Monitoring report form
(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT		
Title of the project activity	Landfill Gas Recovery and Utilization at Bukit Tagar Sanitary Landfill, Hulu Selangor in Malaysia	
UNFCCC reference number of the project activity	2467	
Version number of the monitoring report	1.0	
Completion date of the monitoring report	29/11/2016	
Monitoring period number and duration of this monitoring period	Monitoring period number: 10 Duration of monitoring period: 01/04/2015 – 27/08/2016 inclusive of both days	
Project participant(s)	KUB-Berjaya Enviro Sdn. Bhd. (KBE)	
Host Party	Malaysia	
Sectoral scope(s)	13: Waste handling and disposal	
Selected methodology(ies)	ACM 0001, version 8 [1] Consolidated baseline and monitoring methodology for landfill gas project activities	
Selected standardized baseline(s)	Not applicable	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	465,631 tCO_2e[2]	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	Not applicable	474,762 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1 The ACM 0001 - *Consolidated baseline and monitoring methodology for landfill gas project activities* (Version 8) is no longer valid and is not available for download in UNFCCC.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.

2 Ex-ante for 275 days (Apr – Dec 2015): [291,592 x (275/365)] = 219,693 tCO_2e. Ex-ante for 240 days (Jan – 27th August 2016): [186,503/182 x 240] = 245,938 tCO_2e. Total from 01/04/2015 – 27/08/2016 is 465,631 tCO_2e.

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 Engines 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 Engines
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, Phase 1 and 2 Cells 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), 2 units of 1.56MW Gas Engines (Gas Engine No.2 and No.3) and a unit of 2MW Gas Engine (Gas Engine No.4) to generate electricity. The electricity produced by the gas engines 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
Third flaring system	Not commissioned	Not commissioned	Not commissioned
Gas Engine No.1	03/01/2011 (delivery to site)	01/06/2011	Continued to operate
Gas Engine No.2	06/08/2012 (Signed-off Delivery Order)	06/12/2013[3]	Continued to operate
Gas Engine No.3	06/08/2012 (Signed-off Delivery Order)	06/12/2013[4]	Continued to operate
Gas Engine No.4	18/09/2015 (Invoice issued to KBE)	26/10/2015[5]	Continued to operate

[3] Letter to Sustainable Energy Development Authority (SEDA) Malaysia on Notification on Initial Operation Date (IOD) Occurrence on 6th December 2013.

[4] Letter to Sustainable Energy Development Authority (SEDA) Malaysia on Notification on Initial Operation Date (IOD) Occurrence on 6th December 2013.

[5] Letter to Sustainable Energy Development Authority (SEDA) Malaysia on Notification on Initial Operation Date (IOD) Occurrence on 14th January 2016

The 10th monitoring period is from 01/04/2015 to 27/08/2016 (inclusive of both days). The total emission reductions achieved during this monitoring period is **474,762 tCO_2e.**

A.2. Location of project activity

Information	Description
Host Party(ies)	Malaysia
Region/ State/ Province, etc.	State of Selangor
City/ Town/ Community, etc.	Mukim Sg. Tinggi, District of Hulu Selangor 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.
Physical/ Geographical location	<table><tr><th>Latitude</th><th>Longitude</th><th>Description</th></tr><tr><td>3°30'168"</td><td>101°28'428"</td><td>North</td></tr><tr><td>3°29'07"</td><td>101°28'452"</td><td>South</td></tr><tr><td>3°29'46"</td><td>101°28'20"</td><td>West</td></tr><tr><td>3°29'69"</td><td>101°29'268"</td><td>East</td></tr></table>

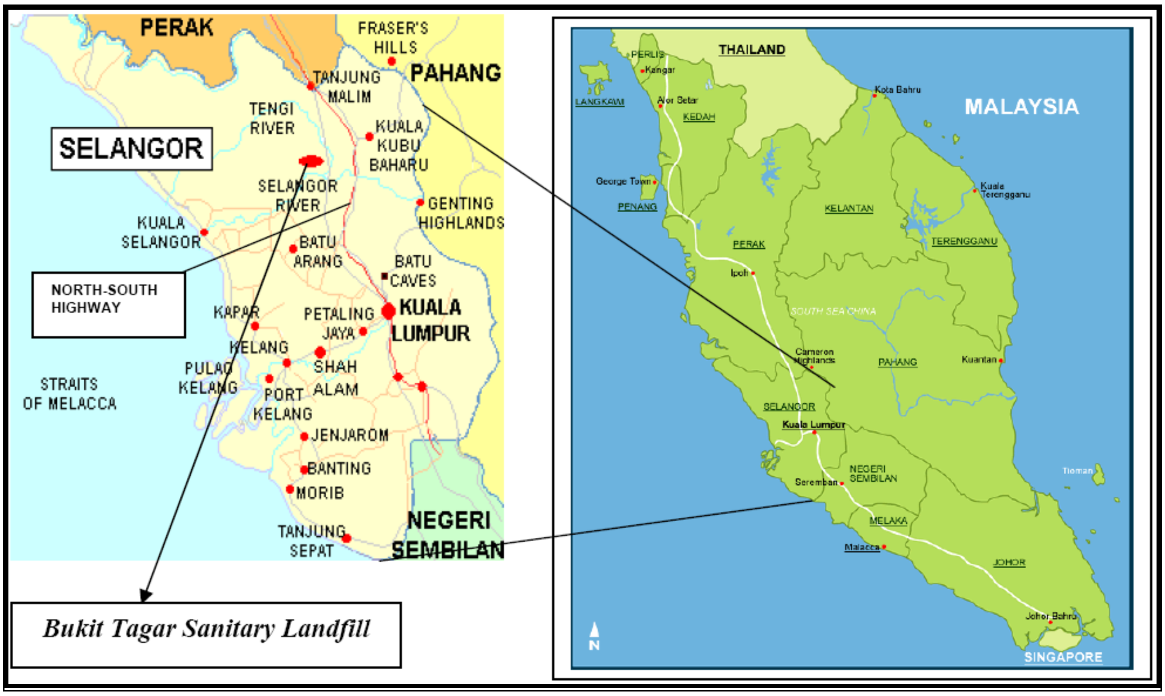


Figure 1: Location of BTSL and Selangor State

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 whether the Party involved wishes to be considered as project participant (yes/no)
Malaysia **(host)**	KUB-Berjaya Enviro Sdn. Bhd. (KBE) (Private)	No

Note: Japan Carbon Finance, Ltd. (JCF) (Private) was removed from this table as JCF had withdrawn on 21/10/2013 (MoC Annex 2 Withdraw Project Participant) valid as of 25/10/2013) http://cdm.unfccc.int/Projects/DB/DNV-CUK1238680609.1/view

A.4. Reference of applied methodology and standardized baseline

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)[6]

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);
- *Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site* (Version 5, EB 55, Annex 18);
- *Tool to calculate the emission factor for an electricity system* (Version 02, EB 50, Annex 14);
- *Tool to calculate project emissions from electricity consumption* (Version 1, EB 39, Annex 7); and
- *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 10th monitoring period is from 01/04/2015 to 27/08/2016 (inclusive of both days).

A.6. Contact information of responsible persons/entities

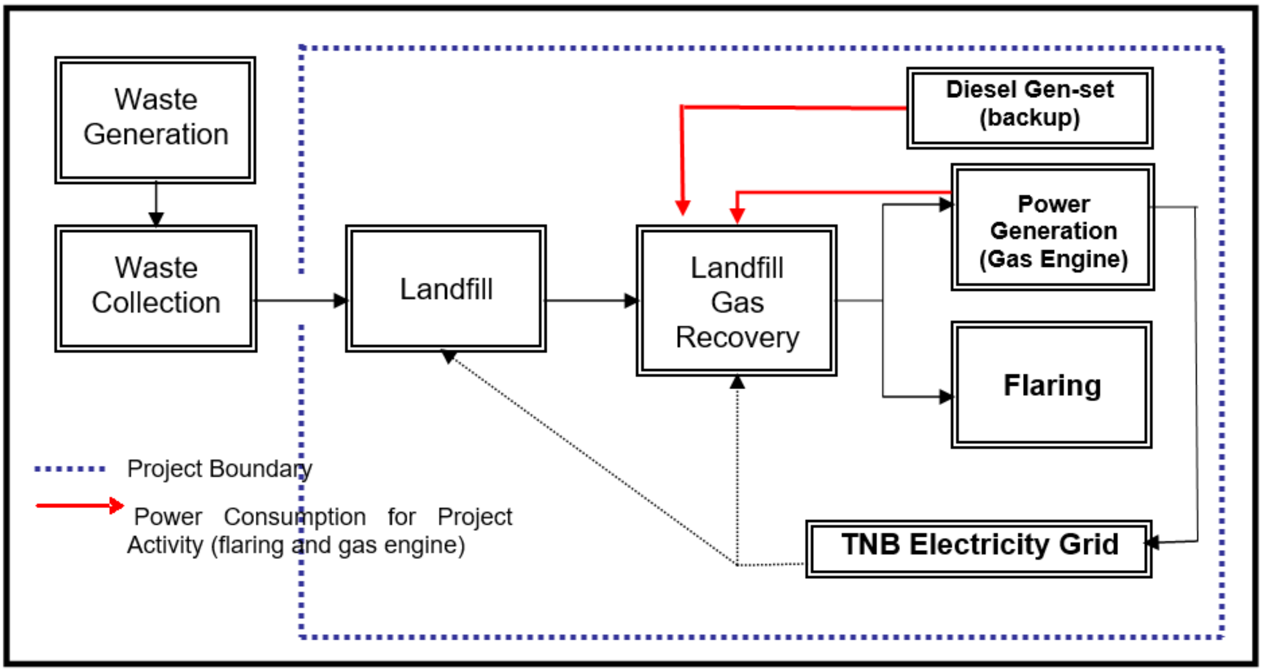
Contact person:	Mr. How Lim Sek
Designation:	Chief Operating Officer
Organisation:	KUB-Berjaya Enviro Sdn. Bhd. (KBE)
Address:	09-03 & 09-05, Level 9 East, Berjaya Times Square, No. 1 Jalan Imbi, 55100 Kuala Lumpur, Malaysia
Tel. No.:	603-2688 6333
Fax. No.:	603-2688 6332
E-mail address:	howls@kbenviro.com.my
Website:	www.kbenviro.com.my

[6] 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 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. *Deleted the arrow for power generation (gas engine) own power consumption to landfill*

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:

<u>Gas Extraction System in Advance Cell</u>

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 800-1,000ºC
Gas blower	Twin-lobe roots blower
Gas analysers	Gas analysers for CH_4 and O_2

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 800-1,000ºC
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 Extraction System in Phase 2 Cell

Phase 2A Cell was completed in October 2012. 12 lines of horizontal wells with gas pipeline were installed in the landfill to extract the LFG. 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 cell.

Third High-Temperature Enclosed Flaring System (Flare No.3)

Due to the delayed landfill gas extraction in Phase 2B Cell, there is no significant amount of excess LFG captured.

During the onsite inspection for this monitoring period, KBE has decided on not implementing Flare No.3. A notification letter has been issued on 06/04/2015 (/O1/). The revised PDD is updated indicating Flare No.3 will not be installed. The request for post-registration changes has been approved on 12/11/2015.

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 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.

With the additional gas extraction of LFG in Phase 2A, 2 units of 1.56 MW gas engines were delivered to the site on 06/08/2012. The gas engines were commissioned on 06/12/2013.

The details of Gas Engine No.2 and Gas Engine No.3 specifications (identical gas engines) are as listed below:

Specifications	Details
Manufacturer (Origin)	MWM (Germany)
Model	TCG 2020 V16
Electric power output	1.56 MW
Voltage	415 V
Frequency	50 Hz
Minimum heating value (LHV)	5.0 kWh/m^3

In addition to the new gas engines installation, an additional pipeline equipped with skid mounted LFG gas blower was installed in September 2012.

An additional 2MW gas engine was delivered to the site on 18/09/2015. The gas engine was commissioned on 26/10/2015. The monitoring parameters for the consumption of the landfill gas and additional power generated from the engine was recorded and included in this monitoring report.

The details of Gas Engine No.4 specifications are listed as below:

Specifications	Details
Manufacturer (Origin)	MTU
Model	GB1948B5
Electric power output	2 MW
Voltage	11000 V
Frequency	50 Hz
Minimum heating value (LHV)	5.0 kWh/m^3

<u>Centralised SCADA System</u>

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 Engines. 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.

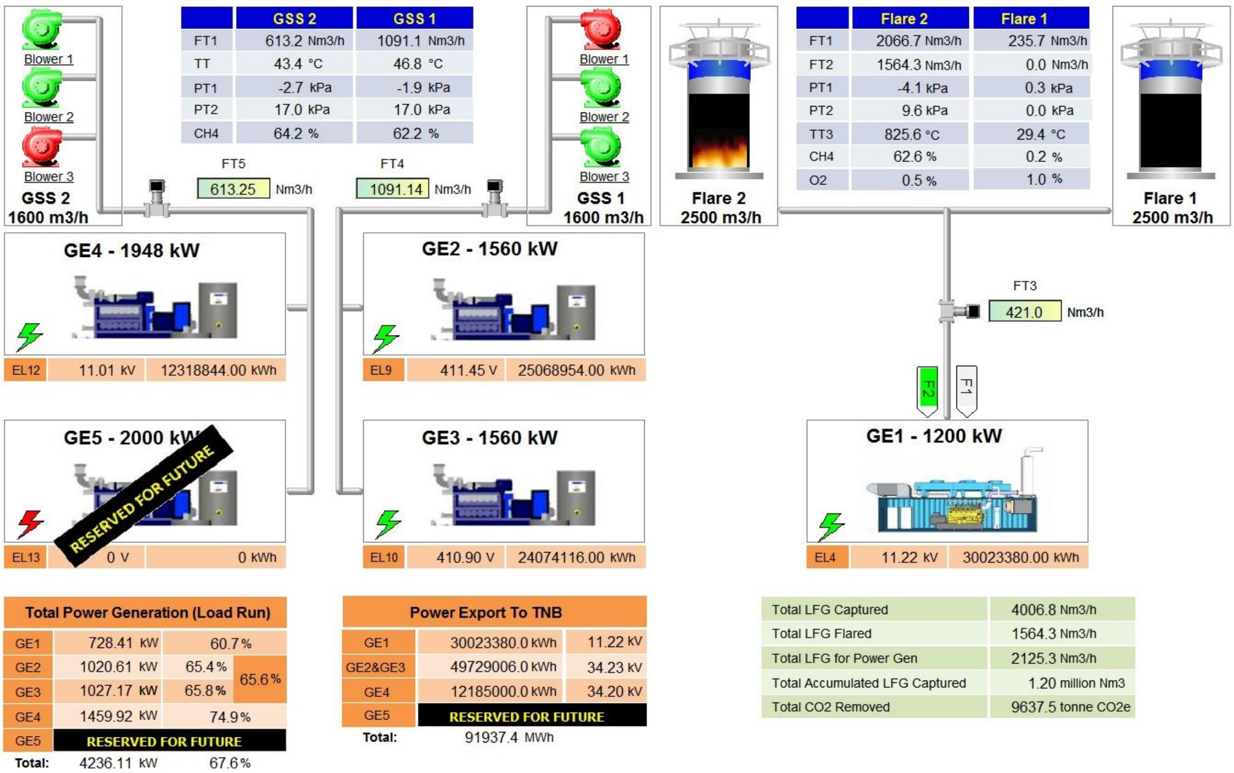


Figure 8: Centralized SCADA Interface

Implementation status of project activity

For the reporting period of 01/04/2015 to 27/08/2016, the key CDM activities implemented are described below:

<u>Gas Extraction System in Advance Cell and Flare No.1</u>

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 93% during this monitoring period.

Gas Extraction System in Phase 1 and 2A Cells 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 during the 6th monitoring period. Flare No.2 was located next to Flare No.1 where most of the LFG extracted from Phase 1 and 2A Cells 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 96% during this monitoring period.

