Monitoring report form for CDM project activity

(Version 06.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT	
Title of the project activity	Quezon City Controlled Disposal Facility Biogas Emission Reduction Project
UNFCCC reference number of the project activity	1258
Version number of the PDD applicable to this monitoring report	11 of 30/11/2007
Version number of this monitoring report	00
Completion date of this monitoring report	02/02/2018
Monitoring period number	13th
Duration of this monitoring period	01/07/2016 – 31/01/2018, including both days
Monitoring report number for this monitoring report	01
Project participants	[1] Quezon City Government [2] Pangea Green Energy Philippines, Inc. [3] Bunge Emissions Fund Limited
Host Party	Republic of the Philippines
Sectoral scopes	Sectoral Scope 1 - Energy industries, Type I: Renewable energy projects, Category D: Renewable electricity generation for a grid Sectoral Scope 13 - Waste handling and disposal (Landfill Gas Project Activity)
Applied methodologies and standardized baselines	Monitoring methodologies: * ACM0001 Version 5 - Consolidated methodology for landfill gas project activities * AMS-I.D. Version 10 - Grid connected renewable electricity generation * Tool to determine project emissions from flaring gases containing methane Baseline methodologies: * ACM0001 Version 5 - Consolidated methodology for landfill gas project activities * AMS-I.D. Version 10 - Grid connected renewable electricity generation * Tool for the demonstration and assessment of additionality - Version 3 * Tool to determine project emissions from flaring gases

	containing methane	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	Not applicable	80,578.50
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	89,551t CO2e	

SECTION A. Description of project activity

A.1. General description of project activity

The project activity involves the extraction, collection, processing and flaring, including the conversion into electricity of the biogas emissions at the Quezon City Controlled Disposal Facility ("Facility") located in 68 Zamboanga Street, Area B, Barangay Payatas, Quezon City, Philippines. This project activity was developed primarily to address the environment, health and safety concerns of the local government of Quezon City for its constituents, particularly those residing in the immediate surroundings of the Facility.

Picture 1: Flare and Biogas Plant

The project has been implemented in two phases. During phase 1, the combustion plant was composed of a biogas extraction system (wells and blower), a high-temperature torch for flaring the methane extracted and an electrical engine for on-site power supply. The electrical engine is fed by biogas during plant operation (about 7,500 hours/year).An electrical connection to the local grid has been provided in order to supply electricity requirement of the plant during engine maintenance and start-up operations.

The plant was completed and commissioned in March 2008.

Phase 2 begun last March 2013 and included the installation of additional 2 engine – 640 kW – as indicated in the PDD.

For this period, the network has included 115 wells and trenches divided into two areas of the dumpsite, the Old and New Mound, on a surface of about 22 hectares. Wells are around 15 to 21 meters deep and are approximately 45 meters from each other to achieve optimum efficiency of biogas extraction process.

Each well is connected to a controlling substation (total of 5 units for the current monitoring period). Substations convey biogas from each well into the main lines up to the extraction plant.

Two extractor fans in parallel, of which one is active and one is on stand-by, allow flow of biogas to the high temperature flare and the electricity generator. Before going into the electricity generator, the biogas collected passes through a heat exchanger and condensate trap to remove remaining moisture. The most important equipment used and their characteristics are described in Table 1.

At present, the generator is not capable to run with fossil fuel. Currently, the electricity produced is for the internal consumption of the plant and for other users (free supplying) in the Payatas area (street light, offices, multipurpose hall, dumping areas, etc.). The excess electricity produced is exported to MERALCO since March 2013.

Equipment	Manufacturer	Type	Technical data
Gas collection network	Various	Wells	250 mm diameter (slotted pipe) 15-25 m deep Equipped with well head and regulation valve
		Pipeline	HDPE material 90 mm diameter (well head to substation)
		Substation	5 m x 2.5 - 2 arms Iron (anti-corrosion painted) Butterfly valve equipped
		Main pipeline	HDPE material 160 mm diameter (substation to main line)
Biogas blower	Continental Industrie	051A.03	Flow: 2,500 Nm^3/h Discharge pressure: 80 mbar Discharge temp: 56.4 °C Electric engine, 37 kW
High temperature enclosed gas flare	Biotecnogas	BTG2500 HT	Capacity: 500 - 2,500 Nm^3/h External diameter: 2,200 mm Height: 9.50 m Thickness: 150 mm Material: stainless steel AISI 304 Feeding pressure: 50 mbar Min % CH_4: 30% Ratio: CH_4/CO_2>1 Combustion chamber: refractory made of ceramic fiber modules, thickness of 150 mm Combustion temperature: > 850 °C Retention time: >= 0.3 sec Critical temperature: 1,260 °C Combustion coefficient ($CO_2/CO + CO_2$): min 99% Output signal of the temperature control: continuous, by a thermocouple Pt-Rh-Pt with output signal 4÷20 mA
Booster	Mapro	CL 18/01 G	Nominal flow rate: 150 Nm^3/h ca Pressure in: 50 mbar Pressure out: 150 mbar Power: 3.6 kW ca
n.1 Engine	Iveco-ATME	Iveco Aifo 8281	8 cylinder turbo engine Biogas feeding set Capacity: 200 kW (250 kVA - power factor of 0.8) 1,500 rpm 400/230 V, 60 Hz 3-phase

