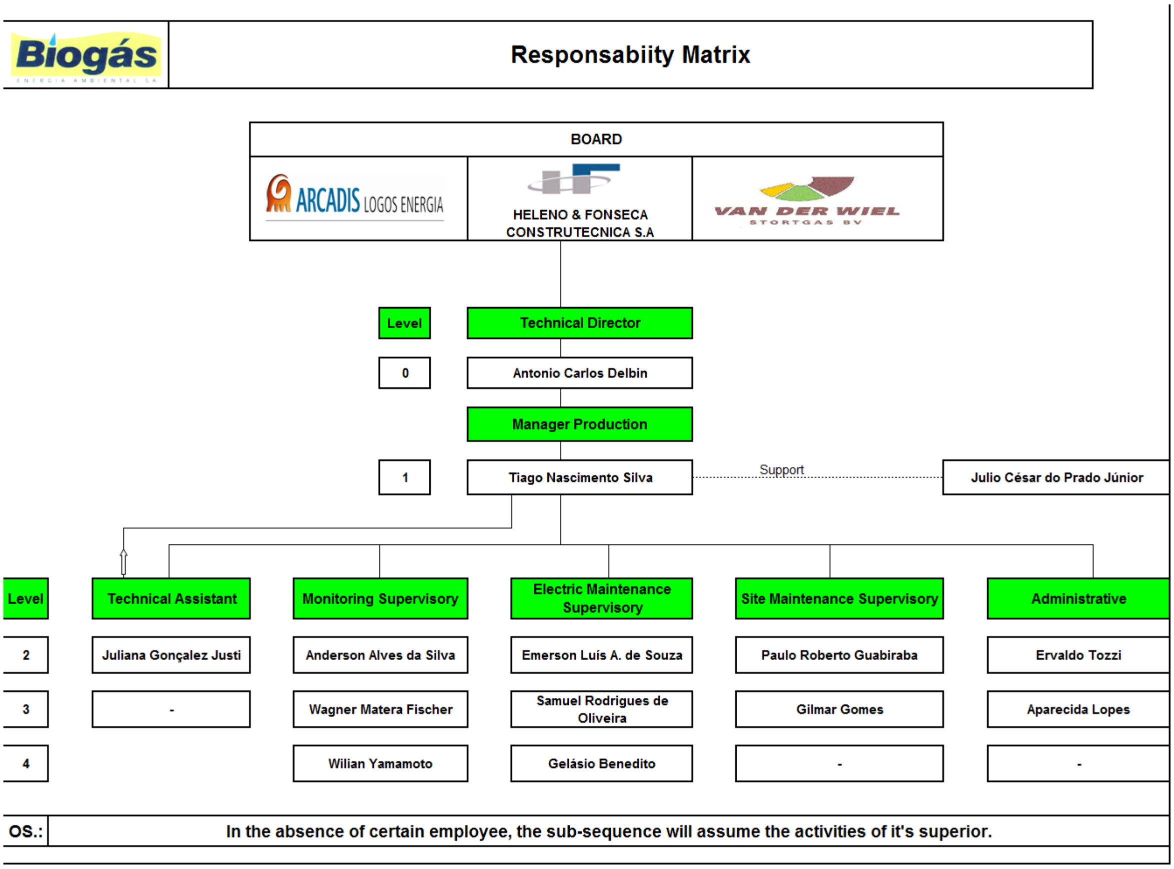

Figure 2-4. Responsibility Matrix of Biogás Energia Ambiental

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 montoring period, no new operators were 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, via a CARS (Central Alarming and Registration 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 reductions 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:

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

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

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

$$ER_y = \left(MD_{project,\ y} - 0{,}2 \times MD_{project,\ y}\right) \times GWP_{CH4} + EG_y \times CEF \quad (6.1)$$

$$ER_y = \left(0{,}8 \times MD_{project,\ y}\right) \times GWP_{CH4} + EG_y \times CEF \quad (6.2)$$

A detailed step-by-step of the calculation is presented in item 3.6.

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 the equipment FIR_i:

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

- $Flow_{methane}$ = methane flow sent to the flare Fi (Nm^3/h);
- $Flow_{FIRi}$ = total flow measured by the flow-meter FIRi 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 ($Flow_{remaining}$):

$$Flow_{remaining} = Flow_{FIR\,i} - Flow_{methane}$$
, 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 ($Flow_{Total}$):

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

where:

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

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

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

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

e) Calculate the Flare Efficiency (FE):

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

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

CORPLAB made two analysis of the methane content in the exhaust gas of the flares F200 and F100 on 23/04/2009 and on 21/07/2009 flare F100 and F200.

Flare	April/2009 [5]	Julyl/2009 [6]
F100	0.8 mg/Nm^3	2.0 mg/Nm^3
F200	0.9 mg/Nm^3	2.4 mg/Nm^3

Other parameters used to calculate the flare efficiency were:

[4] Air_{ratio} is equal to 5, as reccomended by Hoffstetter, the flare manufacturer.
[5] The values presented from the analysis of April/2009 correspond to the highest value detected among 25 measurements
[6] The values presented from the analysis of July/2009 correspond to the highest value detected among 13 measurements

Measurement	$Flow_{FIRi}$		Methane %	
	FIR200	FIR700	F100	F200
April/2009	8,400 Nm^3/h	7,440 Nm^3/h	46.0%	47.9%
July/2009	300 Nm^3/h	420 Nm^3/h	48.1%	49.2%

The results were:

Measurement	Flare Efficiency Calculated	
	F100	F200
April/2009	99.9992%	99.9991%
July/2009	99.9980%	99.9977%

The flare efficiency adopted from from 01/07/2009 to 20/07/2009 is 99.9991% and the flare efficieny adopted from 21/07/2009 to 30/09/2009 was 99.9977% (the lowest efficiencies calculated).

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

- a signal of gas being collected is sent to the PLC, which sends a signal to a solenoid valve;
- the valve is opened and a small amount of gas is delivered to an ignition burner;
- the ignition burner ignites the gas;
- an UV-sond (part of the ignition burner) verifies the existence of an stable flame – if not, the flare is stopped;
- if the stable flame detection is succesfull, the UV-sond sends a signal to the PLC, which then opens the main valve, located in the entrance of the flare;
- the main burner is ignited and gas begans to be destroyed;
- after a few seconds, the ignition burner is switched off and UV-sond begans to monitor the existence of flame in the flare – if no flame is detected, the flare will be automatically stopped by a signal sent from the UV-sond to the PLC;

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

If temperature decreases significantly from one registration to another (5 minutes interval), it means that the main valve is closed – the flare is stopped and no gas is being burned. It can be confirmed that no gas is being burned by the instant reading of gas flow from the flow-meter FIR200 and FIR700. After the deactivation of the auxiliary line, all gas destroyed in both flares was measured by FIR200.

