Monitoring report form
(Version 03.0)

Monitoring report

Title of the project activity	Landfill Gas Recovery and Utilization at Bukit Tagar Sanitary Landfill, Hulu Selangor in Malaysia
Reference number of the project activity	2467
Version number of the monitoring report	1.0
Completion date of the monitoring report	05/01/2013
Registration date of the project activity	28/08/2009
Monitoring period number and duration of this monitoring period	Monitoring period number: 06 Duration of monitoring period: 01/07/2012 to 31/12/2012 inclusive of both days
Project participant(s)	Japan Carbon Finance, Ltd. (JCF) KUB-Berjaya Enviro Sdn. Bhd. (KBE)
Host Party(ies)	Malaysia
Sectoral scope(s) and applied methodology(ies)	13 : Waste handling and disposal ACM 0001, version 8[1] Consolidated baseline and monitoring methodology for landfill gas project activities
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	106,593 tCO_2e ** Ex-ante for 184 days (July 2012 – Dec 2012) – 211,448 x (184/365)*
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	119,202 tCO_2e

1 The ACM 0001 - *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8) is no longer valid and is not available for download in UNFCCC. The version has been replaced with Version 8.1.

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

The Bukit Tagar Sanitary Landfill (BTSL) is operated by KUB-Berjaya Enviro Sdn. Bhd. (KBE) and located in Hulu Selangor, Malaysia. The landfill receives municipal solid waste (MSW) from the country's capital, Kuala Lumpur and Selayang district in Selangor State.

The main objective for the Clean Development Mechanism (CDM) project is to avoid direct emissions of greenhouse gases (GHGs) from the landfill into the atmosphere through active extraction. The gas collected is destructed by high temperature enclosed flares as well as is used for power generation using Gas Engine(s) with high efficiency.

Carbon emissions are reduced through two major activities:

Emission Reduction Aspects	How will emissions be reduced?
Landfill gas (LFG) Extraction and Destruction (Methane (CH_4) avoidance)	Instead of releasing LFG (consisting CH_4) to the atmosphere, the gas will be collected and destroyed in enclosed flares and Gas Engine(s)
Power Generation (Fuel replacement)	Less carbon dioxide (CO_2) will be emitted by replacing electricity generated from grid power with electricity produced from LFG (considered as renewable)

LFG extraction from Advance Cell and Phase 1 Cell has continued to operate during this monitoring period.

Two high temperature enclosed flares with maximum capacity of 2,500 Nm^3/hr have continued to be in operation while a portion of the gas captured was sent to a unit of 1MW Gas Engine (Gas Engine No.1) to generate electricity. The electricity produced by Gas Engine No.1 was exported to the grid during this monitoring period.

Relevant dates for the project activities tabulated below:

Bukit Tagar Project	Construction Start	Commissioned	Continued operation periods
First flaring system	17/06/2008	28/08/2009	Continued to operate
Second flaring system	22/01/2010	07/08/2010	Continued to operate
Gas Engine No.1	03/01/2011 (delivery to site)	01/06/2011	Continued to operate

The 6th monitoring period is from 01/07/2012 to 31/12/2012 (inclusive of both days). The total emission reductions achieved during this monitoring period is **119,202 tCO_2e.**

A.2. Location of project activity

The project location is situated approximately 5km to the west of the Bukit Tagar Interchange along the North-South Expressway and 40km from central Kuala Lumpur. The landfill is easily accessible via expressway and a dedicated Bukit Tagar Interchange has been developed for the access from the North-South Expressway. The landfill is situated in a leased agricultural land, surrounded by hectares of oil palm plantations and rubber trees.

Figure 1: Location of BTSL and Selangor State

The specific geographical coordinates of the landfill are:

Latitude	Longitude	Description
3^{0} 30' 168''	101^{0} 28' 428''	North
3^{0} 29' 07''	101^{0} 28' 452''	South
3^{0} 29' 46''	101^{0} 28' 20''	West
3^{0} 29' 69''	101^{0} 29' 268''	East

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Malaysia (Host)	KUB-Berjaya Enviro Sdn. Bhd. (KBE) (Private)	No
Japan	Japan Carbon Finance, Ltd. (JCF) (Private)	No

A.4. Reference of applied methodology

The project has applied the following approved methodology and tools:

Approved Methodology:

ACM 0001 – *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8)[2]

Methodological Tools referred to include:

- *Tool for the demonstration and assessment of additionality* (Version 5.2, EB 39, Annex 10);
- *Tool to determine project emissions from flaring gases containing methane* (Version 1, EB 28, Annex 13);

[2] The ACM 0001 - *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8) is no longer valid and is not available for download in UNFCCC. The version has been replaced with Version 8.1.

- *Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site* (Version 05, EB 55, Annex 18);
- *Tool to calculate the emission factor for an electricity system* (Version 02, EB 50, Annex 14); and
- *Tool to calculate baseline, project and/or leakage emissions from electricity consumption* (Version 1, EB 39, Annex 7)
- *Tool to determine the mass flow of a greenhouse gas in a gaseous stream* (Version 02.0.0, EB 61, Annex 11).

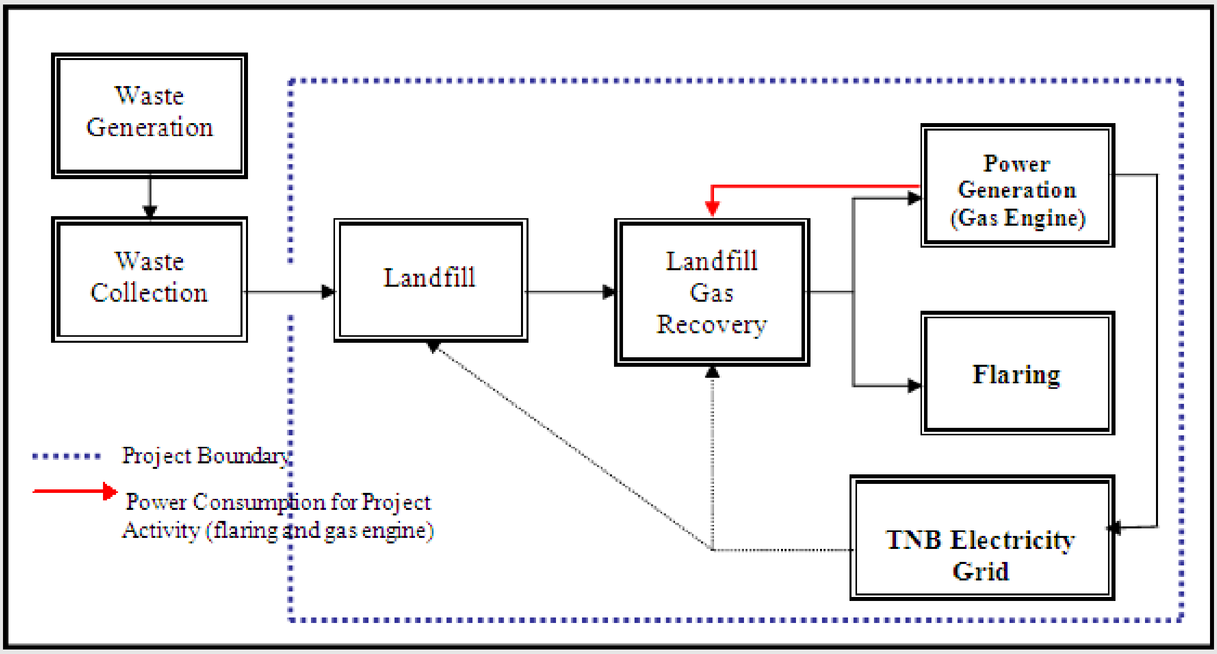
A.5. Crediting period of project activity

The start date of the crediting period of the project activity is 28/08/2009 (date of registration) and the end date of the 1st crediting period is 27/08/2016. The selected crediting period is renewable (7 years). The 6th monitoring period is from 01/07/2012 to 31/12/2012 (inclusive of both days).

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

The landfill gas recovery, flaring and power generation system can be illustrated below:



Note:

1. *With reference to paragraph 3, Section A.2, CDM PDD version 7.2, the landfill is being developed in phases. Currently, landfill gas extraction has been implemented on 2 cells in the landfill, i.e. Advance Cell and Phase 1. Both of these phases are included in this project as well as any future phases to be developed in accordance to the PDD.*
2. *Notification of change was submitted earlier to remove the on-site power consumption for landfill operation. Notification of change was approved by UNFCCC on 09/05/2012.*

Figure 2: Overall LFG Recovery, Flaring and Power Generation Design

Description on the installed technologies

The technology applied and transferred into this project has been implemented and proven in Europe (Denmark and Germany) as well as in China (extraction and flaring system).

Detailed technical description is further described below:

Gas Extraction System in Advance Cell

Q2 Engineering Sdn. Bhd., a subsidiary of Q2 A/S of Denmark was appointed as the turnkey contractor to construct the gas extraction and flaring system for Advance Cell. 42 vertical gas extraction pipes were installed in the landfill to extract the LFG. These wells were connected to 8 units of main gas collection pipes that led to the LFG flaring system.

Figure 3: An Example of Vertical Well Installed in Advance Cell

These vertical wells can be individually regulated and controlled.

First High-Temperature Enclosed Flaring System (Flare No.1)

One unit of high-temperature enclosed flaring system had been installed to flare off the LFG extracted. The flare system included a containerised blower and flaring system with a maximum capacity to flare off 2,500 Nm^3/hr LFG.

Figure 4: Enclosed Flare Installed at Advanced Cell (Flare No.1)

The details of the flare specifications are listed below:

Specifications	**Details**
Manufacturer	Fairyland Environmental Technology, China
Gas flow	Maximum – 2,500 Nm^3/hr
Retention time	>0.3 seconds at 800-1,000^oC
Gas blower	Twin-lobe roots blower
Gas analysers	Gas analysers for CH_4 and O_2

Gas Analyser and Data Logging

Monitoring of the correct functioning of the flare system was provided by a continuous-logging system which examines the operational parameters of the flare. The gas analyzing system is a multi-functional environmental monitoring equipment that can monitor up to 14 different measurements and data logging channels. Data from the logging system was presented on a local screen (on-line data) and stored in a local personal computer (PC) unit with external communication via Global System for Mobile Communications (GSM).

Data were downloaded directly from the built-in data logger to a PC and were also transmitted to external server and PC as back-up.

Gas Extraction System in Phase 1 Cell

Stage 1 of Phase 1 Cell was completed in August 2010. The cell is still an operational cell which will be filled according to the proposed plan of the landfill sequence at a later stage. The design of the gas extraction wells is based on a series of horizontal gas extraction wells constructed over the entire Phase 1 Cell.

Figure 5: Horizontal Gas Extraction Wells in Phase 1 Cell

Second High-Temperature Enclosed Flaring System (Flare No.2)

The second unit of high-temperature enclosed flaring system was installed to cater for the extra LFG extracted from Phase 1 Cell. The flare system included a containerised blower and flaring system with a maximum capacity to flare off 2,500 Nm^3/hr LFG.

Figure 6: High-Temperature Enclosed Flares

The flare was supplied by the same manufacturer for Flare No.1. Details of the flare specifications are listed below:

Specifications	Details
Manufacturer	Fairyland Environmental Technology, China
Gas flow	Maximum – 2,500 Nm^3/hr
Retention time	>0.3 seconds at 800-1,000^oC
Gas blower	Twin-lobe roots blower
Gas analysers	Gas analysers for CH_4 and O_2

The analyser and data logging system is similar to Flare No.1 (as described above).

Gas Engine Energy Power Plants

A high-efficiency (electrical efficiency > 42%) Gas Engine (net dispatch of 1 MW) was chosen for the generation of electricity from LFG.

Figure 7: High-Efficiency Landfill Gas Engine Used in BTSL

The details of Gas Engine No.1 specifications are listed below:

Specifications	Details
Manufacturer (Origin)	MWM (Germany)
Model	TCG 2020V12
Electric power output (net to grid)	1 MW (total max. gross output 1.2 MW)
Voltage	11 kV
Frequency	50 Hz
Minimum heating value (LHV)	5.9 kWh/m^3

To ensure that good quality LFG arrives at Gas Engine No.1, a LFG pre-treatment system comprising of a chiller (made in Germany) and activated carbon filter was also set up to remove moisture and impurities such as hydrogen sulphide (H_2S) and siloxanes before Gas Engine No.1.

A landfill gas blower was installed to ensure that the required gas pressure for Gas Engine No.1 is maintained.

Centralised SCADA System

The Centralized (Supervisory Control and Data Acquisition) SCADA Interface was developed to integrate all existing SCADA or operation monitor system, ranging from individual Flare to Gas Engine(s). The objective of the integrated monitoring system is aimed to improve the efficiency of staff movement, monitoring process and data collection as well as serving as additional storage of database. The new system offered remote monitoring option which allows access through internet connection for view-only if provided with the correct

authentication key.

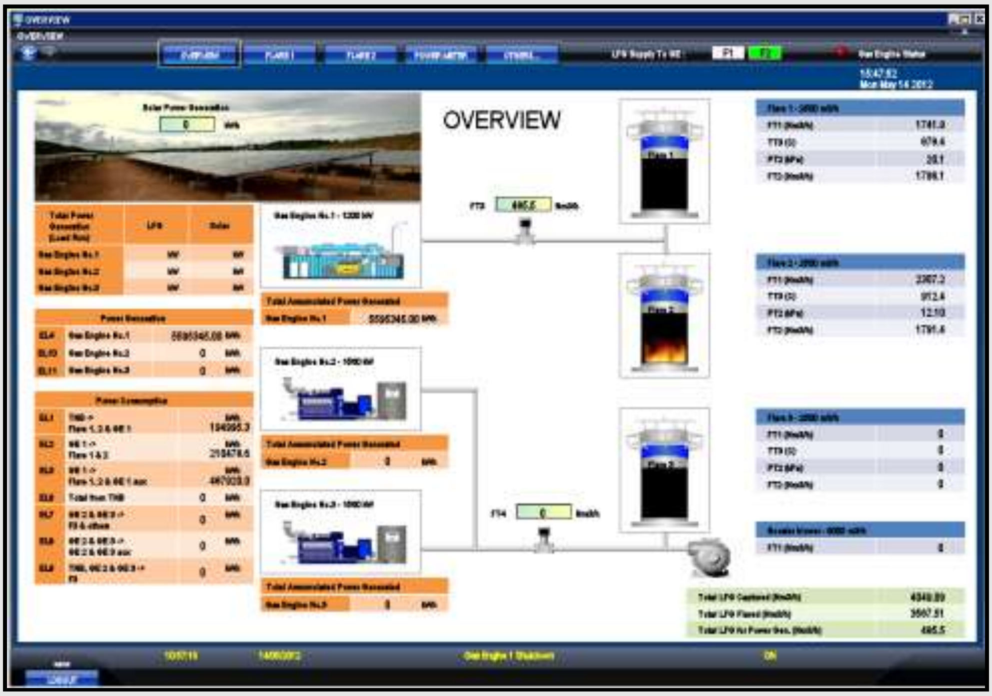


Figure 8: Centralized SCADA Interface

Implementation status of project activity

For the reporting period of 01/07/2012 to 31/12/2012, the key CDM activities implemented are described below:

Gas Extraction System in Advance Cell and Flare No.1

The actual implementation of the flaring system was initiated in August 2009 and has continued through this monitoring period.

The details on the downtime of the system (over the monitoring period covered by this report) are presented in **Appendix 1**.

The total running time for Flare No.1 is 83% during this monitoring period.

Gas Extraction System in Phase 1 Cell and Flare No.2

The flaring system in Phase 1 Cell was completed during the 2nd monitoring period and has started its operation on 07/08/2010. Flare No.2 was located next to Flare No.1 where most of the LFG extracted from Phase 1 Cell is transferred via a transfer pipe and fed to Flare No.2.
The details on the downtime of the system (over the monitoring period covered by this report) are presented in **Appendix 2**.

