Monitoring report form for CDM project activity

(Version 06.0)

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

MONITORING REPORT		
Title of the project activity	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 PDD applicable to this monitoring report	20.5	
Version number of this monitoring report	1.2	
Completion date of this monitoring report	02/04/2019	
Monitoring period number	1	
Duration of this monitoring period	28/08/2016 – 31/12/2017 inclusive of both days	
Monitoring report number for this monitoring report	1.0	
Project participants	KUB-Berjaya Enviro Sdn. Bhd. (KBE)	
Host Party	Malaysia	
Sectoral scopes	13 – Waste handling and disposal	
Applied methodologies and standardized baselines	• Applied methodologies: ACM0001 – "Flaring or use of landfill gas" (Version 18.0) • Standardized baselines: Not applicable	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	Not applicable	342,427 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	364,568 tCO_2e	

SECTION A. Description of project activity

A.1. 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 Phase 1 and 2 Cells has continued to operate during this monitoring period.

One (1) high temperature enclosed flare (Flare No. 2) with maximum capacity of 2,500 Nm3/hr is in operation during this monitoring period, while the other high temperature enclosed flare (Flare No. 1) is no longer in operation starting from 03/01/2017 onwards.

The remaining portion of the gas captured was sent to a unit of 1.2MW Gas Engine (Gas Engine No.1), 2 units of 1.56MW Gas Engines (Gas Engine No.2 and No.3) and one unit of 2MW Gas Engine (Gas Engine No.4) to generate electricity. The electricity produced by the gas engines is exported to the grid.

The 1st monitoring period of 2nd crediting period is from 28/08/2016 to 31/12/2017 (inclusive of both days). The total emission reductions achieved during this monitoring period is **342,427 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	Latitude / Longitude / Description: 3°30'168" / 101°28'428" / North 3°29'07" / 101°28'452" / South 3°29'46" / 101°28'20" / West 3°29'69" / 101°29'268" / East