However, in some readings it was detected that the flare accepted gas, but with a combustion chamber temperature below 900°C. It happened because between a 5 minutes interval the flare might have stopped and turned on again (p.e. the flare was stopped at 10:01 and tuned on on 10:04, not remaining enough time to register a temperature above 900°C). To discount the values below 900°C, the following procedure was applied:

- an hourly average of flares temperature was calculated, considering the temperature registers when the instant gas-flow was above 0 Nm^3/h (flares are accepting gas);
- If the average temperature is below 900°C, the gas-flow registered during this certain hour is considered equal to zero and excluded from ERs calculation.

Proper Excel sheets applying the above mentioned procedure were presented to the Verification Team.

Moreover, the flares are equipped with an hour-meter, which measures the accumulated operating hours of the flares. Despite of not being registered by BLFGE'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 BLFGE. This evidence was sent to the Verification Team.

4. Monitored and Calculated Data

4.1. Table presenting the monitored data

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

	MAIN PIPELINE							SECONDARY PIPELINE			ELECTRICITY GENERATION								
	COLLECTING SYSTEM				FLARE F100			FLARE F200			FIR300		FIR400		FIR500		FIR600		
	LFG measured FIR100 (Nm^3)	Methane (%)	*Methane measured FIR100 (Nm^3)*	Flares Efficiencies (%)	LFG measured FIR200 (Nm^3)	*Methane measured FIR200 (Nm^3)*	*Methne Destroyed in F100 (Nm^3)*	LFG measured FIR700 (Nm^3)	*Methane measured FIR700 (Nm^3)*	*Methne Destroyed F200 (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	Eletricity Exported (MWh)
DATE	A	B	*C = A . B*	D	E	*F = E . B*	*G = F . D*	H	*I = H . B*	*J = I . D*	K	*L = K . B*	M	*N = M . B*	O	*P = O . B*	Q	*R = Q . B*	S
01/07/2009	155,781	47.6774	*74,272.3304*	99.9991%	381	*181,6508*	*181,6491*	0	*0,0000*	*0,0000*	56.051	*26.723,6594*	30,543	*14,562.1082*	20,901	*9,965.0533*	44,395	*21,166.3817*	231.26
02/07/2009	158,609	47.4315	*75,230.6278*	99.9991%	0	*0,0000*	*0,0000*	0	*0,0000*	*0,0000*	61.551	*29.194,5625*	15,768	*7,478.9989*	9,261	*4,392.6312*	75,555	*35,836.8698*	239.55
03/07/2009	143,768	48.1128	*69,170.8103*	99.9991%	0	*0,0000*	*0,0000*	0	*0,0000*	*0,0000*	39.649	*19.076,2440*	11,857	*5,704.7346*	39,955	*19,223.4692*	44,683	*21,498.2424*	211.58
04/07/2009	152,818	48.4635	*74,060.9514*	99.9991%	5,397	*2.615,5750*	*2.615,5514*	0	*0,0000*	*0,0000*	41.839	*20.276,6437*	13,746	*6,661.7927*	59,938	*29,048.0526*	29,407	*14,251.6614*	219.74
05/07/2009	158,124	47.8878	*75,722.1048*	99.9991%	222	*106,3109*	*106,3099*	0	*0,0000*	*0,0000*	34.987	*16.754,5045*	21,956	*10,514.2453*	52,802	*25,285.7161*	46,407	*22,223.2913*	235.81
06/07/2009	160,788	47.4656	*76,318.9889*	99.9991%	0	*0,0000*	*0,0000*	0	*0,0000*	*0,0000*	46.993	*22.305,5094*	18,030	*8,558.0476*	50,520	*23,979.6211*	43,673	*20,729.6514*	239.36
07/07/2009	165,225	47.5454	*78,556.8871*	99.9991%	1,860	*884,3444*	*884,3364*	0	*0,0000*	*0,0000*	30.972	*14.725,7612*	27,335	*12,996.5350*	55,235	*26,261.7016*	47,101	*22,394.3588*	240.48
08/07/2009	164,123	47.3555	*77,721.2672*	99.9991%	84	*39,7786*	*39,7782*	0	*0,0000*	*0,0000*	25.034	*11.854,9758*	32,839	*15,551.0726*	44,937	*21,280.1410*	58,330	*27,622.4631*	239.71
09/07/2009	158,929	48.0923	*76,432.6114*	99.9991%	0	*0,0000*	*0,0000*	0	*0,0000*	*0,0000*	24.684	*11.871,1033*	32,985	*15,863.2451*	42,962	*20,661.4139*	55,996	*26,929.7643*	237.54
10/07/2009	163,223	47.5024	*77,534.8423*	99.9991%	0	*0,0000*	*0,0000*	0	*0,0000*	*0,0000*	32.334	*15.359,4260*	27,165	*12,904.0269*	44,323	*21,054.4887*	58,254	*27,672.0480*	241.34
11/07/2009	163,732	47.3041	*77,451.9490*	99.9991%	0	*0,0000*	*0,0000*	0	*0,0000*	*0,0000*	35.746	*16.909,3235*	26,084	*12,338.8014*	42,692	*20,195.0663*	58,772	*27,801.5656*	241.89