Power Generation

During this monitoring period, power generated from Gas Engine No.1, No.2 and No.3 (GSS1) continued to be uploaded to the grid.

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. The supply of landfill gas for Gas Engine No.1 is linked with Flare No.2.

Gas Engine No.4 was commissioned on 26/10/2015. The supply of landfill gas for Gas Engine No.4 comes from an independent piping system linked from GSS1 (Gas Engine No.2 and No.3) and passes through GSS2 (Gas Engine No. 4). The properties of the landfill gas is monitored by independent monitoring equipment, i.e. temperature, pressure, methane content and flow rate for GSS1 and GSS2. The power generated from the gas engine is uploaded to the grid.

The details on the downtime of Gas Engine No.1, No.2, No.3 and No.4 are presented in **Appendix 3**.

B.2. Post-registration changes

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

No temporary deviations have been applied during this monitoring period.

B.2.2. Corrections

No corrections during this monitoring period.

B.2.3. Changes to start date of crediting period

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

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

No inclusion of a monitoring plan to the registered PDD that was not included at registration.

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

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

During the 9th monitoring period, KBE has decided on utilizing the EL6 power meter starting from 14/06/2014 to measure electricity consumed by Flare No.1, 2, Gas Engine No.1, 2, 3 and GSS. EL1 will not be used and will only be used as a back-up meter to measure electricity consumed by Flare No.1, 2 and Gas Engine No.1. A notification letter has been issued on 09/06/2015. A revision for the monitoring plan is requested and approved on 12/11/2015 (PRC-2467-003).

The following were submitted for the revision of monitoring plan:

- Determination of the calculated power consumption by Gas Engine No.2, 3 and GSS during the period from 01/04/2014 to 13/06/2014
- Estimation of power consumption by Flare No.1, 2 and Gas Engine No.1 when meter EL1 malfunction

The revision is related to the utilisation of EL6 meter instead of EL1 meter for the measurement of power consumed for the project activity and non-implementation of Flare No.3.

B.2.6. Changes to project design of registered project activity

The 2nd notification of change request (PRC-2467-001) was submitted to UNFCCC on 25/04/2013 and was approved by UNFCCC on 09/09/2013.

The change is related to the following:

- Increase of power generation approximately 3MW and upload to the grid by year 2013
- Installation of an additional pipeline and flare system equipped with skid mounted LFG gas blower to handle any excess LFG captured which is expected to be commissioned at the beginning of year 2014

The 3rd notification of change request (PRC-2467-003) was published in UNFCCC on 22/09/2015 and was approved by UNFCCC on 12/11/2015. The change is on non-implementation of Flare No.3.

The 4th notification of change request (PRC-2467-004) was published in UNFCCC on 11/10/2016 and was approved by UNFCCC on 15/11/2016.

The change is related to the following:

- Increase of power generation approximately 2MW and upload to the grid by year 2015
- Included diesel generator as backup for project activities during the power failure of the grid

B.2.7. 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:

- 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 ºC, 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 60ºC, 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 34 of the revised registered PDD, version 12.0, the Transmission and Distribution Losses (TDL_y) value applied in this project is 10%. This value was reported in the Tenaga Nasional Berhad (TNB)[7] Annual Report 2007[8] in page 23.

[7] Tenaga Nasional Berhad is the largest electricity provider in Malaysia and is responsible for the grid transmission and distribution in Peninsular Malaysia.

[8] http://announcements.bursamalaysia.com/EDMS/subweb.nsf/7f04516f8098680348256c6f0017a6bf/303144432ec5170e482573af00388df6/$FILE/TENAGA-Cover%20to%20Page%2050%20(2.3MB).pdf

Operation and Management Structure for Monitoring

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

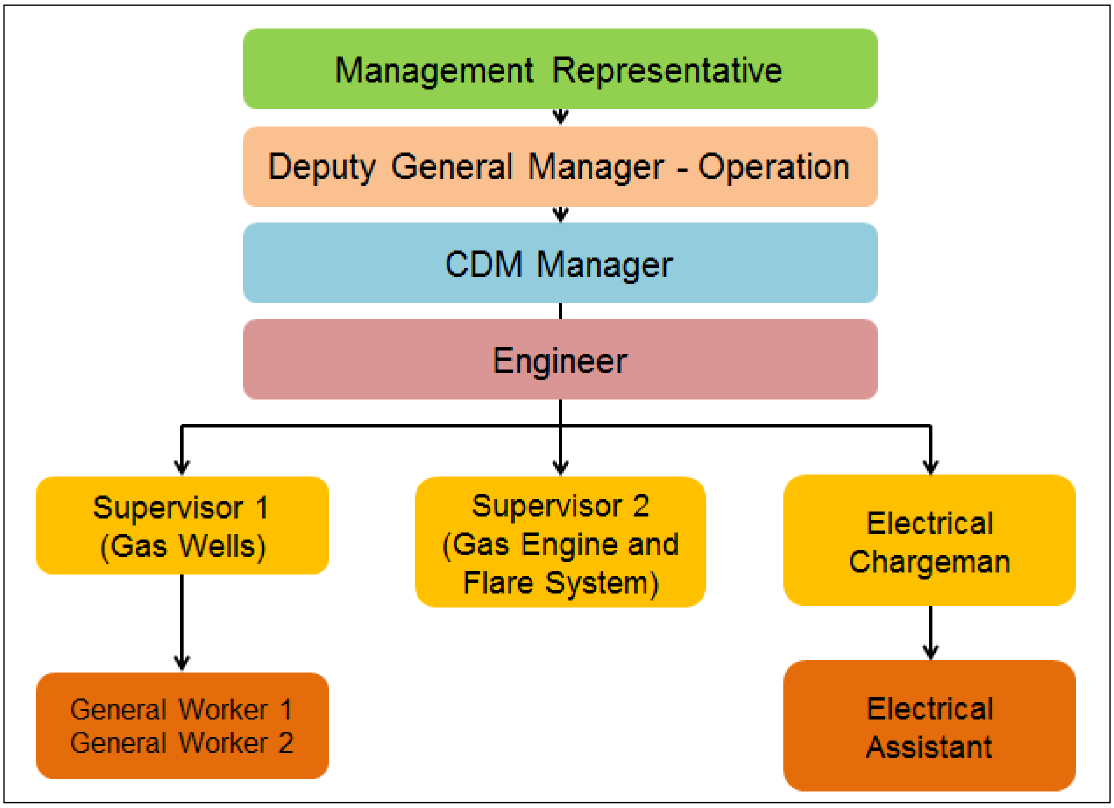


Figure 9: Organisational Structure for CDM Monitoring for BTSL LFG Recovery and Utilisation Project

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
Deputy General Manager - Operation	• 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 Deputy General Manager - Operation • 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
Engineer	• Reports to the CDM Manager • Assists the CDM Manager in performing CDM monitoring works • To monitor daily operation for landfill gas operations • To assist in daily monitoring records for all CDM related equipment • To prepare daily summary record for landfill gas operation

Role	Responsibility in CDM monitoring
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
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 Deputy General Manager - Operation. The Deputy General Manager – Operation is supported by the CDM Manager who is the key coordinator to all CDM monitoring matters on-site. The CDM Manager is assisted by an engineer, 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, one CDM Management Meeting was held on 19/11/2015.

Relevant Monitoring Points

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

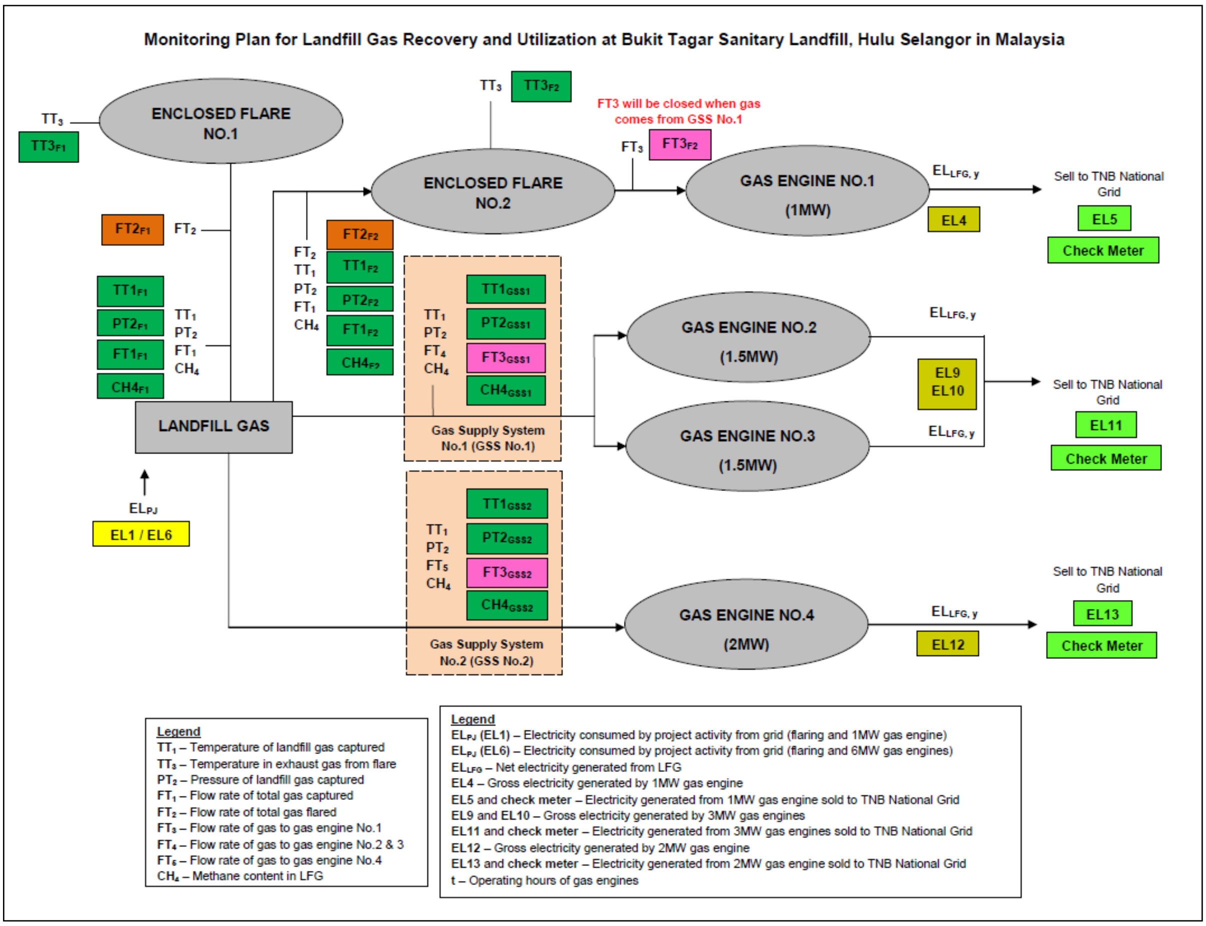


Figure 10: Key Parameters Monitored under the CDM Monitoring Plan

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.

<u>Data Recording and Documentation</u>

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:

<u>Continuous Monitoring – Data in Softcopy:</u>
Data logger (automatic recording in computer)

<u>Manual Recording – Data in Hardcopy:</u>
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	$T_{TT1,F1}$ $T_{TT1,F2}$ $T_{TT1,GSS}$	$TT_{1,Flare No.1/Flare No.2/GSS1/GSS2}$	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	$P_{PT2,F1}$ $P_{PT2,F2}$ $P_{PT2,GSS}$	$PT_{2,Flare No.1/Flare No.2/GSS1/GSS2}$	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	$LFG_{total,Flare No.1/Flare No.2,y}$ $LFG_{flare,Flare No.1/Flare No.2,y}$ $LFG_{electricity,Flare No.2/GSS,y}$	$FT_{1,Flare No.1/Flare No.2}$ $FT_{2,Flare No.1/Flare No.2}$ $FT_{3,Flare No.2/GSS1/GSS2}$	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	$W_{CH4,Flare No.1/Flare No.2/GSS,y}$	$CH_{4,Flare No.1/Flare No.2/GSS1/GSS2}$	Continuous Infrared Gas Analyser	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet

Parameter	CDM ID	Equipment ID	Monitoring equipment	Recording frequency	Documentations	Data archive
						will be scanned into PDF format for archiving
Electricity consumed by the project	$EL_{PJ,y}$	EL_{PJ} (EL6)	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	$EL_{LFG,GE\ No.1,y}$ $EL_{LFG,GE\ No.2,y}$ $EL_{LFG,GE\ No.3,y}$ $EL_{LFG,GE\ No.4,y}$	$EL_{LFG,GE\ No.1}$ (EL4) $EL_{LFG,GE\ No.2}$ (EL9) $EL_{LFG,GE\ No.3}$ (EL10) $EL_{LFG,GE\ No.3}$ (EL12)	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, EL11 and EL13, TNB main energy meters) TNB check energy meters	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	PR Electronics	5335A	100944768	≤ ± 0.05% of span	0-100°C	20/11/2014 & CTP 1256-14 (01/04/2015 - 12/01/2016)	19/11/2015	Annually
											13/01/2016 & CTT 1012-16 (13/01/2016 - 27/08/2016)	12/01/2017	Annually
2	Temperature Transmitter	Flare Temperature ($T_{flare,y}$)	$TT_{3,Flare\ No.1}$	$T_{Flare,F1}$	°C	PR Electronics	5335A	110910943	≤ ± 0.05% of span	0-1200°C	29/04/2014 & CTP 1065-14 (01/04/2015 - 11/05/2015)	28/04/2015	Annually
											12/05/2015 & CTT 1186-15 (12/05/2015 - 06/06/2016)	11/05/2016	Annually
											07/06/2016 & CTT 1202-16 (07/06/2016 - 27/08/2016)	06/06/2017	Annually
3	Pressure Sensor	Pressure Transmitter (P)	$PT_{2,Flare\ No.1}$	$P_{PT2,F1}$	kPa	Rosemount	3051TG1A2B21AB 4E5M5Q4	02492864	±0.25%	0-2 to 0-207 kPa	20/11/2014 & CTP 1756-14 (01/04/2015 - 12/01/2016)	19/11/2015	Annually
											13/01/2016 & CTP 1067-16 (13/01/2016 - 27/08/2016)	12/01/2017	Annually
4	Flow Meter	Total Biogas Flow Rate ($LFG_{total,y}$)	$FT_{1,Flare\ No.1}$	$LFG_{total,Flare\ No.1,y}$	NM^3/hr	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways	3051 / KVS10IIKC23FSN	4972946 / FT119 (8102101)	±1%	3-5000Nm^3/h	25/04/2013 & CTP 1139-13 (01/04/2015 - 11/05/2015)	24/04/2015	24 months
											12/05/2015 & CTP 1406-15 (12/05/2015 - 27/08/2016)	11/05/2017	24 months
5	Flow Meter	Flaring Biogas Flow Rate	$FT_{2,Flare\ No.1}$	$LFG_{flare,Flare\ No.1,y}$	NM^3/hr	Flow transmitter – Rosemount	3051 / KVS10IIKC23FSN	02768008 / FT120	±1%	3-5000Nm^3/h	20/11/2014 & CTP 1755-14 (01/04/2015 - 27/08/2016)	19/11/2016	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	32560	±2% of full scale	0-100%	29/04/2014 & CTM 1106-14 (01/04/2015 - 11/05/2015)	28/04/2015	Annually
											12/05/2015 & CTM 1098-15 (12/05/2015 - 06/06/2016)	11/05/2016	Annually
											07/06/2016 & CTM 1230-16 (07/06/2016 - 27/08/2016)	06/06/2017	Annually

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No	Parameters	Analysis date	Best if used by
1	N_2, CH_4	01/08/2011	01/08/2021
2	N_2, O_2	26/10/2009	26/10/2019
		09/01/2012	09/01/2022