The total running time for Flare No.2 is 95% during this monitoring period.

Power Generation

During this monitoring period, power generated from Gas Engine No.1 continued to be uploaded to the grid.

The details on the downtime of the Gas Engine No.1 are presented in **Appendix 3.**

Currently, the data recording for the amount of gas channelled to Gas Engine No.1 is linked with the Flare No.2 SCADA system. Hence, the shutdown of Flare No.2 also indicated the shutdown of Gas Engine No.1.

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

No temporary deviations from registered monitoring plan or applied methodology during this monitoring period.

B.2.2. Corrections

No corrections during this monitoring period.

B.2.3. Permanent changes from registered monitoring plan or applied methodology

No permanent changes from registered monitoring plan or applied methodology during this monitoring period.

During the 3rd monitoring period, the revision of monitoring plan was submitted to UNFCCC and approved on 09/05/2012[3].

The revision is related to alternative measurement and handling of data during emergency conditions for methane content, flow meters and electricity meter.

B.2.4. Changes to project design of registered project activity

There is no change to project design of registered project activity during this monitoring period.

During the 3rd monitoring period, the notification of change request was submitted to UNFCCC and approved on 09/05/2012[4].

The change is related to the internal use of power generated for the landfill operation which was not successful and was not approved by the relevant authorities and the grid operator. This was due to the technical constraints and removal of on-site utilization from the PDD.

B.2.5. Changes to start date of crediting period

No changes to start date of crediting period during this monitoring period.

B.2.6. Types of changes specific to afforestation or reforestation project activity

Not applicable.

SECTION C. Description of monitoring system

Monitoring Methodology

The basis of the monitoring plan (MP) was formulated based on the approved methodology ACM 0001 – *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8).

Tool to determine project emissions from flaring gases containing methane

According to page 10 of the *Tool to determine project emissions from flaring gases containing methane*, in case of enclosed flares and use of the default value for the flare efficiency, the flare efficiency in the hour *h* ($\eta_{flare,h}$) is:

[3] http://cdm.unfccc.int/Projects/DB/DNV-CUK1238680609.1/view
[4] http://cdm.unfccc.int/Projects/DB/DNV-CUK1238680609.1/view

- 0%, if the temperature in the exhaust gas of the flare (T_{flare}) is below 500°C for more than 20 minutes during the hour *h*
- 50%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour *h* but the manufacturer's specifications on proper operation of the flare are not met at any point in time during the hour *h*
- 90%, if the temperature in the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour *h* and the manufacturer's specifications on proper operation of the flare are met continuously during the hour *h*

The manufacturer's specification on proper operation of the flare need to be met in order to apply 90% flare efficiency in the hour *h* whenever the exhaust gas of the flare (T_{flare}) is above 500°C for more than 40 minutes during the hour *h*.

The manufacturer's specification on proper operation of the flare is monitored through the operating set point for the flare which was pre-set at the SCADA system. Whenever there is an issue where the flare operates below or above the set point; the system will be automatically shut down.

Tool to determine the mass flow of a greenhouse gas in a gaseous stream

The MP also referred to the *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*.

Referring to the tools, for LFG temperatures below 60 ^{o}C, moisture could be neglected due to its very low influence on final results and thus, the measurement in wet or dry basis are not important (as reflected in the amendments to ACM 0001, version 9.1 onwards). In case where the LFG temperature exceeds 60^{o}C, the same basis for both CH_4 concentration and flow measurement will be considered according to the tools.

The detailed description on the calculation applied to the CER Calculation Sheet is as shown in **Appendix 4**.

Transmission and Distribution Losses (TDL_y)

According to page 35 of the registered PDD, the Transmission and Distribution Losses (TDL_y) value applied in this project is 10%. This value was reported in the Tenaga Nasional Berhad (TNB)[5] Annual Report 2007[6] in page 23.

Operation and Management Structure for Monitoring

The organization structure for the Bukit Tagar CDM monitoring team is shown below:

[5] Tenaga Nasional Berhad is the largest electricity provider in Malaysia and is responsible for the grid transmission and distribution in Peninsular Malaysia.
[6] http://announcements.bursamalaysia.com/EDMS/subweb.nsf/7f04516f8098680348256c6f0017a6bf/303144432ec51 70e482573af00388df6/$FILE/TENAGA-Cover%20to%20Page%2050%20(2.3MB).pdf

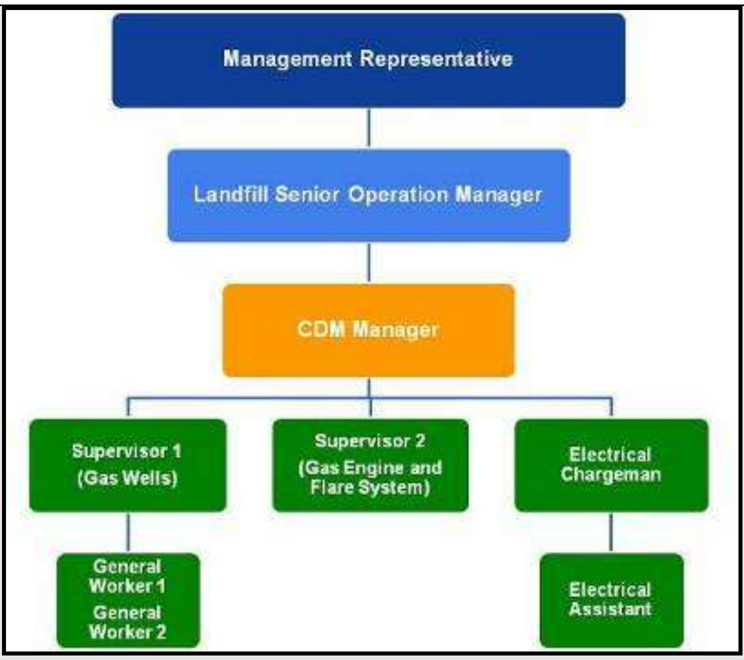


Figure 9: Organisational Structure for CDM Monitoring for BTSL LFG Recovery and Utilisation Project

The roles and responsibilities of the monitoring team in carrying out the MP are detailed as follow:

Table 1: Responsibilities of the CDM Monitoring Team

Role	Responsibility in CDM monitoring
Management Representative	• Reports to and obtain decisions from management on CDM-related matters • Chairs internal meetings on CDM matters • Signs off official correspondence for external parties
Senior Landfill Operation Manager	• Reports to the management representative (MR) • Oversees entire operation of landfills (including LFG management system) • Covers responsibility of CDM Manager when he is not available
CDM Manager	• Reports to the Senior Landfill Operation Manager • Oversees and coordinates the entire CDM monitoring plan • Verifies and signs off all relevant monitoring records • Ensures Quality Control / Quality Assurance (QC/QA) is carried out • Ensures all data are recorded and necessary documentations are prepared according to the requirements of CDM monitoring • Responsible in optimising the LFG extraction and utilisation system
CDM Consultant	• Provides advice on all CDM-related matters • Prepares monitoring reports for verifications • Liaises with the verifier on verification process • Conducts regular audits on CDM monitoring

Supervisors	• Report to the CDM Manager on CDM monitoring issues • Check and ensure that the flaring system is functional • Ensure all data recording devices are functioning and calibrated as planned (including performing QA/QC) • Check and sign the daily monitoring log sheets for CDM monitoring • Supervise general workers in maintenance work and record monitored parameters for CDM monitoring • Identify maintenance requirement and contact the supplier if maintenance and support are needed • Optimise the flare operation together with the CDM Manager • Responsible with the security of locked Programmable Logic Controller (PLC) control room. The supervisor will hold the door key for the PLC control room
Electrical Chargeman	• Conducts regular checks on the electrical components of the flaring system • Ensures continuous power supply to flaring system • Identifies and fixes all electrical and electronic faults detected • Ensures all electrical meters are functioning and calibrated as per the supplier requirement / industrial standards • Records the electricity consumption for the flare system in the daily monitoring log sheets
General Workers	• Perform regular operational and maintenance tasks • Record necessary readings in daily monitoring log sheets and request verification from the supervisors on the log sheets • Report any fault to supervisor-in-charge or the electrical chargeman

The team is overall headed by the MR who oversees the entire CDM monitoring implementation. The MR receives direct updates and support from the site staff headed by the Senior Landfill Operation Manager. The Senior Landfill Operation Manager is supported by the CDM Manager who is the key coordinator to all CDM monitoring matters on-site. The CDM Manager is assisted by a group of technicians and workers who will perform the daily recording and checking tasks.

The CDM Consultant (Eco-Ideal Consulting Sdn. Bhd.) was appointed to assist KBE in ensuring that the monitoring plan and requirements were done according to the MP. The consultant played the role of a trainer and conducted independent audits as part of the QA/QC procedures set up for this project.

During this monitoring period, a CDM Management Meeting was held on 16/07/2012.

Relevant Monitoring Points

The parameters monitored during the monitoring period are illustrated in the following figure:

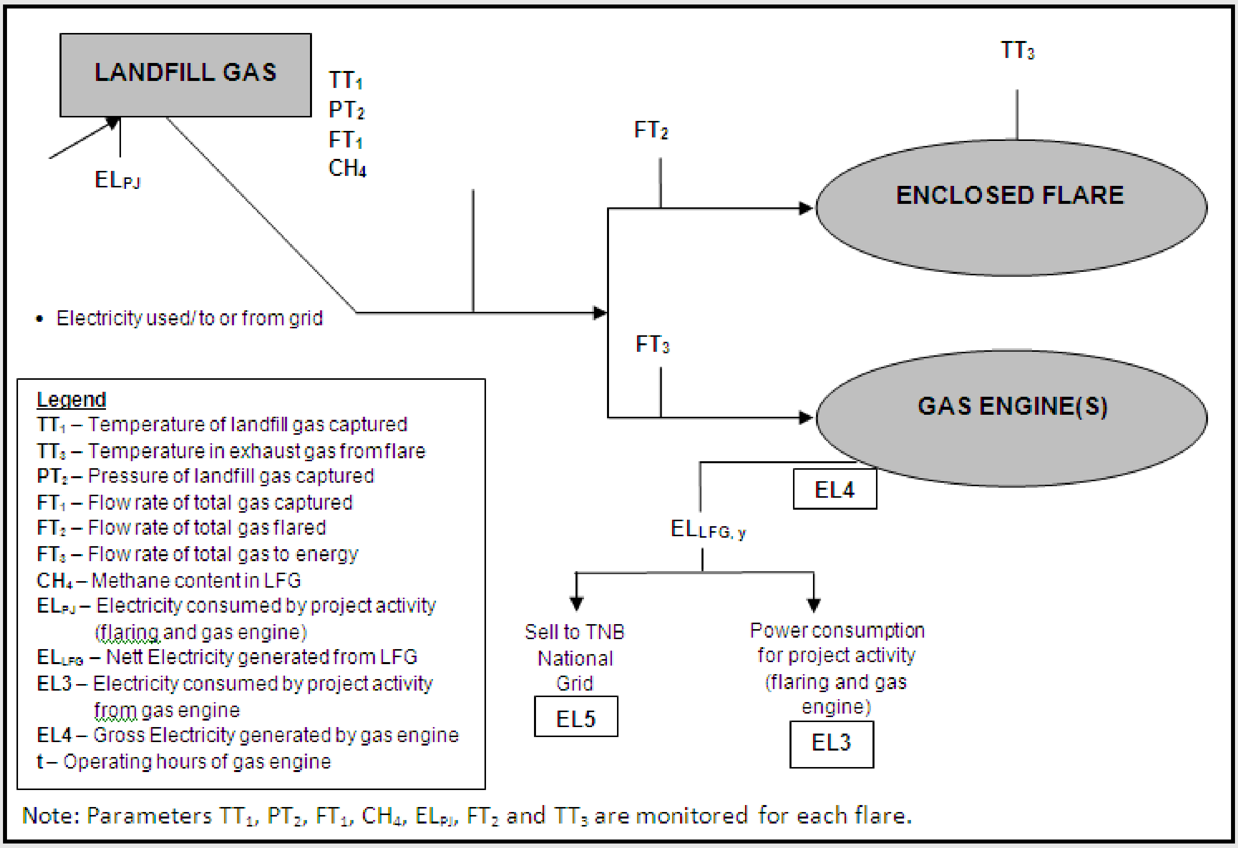


Figure 10: Key Parameters Monitored under the CDM Monitoring Plan

Remark: The power meter used to measure the electricity consumed by Flare No.1 and Flare No.2 from the grid was no longer in use effective from 22/06/2011. The total power consumption by the project activity from the grid (flaring systems and Gas Engine No.1) was measured by the new power meter installed, i.e. EL1.

A physical connection has been installed to allow the transfer of gas from Phase 1 Cell to Flare No.1. When Flare No.2 is unable to operate, the gas from Phase 1 Cell will be channelled to Flare No.1 to be flared. A part of the gas will also be transferred to the gen-set for electricity production if required. Necessary monitoring is carried out to ensure compliance with the MP.

Data Recording and Documentation

All relevant data/measurements of the parameters taken were recorded and kept in an appropriate format and archived after the crediting period to ensure that the data are accessible especially during the monitoring and verification process of the project.

Data was recorded in the following way:

Continuous Monitoring – Data in Softcopy:
Data logger (automatic recording in computer)

Manual Recording – Data in Hardcopy:

Daily monitoring log sheets and record books (manual recording)

Based on the MP, key parameters (temperature, pressure, flow of gas, CH_4 concentration in biogas) were continuously monitored and recorded via the data logger at the control room.

As a back-up data recording system, the on-site workers were required to manually record certain monitored parameters in daily monitoring log sheets. These records were filed and kept in the office which can be

accessible by the CDM Manager and technicians whenever necessary. These log sheets (in hard copies) were scanned for electronic filing on a monthly basis.

A summary of the data directly monitored is tabulated below:

Table 2: CDM Monitoring Parameters, Frequency and Archiving

Parameter	CDM ID	Equipment ID	Monitoring equipment	Recording frequency	Documentations	Data archive
Temperature	$T_{TT1,F1}$ $T_{TT1,F2}$	$TT_{1,Flare\ No.1/Flare\ No.2}$	Thermocouple	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into PDF format for archiving
Flare Temperature	$T_{Flare,F1}$ $T_{Flare,F2}$	$TT_{3,Flare\ No.1/Flare\ No.2}$	Thermocouple	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into PDF format for archiving
Pressure	$P_{PT2,F1}$ $P_{PT2,F2}$	$PT_{2,Flare\ No.1/Flare\ No.2}$	Pressure Gauge	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into PDF format for archiving
Flowrate	$LFG_{total,Flare\ No.1/Flare\ No.2,y}$ $LFG_{flare,Flare\ No.1/Flare\ No.2,y}$ $LFG_{electricity,Flare\ No.2,y}$	$FT_{1,Flare\ No.1/Flare\ No.2}$ $FT_{2,Flare\ No.1/Flare\ No.2}$ $FT_{3,Flare\ No.2}$	V-Cone Differential Pressure Flowmeter	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into PDF format for archiving
Methane Fraction	$W_{CH4,Flare\ No.1/Flare\ No.2,y}$	$CH_{4,Flare\ No.1/Flare\ No.2}$	Continuous Infrared Gas Analyser	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into PDF format for archiving

Electricity consumed by the project	$EL_{PJ,y}$ $EL_{PJ,GE,auxiliary\ \&\ flare,y}$	EL_{PJ} (EL1) $EL_{PJ,GE,auxiliary\ \&\ flare}$ (EL3)	kWh meter	Daily (manual)	Softcopy (scanned copy) Hardcopy	Data recorded will be compiled into MS Excel and aggregated for monthly amount Daily log sheet will be scanned for archiving
Electricity generated by LFG	$EL_{LFG,GE,total,y}$	$EL_{LFG,GE,total}$ (EL4)	kWh meter	Daily (manual)	Softcopy (scanned copy) Hardcopy	Data recorded will be compiled into MS Excel and aggregated for monthly amount Daily log sheet will be scanned for archiving
	$EL_{LFG,y}$	EL_{LFG} (EL5, TNB main energy meter) TNB check energy meter	kWh meter	Daily (manual)	Softcopy (scanned copy) Hardcopy	TNB joint meter reading certificate will be scanned for archiving

NOTE:
Data recorded by the flow meters were normalised to Nm^3 with the temperature and pressure monitored automatically via the software. Thus, there was no need to normalise the recorded flow further.