DATE	MAIN PIPELINE							SECONDARY PIPELINE			ELECTRICITY GENERATION								
	COLLECTING SYSTEM				FLARE F100			FLARE F200			FIR300		FIR400		FIR500		FIR600		
	LFG measured FIR100 (Nm^3)	Methane (%)	*Methane measured FIR100 (Nm^3)*	Flares Efficiencies (%)	LFG measured FIR200 (Nm^3)	*Methane measured FIR200 (Nm^3)*	*Methne Destroyed in F100 (Nm^3)*	LFG measured FIR700 (Nm^3)	*Methane measured FIR700 (Nm^3)*	*Methne Destroyed F200 (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	Eletricity Exported (MWh)
	A	B	*C = A . B*	D	E	*F = E . B*	*G = F . D*	H	*I = H . B*	*J = I . D*	K	*L = K . B*	M	*N = M . B*	O	*P = O . B*	Q	*R = Q . B*	S
12/07/2009	160,187	47.8670	*76,676.7112*	99.9991%	0	*0,0000*	*0,0000*	0	*0,0000*	*0,0000*	43.506	*20,825.0170*	24,761	*11,852.3478*	30,757	*14,722.4531*	59,074	*28,276.9515*	233.60
13/07/2009	161,982	47.8114	*77,445.8619*	99.9991%	385	*184.0738*	*184,0721*	0	*0,0000*	*0,0000*	51.948	*24,837.0660*	20,905	*9,994.9731*	28,400	*13,578.4376*	57,030	*27,266.8414*	236.35
14/07/2009	164,378	47.1770	*77,548.6090*	99.9991%	921	*434.5001*	*434,4961*	0	*0,0000*	*0,0000*	43.397	*20,473.4026*	26,450	*12,478.3165*	27,415	*12,933.5745*	61,871	*29,188.8816*	235.33
15/07/2009	161,709	47.5486	*76,890.3655*	99.9991%	418	*198.7531*	*198,7513*	0	*0,0000*	*0,0000*	39.567	*18,813.5545*	41,528	*19,745.9826*	32,315	*15,365.3300*	43,841	*20,845.7817*	235.90
16/07/2009	164,869	47.6722	*78,596.6794*	99.9991%	436	*207.8507*	*207,8488*	0	*0,0000*	*0,0000*	53.852	*25,672.4331*	33,545	*15,991.6394*	38,866	*18,528.2772*	44,178	*21,060.6245*	243.58
17/07/2009	163,951	47.6694	*78,154.4579*	99.9991%	270	*128.7073*	*128,7061*	0	*0,0000*	*0,0000*	42.194	*20,113.6266*	45,218	*21,555.1492*	43,861	*20,908.2755*	31,568	*15,048.2761*	240.32
18/07/2009	159,189	48.8177	*77,712.4084*	99.9991%	1,270	*619.9847*	*619,9791*	0	*0,0000*	*0,0000*	43.615	*21,291.8398*	44,574	*21,760.0015*	39,587	*19,325.4628*	28,230	*13,781.2367*	237.54
19/07/2009	158,531	48.9739	*77,638.8134*	99.9991%	877	*429.5011*	*429,4972*	0	*0,0000*	*0,0000*	52.439	*25,681.4234*	24,137	*11,820.8302*	40,924	*20,042.0788*	42,794	*20,957.8907*	239.01
20/07/2009	165,866	48.2652	*80,055.5566*	99.9991%	824	*397.7052*	*397,7016*	0	*0,0000*	*0,0000*	50.594	*24,419.2952*	29,018	*14,005.5957*	36,201	*17,472.4850*	51,452	*24,833.4107*	243.10
21/07/2009	169,739	47.5364	*80,687.8099*	99.9977%	4,238	*2,014.5926*	*2.014,5452*	0	*0,0000*	*0,0000*	50.574	*24,041.0589*	36,171	*17,194.3912*	23,106	*10,983.7605*	54,375	*25,847.9175*	237.09
22/07/2009	170,651	46.9000	*80,035.3190*	99.9977%	818	*383.6420*	*383,6329*	0	*0,0000*	*0,0000*	47.731	*22.,85.8390*	37,431	*17,555.1390*	33,536	*15,728.3840*	52,187	*24,475.7030*	239.97
23/07/2009	176,405	47.9524	*84,590.4312*	99.9977%	2,459	*1,.179.1495*	*1.179,1217*	0	*0,0000*	*0,0000*	53.217	*25,518.8287*	30,125	*14,445.6605*	28,586	*13,707.6730*	65,507	*31,412.1786*	246.53
24/07/2009	180,080	47.0378	*84,705.6702*	99.9977%	121	*56.9157*	*56,9143*	0	*0,0000*	*0,0000*	49.957	*23,498.6737*	26,270	*12,356.8300*	30,542	*14,366.2848*	72,270	*33,994.2180*	252.54
25/07/2009	177,267	47.1784	*83,631.7343*	99.9977%	0	*0.0000*	*0,0000*	0	*0,0000*	*0,0000*	49.045	*23,138.6462*	29,553	*13,942.6325*	30,563	*14,419.1343*	64,037	*30,211,6320*	252.77
26/07/2009	173,584	48.1847	*83,640.9296*	99.9977%	0	*0.0000*	*0,0000*	0	*0,0000*	*0,0000*	33.287	*16,039.2410*	40,327	*19,431.4439*	35,022	*16,875.2456*	59,597	*28,716,6356*	249.34
27/07/2009	170,988	49.0729	*83,908.7702*	99.9977%	86	*42.2026*	*42,2016*	0	*0,0000*	*0,0000*	43.735	*21,462.0328*	31,366	*15,392.2058*	32,582	*15,988.9322*	59,200	*29,051,1568*	250.11
28/07/2009	171,960	48.5909	*83,556.9116*	99.9977%	2,679	*1,301.7502*	*1.301,7196*	0	*0,0000*	*0,0000*	46.496	*22,592.8248*	33,734	*16,391.6542*	27,795	*13,505.8406*	59,366	*28,846,4736*	242.08
29/07/2009	171,566	48.0999	*82,523.0744*	99.9977%	0	*0.0000*	*0,0000*	0	*0,0000*	*0,0000*	41.215	*19,824.3737*	27,340	*13,150.5126*	37,779	*18,171.6612*	70,098	*33,717.0679*	245.86