Equipment	Manufacturer	Type	Technical data
n. 2 Engine	Iveco-ATME	Iveco Aifo 8291	12 cylinder turbo engine Biogas feeding set Capacity: 320 kW (400 kVA - power factor of 0.8) 1,800 rpm 400/230 V, 60 Hz 3-phase

Picture 2: Plant View from Old Mound

A.2. Location of project activity

Address: 68 Zamboanga Street, Area B, Barangay Payatas, Quezon City, Metro Manila, Philippines
GPS

Picture 3: Location of Quezon City Controlled Disposal Facility

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Philippines (host)	Pangea Green Energy Philippines, Incorporated (Private entity)	No
	Quezon City Government (Public entity)	No
Switzerland	Bunge Emissions Fund Limited	No

A.4. Reference to applied methodologies and standardized baselines

[1] ACM0001 Version 5 - Consolidated methodology for landfill gas project activities
[2] AMS-I.D. Version 10 - Grid connected renewable electricity generation
[3] “Tool for the demonstration and assessment of additionality” Version 3
[4] “Tool to determine project emissions from flaring gases containing methane”

A.5. Crediting period type and duration

The chosen crediting period is 10 years. Fixed crediting is used for this project. It started on the 1st of February 2008

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

The project started on 18th of March 2008.

The improvements from the start of plant activities have been directed for the biogas collection system by way of building new wells, horizontal trenches and substation (see Table 3). For the plant, new flow meters in the main, flare, and engine lines, have been installed to warrant a better

reliability. Also, a new temperature meter has been installed in the flare at the same level of exhaust gas analyzer probe (done in the second verification period).

Period	Wells	Horizontal Trenches	Total	Substations
1st monitoring period (February 1, 2008 - August 31, 2008)	48	0	**48**	3
2nd monitoring period (September 1, 2008 - June 30, 2009)	64	0	**64**	4
3rd monitoring period (July 1, 2009 - December 31, 2009)	71	6	**77**	4
4th monitoring period (January 1, 2010 - March 31, 2010)	71	12	**83**	4
5th monitoring period (April 1, 2010 - September 30, 2010)	71	14	**85**	4
6th monitoring period (October 1, 2010 – March 31, 2011)	71	16	**87**	4
7th monitoring period (April 1, 2011 - September 30, 2011)	71	16	**87**	4
8th monitoring period (October 1, 2011 – March 31, 2012)	71	17	**88**	4
9th monitoring period (April 1, 2012 – December 31, 2012)	71	23	**94**	4
10th monitoring period (January 1, 2013 – December 31, 2013)	92	23	**115**	5
11th monitoring period (January 1, 2014 – December 31, 2014)	92	23	**115**	5
12th monitoring period (January 1, 2015 – June 30, 2016)	92	23	**115**	5
13th monitoring period (July 1, 2016 – January 31, 2018)	92	23	**115**	5

Table 3: Number of Wells, Horizontal Trenches, and Substations

Table 3: Number of Wells, Horizontal Trenches, and Substations

The garbage disposal activity of the Disposal Facility Management Office of Payatas Operations Group (POG), requests periodically the partial disconnection of some wells located in the two mound areas. This situation has caused and causes a loss in biogas production in the areas occupied by dumping activity (this is also the reason for significant less CERs compared to that indicated in the PDD). The lost production is partially recovered through the installation of new wells in elevation and horizontal trenches. This situation, despite the increasing of wells number, affected negatively the targets to be achieved in the PDD.

The structure for biogas capture has been implemented to partially recover the lost production caused by the waste dumping activity. To support the existing drilled wells, we built the increasing wells made for the biogas capture in dumping areas constructed in elevation. In addition, there were horizontal trenches made of slotted pipes – having the same function as the other wells but placed horizontally in the waste.

Phase 2 (installation of 2 additional engine – 640 kW –) started in 2013. The delay related to the start of phase 2 (as described in the PDD: "…depending from the availability of biogas and the technical and financial viability…") was connected to the financial capability that was not available during the years 2010 to 2012. In addition, the delay connected to the CERs issuance caused problems to start this development. During the period of 10th verification, the phase 2 was implemented adding the 2 new engine , 320 kW each, total 640 kWe nominal power generation.

Since the beginning of plant operation, gas odor on top of the mounds has been greatly reduced. The subsidence of the garbage mounds was up to 13 meters in just 800 months of gas and leachate extraction. This means that the mounds have a better compaction and the quantity of perched water and leachate were also reduced, thereby improving stability of the slopes of the dump. This has allowed new dumping activity in the two mounds. Continuous extraction of gas from the dump has reduced the risk of fire and explosion in the area. There were no incidences of fire and explosion due to the project. The plant also supplies free energy for some Payatas users and developed a food program in cooperation with an NGO for Payatas children. Scholarship aide through Mount Hope Initiative is also given by the plant to the children of less fortunate family.

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies or standardized baselines

No deviations were made.

B.2.2. Corrections

No corrections were made

B.2.3. Changes to the start date of the crediting period

No changes were made.

B.2.4. Inclusion of monitoring plan

No inclusions were made.