Monitoring Equipment and Equipment Calibration

The list of CDM monitoring equipment used is shown in Table 3 & Table 4 below:

Table 3: List of CDM Monitoring Equipment and Calibration for Flare No.1

No	Item	Parameters	Equipment ID	CDM Monitoring ID	Unit	Manufacturer	Model No.	Serial No.	Accuracy	Range	Last Calibration Date & Cert No.	Recommended Next Calibration Date	Recommended Frequency of Calibration
Flare System													
1	Temperature Transmitter	Temperature (T)	$TT_{1,Flare\ No.1}$	$T_{TT1,F1}$	°C	1. Honeywell	STT25M-0-EN0-000-000-000-00-3D	8224836437	±0.5%	0-100°C	26/04/2012 & SB 120291 (01/07/2012 - 11/12/2012)	25/04/2013	Annually
						2. PR Electronics	5335A	100944788	±0.5%	0-100°C	07/12/2012 & SB 121016 (12/12/2012 - 31/12/2012)	06/12/2013	Annually
2	Temperature Transmitter	Flare Temperature ($T_{flare,1}$)	$TT_{2,Flare\ No.1}$	$T_{flare,F1}$	°C	1. Honeywell	STT25M-0-EN0-000-000-000-00-	8123070037	±0.5%	0-1200°C	26/04/2012 & SB 120293 (01/07/2012 - 21/09/2012)	25/04/2013	Annually
						2. Honeywell	STT25M-0-EN0-000-000-000-00-	8449004837	±0.5%	0-1200°C	21/09/2012 & SB 120840 (22/09/2012 - 11/12/2012)	20/09/2013	Annually
						3. PR Electronics	5335A	100906480	±0.5%	0-1200°C	07/12/2012 & SB 121015 (12/12/2012 - 31/12/2012)	06/12/2013	Annually
3	Pressure Sensor	Pressure Transmitter (P)	$PT_{2,Flare\ No.1}$	$P_{PT2,F1}$	kPa	Rosemount	3051TG1A2B21AB4E5M5Q4	1. 02255815	±0.25%	0-2 to 0-207 kPa	28/04/2012 & SB 120290 (01/07/2012 - 11/12/2012)	25/04/2013	Annually
								2. 02492864	±0.25%	0-2 to 0-207 kPa	21/12/2012 & SB 121094 (12/12/2012 - 31/12/2012)	20/12/2013	Annually
4	Flow Meter	Total Biogas Flow Rate ($LFG_{total,1}$)	$FT_{1,Flare\ No.1}$	$LFG_{total,Flare\ No.1,1}$	NM^3/hr	Kingsway Vcone Flow transmitter	3051 / KVS10IIKC23FSN	4972946 / FT119 (8102101)	±1%	5-5000Nm³/h	28/04/2011 & SB 110591 (01/07/2012 - 31/12/2012)	27/04/2013	24 months
5	Flow Meter	Flaring Biogas Flow Rate ($LFG_{flare,1}$)	$FT_{2,Flare\ No.1}$	$LFG_{flare,Flare\ No.1,1}$	NM^3/hr	Kingsway Vcone Flow transmitter (Rosemount)	3051 / KVS10IIKC23FSN	1. 4972945 / FT120 (8102102)	±1%	5-5000Nm³/h	28/04/2011 & SB 110592 (01/07/2012 - 21/09/2012)	27/04/2013	24 months
								2. 02255813	±1%	5-5000Nm³/h	21/09/2012 & SB 120839 (22/09/2012 - 11/12/2012)	20/09/2014	24 months
								3. 02768008	±1%	5-5000Nm³/h	21/12/2012 & SB 121096 (12/12/2012 - 31/12/2012)	20/12/2014	24 months
Gas Analysers													
6	CH_4 Meter	Methane fraction of LFG	$CH_{4,Flare\ No.1}$	$W_{CH4,Flare\ No.1,y}$	%	Guardian Plus	97460	28931	±2% of full scale	0-100%	26/04/2012 & SB 120288 (01/07/2012 - 31/12/2012)	25/04/2013	Annually

Span Gas			
No	**Parameters**	**Analysis date**	**Best if used by**
1	N_2, CH_4	18/02/2009	18/02/2014
		01/08/2011	01/08/2021
2	N_2, CO_2	03/02/2009	03/02/2014
3	N_2, O_2	26/10/2009	26/10/2019
		09/01/2012	09/01/2022

During this monitoring period, the equipment which has an overdue calibration is as listed below:

1. *PT2 - The maximum permissible error of ±0.25% has to be applied for PT2 from 11/12/2012 - 21/12/2012 as a conservative approach - effect to normalised flow calculations was demonstrated*
2. *FT2 - The maximum permissible error of ±1% has to be applied for FT2 from 11/12/2012 - 21/12/2012 as a conservative approach*

Table 4: List of CDM Monitoring Equipment and Calibration for Flare No.2

No	Item	Parameters	Equipment ID	CDM Monitoring ID	Unit	Manufacturer	Model No.	Serial No.	Accuracy	Range	Last Calibration Date & Cert No.	Recommended Next Calibration Date	Recommended Frequency of Calibration
Flare System													
1	Temperature Transmitter	Temperature (T)	$TT_{1,Flare\ No.2}$	$T_{TT1,F2}$	°C	Honeywell	STT25M-0-EN0-000-000-000-30-3D	8839917437	±0.5% of span	0-100°C	27/04/2012 & SB 120297 (01/07/2012 - 31/12/2012)	26/04/2013	Annually
2	Temperature Transmitter	Flare Temperature	$TT_{2,Flare\ No.2}$	$T_{flare,F2}$	°C	Honeywell	STT25M-0-EN0-000-000-000-30-3D	8888901937	±0.5% of span	0-1200°C	27/04/2012 & SB 120299 (01/07/2012 - 31/12/2012)	26/04/2013	Annually
3	Pressure Sensor	Pressure Transmitter (P)	$PT_{1,Flare\ No.2}$	$P_{PT1,F2}$	kPa	Rosemount	3051TG1A2B21AB4E5Q4	5584784	±0.25%	0-2 to 0-207 kPa	27/04/2012 & SB 120296 (01/07/2012 - 31/12/2012)	26/04/2013	Annually
4	Flow Meter	Total Biogas Flow Rate	$FT_{1,Flare\ No.2}$	$LFG_{total,Flare\ No.2,y}$	NM^3/hr	Kingsway Flow transmitter	3051CD1A22A1AM5K5Q4 /	5476626 / FT141 (10031702)	±0.5%	3-5000Nm³/h	29/04/2011 & SB 110601 (01/07/2012 - 31/12/2012)	28/04/2013	24 months
5	Flow Meter	Flaring Biogas Flow Rate	$FT_{2,Flare\ No.2}$	$LFG_{flare,Flare\ No.2,y}$	NM^3/hr	Kingsway Flow transmitter	3051CD1A22A1AM5K5Q4 /	5476627 / FT140 (10031701)	±0.5%	3-5000Nm³/h	29/04/2011 & SB 110600 (01/07/2012 - 31/12/2012)	28/04/2013	24 months
6	Flow Meter	Flow Rate of Total Gas to Energy ($LFG_{electricity,y}$)	$FT_{3,Flare\ No.2}$	$LFG_{electricity,Flare\ No.2,y}$	NM^3/hr	Kingsways Control Flow transmitter (Rosemount)	1. 3051CD1A22A1AM5K5Q4 / KVS08IIKC23FSN	5490821 / FT161 (11011001)	±0.5%	200-2000Nm³/h	20/01/2011 & D11-046-JG (01/07/2012 - 11/12/2012)	19/01/2013	24 months
							2. 3051CD1A22A1AM5B4K5Q4	02768007	±0.5%	200-2000Nm³/h	04/10/2012 & 80434527 (PO) (12/12/2012 - 31/12/2012)	03/10/2014	24 months
Gas Analysers													
7	CH_4 Meter	Methane fraction of LFG	$CH_{4,Flare\ No.2}$	$W_{CH4,Flare\ No.2,y}$	%	Guardian Plus	97460	30548	±2% of full scale	0-100%	27/04/2012 & SB 120294 (01/07/2012 - 16/11/2012)	26/04/2013	Annually
								31453	±2% of full scale	0-100%	21/06/2011 & E-0643/0611 (17/11/2012 - 14/12/2012)	20/06/2012	Annually
								31453	±2% of full scale	0-100%	14/12/2012 & E-1181/1212 (15/12/2012 - 31/12/2012)	13/12/2013	Annually

Power Generation and Electricity Consumption													
8	Power meter	Electricity consumed (from grid for flaring system & GE)	EL[illegible] (EL1)	EL[illegible]	kWh	IME	NEMO 96HD+ (MF96021)	2167 8900 35	Class 0.5S (±0.5%)	0-400/5A	10/05/2011 & 2167 8900 35 (01/07/2012 - 31/12/2012)	09/05/2014	36 months
9	Power meter	Electricity consumed (from GE for Flare 1, Flare 2 & GE	EL[illegible] (EL3)	EL[illegible]	kWh	IME	NEMO 96HD+ (MF96021)	1. 2550 3800 15	Class 0.5S (±0.5%)	0-500/5A	20/06/2012 & 2550 3800 15 (01/07/2012 - 09/07/2012)	19/06/2015	36 months
								2. 2175 4100 36	Class 0.5S (±0.5%)	0-500/5A	21/06/2012 & 2175 4100 36 (10/07/2012 - 31/12/2012)	20/06/2015	36 months
10	Power meter	Total electricity generation (MWh) - recorded by project site	EL[illegible] (EL4)	EL[illegible]	kWh (to be converted to MWh)	EDMI Limited	Mk6E	210225256	Class 0.5S	99999999.99k Wh	15/07/2010 & 210225256 1918937 (01/07/2012 - 23/07/2012)	14/07/2012	24 months
											23/07/2012 & SP/RA/2012/314/001-001 (24/07/2012 - 31/12/2012)	22/07/2014	24 months
11	Power meter	Electricity sell to grid (MWh) - recorded by grid operator	EL[illegible] (EL5)	EL[illegible]	kWh	Itron	SL761A071	53099890	Class 0.20	99999999kWh	01/04/2011 & TNBM-QR-064 (01/07/2012 - 31/12/2012)	31/03/2016	5 years
12	Power meter	Electricity sell to grid (MWh) - check energy meter recorded by grid operator	-	-	kWh	Itron	SL761A071	53099681	Class 0.20	99999999kWh	01/04/2011 & TNBM-QR-064 (01/07/2012 - 31/12/2012)	31/03/2016	5 years

Span Gas			
No	Parameters	Analysis date	Best if used by
1	N_2, CH_4	04/10/2010	04/10/2020
2	N_2, CO_2	04/10/2010	04/10/2020
3	N_2, O_2	04/10/2010	04/10/2020

During this monitoring period, the equipment which has an overdue calibration is as listed below:

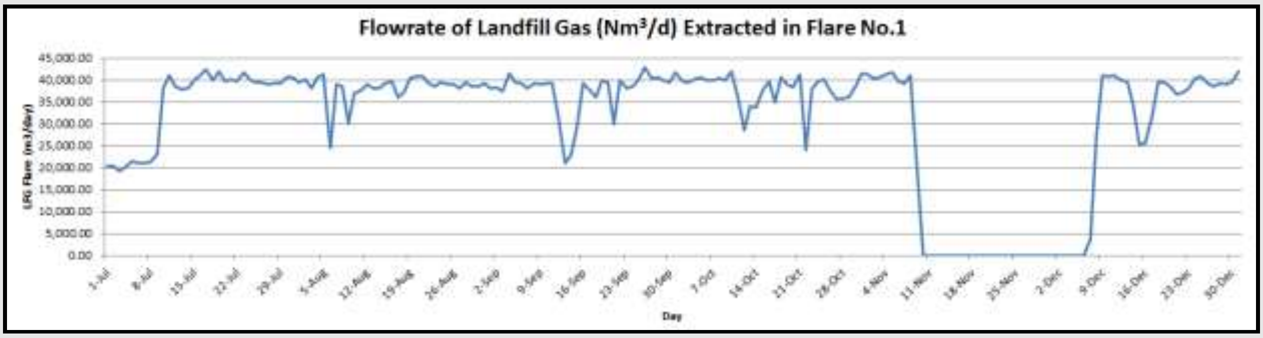
1. *CH4 - The maximum permissible error of ±2% was applied to CH4 from 16/11/2012 - 14/12/2012 as a conservative approach*
2. *EL4 - The maximum permissible error of ±0.5% was applied to EL4 from 15/07/2012 - 23/07/2012 as a conservative approach*

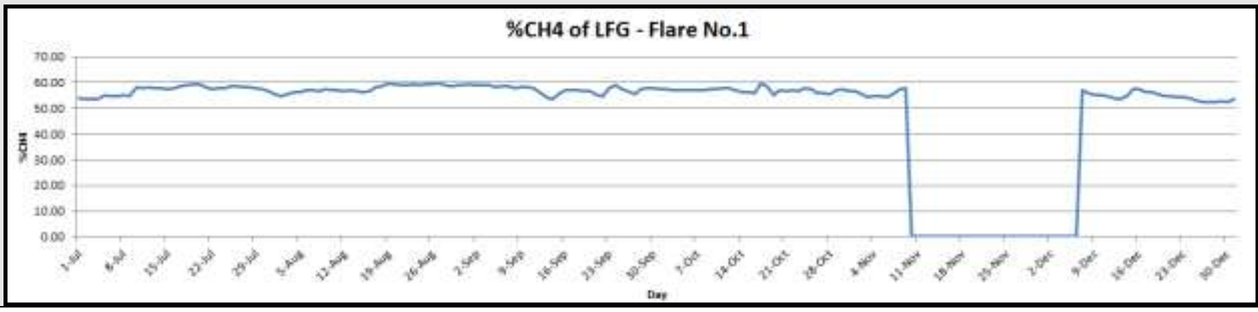
Data Collection (for the whole monitoring period)

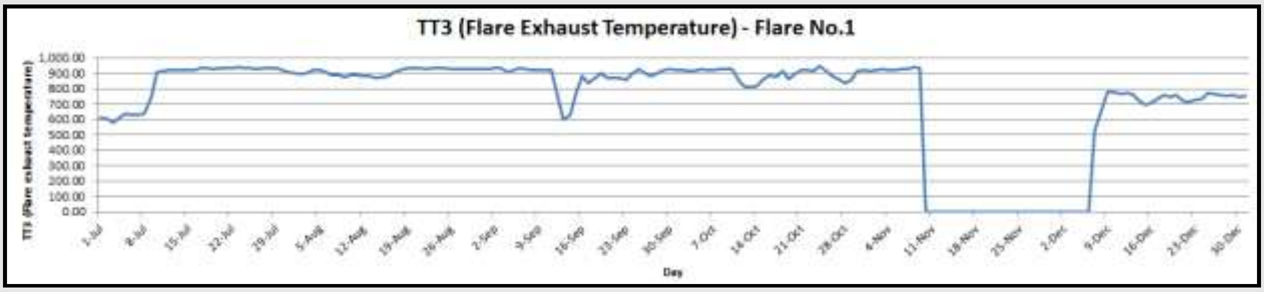
Based on the monitoring plan, key flaring parameters (temperature, pressure, flow of gas, CH_4 concentration in LFG) were continuously monitored and recorded via the data logger at the flare system control room. Continuous flaring data were logged and archived in every minute in the database file. These raw data were compiled and analysed for the calculation of Certified Emission Reductions (CERs).