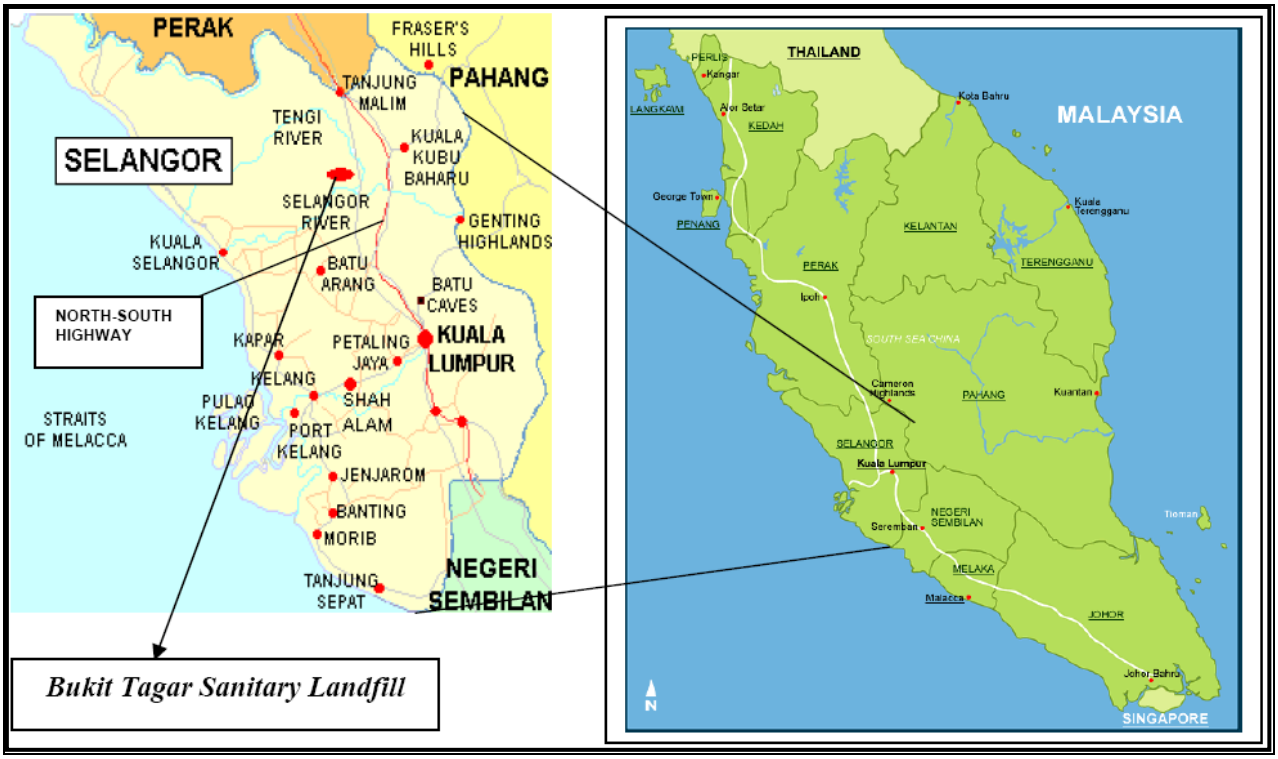


Figure 1: Location of BTSL and Selangor State

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Malaysia (Host Party)	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 to applied methodologies and standardized baselines

The project has applied the following approved methodology and tools:

Approved Methodology:

ACM0001: “Flaring or use of landfill gas – Version 18.0”

Methodological Tools referred to include:

- “Emissions from solid waste disposal sites” (Version 07.0);
- “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 02.0);
- “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (Version 02);
- “Project emissions from flaring” (Version 02.0.0);
- “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0); and
- “Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” (Version 03.0.1).

A.5. Crediting period type and duration

Date of Registration	28/08/2009
Type of Crediting Period	Renewable (7 Years)
1st Crediting Period	28/08/2009 – 27/08/2016 (Both dates inclusive)
2nd Crediting Period	28/08/2016 – 27/08/2023 (Both dates inclusive)

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

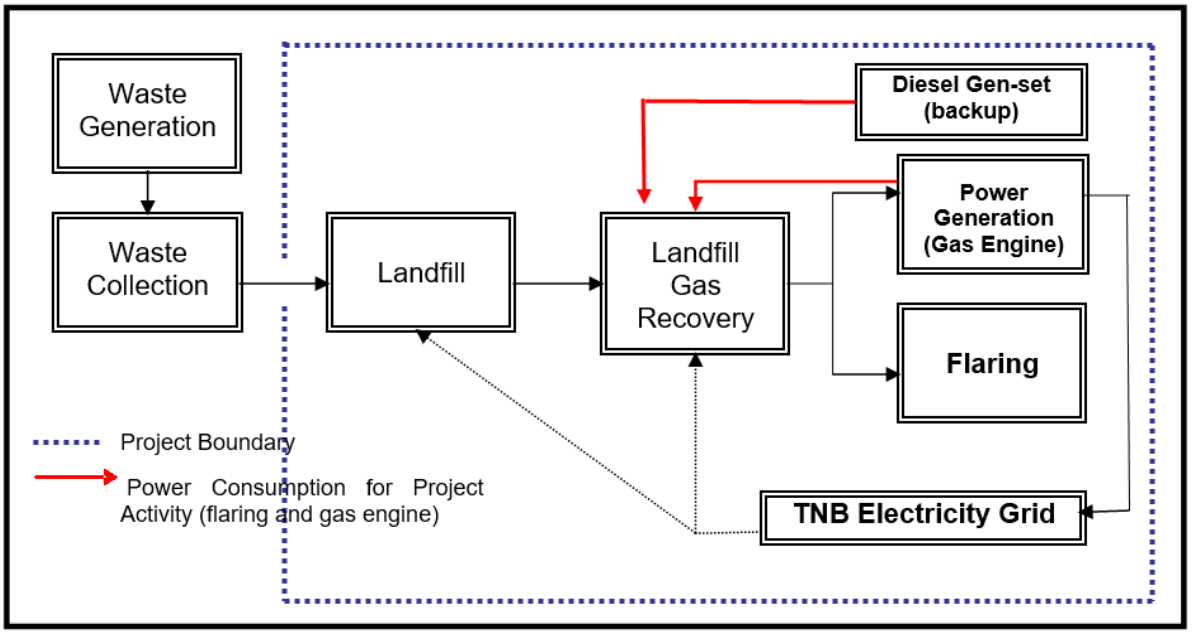
The landfill is being developed in phases. The detail information on the phases is presented as below:

Cell	Status	Duration of Filling	Amount of Waste Disposed (t)
Advance Cell	Closed	Apr 2005 – Nov 2007	1,429,323.47
Phase 1	Closed	Nov 2007 – Dec 2011	3,730,406.57
Phase 2	Closed	Aug 2010 – Dec 2017	6,243,457.40
Phase 3	Operation	Jan 2018 - On-going	667,944.77

Relevant dates for the project activities tabulated below:

Bukit Tagar Project	Construction Start	Commissioned	Continued operation periods
First flaring system (Flare No.1)	17/06/2008	28/08/2009	Stop operation in 03/01/2017
Second flaring system (Flare No.2)	22/01/2010	07/08/2010	Continue to operate
Gas Engine No.1	03/01/2011 (delivery to site)	01/06/2011	Continue to operate
Gas Engine No.2	06/08/2012 (Signed-off Delivery Order)	06/12/2013[1]	Continue to operate
Gas Engine No.3	06/08/2012 (Signed-off Delivery Order)	06/12/2013[2]	Continue to operate
Gas Engine No.4	26/12/2014 (Signed-off Delivery Order)	26/10/2015[3]	Continue to operate

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



Note: Diesel generator which will be used as backup for project activities during the power failure of the grid is added into the chart

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

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

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

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

Description on the installed technologies

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

Detailed technical description is further described below:

Gas Extraction System in Advance Cell

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

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

These vertical wells can be individually regulated and controlled. Advanced cell has stopped operation and caped in this monitoring period.

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. Flare No.1 has stopped operation started from 03/01/2017 for the conversion of GSSF1, the conversion work was completed on 31/05/2017, as a result, GSSF1 started to commission on 01/06/2017.

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

The details of the flare specifications are listed below:

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

Gas Extraction System in Phase 1 Cell

Stage 1 of Phase 1 Cell was completed in August 2010 and closed in December 2011. The gas extraction from phase 1 cell is continued in operation during this monitoring period. 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 and 2 Cell. The flare system included a containerised blower and flaring system with a maximum capacity to flare off 2,500 Nm^3/hr LFG.

Figure 6: High-Temperature Enclosed Flares

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

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

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

Gas Extraction System in Phase 2 Cell

Phase 2 Cell was completed in July 2010. 12 lines of horizontal wells with gas pipeline were installed in the landfill to extract the LFG. The cell stopped receiving waste started on December 2017. The design of the gas extraction wells is based on a series of horizontal gas extraction wells constructed over the cell.

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. This Gas Engine No.1 is no longer attached to Flare No. 2 starting from 03/01/2017. Flare No.1 has been converted to GSS F1, GE No. 1 is attached to GSS F1 and commissioned on 01/06/2017.

Figure 7: Gas Engine 2 & 3

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, 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 2, 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

Centralised SCADA System

The Centralized (Supervisory Control and Data Acquisition) SCADA Interface was developed to integrate all existing SCADA or operation monitor system, ranging from individual Flare to Gas 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.