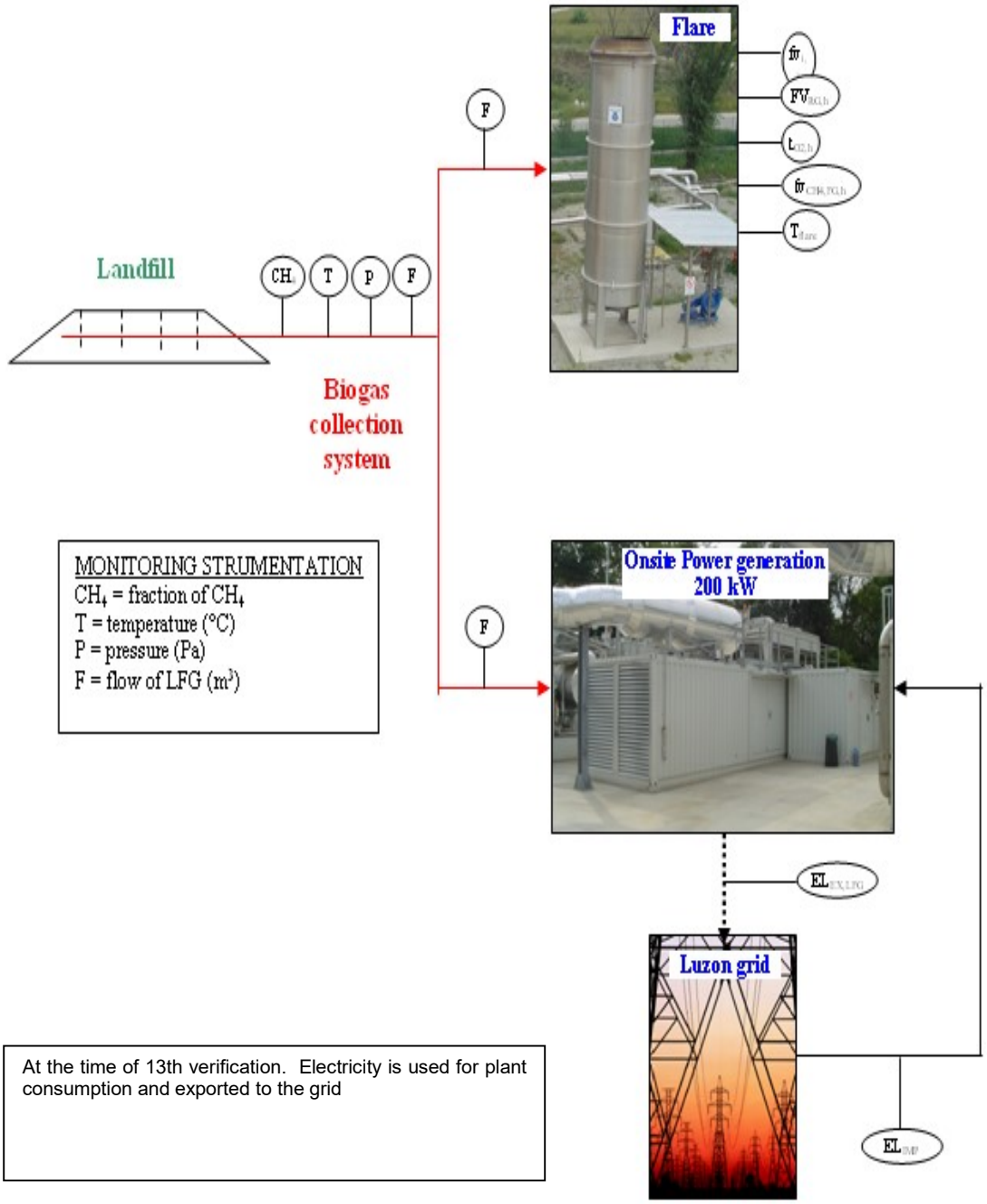
B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

No changes were made.

B.2.6. Changes to project design

No changes were made.

SECTION C. Description of monitoring system



At the time of 13th verification. Electricity is used for plant consumption and exported to the grid

ID	Type	Manufacturer	Model - Serial Number	Location	Error / Uncertainty	Range	Calibration Frequency	Last Calibration	Calibration Entity	Operating Period
FT03_a	Flow Meter	EMERSON - ROSEMOUNT	485 - 0075923 3051S1CD1A2E 12A1AB4D2E1L 4Q4 -8696153	Main pipeline	080% / 0.023%	130-2,500 m^3/h	2 years	16/02/2017	Premier Physic Metrologie	01/07/2016-31/01/2018
FT04_a	Flow Meter	EMERSON - ROSEMOUNT	485 – 0075924 3051S1CD1A2E 12A1AB4D2E1L 4Q4 -8696152	Flare pipeline	5% / 0.012%	130-2,500 m^3/h	2 years	17/02/2017	Premier Physic Metrologie	01/07/2016-31/01/2018
FT05_a	Flow Meter	EMERSON - ROSEMOUNT	485 - 0075925 3051S1CD1A2E 12A1AB4D2E1L 4Q4 -8696154	Engine pipeline	0.000% /0.320 %	13-250 m^3/h	2 years	9/02/2017	Premier Physic Metrologie	01/07/2016-31/01/2018
FT06_a	Flow Meter	ABB	3K646612025470	New Engine	0.000% /0.089%	180-580	2 years	16/02/2017	Premier Physic Metrologie	01/07/2016-31/01/2018
GA01	Methane content analyser	AB ENERGY	AB Energy BTG_1000 s/n 0236_14	Main pipeline	2.400% CH_4 / 0.5 O_2	0-100% CH_4 0-25% O_2	1 year	7/7/2017	Pangea Air Liquide	07/07/2016-31/01/2018
TT02	Temp. meter	ELSI	Probe Model: G1.U10-P20-B0150-S00, Transmitter Model: Y1-SEM203P - Serial number 08-07/305	Main pipeline	0.722% / 0.406%	0-250 °C	2 years	16/02/2017	Premier Physic Metrologie	01/07/2016-31/01/2018
PT04	Pressure meter	ABB	264HS-6407024078	Main pipeline	0.260%	0-250 mbar	2 years	16/02/2017	Premier Physic Metrologie	01/07/2016-31/01/2018