	MAIN PIPELINE							SECONDARY PIPELINE			ELECTRICITY GENERATION								
	COLLECTING SYSTEM				FLARE F100			FLARE F200			FIR300		FIR400		FIR500		FIR600		
	LFG measured FIR100 (Nm^3)	Methane (%)	*Methane measured FIR100 (Nm^3)*	Flares Efficiencies (%)	LFG measured FIR200 (Nm^3)	*Methane measured FIR200 (Nm^3)*	*Methne Destroyed in F100 (Nm^3)*	LFG measured FIR700 (Nm^3)	*Methane measured FIR700 (Nm^3)*	*Methne Destroyed F200 (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	Eletricity Exported (MWh)
DATE	A	B	*C = A . B*	D	E	*F = E . B*	*G = F . D*	H	*I = H . B*	*J = I . D*	K	*L = K . B*	M	*N = M . B*	O	*P = O . B*	Q	*R = Q . B*	S
30/07/2009	168,570	48.4305	*81,639.2938*	99.9977%	280	*135.6054*	*135.6022*	0	*0.0000*	*0,0000*	34,010	*16,471.2130*	33,403	*16,177.2399*	46,392	*22,467.8775*	57,451	*27,823.8065*	243.30
31/07/2009	171,414	48.6315	*83,361.1994*	99.9977%	0	*0.0000*	*0.0000*	0	*0.0000*	*0,0000*	50,772	*24,691.1851*	32,141	*15,630.6504*	22,053	*10,724.7046*	69,199	*33,652.5116*	249.57
01/08/2009	159,520	50.3871	*80,377.5019*	99.9977%	9,719	*4,897.1222*	*4,897.0071*	0	*0.0000*	*0,0000*	49,126	*24,753.1667*	26,228	*13,215.5285*	22,563	*11,368.8413*	60,396	*30,431.7929*	230.30
02/08/2009	169,495	49.9454	*84,654.9557*	99.9977%	86	*42.9530*	*42.9519*	0	*0.0000*	*0,0000*	48,849	*24.,97.8284*	30,881	*15,423.6389*	36,678	*18,318.9738*	55,648	*27,793.6161*	250.88
03/08/2009	166,661	47.5593	*79,262.8049*	99.9977%	0	*0.0000*	*0.0000*	0	*0.0000*	*0,0000*	36,598	*17,405.7526*	36,578	*17,.396.2407*	41,153	*19,572.0787*	54,178	*25,766.6775*	243.55
04/08/2009	164,275	48.1336	*79,071.4714*	99.9977%	0	*0.0000*	*0.0000*	0	*0.0000*	*0,0000*	36,605	*17,619.3042*	36,464	*17,551.4359*	31,923	*15,365.6891*	60,379	*29,062.5863*	244.19
05/08/2009	167,873	47.8875	*80,390.1828*	99.9977%	3,412	*1,633.9215*	*1,633.8831*	0	*0.0000*	*0,0000*	41,017	*19,642.0158*	30,338	*14,528.1097*	30,946	*14,819.2657*	66,945	*32,058.2868*	246.50
06/08/2009	171,269	47.7763	*81,825.9912*	99.9977%	1,560	*745.3102*	*745.2926*	0	*0.0000*	*0,0000*	47,623	*22,752.5073*	28,787	*13,753.3634*	37,010	*17,682.0086*	60,939	*29,114.3994*	251.33
07/08/2009	170,901	47.3791	*80,971.3556*	99.9977%	1,328	*629.1944*	*629.1796*	0	*0.0000*	*0,0000*	45,902	*21.,47.9544*	25,933	*12,286.8220*	47,440	*22,476.6450*	55,524	*26,306.7714*	247.68
08/08/2009	164,611	48.1774	*79,305.2999*	99.9977%	2,488	*1,198.6537*	*1,198.6255*	0	*0.0000*	*0,0000*	45,330	*21,838.8154*	33,720	*16,245.4192*	32,128	*15,478.4350*	53,365	*25,709.8695*	242.40
09/08/2009	165,111	48.4708	*80,030.6225*	99.9977%	793	*384.3734*	*384.3643*	0	*0.0000*	*0,0000*	46,744	*22,657.1907*	34,774	*16,855.2359*	31,948	*15,485.4511*	52,401	*25,399.1839*	247.01
10/08/2009	165,214	47.8729	*79,092.7330*	99.9977%	721	*345.1636*	*345.1554*	0	*0.0000*	*0,0000*	55,845	*26,734.6210*	29,144	*13,952.0779*	25,937	*12,416.7940*	54,964	*26,312.8607*	244.93
11/08/2009	172,550	46.6489	*80,492.6769*	99.9977%	5,043	*2,352.5040*	*2,352.4487*	0	*0.0000*	*0,0000*	54,983	*25,648.9646*	33,715	*15,727.6766*	33,494	*15,624.5825*	48,880	*22,801.9823*	244.64
12/08/2009	164,749	47.5722	*78,374.7237*	99.9977%	71	*33.7762*	*33.7754*	0	*0.0000*	*0,0000*	42,766	*20,344.7270*	38,003	*18,078.8631*	23,690	*11,269.8541*	59,122	*28,125.6360*	239.74
13/08/2009	153,076	50.0267	*76,578.8712*	99.9977%	6,982	*3,492.8641*	*3,492.7820*	0	*0.0000*	*0,0000*	36,608	*18,313.7743*	33,513	*16,765.4479*	15,405	*7,706.6131*	64,019	*32,026.5930*	231.26
14/08/2009	157,667	49.3777	*77,852.3382*	99.9977%	30,534	*15,76.9869*	*15,076.6325*	0	*0.0000*	*0,0000*	30,939	*15,276.9666*	39,715	*19,610.3535*	27,308	*13,484.0623*	52,290	*25,819.5993*	228.32
15/08/2009	158,900	48.4493	*76,985.9377*	99.9977%	2,001	*969.4704*	*969.4476*	0	*0.0000*	*0,0000*	27,719	*13,429.6614*	29,940	*14,505.7204*	59,452	*28,804.0778*	46,676	*22,614.1952*	234.75
16/08/2009	153,376	49.0336	*75,205.7743*	99.9977%	7,388	*3,622.6023*	*3,622.5171*	0	*0.0000*	*0,0000*	16,638	*8,158.2103*	36,573	*17,933.0585*	49,473	*24,258.3929*	50,139	*24,584.9567*	226.53