Data recorded for key parameters are compiled and presented below:

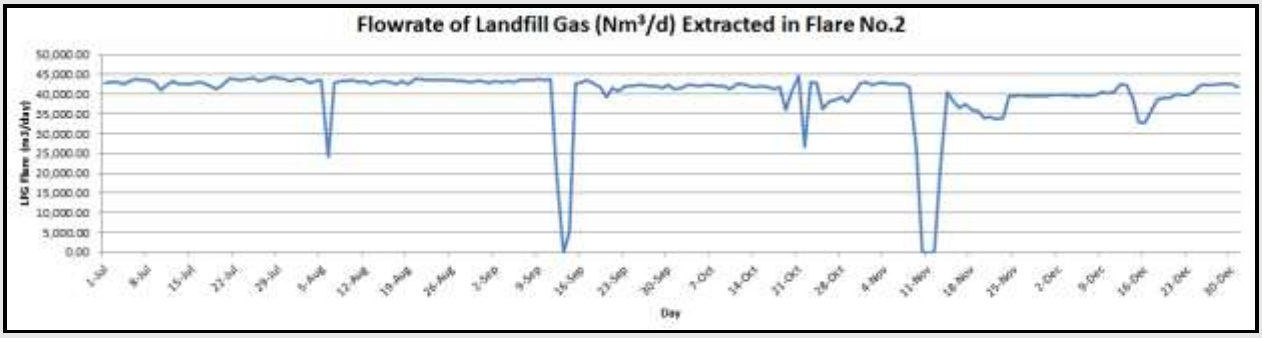
Flare No.1

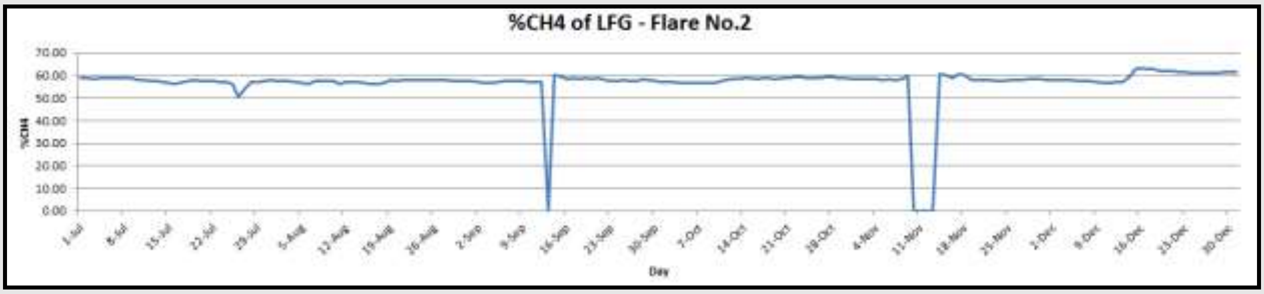


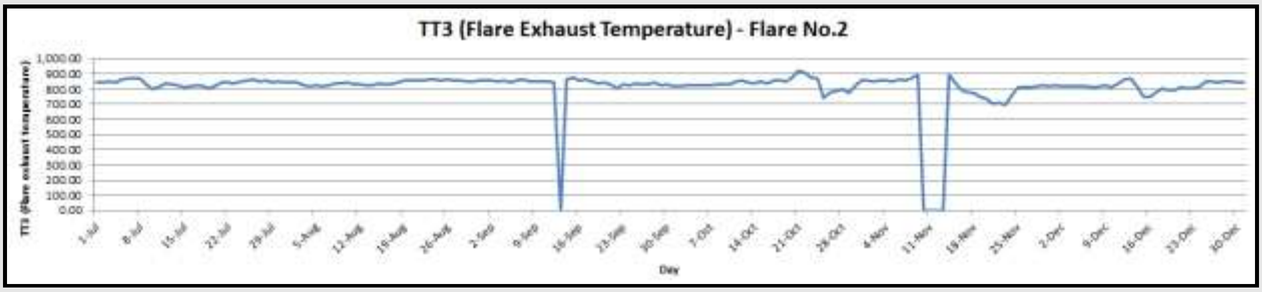


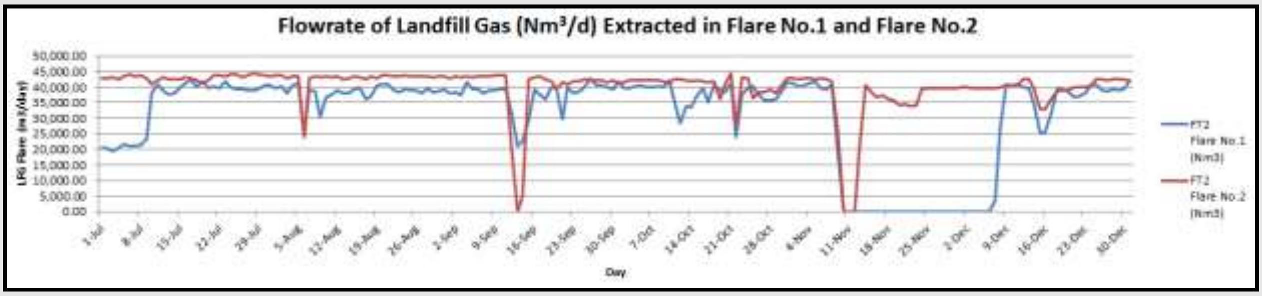


Flare No.2









As a back-up data recording system, the on-site workers have manually recorded certain monitored parameters in the Daily Monitoring Log Sheets. These records were scanned into soft copies for electronic filing on a monthly basis.

Data recorded manually (not recorded in the data logger system), i.e. electricity consumed were recorded in

daily monitoring log sheets on a daily basis and compiled in Microsoft (MS) Excel format weekly.

Data Processing

The data logged were archived in .db file format and compiled.

Data recorded were further processed to yield the results required. A specific computation programme (in MS Access) was developed by the CDM Consultant to process continuously-monitored data to the required format and summary.

An example of data aggregation on-site for flow rate of LFG at the main pipe is shown as follows:

Parameter: FT_1 (Flow rate of LFG at main pipe)

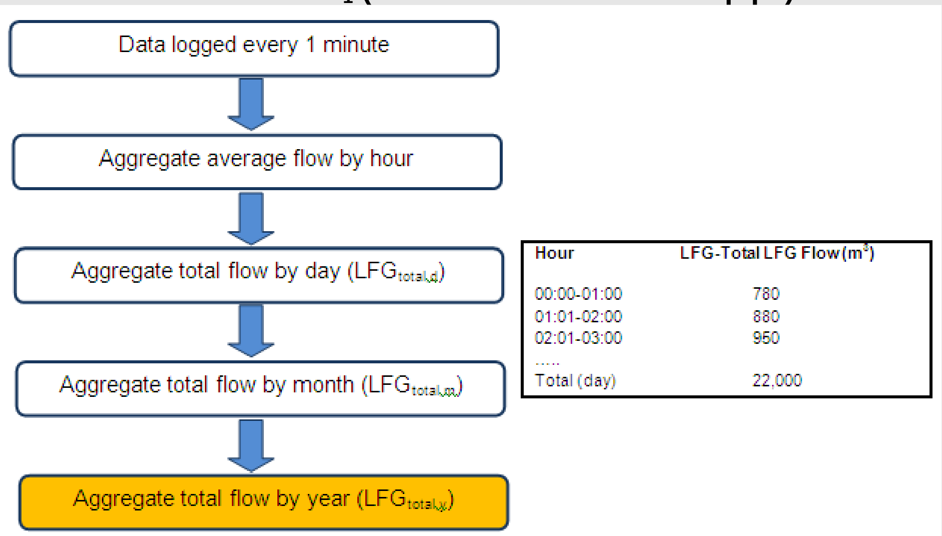


Figure 11: Example of Data Aggregation for Continuous Monitoring

Raw data logged at one (1) minute's interval were used to compute the hourly average. Subsequently, daily readings were computed, followed by aggregation into monthly and finally, yearly summaries.

Similar average values were computed for parameters such as the temperature, pressure and % CH_4.

In accordance to the *Tool to determine project emissions from flaring gases containing methane* (EB 28, Annex 13), 3 conditional default values for flare efficiency can be used for the calculation of CERs. The main criteria or condition for choosing the right default values for each hour is to assess the exhaust gas temperature from the flare stack ($T_{flare,h}$). On the other hand, all the operational parameters (temperature, pressure, etc.) related to CDM monitoring will also have to be taken into account as these parameters can affect $T_{flare,h}$. Therefore, the data of these parameters were recorded continuously through the PLC system.

<u>Quality Assurance and Quality Control (QA & QC)</u>

<u>Documented Procedures and QA/QC Measures</u>

QA/QC was applied throughout the monitoring period:

- Daily inspection of LFG extraction, flaring and monitoring systems;
- Checking and counter-signing of data forms by the CDM Manager;
- Data security (restricted access, password control) was applied to ensure the integrity of data;
- Inspection, observations, incidents and follow-up actions were documented;
- Independent audits were carried out by external consultants; and
- Data was analysed on a weekly basis to determine any irregularities.

<u>Data Management and Storage</u>

A proper data back-up system has been set up to ensure that the data will not be compromised in case of any unforeseen incidents at site resulting in total loss of data. The retention/archiving period for verification and CER issuance documents should be kept in electronic form for at least 2 years after the crediting period.

<u>Continuous Monitoring (data logging system)</u>

The data from continuous monitoring (data logger) was primarily stored in the hard disk located in the flare control room. To ensure that all data recorded are safe and properly archived, the following back-up system was applied for this project:

Types of back-up	Frequency	Back-up location
Manual back-up using a portable hard disk (HD)	Monthly	At the flare
Automatic back-up to the CDM Manager's PC located at the site office, BTSL	Weekly	On-site (site office)
Data server in the CDM Consultant's office (Eco-Ideal Consulting Sdn. Bhd., C-7-2, Wisma Goshen, Plaza Pantai, Kuala Lumpur, Malaysia)	Weekly	Off-site (consultant's office)

The data stored in the data server located at the CDM Consultant's office will be used as the primary back-up data in case of any emergency situation resulting in the loss of data from the flare data recording system.

The automatic data back-up system based on internet data transmission can be illustrated as follows:

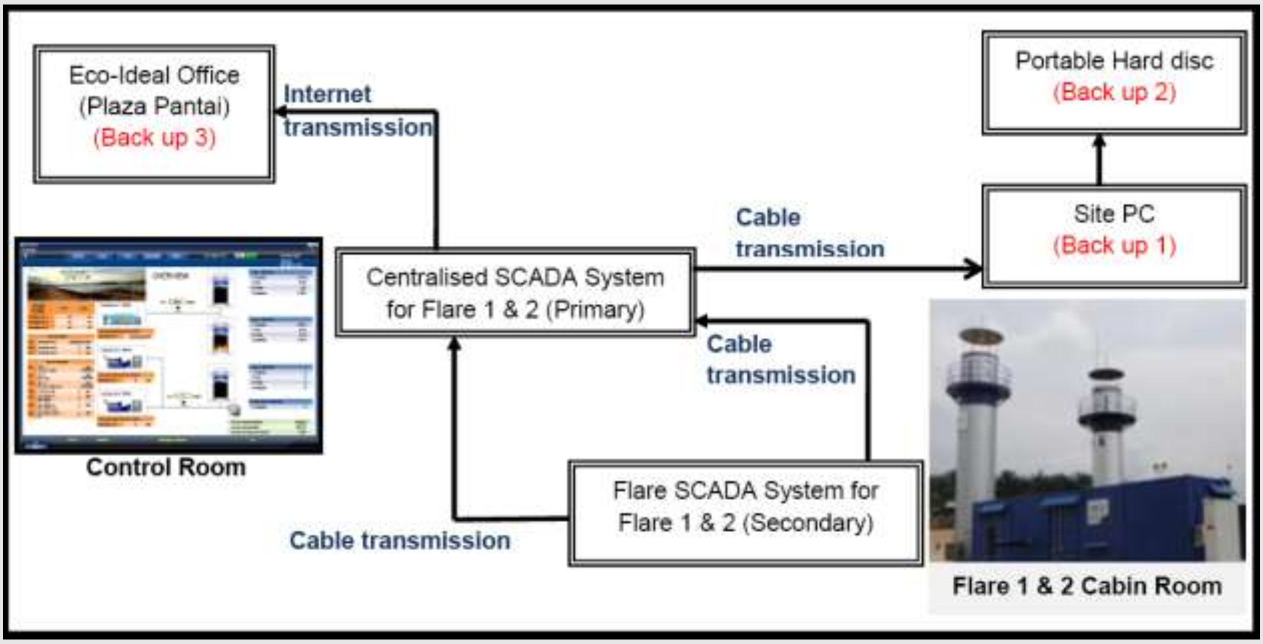


Figure 12: Automatic Data Back-Up for Flaring System at BTSL

<u>Manual Recording</u>

Daily operational data (consisting of CDM parameters monitored) recorded manually was backed-up by scanning all the daily monitoring log sheets on a weekly basis. These data were primarily stored in the computer at the cabin office next to the flare cabin. A copy of these scanned log sheets were handed to the CDM Consultant on a monthly basis for secondary back-up.

Independent Audits and Control Measures

All procedures for audit and QC measures were detailed in the CDM Audit Plan and Procedures. An independent audit relevant to the 6th monitoring period planned to be conducted by the consultant (Eco-Ideal Consulting Sdn. Bhd.):

- Audit No. 9 – 04/01/2013

The independent audit served as an important QC measure to ensure that all the monitoring required are done in accordance to the plan. Through the audit, the project can pre-empt any potential problems, issues as well as identify improvement measures during the monitoring period.

Training

Training is important to ensure that all the involved staff is provided with the needed knowledge and skills to undertake their roles effectively according to the CDM MP.