ID	Type	Manufacturer	Model - Serial Number	Location	Error / Uncertainty	Range	Calibration Frequency	Last Calibration	Calibration Entity	Operating Period
TT03	Temp. meter - flare bottom	ELSI	Probe Model: M1.U07-S00-M00400.1-S20, Transmitter Model: Y1-SEM210/S, Serial Number 11-11/63626	Flare bottom	0.000% / 0.270%	0-1,600 °C	2 years	16/02/2017	Premier Physic Metrologie	01/07/2016-31/01/2018
TT05	Temp. meter - flare top	ELSI	Probe Model: M1.U07-S00-M00400.1-S20, Transmitter Model: Y1-SEM210/S, Serial Number 11-10/63288 Probe Model: M1.U07-S00-M00400.1-S20, Transmitter Model: Y1-SEM210/S, Serial Number 11-10/63288	Flare top	0.000% / 0.043%	0-1,600 °C	1 year	19/01/2016	Premier Physic Metrologie	01/01/2016-19/01/2017
					0.300% / 0.073%			19/01/2017		20/01/2017-31/01/2018
GA02	Exhaust gas analyser	SIEMENS	ULTRAMAT23 - N1-V0-0038	Flare	2.800% CH_4 0.5 % O_2	0-100% CH_4 0-25% O_2	1 year	13/01/2016	Pangea/ Air Liquide	31/07/2016-13/01/2017
					2.800% CH_4 0.5 % O_2			13/01/2017		18/01/2017-31/01/2018

ID	Type	Manufacturer	Model - Serial Number	Location	Error / Uncertainty	Range	Calibration Frequency	Last Calibration	Calibration Entity	Operating Period
EM01	Energy meter	GENIUS	EDMI N680 – 209074056	Main electrical panel	0.0824%	5(20) A – 240V	2 years	29/03/2016	ERC Philippines	01/07/2016-31/01/2018
FT01	Flow meter line "A"	ABB	264DS - 6407021990	Line "A	0.038% / 0.071%	0-1,200 m^3/h	2 years	9/02/2017	Premier Physic Metrologie	01/07/2016-31/01/2018
FT02	Flow meter line "B"	ABB	264DS - 6407021989	Line "B"	0.025% / 0.071%	0-1,200 m^3/h	2 years	9/02/2017	Premier Physic Metrologie	01/07/2016-31/01/2018
HC01	Plant hours counter	BIOTECNOGAS	SCADA	Plant PC	N/A	0-999999 h	Not required	N/A	N/A	01/07/2016-31/01/2018

Table 4: Detailed Equipment and Calibration Information

The flow meters FT01 and FT02 are backup flow meters.

The calibration frequency of all instruments involved in the ER calculation is in compliance with the "Guidelines for Assessing Compliance with the Calibration Frequency Requirements" (version 01, EB 52 Annex 60).

Calibration procedures
See Table 4

Quality assurance and quality control measures

Documented procedures and management plan

The Payatas plant quality management system is based on ISO 9001:2000 standard. The management system considers the conformity of Pangea Quality System to the standard as an important target necessary to achieve future system certifications.

The policy of Pangea Green Energy Philippines, Inc. is to accomplish company mission and achieve targets with the continuous application of quality system procedures.

The system includes the following:
- Documentation of plant operation and maintenance procedures;
- Systematic and consistent data monitoring and analysis;
- Control of documents and records;
- Control of nonconforming output;
- Corrective and preventive actions;
- Internal audits;
- Training and information activities; and
- Emergency management.

Roles and responsibilities

Pangea Green Energy Philippines, Inc. (hereinafter Pangea Phils.) is responsible for the project site operation and maintenance. Regarding local permits and authorizations as well as any CDM related procedures and requirements, Pangea Phils. provides technical support for the proper management, operation and maintenance of the plant.

For best plant performance, Pangea Phils. structured the plant operation management organization and defined the roles and responsibilities as attached:

The plant operation management includes the following activities:
- Biogas extraction system setting;
- Biogas wells and pipeline network maintenance;
- Plant operation management;
- Plant data management;
- Plant maintenance;
- Biogas extraction system expansion.

All the plant activities especially operation and maintenance are defined in the PGBIO001 Operation including all scheduled and unscheduled service and maintenance activities. Activities that cannot be performed by existing human resources and facilities shall be ordered separately from qualified supplier selected under the internal purchase procedure POPRC001.

Trainings

Training is one of the most important activities that permit optimum operation of the plant. Pangea ensures that its workers are properly and sufficiently trained to operate and maintain the plant, and constantly updated on relevant information on biogas or landfill gas management, control, recovery and utilization as well as Clean Development Mechanism procedures.

All Pangea's staff received complete orientation and training regarding:
- Plant operation and maintenance;
- Plant quality management system;
- Specific tasks and activities, and their relevance to achieving the general objectives;
- Health and safety rules; and
- Environment specification.