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-EN0-000-000-000-00-3D	B839917437	±0.5% of span	0-100°C	29/04/2014 & CTP 1063-14 (01/04/2015 - 11/05/2015)	28/04/2015	Annually
											12/05/2015 & CTT 1182-15 (12/05/2015 - 06/06/2016)	11/05/2016	Annually
											07/06/2016 & CTT 1203-16 (07/06/2016 - 27/08/2016)	06/06/2017	Annually
2	Temperature Transmitter	Flare Temperature ($T_{flare,y}$)	$TT_{3,Flare\ No.2}$	$T_{Flare,F2}$	°C	Honeywell	STT25M-0-EN0-000-000-000-00-3D	B838901937	±0.5% of span	0-1200°C	29/04/2014 & CTP 1064-14 (01/04/2015 - 11/05/2015)	28/04/2015	Annually
											12/05/2015 & CTT 1183-15 (12/05/2015 - 06/06/2016)	11/05/2016	Annually
											07/06/2016 & CTT 1204-16 (07/06/2016 - 27/08/2016)	06/06/2017	Annually
3	Pressure Sensor	Pressure Transmitter (P)	$PT_{2,Flare\ No.2}$	$P_{PT2,F2}$	kPa	Rosemount	3051TG1A2B21AB4E 5Q4	5584784	±0.25%	0-2 to 0-207 kPa	29/04/2014 & CTP 1088-14 (01/04/2015 - 11/05/2015)	28/04/2015	Annually
											12/05/2015 & CTP 1402-15 (12/05/2015 - 06/06/2016)	11/05/2016	Annually
											07/06/2016 & CTP 2913-16 (07/06/2016 - 27/08/2016)	06/06/2017	Annually
4	Flow Meter	Total Biogas Flow Rate ($LFG_{total,y}$)	$FT_{1,Flare\ No.2}$	$LFG_{total,Flare\ No.2,y}$	NM^3/hr	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways	3051CD1A22A1AM5K 5Q4 / KVS10IIKC23FSN	5476626 / FT141 (10031702)	±0.5%	3-5000Nm^3/h	25/04/2013 & CTP 1136-13 (01/04/2015 - 11/05/2015)	24/04/2015	24 months
											12/05/2015 & CTP 1404-15 (12/05/2015 - 27/08/2016)	11/05/2017	24 months
5	Flow Meter	Flaring Biogas Flow Rate ($LFG_{flare,y}$)	$FT_{2,Flare\ No.2}$	$LFG_{flare,Flare\ No.2,y}$	NM^3/hr	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways	3051CD1A22A1AM5K 5Q4 / KVS10IIKC23FSN	5476627 / FT140 (10031701)	±0.5%	3-5000Nm^3/h	25/04/2013 & CTP 1137-13 (01/04/2015 - 11/05/2015)	24/04/2015	24 months
											12/05/2015 & CTP 1405-15 (12/05/2015 - 27/08/2016)	11/05/2017	24 months
6	Flow Meter	Flow Rate of Total Gas to	$FT_{3,Flare\ No.2}$	$LFG_{electricity,Flare}$	NM^3/hr	Flow transmitter – Rosemount	3051CD1A22A1AM5 B4K5Q4 /	02768007 / FT161 (11011001)	±0.5%	200-2000Nm^3/h	20/11/2014 & CTP 1754-14 (01/04/2015 - 27/08/2016)	19/11/2016	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	31453	±2% of full scale	0-100%	20/11/2014 & CTM 1347-14 (01/04/2015 - 13/01/2016)	19/11/2015	Annually
											13/01/2016 & CTM 1031-16 (13/01/2016 - 27/08/2016)	12/01/2017	Annually
Power Generation and Electricity Consumption													
8	Power meter	Total electricity generation (MWh) -	$EL_{LFG,GE\ No.1}$ (EL4)	$EL_{LFG,GE\ No.1,y}$	kWh (to be convert	EDMI Limited	Mk6E	210225256	Class 0.5S	99999999.99kWh	03/10/2014 & SP/RA/2014/505/002 (01/04/2015 - 27/08/2016)	02/10/2016	24 months
9	Power meter	Electricity sell to grid (MWh) - recorded by grid operator	EL_{LFG} (EL5)	$EL_{LFG,y}$	kWh	Itron	SL761A071	53099690	Class 0.20	999999999kWh	01/04/2011 & TNBM-QR-064 (01/04/2015 - 27/08/2016)	31/03/2016	5 years
10	Power meter	Electricity sell to grid (MWh) - check energy meter recorded by grid operator	-	-	kWh	Itron	SL761A071	53099691	Class 0.20	999999999kWh	01/04/2011 & TNBM-QR-064 (01/04/2015 - 27/08/2016)	31/03/2016	5 years

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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

Table 5: List of CDM Monitoring Equipment and Calibration for GSS1

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
Gas Supply System													
1	Temperature Transmitter	Temperature (T)	$TT_{1,GSS1}$	$T_{TT1,GSS1}$	°C	Honeywell	STT25M-0-ENS-000-000-000-00-3H	b527143837	±1%	0-100°C	09/05/2014 & CTT 1096-14 (01/04/2015 - 12/05/2015)	08/05/2015	Annually
											13/05/2015 & CTT 1185-15 (13/05/2015 - 06/06/2016)	12/05/2016	Annually
											07/06/2016 & CTT 1201-16 (07/06/2016 - 27/08/2016)	06/06/2017	Annually
2	Pressure Sensor	Pressure Transmitter (P)	$PT_{2,GSS1}$	$P_{PT2,GSS1}$	kPa	Rosemount	3051TG1A2B21AB4K5M5	5916057	±0.1%	0-60 kPa	09/05/2014 & CTP 1122-14 (01/04/2015 - 12/05/2015)	08/05/2015	Annually
											13/05/2015 & CTP 1403-15 (13/05/2015 - 06/06/2016)	12/05/2016	Annually
											07/06/2016 & CTP 2911-16 (07/06/2016 - 27/08/2016)	06/06/2017	Annually
3	Flow Meter	Flow Rate of Total Gas to Energy ($LFG_{electricity,y}$)	$FT_{3,GSS1}$	$LFG_{electricity,GSS1,y}$	NM^3/hr	Rosemount	3051CD1A22A1AM5B4DFK5	5988022	±0.5%	200-2,000 Nm^3/h	09/05/2014 & CTP 1121-14 (01/04/2015 - 06/06/2016)	08/05/2016	24 months
											07/06/2016 & CTP 2912-16 (07/06/2016 - 27/08/2016)	06/06/2018	24 months
Gas Analyser													
4	CH_4 Meter	Methane fraction of LFG	$CH_{4,GSS1}$	$W_{CH4,GSS1,y}$	%	Guardian Plus	97460	34140	±2% of full scale	0-100%	09/05/2014 & CTM 1113-14 (01/04/2015 - 11/05/2015)	08/05/2015	Annually
											12/05/2015 & CTM 1099-15 (12/05/2015 - 06/06/2016)	11/05/2016	Annually
											07/06/2016 & CTM 1231-16 (07/06/2016 - 27/08/2016)	06/06/2017	Annually
Power Generation and Electricity Consumption													
5	Power meter	Grid for project activity	EL_{PJ} (EL6)	$EL_{PJ,y}$	kWh	IME	NEMO 96HDL	2661930098	Class 1 (±1%)	0-250/5A	23/07/2014 & 2661 9300 98 (01/04/2015 - 27/08/2016)	22/07/2017	36 months
6	Power meter	Gross generation from GE No.2	$EL_{LFG,GE\ No.2}$ (EL9)	$EL_{LFG,GE\ No.2,y}$	kWh (to be converted to MWh)	EDMI Limited	Genius	211516862	Class 0.5S	99999999.99kWh	08/04/2013 & PP/13AM/385 (01/04/2015 - 12/05/2015)	07/04/2015	24 months
											13/05/2015 & SP/RA/2015/209/002 (13/05/2015 - 27/08/2016)	12/05/2017	24 months
7	Power meter	Gross generation from GE No.3	$EL_{LFG,GE\ No.3}$ (EL10)	$EL_{LFG,GE\ No.3,y}$	kWh (to be converted to MWh)	EDMI Limited	Genius	211516863	Class 0.5S	99999999.99kWh	09/04/2013 & PP/13AM/386 (01/04/2015 - 12/05/2015)	08/04/2015	24 months
											13/05/2015 & SP/RA/2015/209/001-002 (13/05/2015 - 27/08/2016)	12/05/2017	24 months
8	Power meter	Electricity sold to grid (MWh) - recorded by grid operator	EL_{LFG} (EL11)	$EL_{LFG,y}$	kWh	EDMI Limited	Mk6E	908705152	Class 0.5S	99,999,999kWh	06/12/2009 & TNBM/PJ/09/076 (01/04/2015 - 27/08/2016)	05/12/2014	5 years
9	Power meter	Electricity sell to grid (MWh) - check energy meter recorded by grid operator	-	-	kWh	EDMI Limited	Mk6E	908705154	Class 0.5S	99,999,999kWh	06/12/2009 & TNBM/PJ/09/076 (01/04/2015 - 27/08/2016)	05/12/2014	5 years

Table 6: List of CDM Monitoring Equipment and Calibration for GSS2

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
Gas Supply System													
1	Temperature Transmitter	Temperature (T)	$TT_{1,GSS2}$	$T_{TT1,GSS2}$	°C	Autrol	ATT2100-S11HA3E1-M1	4151000	±0.1%	0-100°C	23/04/2015 & AC1504-137 (26/10/2015 - 27/08/2016)	22/04/2016	Annually
2	Pressure Sensor	Pressure Transmitter (P)	$PT_{2,GSS2}$	$P_{PT2,GSS2}$	kPa	Autrol	APT3200-G4M11E11S1-M1	APT3200-4150998	±0.075% of span	-100-1,500kPa	23/04/2015 & AC1504-137 (26/10/2015 - 27/08/2016)	22/04/2016	Annually
3	Flow Meter	Flow Rate of Total Gas to Energy ($LFG_{electricity,y}$)	$FT_{3,GSS2}$	$LFG_{electricity,GSS2,y}$	NM^3/hr	Binder	EIA-C100000-1MA100-D1104501-21BS2410	C150327	2.5% of reading + 0.2% of full scale	0.25-25 Nm/s	23/06/2015 & C150327 (26/10/2015 - 27/08/2016)	22/06/2017	24 months
Gas Analyser													
4	CH_4 Meter	Methane fraction of LFG	$CH_{4,GSS2}$	$W_{CH4,GSS2,y}$	%	Guardian NG	200950	8154	±2% of full scale	0-100%	08/03/2016 & AL-E/0011/0316 (26/10/2015 - 27/08/2016)	07/03/2017	Annually
Power Generation and Electricity Consumption													
5	Power meter	Gross generation from GE No.4	$EL_{LFG,GE\ No.4}$ (EL12)	$EL_{LFG,GE\ No.4,y}$	kWh (to be converted to MWh)	EDMI	2000-6N00-30A31-04-L00-02A2-1D	213545834	Class 0.5S	99999999.99kWh	04/02/2016 & SP/RA/2016/081/001-001 (26/10/2015 - 27/08/2016)	03/02/2018	24 months
6	Power meter	Electricity sold to grid (MWh) - recorded by grid operator	EL_{LFG} (EL13)	$EL_{LFG,y}$	kWh	Itron	SL761W071	81480576	Class 0.2S	999999999kWh	14/06/2016 & TNB(B)/PP/UPH-PJ17/6/7-141 (26/10/2015 - 27/08/2016)	13/06/2021	5 years
7	Power meter	Electricity sell to grid (MWh) - check energy meter recorded by grid operator	-	-	kWh	Itron	SL761W071	81480578	Class 0.2S	999999999kWh	14/06/2016 & TNB(B)/PP/UPH-PJ17/6/7-141 (26/10/2015 - 27/08/2016)	13/06/2021	5 years

With reference to the Clean Development Mechanism Validation and Verification Standard, version 09.0, section 11.4.5, paragraph 395 (a), "Applying the maximum permissible error of the instrument to the measured values taken during the period between the scheduled date of calibration and the actual date of calibration, if the results of the delayed calibration do not show any errors in the measuring equipment, or if the error is smaller than the maximum permissible error", during this monitoring period, the equipment which have delay in calibration and the error of new calibration are less than the maximum permission error (MPE) are as listed below:

List of Equipment from Flare 1

1. TT1 – Due to overdue calibration, the maximum permissible error of ±0.7% which is the equipment accuracy error was applied to TT1 from 20/11/2015 – 13/01/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
2. TT3 – Due to overdue calibration, the maximum permissible error of ±0.05% which is the equipment accuracy error was applied to TT3 from 29/04/2015 – 12/05/2015 and ±0.07% which is the equipment calibration error was applied from 12/05/2015 – 07/06/2016 as a conservative approach.
3. PT2 – Due to overdue calibration, the maximum permissible error of ±0.25% which is the equipment accuracy error was applied to PT2 from 20/11/2015 – 13/01/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
4. FT1 – Due to overdue calibration, the maximum permissible error of ±1.00% which is the equipment accuracy error was applied to FT1 from 25/04/2015 – 12/05/2015 as a conservative approach.
5. CH4 – Due to overdue calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH4 from 29/04/2015 – 12/05/2015 and 12/05/2016 – 07/06/2016 as a conservative approach.

List of Equipment from Flare 2

1. TT1 – Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment calibration error was applied to TT1 from 29/04/2015 - 12/05/2015 and 12/05/2016 – 07/06/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
2. TT3 – Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment calibration error was applied to TT3 from 29/04/2015 - 12/05/2015 and 12/05/2016 – 07/06/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
3. PT2 – Due to overdue calibration, the maximum permissible error of ±0.25% which is the equipment calibration error was applied to PT2 from 29/04/2015 – 12/05/2015 as a conservative approach.
4. FT1 – Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment calibration error was applied to FT1 from 25/04/2015 – 12/05/2015 as a conservative approach.
5. FT2 – Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment calibration error was applied to FT2 from 25/04/2015 – 12/05/2015 as a conservative approach.
6. CH4 – Due to overdue calibration, the maximum permissible error of ±2.00% which is the equipment calibration error was applied to FT2 from 20/11/2015 – 13/01/2016 as a conservative approach.

List of Equipment from GSS1

1. TT1 – Due to overdue calibration, the maximum permissible error of ±1% which is the equipment accuracy error was applied to TT1 from 09/05/2015 - 13/05/2015 and 13/05/2016 0 07/06/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
2. PT2 – Due to overdue calibration, the maximum permissible error of ±0.1% which is the equipment calibration error was applied to PT2 from 09/05/2015 - 13/05/2015 and the maximum permissible error of ±0.12% was applied from 13/05/2016 – 07/06/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
3. FT3 – Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment calibration error was applied to FT3 from 09/05/2016 – 07/06/2016 as a conservative approach.
4. CH4 – Due to overdue calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH4 from 09/05/2015 – 12/05/2015 and 12/05/2016 – 07/06/2016 as a conservative approach.
5. EL9 – Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to EL9 from 08/04/2015 – 13/05/2015 as a conservative approach.
6. EL10 – Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to EL10 from 09/04/2015 – 13/05/2015 as a conservative approach.

List of Equipment from GSS2

1. TT1 – Due to overdue calibration, the maximum permissible error of ±0.1% of reading which is the equipment accuracy error was applied to TT1 from 23/04/2016 - 27/08/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
2. PT2 – Due to overdue calibration, the maximum permissible error of ±0.075% of reading which is the equipment accuracy error was applied to PT2 from 23/04/2016 - 27/08/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
3. EL12 – Due to overdue calibration, the maximum permissible error of ±0.5% of reading which is the equipment accuracy error was applied to EL12 from 26/10/2015 - 04/02/2016 as a conservative approach.
4. CH4 – Due to overdue calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH4 from 26/10/2015 - 08/03/2016 as a conservative approach.

With reference to the Clean Development Mechanism Validation and Verification Standard, version 09.0, section 11.4.5, paragraph 397, "In cases where the results of the delayed calibration are not available, or the calibration has not been conducted at the time of verification, the DOE, prior to finalizing verification, shall request the project participants or the coordinating/managing entity to conduct the required calibration and shall determine whether the project participants or the coordinating/managing entity have calculated the emission reductions conservatively using the approach mentioned in paragraph 395 above".