During this monitoring period, the staff has also attended several technical/operational trainings as listed below:

No.	Description	Date	No. of participants
1	Refresher Training – Landfill Gas System	03/08/2012	6
2	Training – Gas Engine (Pre-treatment)	02/10/2012	5
3	Training – SPE (Gas Engine Service)	18/12/2012	5

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante or at renewal of crediting period

Data / Parameter	**Regulatory requirement relating to landfill gas projects**
Unit	-
Description	Regulatory requirement relating to landfill gas projects
Source of data	There is no regulatory requirement to recover and utilize landfill gas in Malaysia. Confirmation from the Department of National Solid Waste Management of the Ministry of Housing and Local Government regarding regulation aspects of landfill gas has already been obtained at the beginning of the earliest crediting period, i.e. during the 1st monitoring period (28/08/2009 – 28/02/2010).
Value (s) applied	NA
Purpose of data	Baseline emission calculation
Additional Comment	-

Data / Parameter	**GWP_{CH4}**
Unit	tCO_2e/tCH_4
Description	Global Warming Potential (GWP) for CH_4
Source of data	Intergovernmental Panel on Climate Change (IPCC), Technical Summary, Working Group 1, page 33 The default value given by IPCC 2006 guideline for GWP of CH_4
Value (s) applied	21
Purpose of data	Baseline emission calculation
Additional Comment	-

Data / Parameter	**D_{CH4}**
Unit	t_{CH4}/m^3_{CH4}
Description	CH_4 density at standard temperature and pressure
Source of data	ACM 0001 – *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8)
Value (s) applied	0.0007168
Purpose of data	Baseline and Project emission calculation
Additional Comment	-

Data / Parameter	**Φ**
Unit	-
Description	Model correction factor to account for model uncertainties
Source of data	This uncertainty factor was adopted and the value is 0.9 based on recommendations in the *Tool to determine methane emissions avoided from dumping waste at solid waste disposal site*
Value (s) applied	0.9
Purpose of data	Baseline emission calculation
Additional Comment	-

Data / Parameter	**f**
Unit	-
Description	Fraction of methane captured at the solid waste disposal site (SWDS) and flared, combusted or used in another manner
Source of data	There is no methane flared, combusted or used for other purposes in the baseline scenario
Value (s) applied	0
Purpose of data	Baseline emission calculation
Additional Comment	-

Data / Parameter	**OX**
Unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	Site-visit reveals that this landfill is well managed and soil cover is applied on a daily basis. Therefore, the value 0.1 was applied as recommended by *the Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*
Value (s) applied	0.1
Purpose of data	Baseline emission calculation
Additional Comment	-

Data / Parameter	**F**
Unit	%
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	This value was applied based on the recommendation of the IPCC in the *Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site*
Value (s) applied	0.5
Purpose of data	Baseline emission calculation
Additional Comment	-

Data / Parameter	DOC_f
Unit	%
Description	Fraction of degradable organic carbon (DOC) that can decompose
Source of data	This value was applied based on IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value (s) applied	0.5
Purpose of data	Baseline emission calculation
Additional Comment	-

Data / Parameter	MCF
Unit	-
Description	Methane Correction Factor
Source of data	This value was applied based on the recommendation of the IPCC 2006 Guidelines for National Greenhouse Gas Inventories. BTSL site is a fully anaerobically-managed SWDS. The waste received at the landfill was deposited at a specific tipping phase and there was no scavenging of waste in the landfill. Wastes were covered daily with compacted soil. Compaction as well as levelling is practiced based on the international landfill operational practices
Value (s) applied	1.0
Purpose of data	Baseline emission calculation
Additional Comment	-

Data / Parameter	DOC_j
Unit	-
Description	Fraction of degradable organic carbon (by weight) in the waste type *j*
Source of data	The above values were adopted from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 2.4)
Value (s) applied	The following values for the different waste fraction (types) were applied: (see table below)
Purpose of data	Baseline emission calculation
Additional Comment	-

DOC_j

Waste type *j*	DOC_j (% wet basis)	DOC_j (% dry basis)
Wood and wood products	**43**	50
Pulp, paper and cardboard (other than sludge)	**40**	44
Food, food waste, beverages and tobacco (other than sludge)	**15**	38
Textiles	**24**	30
Garden, yard and park waste	**20**	49
Glass, plastic, metal, other inert waste	**0**	0
Nappies	**24**	60

<table>
<tr><td>Data / Parameter</td><td>kj</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data</td><td>The above values were adopted from IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value (s) applied</td><td>The following values for the different waste fraction (types) were applied:
<table>
<tr><th colspan="2" rowspan="2">Waste type j</th><th colspan="2">Boreal and Temperature (MAT<20°C)</th><th colspan="2">Tropical (MAT>20°C)</th></tr>
<tr><th>Dry (MAP/PET<1)</th><th>Wet (MAP/PET>1)</th><th>Dry (MAP<1000 mm)</th><th>Wet (MAP>1000 mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td><td>0/06</td><td>0.045</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td><td>0.03</td><td>0.025</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td><td>0.1</td><td>0.065</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.06</td><td>0.185</td><td>0.085</td><td>0.4</td></tr>
</table>
</td></tr>
<tr><td>Purpose of data</td><td>Baseline emission calculation</td></tr>
<tr><td>Additional Comment</td><td>The project site is located in the State of Selangor, Malaysia. The climate is tropical with an annual mean 24-hr temperature of approximately 27°C and annual mean precipitation of around 2,700 mm. These values were long-term averages documented in the Environmental Impact Assessment (EIA) Report prepared for the landfill in 2005. Thus, the K-values for tropical temperature and wet climate were used</td></tr>
</table>

D.2. Data and parameters monitored

Data / Parameter	**$LFG_{total,y}$**
Unit	m^3
Description	Total amount of LFG captured during the project at normal temperature and pressure
Measured/ Calculated/ Default	Measured
Source of data	Continuous measurement by flow meter during operation of project activity. This parameter was measured continuously and separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period. During temporary malfunctioning of flow meter or data logging system resulting in unrepresentative data, the value of LFG_{total} for the affected period will be taken as the sum of LFG_{flare} and $LFG_{eletricity.}$
Value (s) of monitored parameter	**<u>Flare No.1</u>** According to ACM 0001, version 8[7], page 15 of section III monitoring methodology, the amount of landfill gas generated (in m^3 using a continuous flow meter), where the total quantity (LFG_{total}), as well as the quantities fed to the flare (s) (LFG_{flare}), to the power plant (s) ($LFG_{electricity}$) are measured continuously. In the case where LFG is just flared, one flow meter for each flare can be used provided that these meters used are calibrated periodically by an officially accredited entity; The total LFG captured was the same as the total LFG flared for Flare No.1 during the monitoring period as total LFG captured in Flare No1 was only sent to flare. **<u>Flare No.2</u>** According to ACM 0001, version 8, page 15 of section III monitoring methodology, the amount of landfill gas generated (in m^3 using a continuous flow meter), where the total quantity (LFG_{total}), as well as the quantities fed to the flare (s) (LFG_{flare}), to the power plant (s) ($LFG_{electricity}$) are measured continuously. In the case where LFG is just flared, one flow meter for each flare can be used provided that these meters used are calibrated periodically by an officially accredited entity. From 01/06/2011, the total LFG captured (FT1) is the summation of total LFG flared (FT2) and total LFG electricity (FT3). As a conservative approach, during normal operation, the values of FT1 will be compared with the total of FT2 and FT3 and the lower value of the FT will be used for ER calculation. For the comparison, there are 2 cases which will happen: 1. *<u>When FT1 is greater than FT2 + FT3</u>* When FT1 is greater, the total values of FT2 + FT3 will be used and presented as the value of FT1 in the ER calculation as a conservative approach. 2. *<u>When FT1 is lower than FT2 + FT3</u>* When FT1 is lower, FT1 will then be used in the ER calculation as a

[7] The ACM0001 - *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8) is no longer valid and is not available for download in UNFCCC. The version has been replaced with Version 8.1.

	conservative approach.

Months	Flare No.2 FT1 Value (Nm^3)	Flare No.2 Total of FT2 & FT3 Value (Nm^3)
July 12	1,686,592.58	1,627,396.24
August 12	1,670,021.00	1,635,478.53
September 12	1,494,717.03	1,459,745.75
October 12	1,577,130.96	1,549,720.07
November 12	1,328,060.02	1,254,035.21
December 12	1,598,741.57	1,542,550.04
Total	**9,355,263.16**	**9,068,925.84**

From the monthly comparison of the FT1 & FT2 + FT3 values above, the lower value between the two is taken for the calculation of CERs.

Months	Flare No.1 Value (Nm^3)	Flare No.2 Value (Nm^3)
July 12	1,067,000.73	1,627,396.24
August 12	1,185,525.37	1,635,478.53
September 12	1,116,670.47	1,459,745.75
October 12	1,173,754.56	1,549,720.07
November 12	344,416.67	1,254,035.21
December 12	894,408.49	1,542,550.04
Total	**5,781,776.29**	**9,068,925.84**

For this monitoring period for Flare No.2, the total values of FT2 + FT3 was used in the ER calculation since FT1 is greater than FT2 + FT3.

Monitoring equipment

Item	Flare No.1 Description	Flare No.2 Description
	01/07/2012 – 31/12/2012	**01/07/2012 – 31/12/2012**
Type	Differential Pressure Transmitter – Kingsway Vcone, Flow transmitter – Rosemount	Differential Pressure Transmitter – Kingsway Vcone, Flow transmitter – Rosemount
Accuracy class	± 1%	± 0.5%
Serial No.	4972946 (Rosemount) / FT1 – FT119 (8102101)	5476626 (Rosemount) / FT1 – FT141 (10031702)
Calibration frequency	24 months	24 months
Date of last calibration	28/04/2011	29/04/2011
Validity	24 months	24 months

Measuring/ Reading/ Recording frequency	Measured continuously with a flow meter. Data was aggregated on both monthly and yearly basis
Calculation method (if applicable)	NA
QA/QC procedures	Flow meters were tested, calibrated and maintained regularly

Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	**$LFG_{flare,y}$**
Unit	m^3
Description	Total amount of LFG sent to flare at normal temperature and pressure
Measured/ Calculated/ Default	Measured
Source of data	Continuous measurement by flow meter during operation of project activity. This parameter was measured separately for both of the flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period. During temporary malfunctioning of flow meter or data logging system resulting in unrepresentative data, the value of LFG_{flare} for the affected period will be derived by subtracting $LFG_{electricity}$ from LFG_{total}.
Value (s) of monitored parameter	**<u>Flare No.2</u>** From 01/06/2011, the total LFG flared continued to be measured by FT2. As a conservative approach, during normal operation, the value of FT1 will be compared with the total of FT2 and FT3 and the lower value of the FT will be used for ER calculation. For the comparison, there are 2 cases which will happen: 1. *<u>When FT1 is greater than FT2 + FT3</u>* The value of FT2 will be used in the ER calculation as a conservative approach. 2. *<u>When FT1 is lower than FT2 + FT3</u>* The value of FT1 will be used to calculate the proportion of FT2 by ratio (formula: FT2 value = FT2 / (FT2 + FT3) * FT1.) The calculated value of the proportion of FT2 will be used in the ER calculation as a conservative approach.

Months	Flare No.1 Value (Nm^3)	Flare No.2 Value (Nm^3)
July 12	1,067,000.73	1,337,115.83
August 12	1,185,525.37	1,323,616.85
September 12	1,116,670.47	1,175,372.55
October 12	1,173,754.56	1,263,956.88
November 12	344,416.67	1,026,563.61
December 12	894,408.49	1,239,378.11
Total	**5,781,776.29**	**7,366,003.83**

From the monthly comparison of the FT1 & FT2 + FT3 in this monitoring period, the value of FT2 was used in the ER calculation since FT1 is greater than FT2 + FT3.

<table>
<tr><td>Monitoring equipment</td><td>

Item	Flare No.1 Description	Flare No.1 Description
	01/07/2012 – 21/09/2012	22/09/2012 – 11/12/2012
Type	Differential Pressure Transmitter – Kingsway Vcone, Flow transmitter – Rosemount	Differential Pressure Transmitter – Kingsway Vcone, Flow transmitter – Rosemount
Accuracy class	± 1%	± 1%
Serial No.	4972945 (Rosemount) / FT2 – FT120 (8102102)	02255813
Calibration frequency	24 months	24 months
Date of last calibration	28/04/2011	21/09/2012
Validity	24 months	24 months

Item	Flare No.1 Description	Flare No.2 Description
	12/12/2012 – 31/12/2012	01/07/2012 – 31/12/2012
Type	Differential Pressure Transmitter – Kingsway Vcone, Flow transmitter – Rosemount	Differential Pressure Transmitter – Kingsway Vcone, Flow transmitter – Rosemount
Accuracy class	± 1%	± 0.5%
Serial No.	02768008	5476627 (Rosemount) / FT2 – FT140 (10031701)
Calibration frequency	24 months	24 months
Date of last calibration	21/12/2012	29/04/2011
Validity	24 months	24 months

<u>Flare No.1</u>
On 21/09/2012, there was a change of flow meter from the 4972945 (Rosemount) / FT2 – FT120 (8102102) unit to 02255813 unit. Later, on 11/12/2012, the 02255813 unit was replaced with 02768008 unit. The maximum permissible error of ±1% has to be applied for FT2 from 11/12/2012 - 21/12/2012 as a conservative approach
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency</td><td>Measured continuously with flow meter. Data was aggregated on both monthly and yearly basis</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Raw data logged at 1 minute’s interval were used to compute the hourly average. Subsequently, daily readings were computed, followed by aggregation into monthly and finally, yearly records</td></tr>
<tr><td>QA/QC procedures</td><td>Flow meters were tested, calibrated and maintained regularly</td></tr>
<tr><td>Purpose of data</td><td>Baseline and Project emission calculation</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data / Parameter	$LFG_{electricity,y}$
Unit	m^3
Description	Amount of landfill gas combusted in power plant (Gas Engine No.1) at normal temperature and pressure
Measured/ Calculated/ Default	Measured

Source of data	Continuous measurement by flow meter during operation of project activity. During temporary malfunctioning of flow meter or data logging system resulting in unrepresentative data, the value of $LFG_{electricity}$ for the affected period will be derived by subtracting LFG_{flare} from LFG_{total}.
Value (s) of monitored parameter	**<u>Flare No.2</u>** From 01/06/2011, the total LFG for electricity is measured by FT3. As a conservative approach, during normal operation, the value of FT1 will be compared with the total of FT2 and FT3 and the lower value of the FT will be used for ER calculation. For the comparison, there are 2 cases which will happen: 1. *<u>When FT1 is greater than FT2 + FT3</u>* The value of FT3 will be used in the ER calculation as a conservative approach 2. *<u>When FT1 is lower than FT2 + FT3</u>* The value of FT1 will be used to calculate the proportion of FT3 by ratio (formula: FT3 value = FT3 / (FT2 + FT3) * FT1. The calculated value from the proportion of FT3 will be used in the ER calculation as a conservative approach.

Months	Flare No.2 Value (Nm^3)
July 12	290,280.41
August 12	311,861.68
September 12	284,373.20
October 12	285,763.19
November 12	227,471.60
December 12	303,171.92
Total	**1,702,922.00**

From the monthly comparison of the FT1 & FT2 + FT3 in this monitoring period, the value of FT3 was used in the ER calculation since FT1 is greater than FT2 + FT3.

Monitoring equipment	<table><tr><th rowspan="2">Item</th><th colspan="2">Flare No.2 Description</th></tr><tr><th>01/07/2012 – 11/12/2012</th><th>12/12/2012 – 31/12/2012</th></tr><tr><td>Type</td><td>Differential Pressure Transmitter – Kingsway Vcone, Flow transmitter – Rosemount</td><td>Differential Pressure Transmitter – Kingsway Vcone, Flow transmitter – Rosemount</td></tr><tr><td>Accuracy class</td><td>± 0.5%</td><td>± 0.5%</td></tr><tr><td>Serial No.</td><td>5490821 (Rosemount) / FT3 – FT161 (11011001)</td><td>02768007</td></tr><tr><td>Calibration frequency</td><td>24 months</td><td>24 months</td></tr><tr><td>Date of last calibration</td><td>20/01/2011</td><td>04/10/2012</td></tr><tr><td>Validity</td><td>24 months</td><td>24 months</td></tr></table> **Flare No.2** On 11/12/2012, there was a change of flow meter from the 5490821 / FT161 (11011001) unit to 02768007 unit.
Measuring/ Reading/ Recording frequency	Measured with flow meter. Data will be aggregated both monthly and yearly
Calculation method (if applicable)	Raw data logged at 1 minute's interval were used to compute the hourly average. Subsequently, daily readings were computed, followed by aggregation into monthly and finally, yearly records
QA/QC procedures	Flow meters were tested, calibrated and maintained regularly
Purpose of data	Baseline and Project emission calculation
Additional comment	-

Data / Parameter	$PE_{flare,y}$
Unit	tCO_2e
Description	Project emissions from flaring of the residual gas stream in year *y*
Measured/ Calculated/ Default	Calculated
Source of data	Calculated as per the *Tool to determine project emissions from flaring gases containing methane* (EB 28, Annex 13, page 10). This parameter was measured separately for both of the flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period.