Procedures described in POTR001 specify the orientation and training activities based on the following:

- Continuous improvement of capability and skills of personnel;
- Annual assessment and evaluation of personnel skills, and necessary additional training;
- Scheduling of all periodical training with final evaluation;
- Registration of all training season.

During the plant commissioning, Biotecnogas, the supplier of the biogas extraction and burning plant, trained Pangea's engineers to manage and control the biogas extraction and flaring equipment. All the trainings regarding plant management, operation, control and maintenance were organized by Pangea. The trainings were carried out according to the specifications and manuals of each equipment. The training for the setting of biogas extraction system was carried out by Pangea specifically the adjusting of gas wells and substations as well as draining of condensate traps and knockout pots.

On the plant supervision and management system, the training was carried out by AB Energy, subcontracted by Biotecnogas for the commissioning. AB Energy taught to the Pangea staff how to use and calibrate the landfill gas analyzer; showed the location of the different plant instruments, and explained how each instrument works and what they measure; how the data are logged and are recorded in the computer using the SCADA; and how to manage and adjust the setting of the plant through the SCADA.

Pangea inspects and assesses the performance of the plant, evaluates the staff and provides feedback, and implements modifications if necessary. Any modification to the existing plant shall be done according to the specifications and will be made known and explained to the Pangea site engineers.

Involvement of third parties

In order to accurately determine the amount of exhaust gas produced by the plant, we need to know the actual atmospheric pressure in the area. This can be approximated using the mean sea level pressure data. Pangea requested from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA).

The Quezon City Controlled Disposal Facility is being managed by the Payatas Operations Group (POG), a unit specially created by the Quezon City government to oversee the dumpsite operations. Rehabilitation of the dumpsite, which includes slope re-profiling, soil capping, construction of drainage system for surface runoff and leachate and vegetation cover, is being handled by Quezon City's contractor, the IPM Group of Companies (IPM). Pangea coordinates closely with both the POG and IPM all its activities that will affect the ongoing rehabilitation activities at the dumpsite such as construction of additional wells. The positive environmental impacts of the project are communicated to the Payatas residents through the POG. Pangea also conducts lectures regarding the scope, objectives, impacts and status of the project to interested parties from other parts of the country and even abroad.

Internal audits and control measures

Pangea's management system includes an audit management procedure. The procedure PGSYS002 establishes an annual audit of the main plant procedures and activities. The status of the plant including all technical details are monthly controlled based on the daily operation journals provided by Pangea. There is also a POBIO001 procedure being implemented in order to periodically check all plant equipment and accessories.

All collected data are reviewed periodically during the scheduled controlling meetings, according to its internal quality management policy. Based on the monthly reporting, modifications to the periodic maintenance steps may be implemented if necessary.

On a yearly basis, at the same time the periodic verification of emission reductions, technical control and service activities are repeated by Pangea.

Troubleshooting procedures

The plant management system includes procedure for the operation and maintenance of the plant described in POBIO001, and for emergency situation management described in procedure POEM001.

In case of any failure or malfunction, the plant will set off an automatic alarm. The security personnel were instructed to call the plant engineer in such a situation so that he can immediately inspect the plant and identify the cause of failure or malfunction. The event and the results of the investigation are noted in the daily journal and in the emergency visit report. (Emergency visit reports can be provided on request.)

In case of unclear situation, the engineer contacts the suppliers for consultation and technical service support. In case of external technical problems, the concerned or appropriate service suppliers might be involved to solve the problem.

In case of any failure or malfunction to any measuring device the following troubleshooting procedures will be carried out to meet the requirements of the monitoring methodology:

Power supply failure

In case of short power outages when the complete landfill gas collection system including the blower engine and flare are out of operation as no emergency power supply is installed, all measuring devices are also out of operation. Recorded data are secured by emergency batteries to protect internal memory for approx. 12 hours of power outage or data are fixed based on an analogue measuring device.

Failure of gas flow meter

Gas flow meters and/or any related equipment or device that failed or are not functioning properly shall be repaired as soon as possible. The existing plant lay-out includes three (3) different flow meters – main line, flare line, and engine line. In case of failure of any one of the three flow meters, the data logger can detect the gas flow based on the sum or difference of the other two installed gas flow meters.

The flare line flow meter is of the same type as the main line flow meter hence can provide the flow rate in m^3/h; as such it is also possible to use one in case there is a problem with the other. If both the flare line and main line flow meters fail, it is also possible to use the flow meter installed in Line A,B and C.

Failure of gas analyser instruments

Gas analysers and/or any related equipment or device that failed or are not functioning properly shall be repaired as soon as possible. While the gas analyser is out of service, the portable gas analyser shall be used to monitor the biogas composition.

Failure of temperature sensor

Temperature sensors and/or any related equipment or devices that are not functioning properly will be repaired as soon as possible. Spare parts are readily available in the plant. But in the unlikely event that the item to be replaced is not readily available, a new temperature sensor will be installed.

Failure of energy meter

In case of malfunction of the energy meter, repair or replacement of defective part shall be done as soon as possible. During the period when the energy meter is not in operation, the energy consumption of the project can be determined using the energy meter installed by MERALCO and can be provided upon request. Likewise, it is possible to check the total consumption of energy from the MERALCO billing statement.