During this monitoring period, there is an equipment which the calibration have not been conducted at the time of verification. The equipment is as listed below:

List of Equipment from Flare 2

1. EL 5 (Itron, serial no.: 53099690) – The meter is owned by the grid operator, TNB and thus, it is not within the control of the project. However, due to overdue calibration, the maximum permissible error of ±0.2% which is the equipment accuracy error was applied to EL5 from 01/04/2016 – 27/08/2016 as a conservative approach

List of Equipment from GSS1

1. EL 11 (EDMI Limited, serial no.: 908705152) – The meter is owned by the grid operator, TNB and thus, it is not within the control of the project. However, due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to EL11 from 01/04/2015 – 27/08/2016 as a conservative approach

List of Equipment from GSS2

1. EL 13 (Itron, serial no.: 81480576) – The meter is owned by the grid operator, TNB and thus, it is not within the control of the project. However, due to overdue calibration, the maximum permissible error of ±0.2% which is the equipment accuracy error was applied to EL13 from 26/10/2015 – 14/06/2016 as a conservative approach

During this monitoring period, the equipment which has a calibration error more than the maximum permission error (MPE) are as listed below:

List of Equipment from Flare 1

1. TT3 (PR Electronics, serial no.: 110910943) – Error of 0.07% which is more than maximum permissible error of 0.05% (Calibration date: 07/06/2016)

List of Equipment from Flare 2

1. PT2 (Rosemount, serial no.: 5584784) – Error of 0.45% which is more than maximum permissible error of 0.25% (Calibration date: 07/06/2016)

List of Equipment from GSS1

1. PT2 (Rosemount, serial no.: 5916057) – Error of 0.8% which is more than maximum permissible error of 0.1% (Calibration date: 13/05/2015)

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).

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)

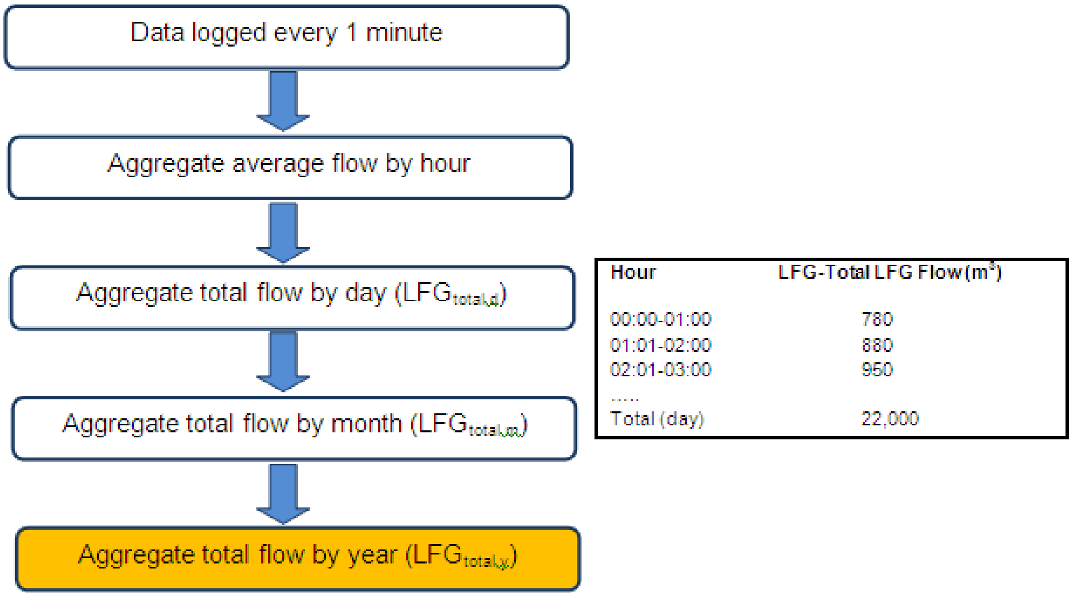

Figure 11: Example of Data Aggregation for Continuous Monitoring

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.

Quality Assurance and Quality Control (QA & QC)

Documented Procedures and QA/QC Measures

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.

Data Management and Storage

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.

Continuous Monitoring (data logging system)

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., Unit C7-2, Tower C, Wisma Goshen, Bangsar Trade Centre, 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:

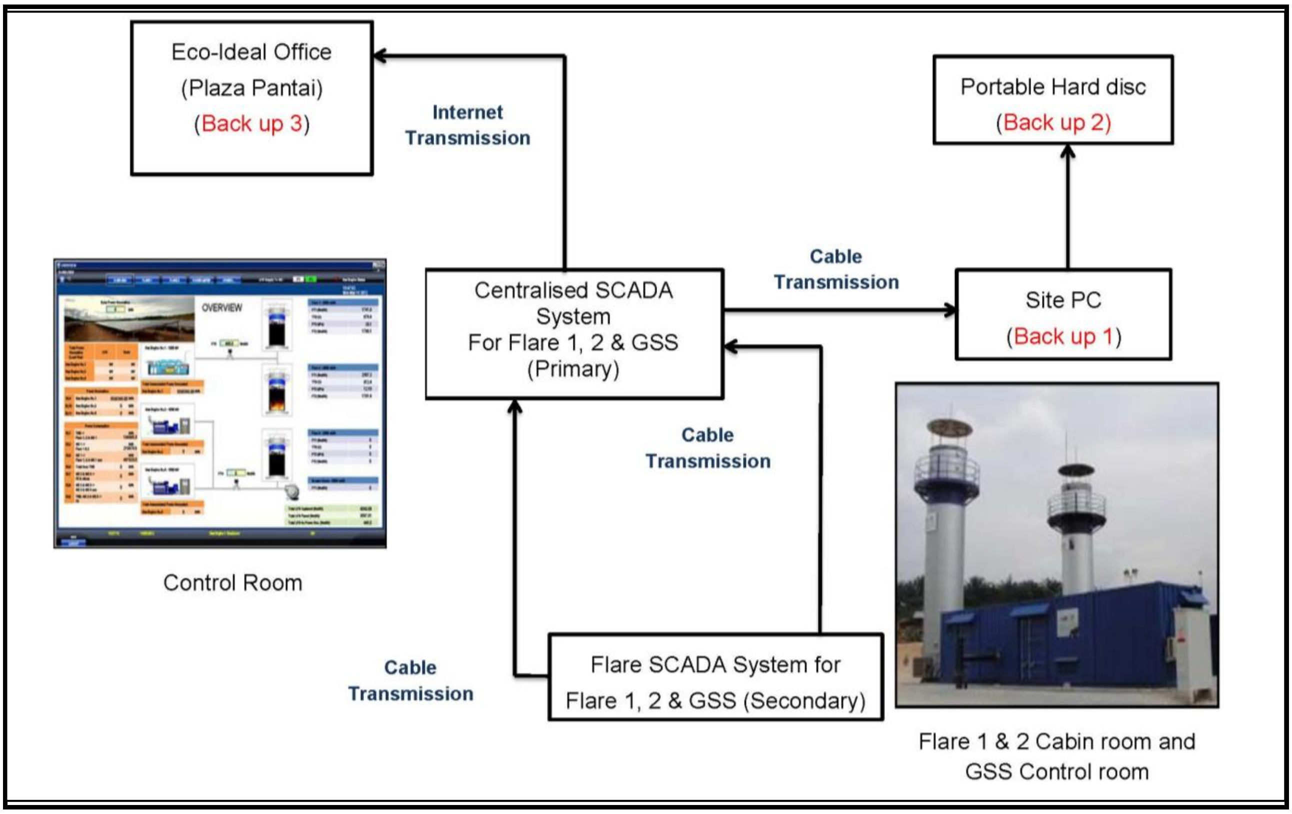

Figure 12: Automatic Data Back-Up for Flaring System at BTSL

Manual Recording

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 was 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 10th monitoring period was conducted by the consultant (Eco-Ideal Consulting Sdn. Bhd.):

- Audit No. 13 – 27/10/2016

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, training has been conducted by the CDM consultants to the site officers on 27/10/2016.

The staff has also attended several technical/operational trainings as listed below:

No.	Description	Date	No. of participants
1	Landfill Gas – Well Operation for Supervisor	12/05/2015	9
2	Landfill Gas Pipeline – Operation	19/08/2015	9
3	Landfill Gas – Condensate Trap Operation	25/11/2015	9
4	SCADA – Landfill Gas Operation	06/01/2016	11
5	CH_4 Analyser – For Flare 1/ Flare 2 / GSS1 / GSS2 Service	18/03/2016	12
6	Gas Engine Control – GCP / AGCM	16/05/2016	11
7	Gas Engine Pre-treatment Operation	14/07/2016	10

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
Choice of data or measurement methods and procedures	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:	With reference to decision 4/CMP7 and paragraph 66 of the EB 69 Meeting Report, for the second commitment period of the Kyoto Protocol, the global warming potentials used by Parties to calculate the carbon dioxide equivalence of anthropogenic emissions by sources and removals by sinks of the greenhouse gases listed in Annex A to the Kyoto Protocol shall be those listed in the column entitled “Global Warming Potential for Given Time Horizon” in Table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon, i.e. 25 tCO_2/tCH_4
Value(s) applied):	25
Choice of data or measurement methods and procedures	Default Value
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
Choice of data or measurement methods and procedures	Default Value
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
Choice of data or measurement methods and procedures	Default Value
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
Choice of data or measurement methods and procedures	Default Value

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
Choice of data or measurement methods and procedures	Default Value
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
Choice of data or measurement methods and procedures	Default Value
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
Choice of data or measurement methods and procedures	Default Value
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
Choice of data or measurement methods and procedures	Default Value
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: **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
Choice of data or measurement methods and procedures	Default Value
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

Data / Parameter:	**kj**
Unit:	-
Description:	Decay rate for 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 3.3)

Value(s) applied):	The following values for the different waste fraction (types) were applied:

Waste type *j*		Boreal and Temperature (MAT<20ºC)		Tropical (MAT>20ºC)	
		Dry (MAP/PET<1)	Wet (MAP/PET>1)	Dry (MAP<1000 mm)	Wet (MAP>1000 mm)
Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.04	0/06	0.045	**0.07**
	Wood, wood products and straw	0.02	0.03	0.025	**0.035**
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.1	0.065	**0.17**
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185	0.085	**0.4**

Choice of data or measurement methods and procedures	Default Value
Purpose of data:	Baseline emission calculation
Additional comment:	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

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 of the flares and gas engines, i.e. Flare No.1 (1 meter) and Flare No.2 & Gas Engine No.1 (1 meter). 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 $LFG_{eletricity.}$ The supply of landfill gas to the Gas Supply System (GSS) comes from an independent piping system. The properties of the landfill gas were monitored by independent monitoring equipment, i.e. temperature ($TT1_{GSS}$), pressure ($PT2_{GSS}$), methane content ($CH4_{GSS}$) and flow rate ($FT3_{GSS}$).
Value(s) of monitored parameter:	**<u>Flare No.1</u>** According to ACM 0001, version 8[9], 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:

[9] 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.

1. *When FT1 is greater than FT2 + FT3*

   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. *When FT1 is lower than FT2 + FT3*

   When FT1 is lower, FT1 will then be used in the ER calculation as a conservative approach.

Months	Flare No.2 FT1 Value (Nm^3)	Flare No.2 Total of FT2 & FT3 Value (Nm^3)
April 15	1,441,893	1,393,184
May 15	1,521,395	1,486,154
June 15	1,448,863	1,398,463
July 15	1,244,474	1,192,100
August 15	1,519,542	1,460,704
September 15	1,206,641	1,166,277
October 15	1,186,447	1,152,097
November 15	1,444,785	1,395,431
December 15	1,238,770	1,195,549
January 16	1,497,285	1,444,642
February 16	1,565,582	1,498,274
March 16	1,674,918	1,595,130
April 16	1,500,033	1,425,141
May 16	1,570,981	1,495,444
June 16	1,393,019	1,312,269
July 16	1,532,298	1,457,809
August 16	1,110,859	1,040,009
Total	**24,097,786**	**23,108,677**

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)
April 15	584,098	1,393,184
May 15	857,101	1,486,154
June 15	696,584	1,398,463
July 15	336,823	1,192,100
August 15	477,799	1,460,704
September 15	662,508	1,166,277
October 15	592,421	1,152,097
November 15	464,963	1,395,431
December 15	540,960	1,195,549
January 16	654,072	1,444,642
February 16	548,122	1,498,274
March 16	438,959	1,595,130

April 16	366,936	1,425,141
May 16	439,468	1,495,444
June 16	359,632	1,312,269
July 16	450,006	1,457,809
August 16	330,914	1,040,009
Total	**8,801,365**	**23,108,677**

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.

Months	GSS1 Value (Nm^3)
April 15	873,100
May 15	848,913
June 15	861,342
July 15	583,635
August 15	719,913
September 15	231,141
October 15	433,550
November 15	548,965
December 15	706,449
January 16	542,706
February 16	508,663
March 16	476,096
April 16	526,470
May 16	566,932
June 16	420,436
July 16	535,728
August 16	407,777
Total	**9,791,817**

Months	GSS2 Value (Nm^3)
April 15	
May 15	
June 15	
July 15	
August 15	
September 15	
October 15	46,996
November 15	510,773
December 15	421,714
January 16	459,874
February 16	452,925
March 16	474,925
April 16	449,747
May 16	473,587
June 16	445,809
July 16	452,096

August 16	381,946
Total	**4,570,391**

GSS1 (Gas Engine No. 2 and 3) and GSS2 (Gas Engine No. 4)

According to ACM 0001, version 8[10], 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 sent to the power plants (gas engines) for electricity generation, one flow meter 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 sent to the gas engines for GSS1 and GSS2 respectively during the monitoring period as total LFG captured in GSS1 was only sent to Gas Engine No.2 and 3 and total LFG captured in GSS2 was only sent to Gas Engine No.4.

The amount of landfill gas generated which is channelled to the Gas Supply System (GSS1 and GSS2) is measured continuously by using a flow meter and the data, as reported under the parameter $\mathbf{LFG_{electricity,y}}$ is as tabulated here. For more details of the parameter and the measuring instrument, please refer to the monitoring parameter $\mathbf{LFG_{electricity,y}}$ below.

Monitoring equipment:

Item	Flare No.1 Description	Flare No.1 Description
	01/04/2015 - 11/05/2015	**12/05/2015 – 27/08/2016**
Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	
Accuracy class	± 1%	
Serial No.	4972946 (Rosemount) / FT1 – FT119 (8102101) (Kingsway)	
Calibration frequency	24 months	
Date of last calibration	25/04/2013	12/05/2015
Validity	24 months	

Item	Flare No.2 Description	Flare No.2 Description
	01/04/2015 - 11/05/2015	**12/05/2015 – 27/08/2016**
Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	
Accuracy class	± 0.5%	
Serial No.	5476626 (Rosemount) / FT1 – FT141 (10031702) (Kingways)	
Calibration frequency	24 months	
Date of last calibration	25/04/2013	12/05/2015
Validity	24 months	

[10] 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.

	Flare No. 1 Due to overdue calibration, the maximum permissible error of ±1% which is the equipment accuracy error was applied to FT1 from 25/04/2015 - 12/05/2015 as a conservative approach. **Flare No. 2** Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to FT1 from 25/04/2015 - 12/05/2015 as a conservative approach. **GSS1 (Gas Engine No. 2 and 3) and GSS2 (Gas Engine No. 4)** The details of the monitoring parameter equipment is as shown under $\mathbf{LFG_{electricity,y}}$ below.
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:	Baseline emission calculation
Additional comment:	-

Data / Parameter:	$\mathbf{LFG_{flare,y}}$
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. *When FT1 is greater than FT2 + FT3*

   The value of FT2 will be used in the ER calculation as a conservative approach.