DATE	MAIN PIPELINE							SECONDARY PIPELINE			ELECTRICITY GENERATION								
	COLLECTING SYSTEM				FLARE F100			FLARE F200			FIR300		FIR400		FIR500		FIR600		
	LFG measured FIR100 (Nm^3)	Methane (%)	*Methane measured FIR100 (Nm^3)*	Flares Efficiencies (%)	LFG measured FIR200 (Nm^3)	*Methane measured FIR200 (Nm^3)*	*Methne Destroyed in F100 (Nm^3)*	LFG measured FIR700 (Nm^3)	*Methane measured FIR700 (Nm^3)*	*Methne Destroyed F200 (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	Eletricity Exported (MWh)
	A	B	*C = A . B*	D	E	*F = E . B*	*G = F . D*	H	*I = H . B*	*J = I . D*	K	*L = K . B*	M	*N = M . B*	O	*P = O . B*	Q	*R = Q . B*	S
17/08/2009	151,962	49.6024	*75,376.7990*	99.9977%	29,909	*14,835.5818*	*14,835.2331*	0	*0.0000*	*0,0000*	13,798	*6,844.1391*	38,047	*18,872.2251*	49,235	*24,421.7416*	45,938	*22,786.3505*	224.19
18/08/2009	154,988	49.6795	*76,997.2634*	99.9977%	31,052	*15,426.4783*	*15,426.1157*	0	*0.0000*	*0,0000*	25,641	*12,738.3205*	32,177	*15,985.3727*	46,832	*23,265.9034*	46,799	*23,249.5092*	229.86
19/08/2009	154,092	49.9277	*76,934.5914*	99.9977%	114,012	*56,923.5693*	*56,922.2315*	0	*0.0000*	*0,0000*	26,031	*12,996.6795*	33,690	*16,820.6421*	37,072	*18,509.1969*	44,308	*22,121.9653*	216.61
20/08/2009	156,990	49.2996	*77,395.4420*	99.9977%	50,651	*24,970.7403*	*24,970.1534*	0	*0.0000*	*0,0000*	33,304	*16,418.7387*	41,358	*20,389.3285*	46,109	*22,731.5525*	28,663	*14,130.7443*	229.15
21/08/2009	152,407	50.1444	*76,423.5757*	99.9977%	22,513	*11,289.0087*	*11,288.7434*	0	*0.0000*	*0,0000*	21,183	*10,622.0882*	45,562	*22,846.7915*	41,525	*20,822.4621*	37,158	*18,632.6561*	226.82
22/08/2009	151,556	50.8197	*77,020.3045*	99.9977%	8,384	*4,260.7236*	*4,260.6234*	0	*0.0000*	*0,0000*	30,193	*15,343.9920*	32,319	*16,424.4188*	44,489	*22,609.1763*	42,960	*21,832.1431*	230.94
23/08/2009	150,858	51.2138	*77,260.1144*	99.9977%	1,468	*751.8185*	*751.8008*	0	*0.0000*	*0,0000*	37,737	*19,326.5517*	29,731	*15,226.,3748*	47,592	*24,373.6716*	37,685	*19,299.9205*	233.38
24/08/2009	154,304	51.2944	*79,149.3109*	99.9977%	45,445	*23,310.7400*	*23,310.1921*	0	*0.0000*	*0,0000*	29,364	*15,062.0876*	37,768	*19,372.8689*	34,104	*17,493.4421*	43,672	*22,401.2903*	226.40
25/08/2009	157,531	50.2041	*79,087.0207*	99.9977%	15,242	*7,652.1089*	*7,651.9290*	0	*0.0000*	*0,0000*	51,589	*25,899.7931*	33,285	*16,710.4346*	36,471	*18,309.9373*	35,721	*17,933.4065*	237.22
26/08/2009	149,868	51.2951	*76,874.9404*	99.9977%	0	*0.0000*	*0.0000*	0	*0.0000*	*0,0000*	44,577	*22,865.8167*	23,309	*11,956.3748*	30,113	*15,446.4934*	58,649	*30,084.0631*	238.66
27/08/2009	150,528	50.7684	*76,420.6571*	99.9977%	6,013	*3,052.7038*	*3.052,6320*	0	*0.0000*	*0,0000*	31,747	*16,117.4439*	33,013	*16,760.1718*	27,713	*14,069.4466*	55,343	*28,096.7556*	234.05
28/08/2009	151,528	50.6923	*76,813.0283*	99.9977%	1,309	*663.5622*	*663,5466*	0	*0.0000*	*0,0000*	24,270	*12,.303.0212*	35,324	*17,906.5480*	36,262	*18,382.0418*	50,539	*25,619.3814*	237.12
29/08/2009	149,824	51.1388	*76,618.1957*	99.9977%	1,302	*665.8271*	*665.8114*	0	*0.0000*	*0,0000*	22,614	*11,564.5282*	36,949	*18,895.2752*	37,879	*19,370.8660*	46,537	*23,798.4633*	234.98
30/08/2009	149,444	51.7996	*77,411.3942*	99.9977%	4,608	*2,386.9255*	*2,386.8694*	0	*0.0000*	*0,0000*	25,974	*13,454.4281*	32,427	*16,797.0562*	37,001	*19,166.3699*	48,834	*25,295.8166*	233.09
31/08/2009	148,578	51.8729	*77,071.7173*	99.9977%	587	*304.4939*	*304.4867*	0	*0.0000*	*0,0000*	35,024	*18,167.9644*	32,306	*16,758.0590*	36,687	*19,030.6108*	44,438	*23,051.2793*	236.58
01/09/2009	145,319	51.2656	*74,498.6572*	99.9977%	0	*0.0000*	*0,.000*	0	*0.0000*	*0,0000*	33,379	*17,111.9446*	27,491	*14,093.4260*	37,141	*19,040.5564*	48,374	*24,799.2213*	229.38
02/09/2009	147,745	50.8871	*75,183.1458*	99.9977%	14,185	*7,218.3351*	*7,218.1654*	0	*0.0000*	*0,0000*	40,323	*20,519.2053*	25,763	*13,110.0435*	23,135	*11,772.7305*	56,774	*28,890.6421*	226.11
03/09/2009	154,700	49.7482	*76,960.4654*	99.9977%	3,259	*1,621.2938*	*1,621.2556*	0	*0.0000*	*0,0000*	38,201	*19,004.3098*	24,320	*12,098.7622*	36,637	*18,226.2480*	56,861	*28,287.3240*	235.58

	MAIN PIPELINE							SECONDARY PIPELINE			ELECTRICITY GENERATION								
	COLLECTING SYSTEM				FLARE F100			FLARE F200			FIR300		FIR400		FIR500		FIR600		
	LFG measured FIR100 (Nm^3)	Methane (%)	*Methane measured FIR100 (Nm^3)*	Flares Efficiencies (%)	LFG measured FIR200 (Nm^3)	*Methane measured FIR200 (Nm^3)*	*Methne Destroyed in F100 (Nm^3)*	LFG measured FIR700 (Nm^3)	*Methane measured FIR700 (Nm^3)*	*Methne Destroyed F200 (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	LFG measured (Nm^3)	*Methane measured (Nm^3)*	Eletricity Exported (MWh)
DATE	A	B	*C = A . B*	D	E	*F = E . B*	*G = F . D*	H	*I = H . B*	*J = I . D*	K	*L = K . B*	M	*N = M . B*	O	*P = O . B*	Q	*R = Q . B*	S
04/09/2009	154,885	50.2354	*77,807,0992*	99,9977%	2,808	*1.410,6100*	*1,410.5768*	0	*0.0000*	*0,0000*	37,010	*18,592.1215*	25,495	*12,807.5152*	41,791	*20,993.8760*	52,026	*26,135.4692*	238.78
05/09/2009	146,369	50.8291	*74,398,0453*	99,9977%	0	*0,0000*	*0.0000*	0	*0.0000*	*0,0000*	33,964	*17,263.5955*	24,617	*12,512.5995*	47,692	*24,241.4143*	42,216	*21,458.0128*	235.10
06/09/2009	148,393	51.0753	*75,792,1699*	99,9977%	3,632	*1.855,0548*	*1,855.0112*	0	*0.0000*	*0,0000*	34,005	*17,368.1557*	22,601	*11,543.5285*	42,951	*21,937.3521*	50,562	*25,824.6931*	238.75
07/09/2009	143,696	51.5500	*74,075,2880*	99,9977%	2,169	*1.118,1195*	*1,118.0932*	0	*0.0000*	*0,0000*	31,098	*16,031.0190*	32,937	*16,979.0235*	36,207	*18,664.7085*	43,794	*22,575.8070*	234.43
08/09/2009	147,103	51.0965	*75,164,4843*	99,9977%	0	*0,0000*	*0.0000*	0	*0.0000*	*0,0000*	33,738	*17,238.9371*	24,146	*12,337.7608*	39,513	*20,189.,7600*	52,547	*26,849.6778*	240.13
09/09/2009	144,828	51.1260	*74,044,7632*	99,9977%	10,745	*5.493,4887*	*5,493.3596*	0	*0.0000*	*0,0000*	34,801	*17,792.3592*	38,025	*19,440.6615*	14,389	*7,356.5201*	52,169	*26,671.9229*	227.78
10/09/2009	150,695	50.1701	*75,603,8321*	99,9977%	3,746	*1.879,3719*	*1,879.3277*	0	*0.0000*	*0,0000*	46,332	*23,244.8107*	25,623	*12,855.0847*	32,342	*16,226.0137*	55,064	*27,625.6638*	235.81
11/09/2009[7]	0	0.0000	*0,0000*	99,9977%	0	*0,0000*	*0.0000*	0	*0.0000*	*0,0000*	0	*0.0000*	0	*0,.000*	0	*0.0000*	0	*.0000*	181.63
12/09/2009	149,590	50.5881	*75,674,7387*	99,9977%	4,256	*2.153,0295*	*2,152.9789*	0	*0.0000*	*0,0000*	37,038	*18,736.8204*	26,773	*13,543.9520*	36,870	*18,651.8324*	48,980	*24,778.0513*	237.18
13/09/2009	148,062	50.3118	*74,492,6573*	99,9977%	893	*449,2843*	*449.2737*	0	*0.0000*	*0,0000*	34,139	*17,175.9454*	24,117	*12,133.6968*	42,430	*21,347.2967*	49,342	*24,824.8483*	235.39
14/09/2009	153,836	49.5104	*76,164,8189*	99,9977%	0	*0,0000*	*0.0000*	0	*0.0000*	*0,0000*	34,544	*17,102.8725*	29,570	*14,640.2252*	42,419	*21,001.8165*	48,873	*24,197.2177*	240.06
15/09/2009	149,159	50.3562	*75,110,8043*	99,9977%	447	*225,0922*	*225.0869*	0	*0.0000*	*0,0000*	36,791	*18,526.5495*	26,235	*13,210.9490*	41,770	*21,033.7847*	45,166	*22,743.8812*	236.10
16/09/2009	141,111	50.9149	*71,846,5245*	99,9977%	2,640	*1.344,1533*	*1,344.1217*	0	*0.0000*	*0,0000*	37,007	*18,842.0770*	27,519	*14,011.2713*	34,262	*17,444.4630*	39,810	*20,269.2216*	225.02
17/09/2009	150,260	50.6621	*76,124,8714*	99,9977%	13,843	*7.013,1545*	*7,012.9896*	0	*0.0000*	*0,0000*	31,466	*15,941.3363*	35,080	*17,772.2646*	40,269	*20,401.1210*	40,736	*20,637.7130*	233.86
18/09/2009	156,743	49.4097	*77,446,2460*	99,9977%	553	*273,2356*	*273.2291*	0	*0.0000*	*0,0000*	34,626	*17,108.6027*	36,017	*17,795.8916*	42,170	*20,836.0704*	44,679	*22,075,7598*	245.63
19/09/2009	152,662	49.0798	*74,926,2042*	99,9977%	0	*0,0000*	*0,.000*	0	*0.0000*	*0,0000*	35,397	*17,372.7768*	34,040	*16,706.7639*	42,284	*20,752.9026*	41,557	*20,396.0924*	238.46