Failure of portable gas analyser

In the unlikely event of malfunction of the portable gas analyser, repair or replacement of defective part shall be done as soon as possible. In case of failure of the oxygen analyser, the plant will be shut down because of safety reasons. In case of failure of the carbon dioxide analyser, immediate troubleshooting is not required as this parameter is not necessary for emission reduction calculation. In case of failure of the methane analyser, the carbon dioxide and oxygen measurements can be used to estimate the amount of methane.

Failure of data-logger

In the unlikely event of malfunction of the Data logger and/or any related equipment, repair or replacement of defective part will be done as soon as possible. In case of failure of the data logger, the following measuring devices can work independently and can be recorded manually:

- Gas flow meters;
- Energy meter;
- Hour counter;
- Gas analysers.

Aside from these independent measurements, landfill gas quality particularly the methane concentration shall be recorded manually according to the troubleshooting procedure for failure of landfill gas analyser. In addition to this manual recording, one gas sample will be taken every week if the data-logger is not in operation. The results can be taken as an average value for the gas quality during the period the data-logger is not in operation. In this case, calibration reports of the portable landfill gas analyser will be included in the monitoring report.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

Data/Parameter	**GWP_{CH4}**
Unit	t CO_{2eq}
Description	Global potential warming of methane
Source of data	Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996)
Value(s) applied	25
Choice of data or measurement methods and procedures	
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Data/Parameter	**D_{CH4}**
Unit	t/m^3
Description	Methane density
Source of data	Intergovernmental Panel on Climate Change, Climate Change 1995: The Science of Climate Change (Cambridge, UK: Cambridge University Press, 1996)
Value(s) applied	0.0007168
Choice of data or measurement methods and procedures	
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Data/Parameter	$CEF_{electricity,y}$
Unit	t CO_2/MWh
Description	CO_2 emissions intensity of the electricity displaced
Source of data	Calculated according to AMS - I.D. Version 10 (see PDD)
Value(s) applied	0.46
Choice of data or measurement methods and procedures	
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Data/Parameter	Wt. of MSW
Unit	t/year
Description	Total amount of solid waste disposed yearly in the landfill
Source of data	Payatas Operations Group (see)
Value(s) applied	Annex 3 of PDD
Choice of data or measurement methods and procedures	
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

D.2. Data and parameters monitored

Data/Parameter	$LFG_{total,y}$
Unit	m^3
Description	Total amount of landfill gas
Measured/calculated/ default	Directly measured
Source of data	FT03_a (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	13,867,011 m^3 (total value in the monitoring period)
Monitoring equipment	FT03_a (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See “Quality assurance and quality control measures” under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 8: Total Amount of Landfill Gas

Data/Parameter	**$LFG_{flare,y}$**
Unit	m^3
Description	Amount of landfill gas flared
Measured/calculated/ default	Directly measured
Source of data	FT04_a (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	882,586 m^3 (total value in the monitoring period)
Monitoring equipment	FT04_a (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See "Quality assurance and quality control measures" under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 9: Amount of Landfill Gas Flared

Data/Parameter	**$LFG_{electricity,y}$**
Unit	m^3
Description	Amount of landfill gas combusted in power plant
Measured/calculated/ default	Directly measured
Source of data	FT05_a and FT06_a (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	9,309,267 m^3 (total value in the monitoring period)
Monitoring equipment	FT05_a and FT06_a(for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See "Quality assurance and quality control measures" under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 10: Amount of Landfill Gas Combusted in Power Plant

Data/Parameter	**$FV_{RG,h}$**
Unit	Nm^3/h

Description	Volumetric flow rate of the residual gas in dry basis at normal conditions in the hour *h*
Measured/calculated/ default	Measured by flow meter (FT04_a)
Source of data	Normalization with formula described in the calculation method below
Value(s) of monitored parameter	199.86 Nm^3/h (average value in the monitoring period)
Monitoring equipment	FT04_a, TT02, PT04 (for detailed information, see Table 4 in Section C.1.1.); the dry basis is ensured for this measurement as well as that of the volumetric fraction of all components in the residual gas
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	Normalization by the formula: $FV_{RG,h} = LFG_{flare,h} \times \{[(P + p_{atm}) \times T_n] / [P_n \times (T + T_n)]\}$ where: $LFG_{flare,h}$ = biogas flow rate at the flare line (m^3/h) P = biogas pressure in the main line (mbar) p_{atm} = atmospheric pressure (mbar) T_n = 273.15 K P_n = 1,013.25 mbar T = biogas temperature in the main line (°C)
QA/QC procedures	See “Quality assurance and quality control measures” under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 11: Volumetric Flow Rate of the Residual Gas

Data/Parameter	**$f_{vCH4,h}$**
Unit	%
Description	Volumetric fraction of methane in the residual gas in the hour *h*
Measured/calculated/ default	Directly measured
Source of data	GA01 (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	45.61% (average value in the monitored period)
Monitoring equipment	GA01
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See “Quality assurance and quality control measures” under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 12: Volumetric Fraction of Methane in the Residual Gas

Data/Parameter	**$t_{O2,h}$**
Unit	%
Description	Volumetric fraction of O_2 in the exhaust gas of the flare in the hour *h*
Measured/calculated/ default	Directly measured

Source of data	GA02 (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	4.79 % (average value in the monitoring period)
Monitoring equipment	GA02 (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See "Quality assurance and quality control measures" under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 13: Volumetric Fraction of Oxygen in the Exhaust Gas