2. *When FT1 is lower than FT2 + FT3*

   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)
April 15	584,098	1,148,281
May 15	857,101	1,222,338
June 15	696,584	1,145,168
July 15	336,823	969,455
August 15	477,799	1,187,265
September 15	662,508	1,117,573
October 15	592,421	1,055,774
November 15	464,963	1,153,043
December 15	540,960	1,012,622
January 16	654,072	1,196,299
February 16	548,122	1,194,541
March 16	438,959	1,264,523
April 16	366,936	1,098,928
May 16	439,468	1,158,036
June 16	359,632	1,115,794
July 16	450,006	1,181,517
August 16	330,914	883,778
Total	**8,801,365**	**19,104,935**

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.

Monitoring equipment:

Item	Flare No.1 Description
	01/04/2015 – 27/08/2016
Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone
Accuracy class	± 1%
Serial No.	02768008 (Rosemount) / FT120 (8102102) (Kingways)
Calibration frequency	24 months
Date of last calibration	20/11/2014
Validity	24 months

Item	Flare No.2 Description	
	01/04/2015 – 11/05/2015	12/05/2015 – 27/08/2016
Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	
Accuracy class	± 0.5%	
Serial No.	5476627 (Rosemount) / FT2 – FT140 (10031701) (Kingways)	
Calibration frequency	24 months	
Date of last calibration	25/04/2013	12/05/2015
Validity	24 months	

Flare No. 2

Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to FT2 from 25/04/2015 - 12/05/2015 as a conservative approach.

Measuring/ Reading/ Recording frequency:	Measured continuously with flow meter. Data was aggregated on both monthly and yearly basis
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:	**$LFG_{electricity,y}$**
Unit:	m^3
Description:	Amount of landfill gas combusted in power plant (Gas Engine No.1, 2, 3 and 4) 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 the gas engines, i.e. Gas Engine No. 1 (1 meter), Gas Engine No. 2 and No. 3 (1 meter) and Gas Engine No. 4 (1 meter). Therefore, 3 sets of equipment have to be used for the monitoring period. 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)	GSS1 Value (Nm^3)	GSS2 Value (Nm^3)
April 15	244,903	873,100	
May 15	263,816	848,913	
June 15	253,295	861,342	
July 15	222,645	583,635	
August 15	273,440	719,913	
September 15	48,704	231,141	
October 15	96,323	433,550	46,996
November 15	242,388	548,965	510,773
December 15	182,927	706,449	421,714
January 16	248,344	542,706	459,874
February 16	303,733	508,663	452,925
March 16	330,607	476,096	474,925
April 16	326,213	526,470	449,747

May 16	337,407	566,932	473,587
June 16	196,475	420,436	445,809
July 16	276,292	535,728	452,096
August 16	156,231	407,777	381,946
Total	**4,003,742**	**9,791,817**	**4,570,391**

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:

Item	Flare No.2 Description
	01/04/2015 – 27/08/2016
Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone
Accuracy class	± 0.5%
Serial No.	02768007 (Rosemount) / FT161 (11011001) (Kingways)
Calibration frequency	24 months
Date of last calibration	20/11/2014
Validity	24 months
	24 months

Item	GSS1 Description	
	01/04/2015 – 06/06/2016	07/06/2016 – 27/08/2016
Type	Flow transmitter – Rosemount	
Accuracy class	± 0.5%	
Serial No.	5988022	
Calibration frequency	24 months	
Date of last calibration	09/05/2014	07/06/2016
Validity	24 months	

Item	GSS2 Description
	26/10/2015 - 27/08/2016
Type	Flow transmitter – Binder
Accuracy class	± 2.5% of reading + 0.2% of full scale
Serial No.	C150327
Calibration frequency	24 months
Date of last calibration	23/06/2015
Validity	24 months

GSS1

Due to having an equipment calibration error more than the equipment accuracy error, the maximum permissible error of ±0.5% which is the equipment calibration error was applied to FT3 from 09/05/2016 – 07/06/2016 as a conservative approach.

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 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 (tCO_2e)	Flare No.2 Value (tCO_2e)
April 15	641	1,191
May 15	856	1,324
June 15	636	1,103
July 15	320	997
August 15	458	1,195
September 15	708	1,150
October 15	626	1,099
November 15	447	1,207
December 15	518	1,090
January 16	582	1,349
February 16	507	1,322
March 16	473	1,406
April 16	396	1,183
May 16	485	1,255
June 16	411	1,244
July 16	439	1,310
August 16	327	925
Total	**8,830**	**20,349**

Monitoring equipment:	Refer to $\mathbf{T_{flare}}$ 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 CH_4 / 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 and the gas engines, i.e. Flare No.1 (1 meter), Flare No.2 & Gas Engine No.1 (1 meter), Gas Engine No.2 and No.3 (1 meter) and Gas Engine No.4 (1 meter). Therefore, 4 sets of equipment have to be 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 (%)	GSS1 Value (%)	GSS2 Value (%)
April 15	0.58	0.56	0.59	
May 15	0.54	0.58	0.58	
June 15	0.51	0.54	0.57	
July 15	0.50	0.55	0.58	
August 15	0.51	0.54	0.58	

	September 15	0.57	0.56	0.60	
	October 15	0.55	0.55	0.58	0.60
	November 15	0.52	0.57	0.58	0.61
	December 15	0.52	0.58	0.59	0.62
	January 16	0.49	0.61	0.58	0.62
	February 16	0.52	0.62	0.64	0.62
	March 16	0.58	0.61	0.56	0.62
	April 16	0.57	0.59	0.67	0.62
	May 16	0.59	0.61	0.61	0.63
	June 16	0.55	0.61	0.64	0.63
	July 16	0.54	0.62	0.66	0.63
	August 16	0.55	0.57	0.61	0.63
	Average	**0.54**	**0.58**	**0.60**	**0.62**

Monitoring equipment:

Item	Flare No.2 Description	
	01/04/2015– 3/01/2016	**13/01/2016– 7/08/2016**
Type	Guardian Plus (97460) Infra-Red Gas Monitor	
Accuracy class	± 2%	
Serial No.	31453	
Calibration frequency	Annually	
Date of last calibration	20/11/2014	13/01/2016
Validity	1 year	

Item	GSS1 Description		
	01/04/2015 – 11/05/2015	**12/05/2015 – 06/06/2016**	**07/06/2016 – 27/08/2016**
Type	Guardian Plus (97460) Infra-Red Gas Monitor		
Accuracy class	± 2%		
Serial No.	34140		
Calibration frequency	Annually		
Date of last calibration	09/05/2014	12/05/2015	07/06/2016
Validity	1 year		

Item	GSS2 Description
	26/10/2015 – 27/08/2016
Type	Guardian NG (200950)
Accuracy class	± 2%
Serial No.	8154
Calibration frequency	Annually
Date of last calibration	08/03/2016
Validity	1 year

Flare No. 1

Due to delayed calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH_4 from 29/04/2015 – 12/05/2015 and 12/05/2016 – 07/06/2016 as a conservative approach.

	Flare No. 2 Due to delayed calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH_4 from 20/11/2015 – 13/01/2016 as a conservative approach. **GSS1 (Gas Engine No. 2 and 3)** Due to delayed calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH_4 from 09/05/2015 – 12/05/2015 and 12/05/2016 – 07/06/2016 as a conservative approach. **GSS2 (Gas Engine No. 4)** Due to overdue calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH_4 from 26/10/2015 – 08/03/2016 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 ($T_{TT1,F1}$, $T_{TT1,F2}$, $T_{TT1,GSS1}$, $T_{TT1,GSS2}$)**
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 and the gas engines, i.e. Flare No.1 (1 meter), Flare No.2 & Gas Engine No.1 (1 meter), Gas Engine No.2 and No.3 (1 meter) and Gas Engine No.4 (1 meter). Therefore, 4 sets of equipment have to be used for the monitoring period.
Value(s) of monitored parameter:	

Months	Flare No.1 Value (°C)	Flare No.2 Value (°C)	GSS1 Value (°C)	GSS2 Value (°C)
April 15	43.40	43.41	51.94	
May 15	47.79	43.91	52.05	
June 15	41.49	44.13	53.89	
July 15	37.06	42.27	46.57	
August 15	39.34	43.98	54.20	
September 15	43.56	42.02	50.41	

October 15	42.86	41.92	50.27	37.77
November 15	38.58	43.51	56.03	43.01
December 15	40.93	43.74	59.45	44.33
January 16	42.76	45.35	55.70	45.91
February 16	41.84	45.23	55.69	47.09
March 16	40.32	45.94	54.09	46.89
April 16	40.37	44.70	62.35	47.52
May 16	39.48	43.56	61.53	46.51
June 16	38.02	42.94	62.55	45.95
July 16	39.15	43.43	62.03	45.83
August 16	37.97	41.70	63.56	45.35
Average	**40.88**	**43.62**	**56.02**	**45.11**

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 60ºC, 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 60ºC, 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 60ºC. 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**.

Monitoring equipment:

Item	**Flare No.1 Description**	
	01/04/2015 – 12/01/2016	**13/01/2016 – 27/08/2016**
Type	PR Electronics (5335A) Temperature Transmitter	
Accuracy class	$\leq$ ± 0.05% of span	
Serial No.	100944768	
Calibration frequency	Annually	
Date of last calibration	20/11/2014	13/01/2016
Validity	1 year	

Item	Flare No.2 Description		
	01/04/2015 – 11/05/2015	**12/05/2015 – 06/06/016**	**07/06/2016 – 27/08/2016**
Type	Honeywell (STT25M-0-EN0-000-000-000-00-3D) Temperature Transmitter		
Accuracy class	± 0.5% of span		
Serial No.	B839917437		
Calibration frequency	Annually		
Date of last calibration	29/04/2014	12/05/2015	07/06/2016
Validity	1 year		

Item	GSS1 Description		
	01/04/2015 – 12/05/2015	**13/05/2015 – 06/06/016**	**07/06/2016 – 27/08/2016**
Type	Honeywell (STT25M-0-ENS-000-000-000-00-3H) Temperature Transmitter		
Accuracy class	± 1%		
Serial No.	b527143837		
Calibration frequency	Annually		
Date of last calibration	09/05/2014	13/05/2015	07/06/2016
Validity	1 year		

Item	GSS2 Description
	26/10/2015 – 27/08/2016
Type	Autrol (ATT2100-S11HA3E1-M1) Temperature Transmitter
Accuracy class	± 0.1%
Serial No.	4151000
Calibration frequency	Annually
Date of last calibration	23/04/2015
Validity	1 year

Flare No.1

Due to having an equipment calibration error more than the equipment accuracy error, the maximum permissible error of ±0.7% which is the equipment calibration error was applied to TT1 from 20/11/2015 – 13/01/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Flare No.2

Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment calibration error was applied to TT1 from 29/04/2015 – 12/05/2015 and 12/05/2016 – 07/06/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

GSS1 (Gas Engine No. 2 and 3)

Due to overdue calibration, the maximum permissible error of ±1% which is the equipment accuracy error was applied to TT1 from 09/05/2015 – 13/05/2015 and 13/05/2016 - 07/06/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

	GSS2 (Gas Engine No. 4) Due to overdue calibration, the maximum permissible error of ±0.1% of reading which is the equipment accuracy error was applied to TT1 from 23/04/2016 – 27/08/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
Measuring/Reading/Recording frequency:	Measured continuously by temperature meter
Calculation method (if applicable):	Raw data logged at 1 minute's interval was used to compute the daily average readings
QA/QC procedures:	The temperature transmitter was calibrated regularly according to the manual given by the manufacturer
Purpose of data:	Baseline and Project emission calculation
Additional comment:	-

Data / Parameter:	**P ($P_{PT2, F1}$, $P_{PT2, F2}$, $P_{PT2, GSS1}$, $P_{PT2, GSS2}$)**
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 and the gas engines, i.e. Flare No.1 (1 meter), Flare No.2 & Gas Engine No.1 (1 meter), Gas Engine No.2 and No.3 (1 meter) and Gas Engine No.4 (1 meter). Therefore, 4 sets of equipment have to be used for the monitoring period.
Value(s) of monitored parameter:	

Gauge pressure (Months)	Flare No.1 Value (kPa)	Flare No.2 Value (kPa)	GSS1 Value (kPa)	GSS2 Value (kPa)
April 15	8.04	10.10	16.99	
May 15	12.81	10.18	16.87	
June 15	8.12	10.40	17.00	
July 15	4.55	8.95	13.44	
August 15	5.01	10.23	15.70	
September 15	8.05	9.67	5.49	
October 15	8.38	9.43	10.39	13.47
November 15	5.19	9.92	16.95	16.84
December 15	7.20	9.67	16.98	16.93
January 16	6.13	9.85	16.76	16.64
February 16	3.81	11.08	17.00	16.97
March 16	1.98	11.24	15.49	16.84
April 16	1.79	9.74	16.98	16.85

May 16	1.99	9.86	16.94	16.83
June 16	1.98	10.03	16.73	16.96
July 16	2.36	10.10	16.97	16.99
August 16	2.17	8.27	16.10	16.36
Average	**5.27**	**9.93**	**15.46**	**16.52**

Absolute pressure (Months)	Flare No.1 Value (kPa)	Flare No.2 Value (kPa)	GSS1 Value (kPa)	GSS2 Value (kPa)
April 15	109.37	111.42	118.32	
May 15	114.13	111.51	118.19	
June 15	109.44	111.73	118.33	
July 15	105.87	110.27	114.77	
August 15	106.33	111.56	117.03	
September 15	109.37	110.99	106.81	
October 15	109.70	110.76	111.71	114.80
November 15	106.52	111.25	118.28	118.16
December 15	108.52	111.00	118.30	118.26
January 16	107.45	111.18	118.09	117.97
February 16	105.13	112.40	118.33	118.29
March 16	103.31	112.56	116.82	118.17
April 16	103.11	111.07	118.31	118.18
May 16	103.31	111.18	118.26	118.16
June 16	103.31	111.36	118.06	118.28
July 16	103.68	111.43	118.30	118.31
August 16	103.49	109.59	117.42	117.69
Average	**105.59**	**111.25**	**116.78**	**117.84**

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.

Monitoring equipment:

Item	Flare No.1 Description	
	01/04/2015 - 12/01/2016	13/01/2016 - 27/08/2016
Type	Rosemount (3051TG1A2B21AB4E5M5Q4) Pressure Transmitter	
Accuracy class	± 0.25%	
Serial No.	02492864	
Calibration frequency	Annually	
Date of last calibration	20/11/2014	13/01/2016
Validity	1 year	

Item	Flare No.2 Description		
	01/04/2015 – 11/05/2015	12/05/2015 – 06/06/2016	07/06/2016 – 27/08/2016
Type	Rosemount (3051TG1A2B21AB4E5Q4) Pressure Transmitter		
Accuracy class	± 0.25%		
Serial No.	5584784		
Calibration frequency	Annually		
Date of last calibration	29/04/2014	12/05/2015	07/06/2016
Validity	1 year		

Item	GSS1 Description		
	01/04/2015 – 12/05/2015	13/05/2015 – 06/06/2016	07/06/2016 – 27/08/2016
Type	Rosemount (3051TG1A2B21AB4K5M5) Pressure Transmitter		
Accuracy class	± 0.1%		
Serial No.	5916057		
Calibration frequency	Annually		
Date of last calibration	09/05/2014	13/05/2015	07/06/2016
Validity	1 year		

Item	GSS2 Description
	26/10/2015 – 27/08/2016
Type	APT3200-G4M11E11S1-M1 Pressure Transmitter
Accuracy class	± 0.075% of span
Serial No.	APT3200-4150998
Calibration frequency	Annually
Date of last calibration	23/04/2015
Validity	1 year

Flare No.1

Due to overdue calibration, the maximum permissible error of ±0.25% which is the equipment calibration error was applied to PT2 from 20/11/2015 – 13/01/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Flare No.2

Due to overdue calibration, the maximum permissible error of ±0.25% which is the equipment calibration error was applied to PT2 from 29/04/2015 - 12/05/2015 and the maximum permissible error of ±0.45% which is the equipment calibration error was applied to PT2 from 12/05/2016 – 07/06/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

During this monitoring period, PT2 has an error exceeding the MPE. The error of 0.45% which is more than the maximum permissible error of 0.25% (Calibration date : 07/06/2016).