[7] Due to problems in the PLC, data was not registered for the whole day in 11/09/2009; in order to adopt a conservative approach, no emission reductions are claimed for methane destruction in this day – including ERs from electricity generation;

	MAIN PIPELINE							SECONDARY PIPELINE			ELECTRICITY GENERATION								
	COLLECTING SYSTEM				FLARE F100			FLARE F200			FIR300		FIR400		FIR500		FIR600		
DATE	LFG measured FIR100 (Nm^3) A	Methane (%) B	*Methane measured FIR100 (Nm^3) C = A . B*	Flares Efficiencies (%) D	LFG measured FIR200 (Nm^3) E	*Methane measured FIR200 (Nm^3) F = E . B*	*Methne Destroyed in F100 (Nm^3) G = F . D*	LFG measured FIR700 (Nm^3) H	*Methane measured FIR700 (Nm^3) I = H . B*	*Methne Destroyed F200 (Nm^3) J = I . D*	LFG measured (Nm^3) K	*Methane measured (Nm^3) L = K . B*	LFG measured (Nm^3) M	*Methane measured (Nm^3) N = M . B*	LFG measured (Nm^3) O	*Methane measured (Nm^3) P = O . B*	LFG measured (Nm^3) Q	*Methane measured (Nm^3) R = Q . B*	Eletricity Exported (MWh) S
20/09/2009	148,001	49.8333	*73,753,7823*	99,9977%	0	*0,0000*	*0,0000*	0	*0.0000*	*0,0000*	35,040	*17.461,5883*	31.779	*15.836,5244*	41,017	*20,440,1246*	40,923	*20,393.2813*	234.27
21/09/2009	151,852	49.7631	*75,566,2626*	99,9977%	0	*0,0000*	*0,0000*	0	*0.0000*	*0,0000*	34,137	*16.987,6294*	30.190	*15.023,4798*	47,470	*23,622,5435*	41,523	*20,663.,1320*	238.40
22/09/2009	148,987	49.8545	*74,276,7239*	99,9977%	1,285	*640,6303*	*640,6152*	0	*0.0000*	*0,0000*	25,164	*12.545,3863*	40.449	*20.165,6467*	53,012	*26,428,8675*	38,113	*19,001.0455*	243.04
23/09/2009	161,849	48.4562	*78,425,8751*	99,9977%	282	*136,6464*	*136,6431*	0	*0.0000*	*0,0000*	27,999	*13.567,2514*	47.398	*22.967,2696*	52,217	*25,302,3739*	35,143	*17,028.9623*	248.13
24/09/2009	160,517	47.8736	*76,845,2665*	99,9977%	89	*42,6075*	*42,6064*	0	*0.0000*	*0,0000*	43,875	*21.004,5420*	30.758	*14.724,9618*	40,942	*19,600,4093*	46,428	*22,226.7550*	242.27
25/09/2009	155,960	48.7885	*76,090,5446*	99,9977%	1,213	*591,8045*	*591,7905*	0	*0.0000*	*0,0000*	40,148	*19.587,6069*	33.365	*16.278,2830*	28,562	*13,934,9713*	53,926	*26,309.6865*	237.54
26/09/2009	159,094	48.2090	*76,697,6264*	99,9977%	3,889	*1.874,8480*	*1.874,8039*	0	*0.0000*	*0,0000*	39,521	*19.052,6788*	37.882	*18.262,5333*	30,903	*14,898,0272*	49,526	*23,875.9893*	239.07
27/09/2009	162,429	47.1621	*76,604,9274*	99,9977%	5,415	*2.553,8277*	*2.553,7676*	0	*0.0000*	*0,0000*	40,647	*19.169,9787*	37.500	*17.685,7875*	33,400	*15,752,1414*	49,492	*23,341.4665*	240.26
28/09/2009	158,876	47.2302	*75,037,4525*	99,9977%	1,029	*485,9987*	*485,9872*	0	*0.0000*	*0,0000*	37,216	*17.577,1912*	39.085	*18.459,9236*	40,201	*18,987,0127*	42,713	*20,173.4353*	237.44
29/09/2009	156,572	47.7864	*74,820,1222*	99,9977%	73	*34,8840*	*34,8831*	0	*0.0000*	*0,0000*	29,101	*13.906,3202*	51.113	*24.425,0626*	37,142	*17,748,8246*	37,520	*17,929.4572*	236.03
30/09/2009	152,791	48.6430	*74,322,1261*	99,9977%	2,118	*1.030,2587*	*1.030,2344*	0	*0.0000*	*0,0000*	22,658	*11.021,5309*	36.390	*17.701,1877*	42,096	*20,476,7572*	52,771	*25,669.3975*	230.08

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

If during a certain hour the average flare temperature (F100 or F200) is below 900°C **and** the instant gas-flow measured by FIR200 and FIR700 (the flow-meter FIR700 is disconnected of the collecting system) is higher than zero, this gas-flow is excluded from ERs calculation.