Data/Parameter	$f_{vCH4,FG,h}$
Unit	mg/m^3
Description	Concentration of methane in the exhaust gas of the flare in dry basis at normal condition in the hour *h*
Measured/calculated/ default	Directly measured
Source of data	GA02 (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	0.0 mg/m^3 (average value in the monitoring period)
Monitoring equipment	GA02 (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See "Quality assurance and quality control measures" under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 14: Concentration of Methane in the Exhaust Gas

Data/Parameter	T_{flare}
Unit	°C
Description	Temperature in the exhaust gas of the flare
Measured/calculated/ default	Directly measured
Source of data	TT05 (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	602.058 °C (average value in the monitoring period)
Monitoring equipment	TT05 (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See "Quality assurance and quality control measures" under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 15: Temperature in the Exhaust Gas of the Flare

Data/Parameter	T
Unit	°C
Description	Temperature of the landfill gas
Measured/calculated/ default	Directly measured
Source of data	TT02 (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	68.64 °C (average value in the monitoring period)
Monitoring equipment	TT02 (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See “Quality assurance and quality control measures” under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 16: Temperature of the Landfill Gas

Data/Parameter	P
Unit	mbar† (Pa)
Description	Pressure of the landfill gas
Measured/calculated/ default	Directly measured
Source of data	PT04 (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	50.32 mbar = 4949.7 Pa (average value in the monitoring period)
Monitoring equipment	PT04 (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See “Quality assurance and quality control measures” under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 17: Pressure of the Landfill Gas

Data/Parameter	$EL_{EX,LFG}$
Unit	MWh
Description	Total amount of electricity exported out of the project boundary
Measured/calculated/ default	Directly measured

Source of data	EM01 (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	11,098.63 MWh (total value in the monitoring period)
Monitoring equipment	EM01 (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See “Quality assurance and quality control measures” under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 18: Total Amount of Electricity Exported Out of the Project Boundary

Data/Parameter	**EL_{IMP}**
Unit	MWh
Description	Total amount of electricity imported to meet project requirements
Measured/calculated/ default	Directly measured
Source of data	EM01 (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	1.542 MWh (total value in the monitoring period)
Monitoring equipment	EM01 (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See “Quality assurance and quality control measures” under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 19: Total Amount of Electricity Imported

Data/Parameter	**H**
Unit	H
Description	Working plant hours
Measured/calculated/ default	Directly measured
Source of data	HC01 (see Annex 1: monitoring equipment location)
Value(s) of monitored parameter	11,332 h (total value in the monitoring period)
Monitoring equipment	HC01 (for detailed information, see Table 4 in Section C.1.1.)
Measuring/reading/recording frequency	Continuously (h)
Calculation method (if applicable)	
QA/QC procedures	See “Quality assurance and quality control measures” under Section C
Purpose of data/parameter	For baseline/project emission calculation
Additional comments	

Table 20: Working Plant Hours

D.3. Implementation of sampling plan

Data and parameters monitored described in section D.2 are not determined by a sampling plan and, hence, no sampling efforts and surveys were implemented

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

$BE_y = ER_y + PE_y$

For the meaning of all the terms, see sections D and E.2.

E.2. Calculation of project emissions or actual net removals

The formula used for the calculation of project emissions is shown below (can be confirmed through the spreadsheets *01ER calculation sheet_2016 JUL.xls, 02ER calculation sheet_2016 AUG.xls, 03ER calculation sheet_2016 SEP.xls, 04ER calculation sheet_2016 OCT.xls, 05ER calculation sheet_2016 Nov.xls, 06ER calculation sheet_2016 DEC.xls, 01ER calculation sheet_2017 JAN.xls, 02ER calculation sheet_2017 FEB.xls,* and *03ER calculation sheet_2017 MAR.xls,04ER calculation sheet_2017 APR.xls, 05ER calculation sheet_2017 MAY.xls* and *06ER calculation sheet_2017 JUN.xls, 07ER calculation sheet_2017 JUL.xls, 08ER calculation sheet_2017 AUG.xls, 09ER calculation sheet_2017 SEP.xls, 10ER calculation sheet_2017 OCT.xls, 11ER calculation sheet_2017 NOV.xls, 12ER calculation sheet_2017 DEC.xls 01ER calculation sheet_2018 JAN.xls,*):

Variable	Name	Unit	Equation
PE_{flare}	Project emissions	t CO_{2eq}	$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \cdot \left(1 - \eta_{flare,h}\right) \cdot \frac{GWP_{CH4}}{1000}$
$MM_{RG,h}$	Molecular mass of the residual gas	kg/kmol	$MM_{RG,h} = \sum_{i} (fv_{i,h} * MM_i)$ ($fv_{i,h} = fv_{CH4,h}$)
$\rho_{RG,h}$	Density of the residual gas	kg/m^3	$\rho_{RG,n,h} = \frac{P_n}{\frac{R_u}{MM_{RG,h}} \times T_n}$
$FM_{RG,h}$	Mass flow rate of the residual gas	kg/h	$FM_{RG,h} = \rho_{RG,n,h} \times FV_{RG,h}$
$TV_{n,FG,h}$	Volumetric flow rate of the exhaust gas	m^3/h	$TV_{n,FG,h} = V_{n,FG,h} \times FM_{RG,h}$
$TM_{FG,h}$	Mass flow rate of methane in the exhaust gases	kg/h	$\mathrm{TM}_{\mathrm{FG,h}} = \frac{\mathrm{TV}_{\mathrm{n,FG,h}} * \mathrm{fv}_{\mathrm{CH4,FG,h}}}{1000000}$
$TM_{RG,h}$	Mass flow rate of methane in the residual gas	kg/h	$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$