Value (s) of monitored parameter	<table><tr><th>Months</th><th>Flare No.1 Value (tCO_2e)</th><th>Flare No.2 Value (tCO_2e)</th></tr><tr><td>July 12</td><td>929.41</td><td>1,155.97</td></tr><tr><td>August 12</td><td>1,079.38</td><td>1,163.92</td></tr><tr><td>September 12</td><td>981.81</td><td>1,039.51</td></tr><tr><td>October 12</td><td>1,044.05</td><td>1,120.44</td></tr><tr><td>November 12</td><td>288.40</td><td>894.15</td></tr><tr><td>December 12</td><td>745.63</td><td>1,115.94</td></tr><tr><td>**Total**</td><td>**5,068.67**</td><td>**6,489.93**</td></tr></table>
Monitoring equipment	Refer to T_{flare} below
Measuring/ Reading/ Recording frequency	As per the *Tool to determine project emissions from flaring gases containing methane* (EB 28, Annex 13, page 10). As the project has installed an enclosed flaring system, the default value of 0.90 for enclosed flare efficiency for flare temperatures above 500^0C for more than 40 minutes in an hour was applied and monitored during the monitoring period. This is conservative as the enclosed flare was typically designed to operate at a much higher temperature (>900^0C).
Calculation method (if applicable)	As per the *Tool to determine project emissions from flaring gases containing methane* (EB 28, Annex 13, page 10)
QA/QC procedures	As per the *Tool to determine project emissions from flaring gases containing methane* (EB 28, Annex 13, page 10)
Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	w_{CH4}
Unit	m^3 CH4 / m^3 LFG
Description	Fraction of CH_4 in LFG
Measured/ Calculated/ Default	Measured
Source of data	Continuous measurement by using certified equipment. This parameter was measured separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period. In case of temporary situation such as the installed CH_4 gas analyser malfunctioned or gave unrepresentative results due to data logging problem, the w_{CH4} shall be measured manually with a portable gas analyser according to ACM 0001 Version 8. At least 8 hourly samples shall be taken per operating day. For any affected day, the calculation of the values measured using the portable analyser will be based on the *Guidelines to calculate the fraction of methane in the landfill gas from periodical measurements* (Version 1). As a conservative approach, the lower bound of the 95% Confidence Interval will be applied as per the guideline.

Value (s) of monitored parameter

Months	Flare No.1 Value	Flare No.2 Value
July 12	0.57	0.57
August 12	0.58	0.57
September 12	0.57	0.58
October 12	0.57	0.58
November 12	0.56	0.59
December 12	0.55	0.60
Average	**0.57**	**0.58**

Monitoring equipment

Item	Flare No.1 Description 01/07/2012 – 31/12/2012
Type	Guardian Plus (97460) Infra-Red Gas Monitor
Accuracy class	± 2%
Serial No.	28931
Calibration frequency	Annually
Date of last calibration	26/04/2012
Validity	1 year

Item	Flare No.2 Description		
	01/07/2012 – 16/11/2012	**17/11/2012 – 14/12/2012**	**15/12/2012 – 31/12/2012**
Type	Guardian Plus (97460) Infra-Red Gas Monitor		
Accuracy class	± 2%		
Serial No.	30548	31453	31453
Calibration frequency	Annually		
Date of last calibration	27/04/2012	21/06/2011	14/12/2012
Validity	1 year		

<u>Flare No.2</u>

On 16/11/2012, there was a change of gas analyser from the 30548 unit to 31453 unit. The maximum permissible error of ±2% was applied to the CH_4 data from 16/11/2012 - 14/12/2012 for the overdue calibration of the 31453 unit as a conservative approach.

Measuring/ Reading/ Recording frequency	The CH_4 fraction were measured continuously with certified equipment or measured manually with a portable gas analyser during emergency cases
Calculation method (if applicable)	Raw data logged at 1 minute's interval was used to compute the daily average readings
QA/QC procedures	The CH_4 gas analyser was checked and calibrated regularly according to the manual given by the manufacturer
Purpose of data	Baseline and Project emission calculation
Additional comment	-

Data / Parameter	**T ($T_{TT1,F1}$ and $T_{TT1,F2}$)**

Unit	°C
Description	Temperature of the LFG
Measured/ Calculated/ Default	Measured
Source of data	Continuous measurement by temperature meter. This parameter was measured separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period.
Value (s) of monitored parameter	(see below)

Months	Flare No.1 Value (°C)	Flare No.2 Value (°C)
July 12	54.98	48.22
August 12	59.61	48.76
September 12	57.16	47.55
October 12	57.81	46.56
November 12	60.46	42.75
December 12	50.30	43.96
Average	**56.72**	**46.30**

Flare No.1

Referring to the *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*, version 2.0, for LFG temperatures below 60^{o}C, moisture could be neglected due to its very low influence on final results and thus, the measurement in wet or dry basis is not important (as reflected in the amendments to ACM 0001, version 9.1 onwards). In the case where the LFG temperature exceeds 60^{o}C, the same basis for both methane concentration and flow measurement will be considered according to the tools.

During this monitoring period, there were several periods of which the LFG temperature exceeds 60^{o}C. Hence, the tool was applied in the CER Calculation sheet as a conservative approach. The details of the calculation are as attached in **Appendix 4**.

<table>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><th rowspan="2">Item</th><th colspan="2">Flare No.1 Description</th><th>Flare No.2 Description</th></tr>
<tr><th>01/07/2012 – 11/12/2012</th><th>12/12/2012 – 31/12/2012</th><th>01/07/2012 – 31/12/2012</th></tr>
<tr><td>Type</td><td>Honeywell (STT25M-0-EN0-000-000-000-00-3D) Temperature Transmitter</td><td>PR Electronics</td><td>Honeywell (STT25M-0-EN0-000-000-000-00-3D) Temperature Transmitter</td></tr>
<tr><td>Accuracy class</td><td colspan="2">± 0.5%</td><td>± 0.5% of span</td></tr>
<tr><td>Serial No.</td><td>B224836437</td><td>100944768</td><td>B839917437</td></tr>
<tr><td>Calibration frequency</td><td colspan="2">Annually</td><td>Annually</td></tr>
<tr><td>Date of last calibration</td><td>26/04/2012</td><td>07/12/2012</td><td>27/04/2012</td></tr>
<tr><td>Validity</td><td colspan="2">1 year</td><td>1 year</td></tr>
</table>
<u>Flare No.1</u>
On 11/12/2012, there was a change of temperature transmitter from the B224836437 unit to 100944768 unit.</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency</td><td>Measured continuously by temperature meter</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Raw data logged at 1 minute’s interval was used to compute the daily average readings</td></tr>
<tr><td>QA/QC procedures</td><td>The temperature transmitter was calibrated regularly according to the manual given by the manufacturer</td></tr>
<tr><td>Purpose of data</td><td>Baseline and Project emission calculation</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data / Parameter	**P ($P_{PT2,F1}$ and $P_{PT2,F2}$)**
Unit	kPa
Description	Pressure of the LFG
Measured/ Calculated/ Default	Measured
Source of data	Continuous measurement by pressure transmitter. This parameter was measured separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period.

Value (s) of monitored parameter	

Gauge pressure (Months)	Flare No.1 Value (kPa)	Flare No.2 Value (kPa)
July 12	16.59	11.71
August 12	19.42	11.83
September 12	18.00	11.42
October 12	19.33	11.02
November 12	21.70	8.89
December 12	16.02	10.03
Average	**18.51**	**10.82**

Absolute pressure (Months)	Flare No.1 Value (kPa)	Flare No.2 Value (kPa)
July 12	117.915	113.035
August 12	120.745	113.155
September 12	119.325	112.745
October 12	120.655	112.345
November 12	123.025	110.215
December 12	117.345	111.355
Average	**119.84**	**112.14**

Referring to the *Tool to determine the mass flow of a greenhouse gas in a gaseous stream* (Version 2.0), page 11, pressure at normal conditions is 101,325 Pa. The values of the absolute pressure are calculated by adding the ambient pressure at normal conditions to the gauge pressure.

Flare No.1

The maximum permissible error of ±0.25% has to be applied for PT2 from 11/12/2012 - 21/12/2012 as a conservative approach - effect to normalised flow calculations was demonstrated

<table>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><th rowspan="2">Item</th><th colspan="2">Flare No.1 Description</th><th>Flare No.2 Description</th></tr>
<tr><th>01/07/2012 – 11/12/2012</th><th>12/12/2012 – 31/12/2012</th><th>01/07/2012 – 31/12/2012</th></tr>
<tr><td>Type</td><td colspan="2">Rosemount (3051TG1A2B21AB4E5M5Q4) Pressure Transmitter</td><td>Rosemount (3051TG1A2B21AB4E5Q4) Pressure Transmitter</td></tr>
<tr><td>Accuracy class</td><td colspan="2">± 0.25%</td><td>± 0.25%</td></tr>
<tr><td>Serial No.</td><td>02255815</td><td>02492864</td><td>5584784</td></tr>
<tr><td>Calibration frequency</td><td colspan="2">Annually</td><td>Annually</td></tr>
<tr><td>Date of last calibration</td><td>26/04/2012</td><td>21/12/2012</td><td>27/04/2012</td></tr>
<tr><td>Validity</td><td colspan="2">1 year</td><td>1 year</td></tr>
</table>

<u>Flare No.1</u>
On 11/12/2012, there was a change of pressure transmitter from the 02255815 unit to 02492864 unit.
</td></tr>
<tr><td>Measuring/ Reading/ Recording frequency</td><td>Measured continuously by a pressure transmitter</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Raw data logged at 1 minute’s interval was used to compute the daily average readings</td></tr>
<tr><td>QA/QC procedures</td><td>The meter was checked and calibrated regularly according to the manual given by the manufacturer</td></tr>
<tr><td>Purpose of data</td><td>Baseline and Project emission calculation</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

Data / Parameter	**EL_{LFG}**
Unit	MWh
Description	Net amount of electricity generated using landfill gas
Measured/ Calculated/ Default	Measured
Source of data	Data as measured by electricity meter

Value (s) of monitored parameter	

Months	Net electricity generated (Total electricity generated (EL4) – electricity consumed from GE for Flare No.1 & Flare No.2 & GE auxiliaries (EL3) (MWh)	Electricity sell to grid (MWh) - recorded by grid operator EL5 (MWh)	
		Main energy meter	Check energy meter
July 12	521.50	510.263	510.546
August 12	554.69	545.271	545.558
September 12	521.60	509.429	509.700
October 12	539.20	507.977	508.240
November 12	444.03	429.606	429.809
December 12	622.90	611.623	611.913
Total	**3,203.92**	**3,114.169**	**3,115.766**

There were 2 power meters used to measure the amount of electricity sold to the grid, i.e. the main energy meter and check energy meter. Only the readings recorded by the main energy meter was used by the grid operator and the project participant in the calculation of CERs while the readings recorded by the check energy meter were only used to check or confirm on the readings recorded by the main energy meter.

From the comparison of the EL4 – EL3 and EL5 (main meter) values above, the lower value between the two is taken for the calculation of CERs.

Months	Net amount of electricity generated (MWh)
July 12	510.263
August 12	545.271
September 12	509.429
October 12	507.977
November 12	429.606
December 12	611.623
Total	**3,114.169**

Monitoring equipment

Item	Flare No.2 Description (EL4)		Flare No.2 Description (EL5)	
	01/07/2012 – 23/07/2012	24/07/2012 – 31/12/2012	01/07/2012 – 31/12/2012	
			Main energy meter	Check energy meter
Type	EDMI Limited (Mk6E) Power Meter		Itron (SL761A071) Power Meter	
Accuracy class	Class 0.5S		Class 0.20	
Serial No.	210225256		53099690	53099691
Calibration frequency	24 months		5 years	
Date of last calibration	15/07/2010	23/07/2012	01/04/2011	
Validity	24 months		5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)	

The maximum permissible error of ±0.5% was applied to the EL4 reading from 15/07/2012 - 23/07/2012 for the overdue calibration as a conservative approach.

Measuring/ Reading/ Recording frequency	Measured continuously with electricity meter installed. The net amount of electricity generated shall be derived by deducting the amount consumed by the project activity (EL3) from the gross generated amount recorded by installed electricity meter (EL4).
Calculation method (if applicable)	NA
QA/QC procedures	As a quality control procedure, the amount of electricity actually uploaded to grid will be measured by another electricity meter (EL5) and compared with the net amount derived from above. Lower value of the amount will be taken as the net amount for emission reduction calculations. Electricity meters (except the meter owned by the grid operator, i.e. EL5) will be checked and calibrated regularly according to manufacturer's recommendations. The meter EL5 is owned by the grid operator and thus, it is not within the control of the project. The calibration of this meter will be based on the grid operator's requirement and standard practice.
Purpose of data	Baseline emission calculation
Additional comment	-

Data / Parameter	**$CEF_{elec,PR,y}$**
Unit	tCO_2/MWh
Description	Carbon emission factor of electricity
Measured/ Calculated/ Default	Calculated
Source of data	Grid connected baseline for Peninsular Malaysia for 2011 by Malaysian Green Technology Corporation (MGTC)
Value (s) of monitored parameter	**0.670** tCO_2/MWh based on the latest released grid connected baseline emission factor for Peninsular Malaysia for 2011
Monitoring equipment	NA

Measuring/ Reading/ Recording frequency	To be re-calculated with the latest release of grid connected baseline emission factor. The emission factor for year 2011 was applied for this monitoring period as this was the latest publicly released data for the grid emission factor for Malaysia during this monitoring period.
Calculation method (if applicable)	The $\mathbf{CEF}_{elec,PR,y}$ was calculated based on the *Tool to calculate the emission factor for an electricity system* (Version 2, EB 50)
QA/QC procedures	NA
Purpose of data	Baseline and Project emission calculation
Additional comment	-

Data / Parameter	**Operation of the energy plant (t)**
Unit	Hours
Description	Operation of the energy plant
Measured/ Calculated/ Default	Measured
Source of data	Based on actual documented operating hours
Value (s) of monitored parameter	(see table below) The operating time is calculated by using the reading on the 1st day of the following month (m+1) to deduct the reading on the 1st day of the current month (m). The reading used is the total of the operating time at operation hour and operation hour since oil change as stated in the Daily Monitoring Log Sheet for Gas Engine No.1, row No. 6.
Monitoring equipment	The operation time of the Gas Engine No.1 is recorded by the Gas Engine SCADA system known as Total Energy Management (TEM) Evo System. The operation hour of the Gas Engine No.1 is based on the signal provided by the power meter (EL4).
Measuring/ Reading/ Recording frequency	The operation time is recorded continuously and aggregated into monthly data. A daily reading and recording is taken.
Calculation method (if applicable)	NA
QA/QC procedures	The system will be checked periodically by the engine manufacturer during servicing. The source of the operational hours is from the power meter EL4 which is calibrated regularly according to requirement by the manufacturer.
Purpose of data	NA
Additional comment	-

Months	Operating time (hr)
July 12	697
August 12	690
September 12	612
October 12	602
November 12	506
December 12	728
Total	**3,835**

Data / Parameter	$EL_{PJ,y}$
Unit	MWh
Description	Quantity of electricity consumed by project activity
Measured/ Calculated/ Default	Measured
Source of data	Based on continuous measurement by sealed electricity meter installed

Value (s) of monitored parameter

Months	Electricity consumed (from grid for project activity-flaring system & Gas Engine No.1) (EL1) (MWh)	Electricity consumed (from GE for Flare No.1 & Flare No.2 & GE auxiliaries) (EL3) (MWh)
July 12	22.69	60.30
August 12	17.05	71.91
September 12	18.80	61.07
October 12	9.78	49.24
November 12	36.13	15.72
December 12	78.82	0.00
Total	**183.27**	**258.24**

Electricity consumed from the Gas Engine for Flare No.1 & Flare No.2 and Gas Engine No.1 auxiliaries (EL3) is not included in the calculation of project emission as the electricity is generated from landfill gas.

Monitoring equipment

Item	Electricity consumed (from grid for Flare No.1 & Flare No.2) (EL1)	Electricity consumed (from GE for Flare No.1 & Flare No.2 & GE auxiliaries) (EL3)	
	01/07/2012 – 31/12/2012	**01/07/2012 – 09/07/2012**	**10/07/2012 – 31/12/2012**
Type	IME NEMO 96HD+ (MF96021) Power Meter	IME NEMO 96HD+ (MF96021) Power Meter	
Accuracy class	Class 0.5S (± 0.5%)	Class 0.5S (± 0.5%)	
Serial No.	2167 8900 35	2350 3800 15	2175 4100 36
Calibration frequency	36 months	36 months	
Date of last calibration	10/05/2011	20/06/2012	21/06/2012
Validity	3 years according to manufacturer's recommendation	3 years according to manufacturer's recommendation	

Flare No.2

On 09/07/2012, there was a change of electricity meter (EL3) from the 2350 3800 15 unit to 2175 4100 36 unit.