The table below presents the electricity exported and registered by Sotreq and the value registered by Eletropaulo, the local electricity utility:

MONTH	ELECTRICITY REGISTERED BY BLFGE (MWh)	ELECTRICITY REGISTERED BY ELETROPAULO (MWh)	DIFFERENCE (%)
July	7,432.16	7,504.11	0.96%
August	7,323.04	7,394.26	0.96%
September	7,041.71	7,109.80	0,96%

Thus, as per presented in the revised Monitoring Plan, the difference between the two meters is below 1.5% and the lowest values were adopted for the ERs calculation (the one from BLFGE).

	PART O1
Total Methane Destroyed in Flare F100 (Nm^3)	181.6491
Total Methane Destroyed in Flare F200 (Nm^3)	0.0000
Total Methane Measured by FIR300 (Nm^3)	55,918.2219
Total Methane Measured by FIR400 (Nm^3)	22,041.1071
Total Methane Measured by FIR500 (Nm^3)	14,357.6845
Total Methane Measured by FIR600 (Nm^3)	57,003.2515
Total Electricity Exported (MWh)	470.8160

	PART 02
Total Methane Destroyed in Flares F100 and F200 (Nm^3)	252,719.9978
Total Methane Measured by FIR300 (Nm^3)	1,648,227.2632
Total Methane Measured by FIR400 (Nm^3)	1,386,640.7111
Total Methane Measured by FIR500 (Nm^3)	1,646,250.7407
Total Methane Measured by FIR600 (Nm^3)	2,188,048.8221
Total Electricity Exported (MWh)	21,326.1140

4.2. Events registered

For this monitoring period, the follow event was registreted:

EVENT #	DESCRIPTION	HOW THE EVENT WAS CONSIDERED
01	In 03/07/2009, Biogás decided to replace FIR200, TTF201 and TPF201 (calibration on 28/07/2009, 09/10/2012 and 17/08/2009 respectivelly) with FIR700 and its respective transmitters.	From this day on, the erros from FIR700 were updated to FIR200.

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 tables below.

PART 01 – From 01/07/2009 to 02/07/2009

Methodology ID	Equipment	TAG	Error (%)	Date of the last calibration	Date of the next calibration
$LFG_{Total, y}$	Turbine Flow-meter	FIR100	1.000	22/06/2004	22/06/2009
$LFG_{Flare, y}$	Turbine Flow-meters	FIR200 FIR700	0.300 0.890	28/07/2004 02/07/2009[8]	28/07/2009 N/A
$LFG_{Electricity, y}$	Turbine Flow-meters	FIR300 FIR400 FIR500 FIR600	0.7720 0.5960 0.6320 0.8110	12/12/2006 12/12/2006 12/12/2006 12/12/2006	12/12/2011 12/12/2011 12/12/2011 12/12/2011
$w_{CH4, y}$	Methane Analyzer	A100	1.0000	Dec/2003	Weekly, with a standard gas
T	Temperature Transmitter[9]	TTF101 TTF201 TTF701 TTF301 TTF401 TTF501 TTF601	0.2329 0.1801 0.6471 0.5993 0.1775 0.8717 0.1998	09/10/2007 09/10/2007 26/03/2009 26/03/2009 26/03/2009 26/03/2009 26/03/2009	09/10/2012 09/10/2012 26/03/2014 26/03/2014 26/03/2014 26/03/2014 26/03/2014
P	Pressure Transmitter	TPF101 TPF201 TPF701 TPF301 TPF401 TPF501 TPF601	0.1500 0.1500 0.0851 0.0567 0.0317 0.0417 0.0417	17/08/2004 17/08/2004 27/03/2009 06/05/2009 27/03/2009 23/06/2009 17/04/2008	17/08/2009 17/08/2009 27/03/2014 06/05/2014 27/03/2014 23/06/2014 17/04/2013
EG_y	Electricity Meter	N/A	1.0000	Sep/2004	Sep/2009

[8] The flow-meter FIR700 was first calibrated in 02/04/2009; a re-calibration with a volume correction device took place in 01/07/2009.

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

PART 02 – From 03/07/2009 to 30/09/2009

Methodology ID	Equipment	TAG	Error (%)	Date of the last calibration	Date of the next calibration
$LFG_{Total, y}$	Turbine Flow-meter	FIR100	1.000	22/06/2004	22/06/2009
$LFG_{Flare, y}$	Turbine Flow-meters [10]	FIR200 FIR700	0.8900 N/A	02/07/2009 N/A	02/07/2014 N/A
$LFG_{Electricity, y}$	Turbine Flow-meters	FIR300 FIR400 FIR500 FIR600	0.7720 0.5960 0.6320 0.8110	12/12/2006 12/12/2006 12/12/2006 12/12/2006	12/12/2011 12/12/2011 12/12/2011 12/12/2011
$w_{CH4, y}$	Methane Analyzer	A100	1.0000	Dec/2003	Weekly, with a standard gas
T	Temperature Transmitter	TTF101 TTF201 TTF701 TTF301 TTF401 TTF501 TTF601	0.2329 0.6471 N/A 0.5993 0.1775 0.8717 0.1998	09/10/2007 26/03/2009 N/A 26/03/2009 26/03/2009 26/03/2009 26/03/2009	09/10/2012 26/03/2014 N/A 26/03/2014 26/03/2014 26/03/2014 26/03/2014
p	Pressure Transmitter	TPF101 TPF201 TPF701 TPF301 TPF401 TPF501 TPF601	0.1500 0.0851 N/A 0.0567 0.0317 0.0417 0.0417	17/08/2004 27/03/2009 N/A 06/05/2009 27/03/2009 23/06/2009 17/04/2008	17/08/2009 27/03/2014 N/A 06/05/2014 27/03/2014 23/06/2014 17/04/2013
EG_y	Electricity Meter	N/A	1.0000	Sep/2004	Sep/2009

[10] For this morning period, FIR700, TTF701 and TPF701 were removed and replaced FIR 200, TTF201 and TPF201, as explained in item 1.7

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:

$$\varepsilon_{FIR200} = \sqrt{\left(\varepsilon_{Gas\ Flow\ FIR200}\right)^2 + \left(\varepsilon_{Temperature\ FIR200}\right)^2 + \left(\varepsilon_{Pressure\ FIR200}\right)^2 + \left(\varepsilon_{Methane\ Analysis}\right)^2}$$

$$\varepsilon_{FIR700} = \sqrt{\left(\varepsilon_{Gas\ Flow\ FIR700}\right)^2 + \left(\varepsilon_{Temperature\ FIR700}\right)^2 + \left(\varepsilon_{Pressure\ FIR700}\right)^2 + \left(\varepsilon_{Methane\ Analysis}\right)^2}$$

$$\varepsilon_{FIR300} = \sqrt{\left(\varepsilon_{Gas\ Flow\ FIR300}\right)^2 + \left(\varepsilon_{Temperature\ FIR300}\right)^2 + \left(\varepsilon_{Pressure\ FIR300}\right)^2 + \left(\varepsilon_{Methane\ Analysis}\right)^2}$$

$$\varepsilon_{FIR400} = \sqrt{\left(\varepsilon_{Gas\ Flow\ FIR400}\right)^2 + \left(\varepsilon_{Temperature\ FIR400}\right)^2 + \left(\varepsilon_{Pressure\ FIR400}\right)^2 + \left(\varepsilon_{Methane\ Analysis}\right)^2}$$

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

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

OBS: the calculation of the error from FIR700 was considered only from 11/05/2009 on, as before this date the flow-meter was not connected to the PLC – thus no data was registered.