	GSS1 (Gas Engine No. 2 and 3) Due to overdue calibration, the maximum permissible error of ±0.1% which is the equipment calibration error was applied to PT2 from 09/05/2015 - 13/05/2015 and the maximum permissible error of ±0.12% which is the equipment calibration error was applied to PT2 from 13/05/2016 – 07/06/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible. During this monitoring period, PT2 has an error exceeding the MPE. The error is 0.8% which is more than the maximum permissible error of 0.1% (Calibration date : 13/05/2015). **GSS2 (Gas Engine No. 4)** Due to overdue calibration, the maximum permissible error of ±0.075% of reading which is the equipment accuracy error was applied to PT2 from 23/04/2016 - 27/08/2016 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
Measuring/Reading/ Recording frequency:	Measured continuously by a pressure transmitter
Calculation method (if applicable):	Raw data logged at 1 minute's interval was used to compute the daily average readings
QA/QC procedures:	The meter 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:	**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 meters. This parameter was measured separately for the gas engines, i.e. Gas Engine No.1 (1 meter),Gas Engine No.2 and No.3 (1 meter) and Gas Engine No.4 (1 meter). Therefore, 3 sets of equipment have to be used for the monitoring period.
Value(s) of monitored parameter:	There were 2 sets of 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 EL4 and EL5 (main meter), the lower value between the two is taken for the calculation of net amount of electricity generated for Gas Engine No.1.

From the comparison of EL9 + EL10 and EL11 (main meter), the lower value between the two is taken for the calculation of net amount of electricity generated for Gas Engine No.2 and No.3.

From the comparison of EL12 and EL13 (main meter), the lower value between the two is taken for the calculation of net amount of electricity generated for Gas Engine No.4.

The detailed calculation was shown in the CER calculation sheet under each monthly 'ELPJ' tab.

Months	Net amount of electricity generated (MWh)
April 15	1,987.15
May 15	2,210.04
June 15	2,158.78
July 15	1,454.21
August 15	1,922.10
September 15	559.94
October 15	1,140.74
November 15	2,739.71
December 15	2,662.99
January 16	2,482.37
February 16	2,527.92
March 16	2,610.09
April 16	2,752.44
May 16	2,908.51
June 16	2,565.29
July 16	2,540.18
August 16	2,024.17
Total	**37,247**

Monitoring equipment:

Item	Flare No.2 Description (EL4)	Flare No.2 Description (EL5)	
	01/04/2015 – 27/08/2016	01/04/2015 – 27/08/2016	
		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	03/10/2014	01/04/2011	
Validity	24 months	5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)	

Item	GSS1 Description (EL9)		GSS1 Description (EL10)	
	01/04/2015 - 12/05/2015	13/05/2015 - 27/08/2016	01/04/2015 - 12/05/2015	13/05/2015 - 27/08/2016
Type	EDMI Limited (Genius) Power Meter		EDMI Limited (Genius) Power Meter	
Accuracy class	Class 0.5S		Class 0.5S	
Serial No.	211516862		211516863	
Calibration frequency	24 months		24 months	
Date of last calibration	08/04/2013	13/05/2015	09/04/2013	13/05/2015
Validity	24 months		24 months	

Item	GSS1 Description (EL11)	
	01/04/2015 - 27/08/2016	
	Main energy meter	Check energy meter
Type	EDMI (Mk6E) Power Meter	
Accuracy class	Class 0.5S	
Serial No.	908705152	908705154
Calibration frequency	5 years	
Date of last calibration	06/12/2009	
Validity	5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)	

Item	GSS2 Description (EL12)	GSS2 Description (EL13)	
	26/10/2015 - 27/08/2016	26/10/2015 - 27/08/2016	
		Main energy meter	Check energy meter
Type	EDMI Limited (2000-6N00-30A31-04-L00-02A2-1D) Power Meter	Itron (SL761W071) Power Meter	
Accuracy class	Class 0.5S	Class 0.2S	
Serial No.	213545834	81480576	81480578

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<tr><td></td><td>
<table>
<tr><td>Calibration frequency</td><td>24 months</td><td>5 years</td></tr>
<tr><td>Date of last calibration</td><td>04/02/2016</td><td>14/06/2016</td></tr>
<tr><td>Validity</td><td>24 months</td><td>5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)</td></tr>
</table>
<u>Flare No.2</u>
The meter is owned by the grid operator, TNB and thus, it is not within the control of the project. However, due to overdue calibration, the maximum permissible error of ±0.2% which is the equipment accuracy error was applied to EL5 from 01/04/2016 – 27/08/2016 as a conservative approach.
<u>GSS1 (Gas Engine No. 2 and 3)</u>
Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment calibration error was applied to EL9 from 08/04/2015 – 13/05/2015 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment calibration error was applied to EL10 from 09/04/2015 – 13/05/2015 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
The meter is owned by the grid operator, TNB and thus, it is not within the control of the project. However, due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to EL11 from 01/04/2015 – 27/08/2016 as a conservative approach.
<u>GSS2 (Gas Engine No. 4)</u>
Due to overdue calibration, the maximum permissible error of ±0.5% of reading which is the equipment accuracy error was applied to EL12 from 26/10/2015 - 04/02/2016 as a conservative approach.
The meter is owned by the grid operator, TNB and thus, it is not within the control of the project. However, due to overdue calibration, the maximum permissible error of ±0.2% which is the equipment accuracy error was applied to EL13 from 26/10/2015 - 14/06/2016 as a conservative approach.
</td></tr>
<tr><td>Measuring/
Reading/
Recording frequency:</td><td>Measured continuously with electricity meter installed.</td></tr>
<tr><td>Calculation method (if applicable):</td><td>NA</td></tr>
<tr><td>QA/QC procedures:</td><td> As a quality control procedure, the amount of electricity actually uploaded to grid will be measured by other electricity meters (EL5, EL11 and EL13) 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 meters owned by the grid operator, i.e. EL5, EL11 and EL13) will be checked and calibrated regularly according to manufacturer’s recommendations. </td></tr>
</table>

	The meters EL5, EL11 and EL13 are owned by the grid operator and thus, they are not within the control of the project. The calibration of these meters will be based on the grid operator's requirement and standard practice.
Purpose of data:	Baseline emission calculation
Additional comment:	-

Data / Parameter:	$\mathbf{CEF_{elec,PR,y}}$
Unit:	tCO_2/MWh
Description:	Carbon emission factor of electricity
Measured/ Calculated / Default:	Calculated
Source of data:	Grid connected baseline for Peninsular Malaysia for 2013 by Malaysian Green Technology Corporation (MGTC)
Value(s) of monitored parameter:	**0.694** tCO_2/MWh based on the latest released grid connected baseline emission factor for Peninsular Malaysia for 2014 (applied from 01/04/2015 – 27/08/2016)
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 2014 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. This parameter was measured separately for the gas engines, i.e. Gas Engine No.1 (1 meter), Gas Engine No.2 and No.3 (1 meter) and Gas Engine No.4 (1 meter).

Value(s) of monitored parameter:	(see table below)

Months	Gas Engine No. 1 Operating time (hr)	Gas Engine No. 2 Operating time (hr)	Gas Engine No. 3 Operating time (hr)	Gas Engine No. 4 Operating time (hr)
April 15	685	707	680	0
May 15	719	683	677	0
June 15	698	720	713	0
July 15	610	541	571	0
August 15	727	656	658	0
September 15	127	216	211	0
October 15	359	384	432	90
November 15	685	710	709	653
December 15	561	723	724	736
January 16	730	252	710	712
February 16	671	384	383	694
March 16	709	645	228	720
April 16	693	701	671	694
May 16	731	721	724	718
June 16	462	698	650	707
July 16	650	732	738	742
August 16	366	603	564	608
Total	**10,183**	**10,076**	**10,043**	**7,074**

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, Gas Engine No. 2 and No. 3 and Gas Engine No.4.

Monitoring equipment:	The operation time of the Gas Engine No.1, No.2, No.3 and No.4 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, No.2, No.3 and No.4 is based on the signal provided by the power meter (EL4, EL9, EL10 and EL12).
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 meters EL4, EL9, EL10 and EL12 which are calibrated regularly according to requirement by the manufacturer.
Purpose of data:	NA
Additional comment:	-

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. This parameter was measured for Flare No. 1, Flare No. 2, Gas Engine No.1, No.2 & No.3 auxiliaries and GSS – 1 meter (EL6).
Value(s) of monitored parameter:	see table below

Months	**Electricity consumed (EL6) (MWh)**
April 15	166.95
May 15	176.28
June 15	132.15
July 15	140.80
August 15	166.59
September 15	73.01
October 15	121.31
November 15	221.67
December 15	229.57
January 16	216.83
February 16	191.62
March 16	202.12
April 16	219.76
May 16	225.76
June 16	198.68
July 16	221.90
August 16	173.33
Total	**3,078**

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

Item	Electricity consumed from grid for project activity (EL6) (MWh)
	01/04/2015 – 27/08/2016
Type	IME NEMO 96HDL Power Meter
Accuracy class	Class 1 (± 1%)
Serial No.	2661930098
Calibration frequency	36 months
Date of last calibration	23/07/2014
Validity	3 years according to manufacturer's recommendation

</td></tr>
<tr><td>Measuring/Reading/ Recording frequency:</td><td>Continuous measurement</td></tr>
<tr><td>Calculation method (if applicable):</td><td>NA</td></tr>
<tr><td>QA/QC procedures:</td><td>The electricity meter was tested and calibrated as per the specifications prescribed by the manufacturer</td></tr>
<tr><td>Purpose of data:</td><td>Project emission calculation</td></tr>
<tr><td>Additional comment:</td><td>-</td></tr>
</table>

<table>
<tr><td>Data / Parameter:</td><td>$T_{flare,y}$</td></tr>
<tr><td>Unit:</td><td>°C</td></tr>
<tr><td>Description:</td><td>Temperature in exhaust gas of the enclosed flare</td></tr>
<tr><td>Measured/ Calculated / Default:</td><td>Measured</td></tr>
<tr><td>Source of data:</td><td>Continuous measurement by temperature 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.</td></tr>
<tr><td>Value(s) of monitored parameter:</td><td>

Months	Flare No.1 Value (°C)	Flare No.2 Value (°C)
April 15	603.91	841.91
May 15	709.13	822.31
June 15	681.47	818.60
July 15	538.57	783.21
August 15	550.98	808.24
September 15	634.84	862.91
October 15	676.26	851.60

</td></tr>
</table>

November 15	568.55	869.67
December 15	685.97	897.58
January 16	660.72	878.98
February 16	633.45	876.82
March 16	559.91	871.54
April 16	547.58	796.70
May 16	557.32	830.53
June 16	554.77	851.21
July 16	558.50	842.72
August 16	547.10	748.14
Average	**604.06**	**838.39**

Monitoring equipment:

Item	**Flare No.1 Description**		
	01/04/2015 – 11/05/2015	**12/05/2015 – 06/06/2016**	**07/06/2016 – 27/08/2016**
Type	PR Electronics (5335A) Temperature Transmitter		
Accuracy class	≤ ± 0.05% of span		
Serial No.	110910943		
Calibration frequency	Annually		
Date of last calibration	29/04/2014	12/05/2015	07/06/2016
Validity	1 year		

Item	**Flare No.2 Description**		
	01/04/2015 – 11/05/2015	**12/05/2015 – 06/06/2016**	**07/06/2016 – 27/08/2016**
Type	Honeywell (STT25M-0-EN0-000-000-000-00 3D) Temperature Transmitter		
Accuracy class	± 0.5% of span		
Serial No.	B838901937		
Calibration frequency	Annually		
Date of last calibration	29/04/2014	12/05/2015	07/06/2016
Validity	1 year		

Flare No.1

Due to having an equipment calibration error more than the equipment accuracy error, the maximum permissible error of ±0.05% which is the equipment calibration error was applied to TT3 from 29/04/2015 – 12/05/2015 and the maximum permissible error of ±0.07% which is the equipment calibration error was applied to TT3 from 12/05/2016 – 07/06/2016 as a conservative approach.

	During this monitoring period, TT3 has an error exceeding the MPE. The error is 0.07% which is more than the maximum permissible error of 0.05% (Calibration date : 07/06/2016). **Flare No.2** Due to overdue calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to TT3 from 29/04/2015 - 12/05/2015 and 12/05/2016 - 07/06/2016 as a conservative approach.
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 FT2 Flare No. 1,y (Nm3)	Methane average fraction Flare No.1 w_{CH4}	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)
Apr-15	584,098	0.58	0.0007168	241.46	25	6,036.62	640.74	215.84	215.84
May-15	857,101	0.54	0.0007168	330.82	25	8,270.42	856.36	296.56	296.56
Jun-15	696,584	0.51	0.0007168	254.58	25	6,364.57	636.22	229.13	229.13
Jul-15	336,823	0.50	0.0007168	119.60	25	2,990.02	319.59	106.82	106.82
Aug-15	477,799	0.51	0.0007168	176.04	25	4,400.89	458.34	157.70	157.70
Sep-15	662,508	0.57	0.0007168	269.20	25	6,730.09	708.33	240.87	240.87
Oct-15	592,421	0.55	0.0007168	233.17	25	5,829.24	626.13	208.12	208.12
Nov-15	464,963	0.52	0.0007168	172.01	25	4,300.25	446.66	154.14	154.14
Dec-15	540,960	0.52	0.0007168	201.59	25	5,039.87	517.75	180.88	180.88
Jan-16	654,072	0.49	0.0007168	229.34	25	5,733.41	582.26	206.05	206.05
Feb-16	548,122	0.52	0.0007168	206.11	25	5,152.76	506.75	185.84	185.84
Mar-16	438,959	0.58	0.0007168	183.22	25	4,580.61	473.37	164.29	164.29
Apr-16	366,936	0.57	0.0007168	150.16	25	3,754.04	395.88	134.33	134.33
May-16	439,468	0.59	0.0007168	184.46	25	4,611.38	484.61	165.07	165.07
Jun-16	359,632	0.54	0.0007168	140.40	25	3,509.97	411.44	123.94	123.94
Jul-16	450,006	0.54	0.0007168	174.12	25	4,352.89	438.72	156.57	156.57
Aug-16	330,914	0.55	0.0007168	129.28	25	3,231.93	326.55	116.22	116.22

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 FT2 Flare No.2,y (Nm3)	Methane average fraction Flare No.2 w_{CH4}	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 GE1 FT3 LFG electricity,y (m^3 LFG)	Average methane fraction of the Landfill Gas Fed into the GE1 w_{CH4}	Quantity of methane destroyed by generation of electricity (J*K) * D MD electricity,y (tCH4)	Quantity of methane that would have been destroyed MD project,y (tCH4)
Apr-15	1,148,280.90	0.56	0.0007168	457.52	25	11,438.06	1,191.19	409.87	244,902.69	0.56	97.58	507.45
May-15	1,222,337.79	0.58	0.0007168	509.98	25	12,749.44	1,324.13	457.01	263,816.32	0.58	110.07	567.08
Jun-15	1,145,168.41	0.54	0.0007168	440.64	25	11,015.96	1,102.60	396.53	253,294.80	0.54	97.46	494.00
Jul-15	969,455.35	0.55	0.0007168	381.32	25	9,532.96	997.40	341.42	222,644.72	0.55	87.57	429.00
Aug-15	1,187,264.56	0.54	0.0007168	460.91	25	11,522.75	1,194.79	413.12	273,439.94	0.54	106.15	519.27
Sep-15	1,117,573.23	0.56	0.0007168	449.93	25	11,248.21	1,149.66	403.94	48,703.61	0.56	19.61	423.55
Oct-15	1,055,773.82	0.55	0.0007168	417.32	25	10,432.99	1,099.29	373.35	96,322.69	0.55	38.07	411.42
Nov-15	1,153,043.15	0.57	0.0007168	471.83	25	11,795.82	1,207.35	423.54	242,388.32	0.57	99.19	522.73
Dec-15	1,012,622.10	0.57	0.0007168	414.00	25	10,350.00	1,089.71	370.41	182,927.14	0.57	74.79	445.20
Jan-16	1,196,298.52	0.61	0.0007168	521.57	25	13,039.31	1,348.83	467.62	248,343.88	0.61	108.28	575.89
Feb-16	1,194,540.70	0.62	0.0007168	528.80	25	13,219.97	1,321.81	475.93	303,733.22	0.62	134.46	610.38
Mar-16	1,264,523.07	0.61	0.0007168	554.91	25	13,872.70	1,406.09	498.66	330,607.23	0.61	145.08	643.74
Apr-16	1,098,927.55	0.59	0.0007168	467.85	25	11,696.29	1,183.05	420.53	326,213.13	0.59	138.88	559.41
May-16	1,158,036.20	0.60	0.0007168	496.24	25	12,406.03	1,254.67	446.05	337,407.43	0.60	144.59	590.64
Jun-16	1,115,794.19	0.61	0.0007168	486.94	25	12,173.56	1,243.67	437.20	196,474.62	0.61	85.74	522.94
Jul-16	1,181,516.95	0.62	0.0007168	523.92	25	13,098.00	1,309.78	471.53	276,291.57	0.62	122.52	594.04
Aug-16	883,778.15	0.57	0.0007168	364.17	25	9,104.13	925.08	327.16	156,230.58	0.57	64.38	391.54