Measuring/ Reading/ Recording frequency	Continuous measurement

Calculation method (if applicable)	NA
QA/QC procedures	The electricity meter was tested and calibrated as per the specifications prescribed by the manufacturer
Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	$T_{flare,y}$
Unit	°C
Description	Temperature in exhaust gas of the enclosed flare
Measured/ Calculated/ Default	Measured
Source of data	Continuous measurement by temperature meter. This parameter was measured separately for both flares, i.e. Flare No.1 and Flare No.2. Therefore, 2 sets of equipment were used for the monitoring period.
Value (s) of monitored parameter	(see table below)

Months	Flare No.1 Value (°C)	Flare No.2 Value (°C)
July 12	840.33	840.04
August 12	908.53	842.67
September 12	873.55	844.54
October 12	892.64	835.52
November 12	925.47	811.42
December 12	734.53	819.33
Average	**862.51**	**832.25**

Monitoring equipment

Item	Flare No.1 Description			Flare No. 2 Description
	01/07/2012 – 21/09/2012	**22/09/2012 – 11/12/2012**	**12/12/2012 – 31/12/2012**	**01/07/2012 – 31/12/2012**
Type	Honeywell (STT25M-0-EN0-000-000-000-00-3D) Temperature Transmitter		PR Electronics	Honeywell (STT25M-0-EN0-000-000-000-00-3D) Temperature Transmitter
Accuracy class	± 0.5%			± 0.5% of span
Serial No.	B123070037	B449004837	100906480	B838901937
Calibration frequency	Annually			Annually
Date of last calibration	26/04/2012	21/09/2012	07/12/2012	27/04/2012
Validity	1 year			1 year

	Flare No.1 On 21/09/2012, there was a change of temperature transmitter from the B123070037 unit to B449004837 unit. Later, on 11/12/2012, the B449004837 unit was replaced with 100906480 unit.
Measuring/ Reading/ Recording frequency	The enclosed flare is monitored continuously by a temperature meter
Calculation method (if applicable)	Data logged at 1 minute's interval was used to determine the default flaring efficiency for each hour in accordance to the *Tool to determine project emissions from flaring gases containing methane* (EB 28, Annex 13)
QA/QC procedures	The temperature meter was tested and calibrated as per the specifications prescribed by the manufacturer
Purpose of data	Project emission calculation
Additional comment	-

Data / Parameter	**Relevant policies and circumstances at the beginning of each crediting period**
Unit	NA
Description	NA
Measured/ Calculated/ Default	NA
Source of data	Monitoring of change of policies and circumstances was done by consultation with relevant governmental authorities (Department of Environment and Department of National Solid Waste Management, Malaysia)
Value (s) of monitored parameter	Not applicable during this monitoring period as it is not at the beginning of the next crediting period
Monitoring equipment	NA
Measuring/ Reading/ Recording frequency	To be checked at the beginning of each crediting period
Calculation method (if applicable)	NA
QA/QC procedures	NA
Purpose of data	NA
Additional comment	-

D.3. Implementation of sampling plan

Not applicable

SECTION E. Calculation of emission reductions or GHG removals by sinks

E.1. Calculation of baseline emissions or baseline net GHG removals by sinks

The total baseline emissions according to ACM0001 (Version 8) were calculated according to the equations below:

$$BE_y = (MD_{project,y} - MD_{BL,y}) \cdot GWP_{CH4} + EL_{LFG,y} \cdot CEF_{elec,BL,y} + ET_{LFG,y} \cdot CEF_{ther,BL,y}$$

BEy	Baseline emissions in year *y* (tCO_2e)
$MD_{project,y}$	The amount of methane that would have been destroyed/combusted during the year, in tonnes of methane (tCH_4) in project scenario
$MD_{BL,y}$	The amount of methane that would have been destroyed/combusted during the year in the absence of the project due to regulatory and/or contractual requirements, in tonnes of methane (tCH_4)
GWP_{CH4}	Global Warming Potential value for methane for the first commitment period is 21 tCO_2e/tCH_4
$EL_{LFG,y}$	Net quantity of electricity produced using LFG, which in the absence of the project activity would have been produced by power plants connected to the grid or by an on-site/off-site fossil fuel based captive power generation, during year *y* (MWh)
$CEF_{elec,BL,y}$	CO_2 emissions intensity of the baseline source of electricity displaced (tCO_2e/MWh)
$ET_{LFG,y}$	The quantity of thermal energy produced utilizing the landfill gas, which in the absence of the project activity would have been produced from on-site/off-site fossil fuel fired boiler, during the year *y* (TJ)
$CEF_{ther,BL,y}$	CO_2 emissions intensity of the fuel used by boiler to generate thermal energy which is displaced by LFG based thermal energy generation (tCO_2e/TJ)

$$MD_{project,y} = MD_{flared,y} + MD_{electricity,y} + MD_{thermal,y} + MD_{PL,y}$$

$MD_{flared,y}$	Quantity of methane destroyed by flaring (tCH_4)
$MD_{electricity,y}$	Quantity of methane destroyed by generation of electricity (tCH_4)
$MD_{thermal,y}$	Quantity of methane destroyed for the generation of thermal energy (tCH_4)
$MD_{PL,y}$	Quantity of methane sent to the pipeline for feeding to the natural gas distribution network (tCH_4)

$$MD_{flared,y} = (LFG_{flare,y} \cdot w_{CH4} \cdot D_{CH4}) - (PE_{flare,y} / GWP_{CH4})$$

$MD_{flared,y}$	Quantity of methane destroyed by flaring (tCH_4)
$LFG_{flare,y}$	Quantity of landfill gas fed to the flare(s) during the year *y* (m^3)
w_{CH4}	Average methane fraction of the landfill gas as measured during the year *y* (m^3CH_4 / m^3LFG)
D_{CH4}	Methane density (tCH_4 / m^3CH_4)
$PE_{flare,y}$	Project emission from flaring of the residual gas stream in year *y* (tCO_2e). This will be determined following the procedure set in the *"Tool to determine project emissions from flaring gases containing methane"*.

$$MD_{electricity,y} = LFG_{electricity,y} \cdot w_{CH4,y} \cdot D_{CH4}$$

$MD_{electricity,y}$	Quantity of methane destroyed be generation of electricity (tCH_4)
$LFG_{electricity,y}$	Quantity of landfill gas fed into the electricity generator (m^3LFG)
$w_{CH4,y}$	Average methane fraction of the landfill gas as measured during the year *y* (m^3CH_4 / m^3LFG)

Determination of $MD_{project,y}$ for Flare No.1

	$MD_{flared,y} = \{LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4})$								$MD_{project,y}$
Month	Quantity of LFG to Flare No.1 Flare No. 1,y (Nm3)	Methane average fraction Flare No.1 WCH4	Density of Methane Flare No.1 DCH4 (t/Nm3)	Total methane Flare No.1 (tCH4)	Global Warming Potential Flare No.1 GWP (tCO2/tCH4)	Emissions from methane Flare No.1 (tCO2e)	PE Flare No.1 (tCO2e)	Quantity of Methane destroyed by flaring MD flared,y (tCH4)	Quantity of methane that would have been destroyed MD project,y (tCH4)
Jul-12	1,067,001	0.57	0.0007168	436.20	21	9,160.19	929.41	391.94	391.94
Aug-12	1,185,525	0.58	0.0007168	490.96	21	10,310.13	1,079.38	439.56	439.56
Sep-12	1,116,670	0.57	0.0007168	458.25	21	9,623.33	981.81	411.50	411.50
Oct-12	1,173,755	0.57	0.0007168	479.83	21	10,076.47	1,044.05	430.12	430.12
Nov-12	344,417	0.56	0.0007168	137.45	21	2,886.49	288.40	123.72	123.72
Dec-12	894,408	0.55	0.0007168	350.13	21	7,352.66	745.63	314.62	314.62

Determination of $MD_{project,y}$ for Flare No.2

	$MD_{flared,y} = (LFG_{flare,y} * w_{CH4,y} * D_{CH4}) - (PE_{flare,y} / GWP_{CH4})$								$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4}$			$MD_{project,y}$
Month	Quantity of LFG to Flare No.2 Flare No.2,y (Nm3)	Methane average fraction Flare No.2 WCH4	Density of Methane Flare No.2 DCH4 (t/Nm3)	Total methane Flare No.2 (tCH4)	Global Warming Potential Flare No.2 GWP (tCO2/tCH4)	Emissions from methane Flare No.2 (tCO2e)	PE Flare No.2 (tCO2e)	Quantity of Methane destroyed by flaring MD flared,y (tCH4)	Quantity of Landfill Gas Fed into the Electricity Generator No. 1 LFG electricity,y (m^3 LFG)	Average methane fraction of the landfill gas as measured WCH4	Quantity of methane destroyed by generation of electricity MD electricity,y (tCH4)	Quantity of methane that would have been destroyed MD project,y (tCH4)
Jul-12	1,337,116	0.57	0.0007168	550.49	21	11,560.21	1,155.97	495.44	290,280.41	0.57	119.51	614.95
Aug-12	1,323,617	0.57	0.0007168	544.02	21	11,424.47	1,163.92	488.60	311,861.68	0.57	128.18	616.78
Sep-12	1,175,373	0.58	0.0007168	487.15	21	10,230.07	1,039.51	437.66	284,373.20	0.58	117.86	555.51
Oct-12	1,263,957	0.58	0.0007168	526.72	21	11,061.12	1,120.44	473.37	285,763.19	0.58	119.08	592.45
Nov-12	1,026,564	0.59	0.0007168	430.85	21	9,047.79	894.15	388.27	227,471.60	0.59	95.47	483.74
Dec-12	1,239,378	0.60	0.0007168	531.81	21	11,168.05	1,115.94	478.67	303,171.92	0.60	130.09	608.76

	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
Total quantity of LFG Flare & LFG Electricity (column B + column J)	1,627,396	1,635,479	1,459,746	1,549,720	1,254,035	1,542,550
Total quantity of LFG Total	1,686,593	1,670,021	1,494,717	1,577,131	1,328,060	1,598,742

From the monthly comparison of the FT1 & FT2 + FT3 in this monitoring period, the value of FT2 was used in the CER calculation since FT1 is greater than FT2 + FT3

For Flare No.2, from the monthly comparison of the FT1 and FT2 + FT3 in this monitoring period, the value of FT2 was used in the CER calculation since FT1 is greater than FT2 + FT3. Details on how the comparison was made and which values were used are explained in Section D.2 above for the parameters LFG_{total}, LFG_{flare} and $LFG_{electricity}$.

Determination of BE_y

Month	BEy Flare No.1 Total Baseline Emissions Flare No.1 (tCO2e)	$(MD_{project,y} - MD_{BL,y}) * GWP_{CH4}$ Emissions from Flare No.2 (tCO2e)	$EL_{LFG,y} \cdot CEF_{elec,BL,y}$ Total electricity generated EL,LFG,y (MWh)	CoEF for electricity Flare No.2 CEF electricity,y	Baseline Emission from electricity generation Flare No.2 (tCO2e)	BEy Flare No.2 Total Baseline Emissions Flare No.2 (tCO2e)
Jul-12	8,230.78	12,913.89	510.26	0.670	341.88	13,255.77
Aug-12	9,230.76	12,952.30	545.27	0.670	365.33	13,317.63
Sep-12	8,641.53	11,665.66	509.43	0.670	341.32	12,006.97
Oct-12	9,032.42	12,441.44	507.98	0.670	340.34	12,781.79
Nov-12	2,598.09	10,158.50	429.61	0.670	287.84	10,446.34
Dec-12	6,607.03	12,784.00	611.62	0.670	409.79	13,193.79

For this project, the following applies:

1. $MD_{thermal,y}$ and $MD_{PL,y}$ are not applicable (=0) to this project since there are no heat generation and feeding to natural gas pipeline
2. For this project, $MD_{BL,y}$ is zero since there are no destruction or combustion of methane today due to regulatory a 2nd contractual requirements

3. $ET_{LFG,y}$ and $CEF_{ther,BL,y}$ are not applicable (=0) to this project since there are no thermal energy production
4. Density of methane for Flare No.2 LFG is obtained from ACM 0001, version 8.0, page 14
5. Power generation of landfill gas was only implemented in June 2011
6. The grid connected baseline for Peninsula Malaysia for 2011 was applied to this project and the $CEF_{electricity,y}$ calculated was 0.670tCO_2/MWh
7. $MD_{electricity,y}$ is not applicable (=0) for Flare No.1 during this monitoring period as no LFG from Flare No.1 sent to Gas Engine No.1
8. $EL_{LFG,y}$ and $CEF_{elec,BL,y}$ are not applicable (=0) for Flare No.1 during this monitoring period as no LFG from Flare No.1 sent to Gas Engine No.1
9. The total electricity generated is the amount based on the invoices to the grid operator (Tenaga National Berhad) which is the lower reading from the comparison between (EL4 - EL3) and EL5

E.2. Calculation of project emissions or actual net GHG removals by sinks

The total project emissions according to ACM0001 (Version 8) were estimated according to the equations below:

$$PE_y = PE_{EC,y} + PE_{FC,j,y}$$

$$PE_{EC,y} = EC_{PJ,y} \cdot EF_{grid,y} \cdot (1+TDL_y)$$

$PE_{EC,y}$	Project emissions from consumption of electricity by the project activity during the year y (tCO2e/yr)
$EC_{PJ,y}$	Quantity of electricity consumed by the project activity during the year y (MWh)
TDL_y	Average technical transmission and distribution losses in the ECPG in the year y for the voltage level at which electricity is obtained from the grid at the project site
EF_{grid}	Emission factor for the grid in year y (tCO2eq/MWh)

Month	Electricity consumed by project activity ELPJ,y (MWh)	Coefficient for grid electricity EF grid,y	Transmission and Distribution Losses TDL,y	Total Project Emission from project activity (tCO2e)
Jul-12	22.69	0.670	0.1	16.72
Aug-12	17.05	0.670	0.1	12.57
Sep-12	18.80	0.670	0.1	13.85
Oct-12	9.78	0.670	0.1	7.21
Nov-12	36.13	0.670	0.1	26.63
Dec-12	78.82	0.670	0.1	58.09

For this project, the following applies:
1. $PE_{fc,y}$ is zero as no heat from fossil fuel is used to generate electricity for this project
2. The grid connected baseline for Peninsula Malaysia for 2011 was applied to this project and the $EF_{grid,y}$ calculated was 0.670tCO_2/MWh
3. TDL = 10% adopted as stated in PDD page 35 (TNB annual report 2007) (http://announcements.bursamalaysia.com/EDMS%5Csubweb.nsf/LsvAllByID/8B0DC73587EFBC114825750B0033ED71?OpenDocument)

E.3. Calculation of leakage

No leakage.

E.4. Summary of calculation of emission reductions or net anthropogenic GHG removals by sinks

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
July 12	21,486	17	0	21,469
August 12	22,548	13	0	22,535
September 12	20,648	14	0	20,634
October 12	21,814	8	0	21,806
November 12	13,044	27	0	13,017
December 12	19,800	59	0	19,741
Total	**119,340**	**138**	**0**	**119,202**

E.5. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period	Item	Values estimated in ex-ante calculation of registered PDD
Emission reductions or GHG removals by sinks (t CO_2e)	106,593	119,202	Emission reductions or GHG removals by sinks (t CO_2e)	106,593

** Ex-ante for 184 days (July 2012 – Dec 2012) – 211,448 x (184/365)*

E.6. Remarks on difference from estimated value in registered PDD

The total CERs claimed was about 11% higher as compared to the value reported in the ex-ante calculations. The higher CERs for this monitoring period were mainly due to:

1. Both flares have low downtime and have operated at high efficiency (refer to 6th monitoring period CER Calculation Sheet and System Shutdown Forms recorded on-site);

Month (July - Dec 12)	Time (minute)		% of total flare running time
	Total flare running time	Total time in July - Dec 12	
Flare 1	220,471	264,960	83
Flare 2	252,369	264,960	95

Note: The total running time of the flares is calculated from the information provided in the System Shutdown Forms recorded on-site

2. The ex-post methane concentration of 57% which was higher compared to the ex-ante value of 50% (at the time of registration as stated in the approved, revised PDD. Please refer to the revised PDD, version 7.2 and 6th monitoring period CER Calculation Sheet for details).