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

The calculation of $LFG_{flared,\ y}$ is the sum of all measurements from FIR200 and FIR700 made during the monitoring period, minus the uncertainties of the flow-meters, as follows:

PART 01 – From 01/07/2009 to 02/07/2009

$$\varepsilon_{FIR200} = \sqrt{0.300^2 + 0.1801^2 + 0.1500^2 + 1.000^2} = 1.0701\%$$

$$\varepsilon_{FIR700} = \sqrt{0.890^2 + 0.6471^2 + 0.0851^2 + 1.000^2} = 1.4894\%$$

PART 02 – From 03/07/2009 to 30/09/2009

$$\varepsilon_{FIR200} = \sqrt{0.890^2 + 0.6471^2 + 0.0851^2 + 1.000^2} = 1.4894\%$$

$$\varepsilon_{FIR700} = \text{N/A}$$

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

The calculation of $LFG_{electricity, y}$ is the sum of all measurements from FIR300, FIR400, FIR500 and FIR600 made during the monitoring period, minus the uncertainties of the flow-meters, as follows:

$$LFG_{electricity,y,corrected} = \sum FIR_{300} \times \left(1 - \frac{\varepsilon_{FIR300}}{100}\right) + \sum FIR_{400} \times \left(1 - \frac{\varepsilon_{FIR400}}{100}\right) + \sum FIR_{500} \times \left(1 - \frac{\varepsilon_{FIR500}}{100}\right) + \sum FIR_{600} \times \left(1 - \frac{\varepsilon_{FIR600}}{100}\right)$$

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

$$\varepsilon_{FIR300} = \sqrt{0.7720^2 + 0.5993^2 + 0.0567^2 + 1.0000^2} = 1.3995\%$$

$$\varepsilon_{FIR400} = \sqrt{0.5960^2 + 0.1775^2 + 0.0317^2 + 1.0000^2} = 1.1781\%$$

$$\varepsilon_{FIR500} = \sqrt{0.6320^2 + 0.8717^2 + 0.0417^2 + 1.0000^2} = 1.4701\%$$

$$\varepsilon_{FIR600} = \sqrt{0.8110^2 + 0.1998^2 + 0.0417^2 + 1.0000^2} = 1.3037\%$$

4.6. Calculation of EG_y,

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, as follows:

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

4.7. List of default values

- *Global Warming Potential of CH_4 (GWP_{CH4})* = 21 tCO_2e/tCH_4;
- *Emission Factor of the S-SE-CO Brazilian Grid (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%).

4.8. Table providing the formulas used

PART 01 – From 01/07/2009 to 02/07/2009

	Variable	Description
Flare F100	A_{F100} (see last table PART 01 from item 4.1)	Total methane destroyed in flare F100 (Nm^3)
	B_{F100}	Total error from measuring equipment (%) – see item 4.4
	$C_{F100} = A_{F100} . (1-B_{F100})$	**Total methane corrected destroyed at the flare F100 (Nm^3)**
Flare F200	A_{F200} (see last table from item 4.1)	Total methane destroyed in flare F200 (Nm^3)
	B_{F200}	Total error from measuring equipment (%) – see item 4.4
	$C_{F200} = A_{F200} . (1-B_{F200})$	**Total methane corrected destroyed at the flare F200 (Nm^3)**
Power House	A_{FIRi}[11] (see last table from item 4.1)	Methane flow to the power house measured by FIRi (Nm^3)
	B_{FIRi}	Total measuring error from FIRi (%) – see item 4.5
	$C_{FIRi} = A_{FIRi} . (1 – B_{FIRi})$	**Total methane corrected measured by FIRi (Nm^3)**
	$D_{power\ house} = C_{FIR300} + C_{FIR400} + C_{FIR500} + C_{FIR600}$	**Total methane corrected destroyed at the electricity (Nm^3)**
CO_2e Methane	$A = C_{F100} + C_{F200} + D_{power\ house}$	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 last table from item 4.1)	Total electricity exported (MWh)
	I	Electricity-meter error (%)
	J = H . (1 – I)	Total electricity corrected (MWh)
	K = 0.2677	Emission Factor (tCO_2e/MWh)
	L = J . K	**Total CO_2e from the energy exported (tCO_2e)**
TOTAL	**M = G + L**	**TOTAL CREDITS DURING THE PERIOD (tCO_2e)**

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

PART 02 – From 03/07/2009 to 30/09/2009

	Variable	Description
Flares F100 and F200	A_{Flares} (see last table PART 02 from item 4.1)	Total methane destroyed in flares F100 and F200 (Nm^3)
	B_{Flares}	Total error from measuring equipment (%) – see item 4.4
	$C_{Flares} = A_{Flares} . (1-B_{Flares})$	**Total methane corrected destroyed at the flares F100 and F200 (Nm^3)**
Power House	A_{FIR}[11] (see last table from item 4.1)	Methane flow to the power house measured by FIRi (Nm^3)
	B_{FIRi}[11]	Total measuring error from FIRi (%) – see item 4.5
	C_{FIRi}[11] $= A_{FIRi} . (1 – B_{FIRi})$	**Total methane corrected measured by FIRi (Nm^3)**
	$D_{power\ house} = C_{FIR300} + C_{FIR400} + C_{FIR500} + C_{FIR600}$	**Total methane corrected destroyed at the electricity (Nm^3)**

[11] Obs: calculation made individually for each Flow-Meter (FIR_{300}, FIR_{400}, FIR_{500} and FIR_{600})

CO_2e Methane	A = C_{Flares} + $D_{power\ house}$	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 last table from item 4.1)	Total electricity exported (MWh)
	I	Electricity-meter error (%)
	J = H . (1 – I)	Total electricity corrected (MWh)
	K = 0.2677	Emission Factor (tCO_2e/MWh)
	L = J . K	**Total CO_2e from the energy exported (tCO_2e)**
TOTAL	**M = G + L**	**TOTAL CREDITS DURING THE PERIOD (tCO_2e)**

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

4.9. GHG emission reductions

	PART 01	PART 02	TOTAL
Total CO_2e from methane destroyed	1,764	84,604	86,368
Total CO_2e from electricity dispatched	124	5,651	5,775
TOTAL CO_2e	**1,888**	**90,255**	**92,143**

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	**05/10/2009**	Initial Adoption

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