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 $MD_{project,y}$ for GSS1

	$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4}$					$MD_{project,y}$
Month	Density of Methane GSS 1 DCH4 (t/Nm3)	Global Warming Potential GSS 1 GWP (tCO2/tCH4)	Quantity of Landfill Gas Fed into the GSS 1 FT3 LFG electricity,y (m³ LFG)	Average methane fraction of the Landfill Gas Fed into the GSS 1 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)
Apr-15	0.0007168	25	873,099.68	0.59	371.59	371.59
May-15	0.0007168	25	848,912.83	0.58	355.08	355.08
Jun-15	0.0007168	25	861,342.00	0.57	349.92	349.92
Jul-15	0.0007168	25	583,634.89	0.58	241.37	241.37
Aug-15	0.0007168	25	719,913.28	0.58	300.02	300.02
Sep-15	0.0007168	25	231,141.20	0.60	99.82	99.82
Oct-15	0.0007168	25	433,549.89	0.58	180.66	180.66
Nov-15	0.0007168	25	548,964.97	0.58	229.54	229.54
Dec-15	0.0007168	25	706,448.88	0.59	296.48	296.48
Jan-16	0.0007168	25	542,706.34	0.58	226.35	226.35
Feb-16	0.0007168	25	508,663.38	0.64	232.87	232.87
Mar-16	0.0007168	25	476,095.75	0.56	189.68	189.68
Apr-16	0.0007168	25	526,470.00	0.67	253.48	253.48
May-16	0.0007168	25	566,932.19	0.61	247.31	247.31
Jun-16	0.0007168	25	420,435.78	0.64	191.75	191.75
Jul-16	0.0007168	25	535,728.28	0.66	253.87	253.87
Aug-16	0.0007168	25	407,777.30	0.61	179.66	179.66

Determination of $MD_{project,y}$ for GSS2

	$MD_{electricity,y} = LFG_{electricity,y} * w_{CH4,y} * D_{CH4}$					$MD_{project,y}$
Month	Density of Methane GSS 2 DCH4 (t/Nm3)	Global Warming Potential GSS 2 GWP (tCO2/tCH4)	Quantity of Landfill Gas Fed into the GSS 2 FT3 LFG electricity,y (m³ LFG)	Average methane fraction of the Landfill Gas Fed into the GSS 2 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)
Apr-15						
May-15						
Jun-15						
Jul-15						
Aug-15						
Sep-15						
Oct-15	0.0007168	25	46,995.80	0.60	20.12	20.12
Nov-15	0.0007168	25	510,772.94	0.61	222.79	222.79
Dec-15	0.0007168	25	421,714.48	0.61	184.85	184.85
Jan-16	0.0007168	25	459,873.72	0.61	200.07	200.07
Feb-16	0.0007168	25	452,924.64	0.61	196.73	196.73
Mar-16	0.0007168	25	474,925.04	0.62	211.52	211.52
Apr-16	0.0007168	25	449,746.99	0.62	201.07	201.07
May-16	0.0007168	25	473,586.61	0.63	213.10	213.10
Jun-16	0.0007168	25	445,809.33	0.63	201.78	201.78
Jul-16	0.0007168	25	452,095.59	0.63	205.52	205.52
Aug-16	0.0007168	25	381,946.09	0.63	171.73	171.73

Determination of BE_y for Flare No.1

Month	$(MD_{project,y} - MD_{BL,y}) * GWP_{CH4}$ Emissions from Flare No.1 (tCO2e)	BEy Flare No.1 Total Baseline Emissions Flare No.1 (tCO2e)
Apr-15	5,395.88	5,395.88
May-15	7,414.06	7,414.06
Jun-15	5,728.34	5,728.34
Jul-15	2,670.44	2,670.44
Aug-15	3,942.55	3,942.55
Sep-15	6,021.76	6,021.76
Oct-15	5,203.11	5,203.11
Nov-15	3,853.58	3,853.58
Dec-15	4,522.12	4,522.12
Jan-16	5,151.15	5,151.15
Feb-16	4,646.01	4,646.01
Mar-16	4,107.23	4,107.23
Apr-16	3,358.16	3,358.16
May-16	4,126.77	4,126.77
Jun-16	3,098.53	3,098.53
Jul-16	3,914.17	3,914.17
Aug-16	2,905.38	2,905.38

Determination of BE_y for Flare No.2

Month	$(MD_{project,y} - MD_{BL,y}) * GWP_{CH4}$ Emissions from Flare No.2 (tCO2e)	$EL_{LFG,y} \cdot CEF_{elec,BL,y}$ Total electricity generated GE1 EL,LFG,y (MWh)	CoEF for electricity GE1 CEF electricity,y	Baseline Emission from electricity generation GE1 (tCO2e)	BEy Flare No.2 & GE1 Total Baseline Emissions Flare No.2 & GE1 (tCO2e)
Apr-15	12,686.35	427.13	0.694	296.43	12,982.77
May-15	14,177.01	435.87	0.694	302.49	14,479.50
Jun-15	12,349.93	435.87	0.694	302.49	12,652.42
Jul-15	10,724.90	360.72	0.694	250.34	10,975.23
Aug-15	12,981.78	449.95	0.694	312.27	13,294.04
Sep-15	10,588.75	76.90	0.694	53.37	10,642.12
Oct-15	10,285.55	204.77	0.694	142.11	10,427.67
Nov-15	13,068.15	431.05	0.694	299.15	13,367.29
Dec-15	11,129.99	328.91	0.694	228.27	11,358.26
Jan-16	14,397.36	445.19	0.694	308.96	14,706.32
Feb-16	15,259.57	563.66	0.694	391.18	15,650.76
Mar-16	16,093.60	616.89	0.694	428.12	16,521.72
Apr-16	13,985.25	608.41	0.694	422.24	14,407.49
May-16	14,766.00	645.69	0.694	448.11	15,214.11
Jun-16	13,073.47	364.37	0.694	252.87	13,326.34
Jul-16	14,851.12	510.26	0.694	354.12	15,205.23
Aug-16	9,788.43	267.64	0.694	185.75	9,974.18

Determination of BE_y for GSS1

	$(MD_{project,y} - MD_{BL,y}) * GWP_{CH4}$	$EL_{LFG,y} \cdot CEF_{elec,BL,y}$			BEy GSS 1
Month	Emissions from GSS 1 (tCO2e)	Total electricity generated GSS 1 EL,LFG,y (MWh)	CoEF for electricity GSS 1 CEF electricity,y	Baseline Emission from electricity generation GSS 1 (tCO2e)	Total Baseline Emissions GSS 1 (tCO2e)
Apr-15	9,289.84	1,551.84	0.694	1,076.98	10,366.81
May-15	8,877.05	1,589.98	0.694	1,103.45	9,980.50
Jun-15	8,748.03	1,671.29	0.694	1,159.88	9,907.91
Jul-15	6,034.35	1,058.87	0.694	734.86	6,769.21
Aug-15	7,500.43	1,428.55	0.694	991.42	8,491.85
Sep-15	2,495.59	483.04	0.694	335.23	2,830.81
Oct-15	4,516.44	824.16	0.694	571.97	5,088.41
Nov-15	5,738.53	1,373.61	0.694	953.28	6,691.82
Dec-15	7,411.94	1,388.30	0.694	963.48	8,375.42
Jan-16	5,658.63	997.21	0.694	692.06	6,350.69
Feb-16	5,821.67	870.92	0.694	604.42	6,426.09
Mar-16	4,742.00	838.56	0.694	581.96	5,323.96
Apr-16	6,336.96	1,076.85	0.694	747.33	7,084.29
May-16	6,182.70	1,126.79	0.694	781.99	6,964.70
Jun-16	4,793.66	1,133.13	0.694	786.39	5,580.06
Jul-16	6,346.84	1,086.64	0.694	754.13	7,100.97
Aug-16	4,491.53	910.66	0.694	632.00	5,123.52

Determination of BE_y for GSS2

	$(MD_{project,y} - MD_{BL,y}) * GWP_{CH4}$	$EL_{LFG,y} \cdot CEF_{elec,BL,y}$			BEy GSS 2
Month	Emissions from GSS 2 (tCO2e)	Total electricity generated GSS 2 EL,LFG,y (MWh)	CoEF for electricity GSS 2 CEF electricity,y	Baseline Emission from electricity generation GSS 2 (tCO2e)	Total Baseline Emissions GSS 2 (tCO2e)
Apr-15					
May-15					
Jun-15					
Jul-15					
Aug-15					
Sep-15					
Oct-15	502.92	76.39	0.694	53.02	555.94
Nov-15	5,569.70	870.36	0.694	604.03	6,173.73
Dec-15	4,621.16	887.34	0.694	615.82	5,236.97
Jan-16	5,001.79	991.34	0.694	687.99	5,689.78
Feb-16	4,918.19	1,019.55	0.694	707.57	5,625.76
Mar-16	5,288.06	1,080.62	0.694	749.95	6,038.01
Apr-16	5,026.77	996.47	0.694	691.55	5,718.32
May-16	5,327.54	1,062.62	0.694	737.46	6,064.99
Jun-16	5,044.43	990.43	0.694	687.36	5,731.79
Jul-16	5,138.06	858.68	0.694	595.92	5,733.98
Aug-16	4,293.29	845.87	0.694	587.03	4,880.33

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 and contractual requirements
3. $MD_{flared,y}$ for GSS1 and GSS2 is zero since there is no flare attached together with GSS1 and GSS2
4. $ET_{LFG,y}$ and $CEF_{ther,BL,y}$ are not applicable (=0) to this project since there are no thermal energy production
5. Density of methane is obtained from ACM 0001, version 8.0, page 14
6. Power generation of landfill gas was only implemented in June 2011
7. The grid connected baseline for Peninsula Malaysia for 2014 was applied to this project and the $CEF_{electricity,y}$ calculated was 0.694tCO_2/MWh (applied from 01/04/2015 – 27/08/2016)
8. $MD_{electricity,y}$ 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
9. $EL_{LFG,y}$ 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
10. The total electricity generated ($EL_{LFG,y}$) is the amount based on the monthly invoices to the grid operator (Tenaga National Berhad (TNB)) which is also the lower reading from the comparison between (EL4 + EL9 + EL10 + EL12) and (EL5 + EL11 + EL13)
11. With reference to decision 4/CMP7 and paragraph 66 of the EB 69 Meeting Report, for the second commitment period of the Kyoto Protocol, the global warming potentials used by Parties to calculate the carbon dioxide equivalence of anthropogenic emissions by sources and removals by sinks of the greenhouse gases listed in Annex A to the Kyoto Protocol shall be those listed in the column entitled "Global Warming Potential for Given Time Horizon" in Table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon, i.e. 25 tCO_2/tCH_4

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)
Apr-15	166.95	0.694	0.1	127.45
May-15	176.28	0.694	0.1	134.57
Jun-15	132.15	0.694	0.1	100.88
Jul-15	140.80	0.694	0.1	107.49
Aug-15	166.59	0.694	0.1	127.17
Sep-15	73.01	0.694	0.1	55.73
Oct-15	121.31	0.694	0.1	92.61
Nov-15	221.67	0.694	0.1	169.22
Dec-15	229.57	0.694	0.1	175.26
Jan-16	216.83	0.694	0.1	165.53
Feb-16	191.62	0.694	0.1	146.28
Mar-16	202.12	0.694	0.1	154.30
Apr-16	219.76	0.694	0.1	167.76
May-16	225.76	0.694	0.1	172.34
Jun-16	198.68	0.694	0.1	151.67
Jul-16	221.90	0.694	0.1	169.40
Aug-16	173.33	0.694	0.1	132.32

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 2014 was applied to this project and the $CEF_{electricity,y}$ calculated was 0.694tCO_2/MWh (applied from 01/04/2015 – 27/08/2016)
3. TDL = 10% adopted as stated in the revised registered PDD, version 9.0 page 33 (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 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)	GHG emission reductions or net GHG removals by sinks (t CO_2e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	477,121	2,359	0	Not applicable	474,762	474,762

E.5. Comparison of actual emission reductions or net 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
Emission reductions or GHG removals by sinks (t CO_2e)	465,631[11]	474,762

[11] Calculated from revised PDD version 19.0 dated 02/09/2016.

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

The total CERs claimed in the 10th monitoring period was 1.9% higher as compared to the value reported in the ex-ante calculations.

The total increase of 1.9% is due to the following reasons:

1. Ex-ante GWP, the revised PDD, version 19.0, a default value of GWP 21 has been applied while in the 10th Monitoring Report, the default was updated to GWP 25[12] and applied.
2. Gas Engine No.4 came into operation in October 2015.

10th monitoring period Gas Engine No.4 running time

Month	Time (hour) from Oct 2015 - 27 August 2016		% of total GE running time
	Total actual GE running time	Total time	
GE 4 (hour)	7,074	7,968	89%

3. The grid connected baseline for Peninsula Malaysia for 2014 was applied to this project from 01/04/2015 – 27/08/2016 and the $CEF_{electricity,y}$ calculated was 0.694tCO_2/MWh which is higher than the ex-ante value, i.e. 0.622tCO_2/MWh.

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

Date	Flaring stopped		Reason	Remarks
	From	To		
07/04/2015	11:50	14:04	TNB power surge – few seconds	
08/04/2015	9:03	12:03	To change moisture separator filter. Pressure high. TT3 sensor damage. Change with KBE's spare unit	
12/04/2015	13:56	14:04	To install and testing new blower (Blower #1)	
12/05/2015	10:44	12:35	To calibrate TT3, FT1, CH_4 – by Nectar	
21/05/2015	11:53	25/5/2015 11:56	O_2 above danger set point. Unable to restart immediately	O_2 analyser damage
27/05/2015	10:46	11:27	TNB power surge – few seconds	

[12] With reference to decision 4/CMP7 and paragraph 66 of the EB 69 Meeting Report, for the second commitment period of the Kyoto Protocol, the global warming potentials used by Parties to calculate the carbon dioxide equivalence of anthropogenic emissions by sources and removals by sinks of the greenhouse gases listed in Annex A to the Kyoto Protocol shall be those listed in the column entitled "Global Warming Potential for Given Time Horizon" in Table 2.14 of the errata to the contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, based on the effects of greenhouse gases over a 100-year time horizon, i.e. 25 tCO_2/tCH_4. This factor has contributed a significant impact to the increase in CERs.