Variable	Name	Unit	Equation
η_{flare}	Flare efficiency	N/A	$\eta_{flare,h} = 1 - \frac{TM_{FG,h}}{TM_{RG,h}}$
$MD_{electricity}$	Methane destroyed by generation of electricity	t CH_4	$MD_{electricity,y} = LFG_{electricity,y} \cdot w_{CH4} \cdot D_{CH4}$
MD_{flared}	Methane flared	t CH_4	$MD_{flared,y} = \{LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / \mathrm{GWP_{CH4}})$
$MD_{project}$	Methane flared/combusted	t CH_4	$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y}$
EL_y	Net exported electricity	MWh	$\mathrm{EL_y} = \mathrm{EL_{EX,LGFG}} - \mathrm{EL_{IMP}}$
ER_y	Emission reductions	t CO_{2eq}	$ER_y = MD_{project,y} \times GWP_{CH4} + EL_y \times CEF_{electricity,y}$

Table 21: Equations Used in the Calculations

The data parameters are measured and rounded off to four decimals. In the baseline calculation, the numbers were rounded down after four decimals. In calculation of the project emissions, the numbers were rounded up after four decimals. Then, the final emission reductions were rounded down to the unit.

The equivalent error ε calculation is applied through the following:

$$\varepsilon_{PE\ flared} = \sqrt{(err_{PT04})^2 + (err_{TT02})^2 + (err_{FT04\_a})^2 + (err_{GA02_{ch4}})^2 + (err_{GA02_{02}})^2}$$

$$\varepsilon_{MD\ flared\ before\ PE\ reduction,y} = \sqrt{(err_{PT04})^2 + (err_{TT02})^2 + (err_{FT04\_a})^2 + (err_{GA01})^2}$$

(Error related to the product of $LFG_{flare,y} * w_{CH4} * D_{CH4}$)

$$\varepsilon_{MD_{electrucity}} = \sqrt{(err_{PT04})^2 + (err_{TT02})^2 + (err_{FT05\_a})^2 + (err_{GA01})^2 + (err_{FT06\_a})^2}$$

$$\varepsilon_{EL} = \sqrt{(err_{EM01})^2}$$

The variable err_{aabb} is the sum of error plus the uncertainty associated to the instrument involved in the variable calculation (see Table 4 in Section C.1.1.)

The variable correction after equivalent error calculation is:

XXcorr = XXy × (1 – εxx)

E.3. Calculation of leakage emissions

No Leakage

E.4. Calculation of emission reductions or net anthropogenic removals

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
7-16	4,546.50	0	0	0	4,546.50	4,546.50
8-16	4,351.60	0	0	0	4,351.60	4,351.60
9-16	4,713.20	0	0	0	4,713.20	4,713.20
10-16	3,848.00	0	0	0	3,848.00	3,848.00
11-16	4,088.10	0	0	0	4,088.10	4,088.10
12-16	3,858.10	0	0	0	3,858.10	3,858.10
1-17	4,148.60	0	0	0	4,148.60	4,148.60
2-17	4,394.80	0	0	0	4,394.80	4,394.80
3-17	4,969.50	0	0	0	4,969.50	4,969.50
4-17	4,614.20	0	0	0	4,614.20	4,614.20
5-17	4,697.80	0	0	0	4,697.80	4,697.80
6-17	4,256.10	0	0	0	4,256.10	4,256.10
7-17	4,311.60	0	0	0	4,311.60	4,311.60
8-17	3,810.10	0	0	0	3,810.10	3,810.10
9-17	4,211.10	0	0	0	4,211.10	4,211.10
10-17	3,758.20	0	0	0	3,758.20	3,758.20
11-17	4,079.20	0	0	0	4,079.20	4,079.20
12-17	4,660.60	0	0	0	4,660.60	4,660.60
1-18	3,261.20	0	0	0	3,261.20	3,261.20
Total	80,578.50	0	0	0	80,578.50	80,578.50

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante (t CO_2e)
131,084	80,578.50

E.6. Remarks on increase in achieved emission reductions

There is a decreasing in the actual emission reductions achieved during the current monitoring period compared to that stated in the registered CDM-PDD.

The garbage disposal activity of the Disposal Facility Management Office of Payatas Operations Group (POG), requests periodically the partial disconnection of some wells located in the two mound areas. This situation has caused and causes a loss in biogas production in the areas occupied by dumping activity (this is also the reason for significant less CERs compared to that indicated in the PDD).

ANNEX 1: Monitoring Equipment Location

LEGEND			
FT01	Flow meter (line A)	TT03	Temperature meter (bottom of flare)
FT02	Flow meter (line B)	TT04	Temperature meter (engine line)
FT03_a	Flow meter (total/main)	TT05	Temperature meter (top of flare)
FT04_a	Flow meter (flare)	PT03	Pressure meter (main line before blower)
FT05_a	Flow meter (engine)	FT03	Flow meter (line C)
GA01	Methane content analyser		
GA02	Exhaust gas analyser		
EM01	Energy meter		
HC01	Plant running hours counter		
FT06_a	Flow meter (new engines)		

'e Carattere Paragrafo