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	119,202	0

Appendix 1: Details on the downtime of Flare No.1

Date	Flaring stopped		Reason	Remarks
	From	To		
09/07/2012	9:43	15:36	Others	Installation of new hard disk by replacing currently used hard disk from PC Flare 1 - done by Interlinx Service Team. Gas engine required for shut down
30/07/2012	16:51	17:55	Power Failure	Due to power surge Flare 1
03/08/2012	15:25	16:30	Power Failure	Due to power surge caused isolating transformer MCB related to gas analyser was tripped
06/08/2012	10:40	21:03	Power Failure	Flare 1 request for shutdown due to scheduled power shutdown - to conduct cabelling termination
09/08/2012	13:07	15:01	Others	MCB isolating transformer found tripped - faulty caused instrument analyser failed due to communicating through flaring system
09/08/2012	7:44	11:56	Power Failure	Due to power surge - isolating transformer MCB which is related to gas system analyser is detected tripped
10/08/2012	12:28	13:09	Equipment Breakdown	Flare 1 shutdown due to MCB isolating transformer tripped
13/08/2012	18:08	18:27	Others	MCB isolating transformer found tripped - faulty caused instrument analyser failed due to communicating through flaring system
16/08/2012	19:41	20:08	Others	Flare 1 shutdown due to MCB isolating transformer tripped
17/08/2012	13:40	15:24	Equipment Breakdown	Flare 1 shutdown due to MCB isolating transformer tripped
23/08/2012	16:07	16:38	Equipment Breakdown	Flare 1 shutdown due to MCB isolating transformer tripped

20/09/2012	10:24	10:32	Equipment Breakdown	Flare 1 shutdown due to MCB isolating transformer tripped
21/09/2012	9:39	16:39		Flare 1 shutdown due to schedule calibration as requirement required by CDM Auditor
28/09/2012	11:25	11:45	Power Failure	Flare 1 shutdown due to power surge-Faulty causing MCB of isolating transformer tripped
11/10/2012	10:59	11:55	Equipment Breakdown	Flare 1 require to shut down due - Nectar to check F1-FT2 transmitter reading have detected Nm^3/hr measured more than $100Nm^3/hr$
12/10/2012	10:06	15:14	Equipment Breakdown	Flare 1 shutdown due FT2 reading problem (transmitter). Service V-cone
16/10/2012	21:48	22:01	Exceed Set Point Limit	O_2 exceed set point limit
17/10/2012	14:31	17:14	Exceed Set Point Limit	Due to re-configuration at check FT1 and FT2 for Flare 1 - Both output reading found abnormal
19/10/2012	20:32	0:33	Power Failure	Flare 1 shut down due to TNB power failure
22/10/2012	9:43	19:26	Others: EL panel installation	Contractor (Chen Guan) install new EL-power meter panel for new gas engines at control room
23/10/2012	10:18	10:56	Maintenance	To check pilot flame solenoid valve/ pilot flame hose from pilot flame tank-LPG. Condition-OK
09/11/2012	9:03	13:07	Maintenance	Flare 1 / FT2 - Fairyland to check different reading for FT2 - Signal isolator / swap FT1 / FT2
09/11/2012	14:34		Equipment Breakdown	Power surge which caused PLC problem. Unable to restart until all PLC module are changed - Fairyland
07/12/2012		18:32		
08/12/2012	10:56	12:05	Maintenance	Fairyland to test Flare 1 - checked flame detector / flame detector relay / FT2 reading
21/12/2012	10:49	11:58	Maintenance	Equipment calibration - Nectar to calibrate PT1 / PT2 / FT2 which was changed by Fairyland during F1 repair work

Appendix 2: Details on the downtime of Flare No.2

Date	Flaring stopped		Reason	Remarks
	From	To		
06/08/2012	8:23	9:17	Power Failure	Flare 2 shutdown due to scheduled power failure to conduct cabling termination for LPG LV-Board
06/08/2012	10:34	20:05	Power Failure	Flare 2 shutdown due to scheduled power shutdown to conduct cabling termination for LPG LV-Board
12/09/2012	10:59		Others	Tai Hoe request for shutdown due to finalise and complete their outstanding work for fitting and connecting new piping line
14/09/2012		21:13		
20/09/2012	10:36	12:19	Maintenance	Flare 2 shut down due to hydrocare contractor carry out schedule maintenance for 2 nos. of blower
19/10/2012	20:32	0:49	Power Failure	TNB power failure- total site
22/10/2012	9:47	19:30	Others: EL panel Installation	Contractor (Chen Guan) install new EL-power meter panel for new gas engine at control room
09/11/2012	14:34		Equipment Breakdown	Power surge - caused PLC modules damage. Interlinx to check on the faulty PLC & network switch. Change by Interlinx. Found FT3 problem - unable to connect to FT3 (error). Flare 2 & GE1 to run without FT3 reading
13/11/2012		12:25		
16/11/2012	10:21	11:00	Equipment Breakdown	CH4 analyser problem. Malfunction. No display, changed to spare unit
23/11/2012	9:02	10:35	Maintenance	To check FT3 transmitter - changed FT3 with spare unit. To monitor reading for FT3
11/12/2012	16:18	16:33	Maintenance	Fairyland to check FT3 (Flare 2) reading with HART Communicator

Appendix 3: Details on the downtime of Gas Engine No.1

Date	Gas Engine No.1 Stopped		Description Of Event
	From	To	
18/08/2012	22:22		Fault-Over Frequency
19/08/2012		17:32	
12/09/2012	10:47		Tai Hoe request for shutdown to transfer pipe works
15/09/2012		12:19	
17/10/2012	8:24		Gas Engine No. 1 no reading at SCADA display
18/10/2012		14:15	

19/10/2012	20:32		TNB power failure - site total shut down
20/10/2012		1:24	
20/10/2012	10:44		GE 1 - Schedule maintenance service - GDU / scrubber change activated carbon / coolant / intake air modify
24/10/2012		22:25	
08/11/2012	15:51		Intake fan problem - SPE to repair and Flare 2 problem
14/11/2012		15:11	
27/11/2012	23:00		Reverse VAR - Unable to restart due to gas mixer
28/11/2012		8:23	
28/11/2012	9:00		Spark plug B2/B3 - Combustion chamber problem
29/11/2012		13:59	

Appendix 4: Description on the calculation applied in ER Calculation Sheet for Tool to determine the mass flow of a greenhouse gas in a gaseous stream, version 2.0

Referring to the tools, for LFG temperatures below 60 ^{o}C, moisture could be neglected due to its very low influence on final results and thus, the measurement in wet or dry basis is not important (as reflected in the amendments to ACM 0001, version 9.1 onwards). In the case where the LFG temperature exceeds 60^{o}C, the same basis for both methane concentration and flow measurement will be considered according to the tools.

There are 6 measurement options as tabulated below:

Option	Flow of gaseous stream	Volumetric fraction
A	Volume flow – dry basis	dry or wet basis[3]
B	Volume flow – wet basis	dry basis
C	Volume flow – wet basis	wet basis
D	Mass flow – dry basis	dry or wet basis
E	Mass flow – wet basis	dry basis
F	Mass flow – wet basis	wet basis

During this monitoring period, for Flare No.1 with LFG temperature exceeding 60^{o}C, option B measurement was selected and was applied in the CER calculation.

Determination of the absolute humidity of the gaseous stream

The absolute humidity is a parameter required for Option B. It can be determined from the measurement of moisture content (Option 1) or by assuming the gaseous stream is dry or saturated in a simplified conservative approach (Option 2).

Option 2 which assumes that the gaseous stream is dry or saturated in a simplified conservative approach was selected for the CER calculation.

Option 2: Simplified calculation without measurement of the moisture content

This option provides a simple and conservative approach to determine the absolute humidity by assuming the gaseous stream is dry or saturated depending on which is the conservative situation. If it is conservative to assume that the gaseous stream is dry, then $m_{H2O,t,db}$ is assumed to equal to 0. If it is conservative to assume that the gaseous stream is saturated, then $m_{H2O,t,db}$ is assumed to be equal to the saturation absolute humidity ($m_{H2O,t,db,sat}$) and is calculated using the equation below:

$$m_{H2O,t,db,Sat} = \frac{p_{H2O,t,Sat} * MM_{H2O}}{(P_t - p_{H2O,t,Sat}) * MM_{t,db}}$$

Where:

$m_{H2O,t,db,sat}$	=	Saturation absolute humidity in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$p_{H2O,t,Sat}$	=	Saturation pressure of H_2O at temperature T_t in time interval t (Pa)
T_t	=	Temperature of the gaseous stream in time interval *t* (K)
P_t	=	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_{H2O}	=	Molecular mass of H_2O (kg H_2O/kmol H_2O)
$MM_{t,db}$	=	Molecular mass of the gaseous stream in a time interval *t* on a dry basis (kg dry gas/kmol dry gas)

<table>
<tr><th>Parameter</th><th>Formula/ description</th></tr>
<tr><td>$p_{H20,t,Sat}$</td><td>
<table>
<tr><th>1</th><th>2</th><th></th></tr>
<tr><td>Filonenko/ Ginzburg (1973) and Filonenko et al. (1971)</td><td>0…100</td><td>$p_s = \exp(6.416 + 17.3 \cdot t / (238+t))$,</td></tr>
</table>
P_s – Saturation pressure of H_2O
t – LFG Temperature
</td></tr>
<tr><td>P_t</td><td>
<table>
<tr><th>Absolute Pressure</th><th></th></tr>
<tr><td>$P_a = P_g + P_{at}$</td><td></td></tr>
<tr><td>$P_a = P_g + 101325$</td><td></td></tr>
<tr><td>where,</td><td></td></tr>
<tr><td>P_a = Absolute Pressure,</td><td></td></tr>
<tr><td>P_g = Gauge Pressure,</td><td></td></tr>
<tr><td>P_{at} = Atmospheric Pressure.</td><td></td></tr>
</table>
</td></tr>
<tr><td>MM_{H2O}</td><td>18.0152 kg/kmol
Default value from the tool</td></tr>
<tr><td>$MM_{t,db}$</td><td>
$$MM_{t,db} = \sum_k (v_{k,t,db} * MM_k)$$
Where:
<table>
<tr><td>$MM_{t,db}$</td><td>=</td><td>Molecular mass of the gaseous stream in time interval t on a dry basis (kg dry gas/kmol dry gas)</td></tr>
<tr><td>$v_{k,t,db}$</td><td>=</td><td>Volumetric fraction of gas k in the gaseous stream in time interval t on a dry basis (m^3 gas k/m^3 dry gas)</td></tr>
<tr><td>MM_k</td><td>=</td><td>Molecular mass of gas k (kg/kmol)</td></tr>
<tr><td>k</td><td>=</td><td>All gases, except H_2O, contained in the gaseous stream (e.g. N_2, CO_2, O2, CO, H2, CH_4, N_2O, NO, NO2, SO_2, SF_6 and PFCs). See available simplification below</td></tr>
</table>
Default value for $MM_{i,k}$, Gases involve in the calculation are CH_4, CO_2, and O_2
</td></tr>
</table>

Data / Parameter:	MM_i		
Data unit:	kg/kmol		
Description:	Molecular mass of greenhouse gas *i*		
Value to be applied:	Compound	Structure	Molecular mass (kg / kmol)
	Carbon dioxide	CO_2	44.01
	Methane	CH_4	16.04
	Nitrous oxide	N_2O	44.02
	Sulfur hexafluoride	SF_6	146.06
	Perfluoromethane	CF_4	88.00
	Perfluoroethane	C_2F_6	138.01
	Perfluoropropane	C_3F_8	188.02
	Perfluorobutane	C_4F_{10}	238.03
	Perfluorocyclobutane	$c\text{-}C_4F_8$	200.03
	Perfluoropentane	C_5F_{12}	288.03
	Perfluorohexane	C_6F_{14}	338.04
Any comment:			

Data / Parameter:	MM_k		
Data unit:	kg/kmol		
Description:	Molecular mass of gas *k*		
Value to be applied:	For gases *k* that are greenhouse gases appy values for MM_i.		
	Compound	Structure	Molecular mass (kg / kmol)
	Nitrogen	N_2	28.01
	Oxygen	O_2	32.00
	Carbon monoxide	CO	28.01
	Hydrogen	H_2	2.02
	Nitric oxide	NO	30.01
	Nitrogen dioxide	NO_2	46.01
	Sulfur dioxide	SO_2	64.06
Any comment:			

Option B of measurement options

The volumetric flow of the gaseous stream in time interval *t* on a dry basis ($V_{t,db}$) is determined by converting the measured volumetric flow from wet basis to dry basis as follows:

$$V_{t,tb} = V_{t,wb} / (1 + v_{H2O,t,db})$$

Where:

$V_{t,db}$	=	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m³ dry gas/h)
$V_{t,wb}$	=	Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m³ wet gas/h)
$v_{H2O,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m³ H_2O/m³ dry gas)

The volumetric fraction of H_2O in time interval *t* on a dry basis ($v_{H2O,t,db}$) is estimated according to the equation below:

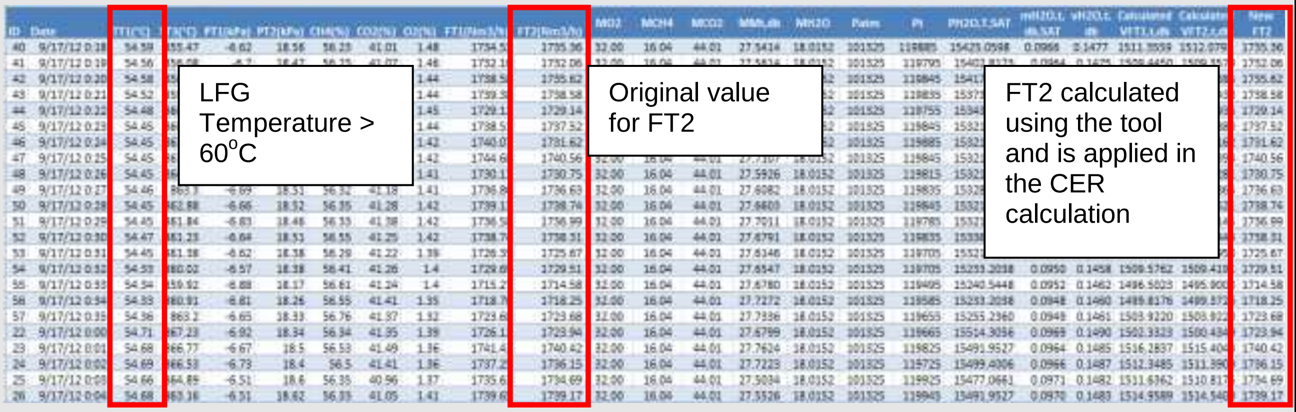
$$\nu_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}}$$

Where:

$\nu_{H2O,t,db}$	=	Volumetric fraction of H_2O in the gaseous stream in time interval *t* on a dry basis (m^3 H_2O/m^3 dry gas)
$m_{H2O,t,db}$	=	Absolute humidity in the gaseous stream in time interval *t* on a dry basis (kg H_2O/kg dry gas)
$MM_{t,db}$	=	Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
MM_{H2O}	=	Molecular mass of H_2O (kg H_2O/kmol H_2O)

The absolute humidity of the gaseous stream ($m_{H2O,t,db}$) is determined using Option 2 above ($MM_{t,db}$) which is as demonstrated above.

Example of the calculation using the *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*, version 2.0.



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Document information

Version	Date	Description
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.

Decision Class: Regulatory
Document Type: Form
Business Function: issuance
Keywords: monitoring report, performance monitoring