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

Date	Flaring stopped		Reason	Remarks
	From	To		
07/04/2015	9:50	13:52	Requested by THR	To test 2B gas extraction
14/4/2015	22:35	22:46	TNB power surge - few seconds	
15/4/2015	1:32	1:36	CH_4 below danger set point	
7/5/2015	12:14	12:29	CH_4 below danger set point	
8/5/2015	11:33	11:46	CH_4 below danger set point	
12/5/2015	12:22	15:29	Nectar to calibrate: TT1, TT3, PT2, FT1, FT2	
15/5/2015	10:35	10:42	CH_4 below danger set point	
21/5/2015	14:17	14:44	TNB power surge – few seconds	
27/5/2015	10:42	11:32	TNB power surge – few seconds	

Appendix 3: Details on the downtime of Gas Engine No.1, No.2 and No.3

Date	Gas Engine No.1 Stopped		Description of Event
	From	To	
7/4/2015	09:39	17:09	Requested by THR to test 2B gas extraction
12/4/2015	09:11	9:14	Gas engine breaker trip. Shutdown for restart
14/4/2015	10:03	17:22	TNB power surge – few seconds. Unable to restart immediately – busbar voltage unstable
	22:35	15/4/2015 18:15	
17/4/2015	16:09	16:19	Jacket water engine outline – high temp
	17:30	17:47	Power surge CB tripped (main's fault)
6/5/2015	11:03	22:42	To service at 1,500 hrs by SPE
7/5/2015	12:14	12:53	Proper shutdown – F2, CH_4 below danger set point
8/5/2015	11:33	11:52	Proper shutdown – F2, CH_4 below danger set point
9/5/2015	16:43	19:52	Mains fault
10/5/2015	11:47	15:10	Mains fault
12/5/2015	12:22	15:39	Nectar to calibrate F2, TT1, TT3, PT2, FT1 & FT2
13/5/2015	14:31	15:53	RA power to calibrate relay
15/5/2015	10:35	10:51	F2 – CH_4 below danger set point
21/5/2015	14:17	15:01	TNB power surge – few seconds
27/5/2015	10:42	11:47	TNB power surge – few seconds
16/6/2015	18:37	20:18	Mains fault

Date	Gas Engine No.1 Stopped		Description of Event
	From	To	
18/6/2015	18:02	18:18	Combustion chamber B2. Restart OK
26/6/2016	15:47	27/06/2015 12:45	Mains fault

Date	Gas Engine No.2 Stopped		Description of Event
	From	To	
2/4/2015	10:04	22:16	Shutdown requested by Chen Guan. To check shunt reactor
7/4/2015	12:46	13:07	TNB power surge – few seconds
14/4/2015	22:34	23:38	TNB power surge – few seconds
7/5/2015	03:30	4:57	T463 combustion chamber A3. Restart OK
	06:12	6:14	T463 combustion chamber A3. Restart OK
9/5/2015	18:51	18:56	Combustion chamber A3
12/5/2015	7:58	8:23	Combustion chamber A3
	14:45	14:48	Combustion chamber A3. Restart OK
13/5/2015	9:35	16:41	Nectar to calibrate GSS, TT1, PT2, CH_4. RA power to calibrate EL9
	22:18	22:36	Combustion to chamber A3 – Change spare plug swap from GE3 (A3)
17/5/2015	9:22	18/5/2015 17:26	Combustion chamber B6. Change new spark plug. Unable to restart immediately battery weak
21/5/2015	14:15	15:40	TNB power surge – few seconds
26/5/2015	20:41	21:25	PI24 Gas Pressure Gas control system. GSS shutdown due to CH_4 below danger set point.CH_4 analyser "error". Restart CH_4 analyser, OK
27/5/2015	10:40	12:05	TNB POWER SURGE - few seconds. Combustion chamber B4, change new spark plug
27/5/2015	19:50	22:20	PI24 Gas Pressure Gas control system. GSS shutdown due to CH_4 below danger set point. CH_4 analyser "error”. Restart CH_4 analyser, OK. Unable to restart immediately - battery weak
27/5/2015	23:48	27/5/2015 1:00	PI24 Gas Pressure Gas control system. GSS shutdown due to CH_4 below danger set point. CH_4 analyser "error". Restart CH_4 analyser, OK
28/5/2015	1:31	1:51	Combustion chamber B7. Restart OK
	8:43	20:07	SPE to service at 1,500 hrs. RA Power, to calibrate relay. Combustion chamber A5, change new spark plug
15/6/2015	01:47	17:08	Proper shutdown - to restart PLC. Unable to restart immediately due to CH_4 below danger set point

Date	Gas Engine No.3 Stopped		Description Of Event
	From	To	
2/4/2015	10:08	17:19	Shutdown requested by Chen Guan. To check shunt reactor
	19:36	19:52	Combustion chamber A3 - Restart OK
3/4/2015	11:42	12:33	Combustion chamber B6 - Restart OK
7/4/2015	12:46	13:11	TNB power surge - few seconds
14/4/2015	11:23	11:49	Combustion chamber A1 - Change spark plug, KBE's spare unit
	22:34	15/4/2015 13:13	TNB power surge - few seconds. Unable to restart immediately due to crankcase pressure high
20/40/2015	8:34	18:06	Proper shutdown - to service at 1,500 hrs by SPE
24/4/2015	12:01	19:34	Throttle valve position
27/4/2015	15:57	16:41	Combustion chamber A4 - change new spark plug, KBE's spare unit
9/5/2015	18:52	18:57	To check on combustion chamber A side
13/5/2015	9:40	15/5/2015 18:19	Nectar to calibrate TT1, PT2, CH_4 - GSS. RA Power to calibrate EL10
21/5/2015	14:15	15:45	TNB POWER SURGE - few seconds
26/5/2015	20:41	21:34	PI24 Gas Pressure Gas control system. GSS shutdown due to CH_4 below danger set point. CH_4 analyser "error”. Restart CH_4 analyser, OK
27/5/2015	10:40	12:17	TNB POWER SURGE - few seconds
27/5/2015	19:50	20:32	PI24 Gas Pressure Gas control system. GSS shutdown due to CH_4 below danger set point. CH_4 analyser "error". Restart CH_4 analyser, OK
27/5/2015	23:48	28/5/2015 0:45	PI24 Gas Pressure Gas control system. GSS shutdown due to CH_4 below danger set point. CH_4 analyser "error". Restart CH_4 analyser, OK
28/5/2015	9:42	15:05	RA POWER, to calibrate relay
4/6/2015	10:17	17:41	GE3 trip due to TEM - lost signal - Unable to restart immediately due to CH4 sensor issue - low
15/6/2015	01:47	17:19	Proper shutdown - to restart PLC. Unable to restart immediately due to CH4 below danger set point
16/6/2015	22:36	22:41	GE3 trip due to TEM - lost signal

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 ºC, 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 60ºC, 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 60ºC, option B measurement was selected and was applied in the CER calculation.

<u>Determination of the absolute humidity of the gaseous stream</u>

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)
$p_{H20,t,Sat}$	=	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)

Parameter	Formula / description
$p_{H2O,t,Sat}$	(see below)

1	2	
Filonenko/ Ginzburg (1973) and Filonenko et al. (1971)	0…100	$p_s = \exp(6.416 + 17.3 \cdot t / (238+t))$,

P_s – Saturation pressure of H_2O
t – LFG Temperature

Parameter	Formula / description
P_t	(see below)

Absolute Pressure
$P_a = P_g + P_{at}$
$P_a = P_g + 101325$
where,
P_a = Absolute Pressure,
P_g = Gauge Pressure,
P_{at} = Atmospheric Pressure.

Parameter	Formula / description
MM_{H2O}	18.0152 kg/kmol Default value from the tool
$MM_{t,db}$	(see below)

$$MM_{t,db} = \sum_k (v_{k,t,db} * MM_k)$$

Where:

$MM_{t,db}$	=	Molecular mass of the gaseous stream in time interval *t* on a dry basis (kg dry gas/kmol dry gas)
$v_{k,t,db}$	=	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)
MM_k	=	Molecular mass of gas *k* (kg/kmol)
k	=	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

Default value for $MM_{i,k}$, Gases involve in the calculation are CH_4, CO_2, and O_2

Data / Parameter:	MM_i
Data unit:	kg/kmol
Description:	Molecular mass of greenhouse gas *i*
Value to be applied:	(see table below)
Any comment:	

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

Parameter	Formula / description
	(see table below)

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.
Any comment:	

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

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 (m^3 dry gas/h)
$V_{t,wb}$	=	Volumetric flow of the gaseous stream in time interval *t* on a wet basis (m^3 wet gas/h)
$v_{H2O,t,db}$	=	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)

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:

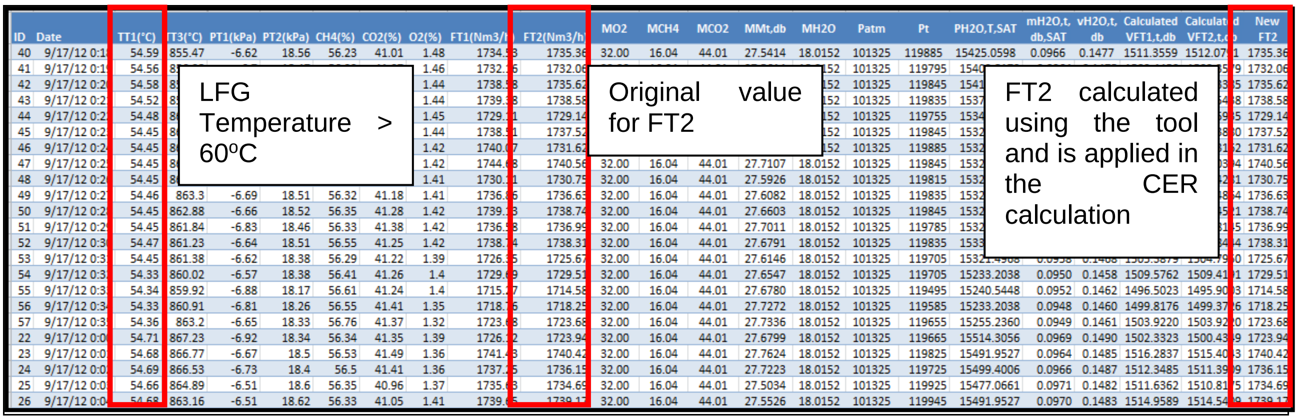
$$v_{H2O,t,db} = \frac{m_{H2O,t,db} * MM_{t,db}}{MM_{H2O}}$$

Where:

$v_{H2O,t,db}$	=	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.



ID	Date	TT1(°C)	TT3(°C)	PT1(kPa)	PT2(kPa)	CH4(%)	CO2(%)	O2(%)	FT1(Nm3/h)	FT2(Nm3/h)	MO2	MCH4	MCO2	MMt,db	MH2O	Patm	Pt	PH2O,T,SAT	mH2O,t,db,SAT	vH2O,t,db	Calculated VFT1,t,db	Calculated VFT2,t,db	New FT2
40	9/17/12 0:1	54.59	855.47	-6.62	18.56	56.23	41.01	1.48	1734.[illegible]3	1735.36	32.00	16.04	44.01	27.5414	18.0152	101325	119885	15425.0598	0.0966	0.1477	1511.3559	1512.07[illegible]1	1735.36
41	9/17/12 0:1	54.56	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.46	1732.[illegible]6	1732.06	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101325	119795	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1732.06
42	9/17/12 0:2	54.58	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.44	1738.[illegible]8	1735.62	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101325	119845	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1735.62
43	9/17/12 0:2	54.52	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.44	1739.[illegible]8	1738.58	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101325	119835	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1738.58
44	9/17/12 0:2	54.48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.45	1729.[illegible]1	1729.14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101325	119755	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1729.14
45	9/17/12 0:2	54.45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.44	1738.[illegible]1	1737.52	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101325	119845	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1737.52
46	9/17/12 0:2	54.45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.42	1740.[illegible]7	1731.62	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	101325	119885	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1731.62
47	9/17/12 0:2	54.45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.42	1744.[illegible]8	1740.56	32.00	16.04	44.01	27.7107	18.0152	101325	119845	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1740.56
48	9/17/12 0:2	54.45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.41	1730.[illegible]1	1730.75	32.00	16.04	44.01	27.5926	18.0152	101325	119815	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1730.75
49	9/17/12 0:2	54.46	863.3	-6.69	18.51	56.32	41.18	1.41	1736.[illegible]6	1736.63	32.00	16.04	44.01	27.6082	18.0152	101325	119835	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1736.63
50	9/17/12 0:2	54.45	862.88	-6.66	18.52	56.35	41.28	1.42	1739.[illegible]3	1738.74	32.00	16.04	44.01	27.6603	18.0152	101325	119845	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1738.74
51	9/17/12 0:2	54.45	861.84	-6.83	18.46	56.33	41.38	1.42	1736.[illegible]8	1736.99	32.00	16.04	44.01	27.7011	18.0152	101325	119785	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1736.99
52	9/17/12 0:3	54.47	861.23	-6.64	18.51	56.55	41.25	1.42	1738.[illegible]4	1738.31	32.00	16.04	44.01	27.6791	18.0152	101325	119835	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1738.31
53	9/17/12 0:3	54.45	861.38	-6.62	18.38	56.29	41.22	1.39	1726.[illegible]5	1725.67	32.00	16.04	44.01	27.6146	18.0152	101325	119705	[illegible]	[illegible]	[illegible]	[illegible]	1504.7[illegible]0	1725.67
54	9/17/12 0:3	54.33	860.02	-6.57	18.38	56.41	41.26	1.4	1729.[illegible]9	1729.51	32.00	16.04	44.01	27.6547	18.0152	101325	119705	15233.2038	0.0950	0.1458	1509.5762	1509.41[illegible]1	1729.51
55	9/17/12 0:3	54.34	859.92	-6.88	18.17	56.61	41.24	1.4	1715.[illegible]7	1714.58	32.00	16.04	44.01	27.6780	18.0152	101325	119495	15240.5448	0.0952	0.1462	1496.5023	1495.90[illegible]3	1714.58
56	9/17/12 0:3	54.33	860.91	-6.81	18.26	56.55	41.41	1.35	1718.[illegible]6	1718.25	32.00	16.04	44.01	27.7272	18.0152	101325	119585	15233.2038	0.0948	0.1460	1499.8176	1499.37[illegible]6	1718.25
57	9/17/12 0:3	54.36	863.2	-6.65	18.33	56.76	41.37	1.32	1723.[illegible]8	1723.68	32.00	16.04	44.01	27.7336	18.0152	101325	119655	15255.2360	0.0949	0.1461	1503.9220	1503.92[illegible]0	1723.68
22	9/17/12 0:0	54.71	867.23	-6.92	18.34	56.34	41.35	1.39	1726.[illegible]2	1723.94	32.00	16.04	44.01	27.6799	18.0152	101325	119665	15514.3056	0.0969	0.1490	1502.3323	1500.43[illegible]9	1723.94
23	9/17/12 0:0	54.68	866.77	-6.67	18.5	56.53	41.49	1.36	1741.[illegible]3	1740.42	32.00	16.04	44.01	27.7624	18.0152	101325	119825	15491.9527	0.0964	0.1485	1516.2837	1515.40[illegible]3	1740.42
24	9/17/12 0:0	54.69	866.53	-6.73	18.4	56.5	41.41	1.36	1737.[illegible]5	1736.15	32.00	16.04	44.01	27.7223	18.0152	101325	119725	15499.4006	0.0966	0.1487	1512.3485	1511.39[illegible]9	1736.15
25	9/17/12 0:0	54.66	864.89	-6.51	18.6	56.35	40.96	1.37	1735.[illegible]3	1734.69	32.00	16.04	44.01	27.5034	18.0152	101325	119925	15477.0661	0.0971	0.1482	1511.6362	1510.81[illegible]5	1734.69
26	9/17/12 0:0	54.68	863.16	-6.51	18.62	56.33	41.05	1.41	1739.[illegible]5	1739.17	32.00	16.04	44.01	27.5526	18.0152	101325	119945	15491.9527	0.0970	0.1483	1514.9589	1514.5[illegible]9	1739.17

Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	☒ Project participant ☒ Person/entity responsible for completing the CDM-MR-FORM
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