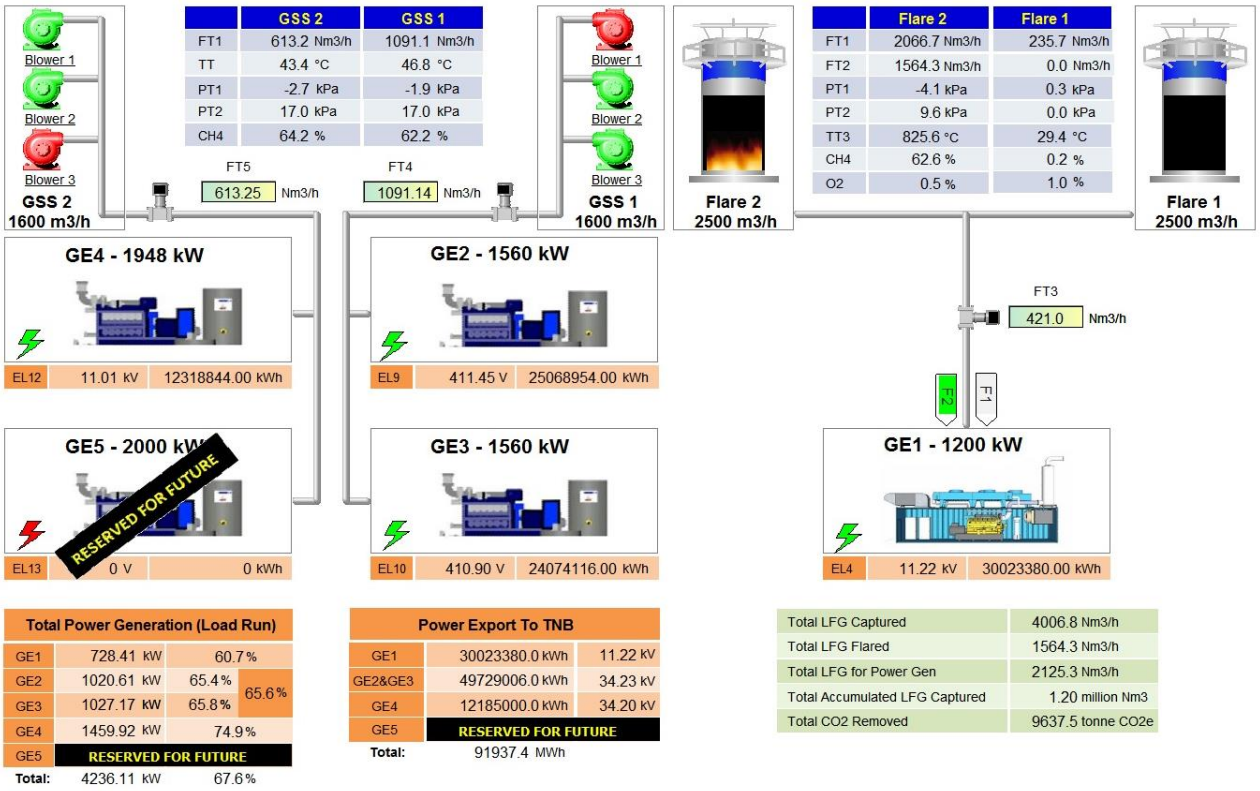


Figure 8: Centralized SCADA Interface

Implementation status of project activity

For the reporting period of 28/08/2016 to 31/12/2017, the key CDM activities implemented are described below:

Gas Extraction System in Advance Cell and Flare No.1

Advanced cell has stopped operation and capped during this monitoring period. Flare No. 1 has stopped operation officially on 03/01/2017. As a result, the operating period for Flare No. 1 in this monitoring period was from 28/08/2016 – 03/01/2017. However, Flare No. 1 only operated until 31/10/2016 and was shut down from 01/11/2016 to 03/01/2017 for the conversion of Flare No. 1 to GSSF1.

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 38.8% in its operation period (28/08/2016 – 31/10/2016) in this monitoring period. Flare No.1 stopped operation since November 2016 due to conversion to GSSF1.

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

The flaring system in Phase 1 Cell was completed during the 2nd monitoring period of the first crediting period, and 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 2 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 96.8% in this monitoring period.

Power Generation

During this monitoring period, power generated from Gas Engine No.1, No.2, No.3 and No.4 continued to be uploaded to the grid.

For the period of 28/08/2016 –31/05/2017, 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. However, starting from 01/06/2017, Gas Engine No.1 was no longer attached to Flare No.2 and was converted to GSSF1.

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 are monitored by independent monitoring equipment, i.e. temperature, pressure, methane content and flow rate for GSS1, GSS2 and GSSF1. The power generated from the gas engines is uploaded to the grid.

The total running time for Gas Engines in this monitoring period is tabulated as below:

No	Description	Total Running Time (%)
1	Gas Engine No. 1	92.7%
2	Gas Engine No. 2	78.5%
3	Gas Engine No. 3	78.9%
4	Gas Engine No. 4	71.1%

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 the registered monitoring plan, applied methodologies or 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

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

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

During the 1st monitoring period of 2nd crediting period, KBE has decided to shut down Flare No.1 starting from 03/01/2017 and converting Flare No.1 to GSSF1. Gas engine No. 1 which was attached to Flare 2 previously has been converted to GSSF1. A revision for the monitoring plan was requested and approved on 21/06/2018 (PRC-2467-005).

B.2.6. Changes to project design

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

SECTION C. Description of monitoring system

Monitoring Methodology

The basis of the monitoring plan (MP) was formulated based on the approved methodology ACM0001 – *Flaring or use of landfill gas (Version 18.0).*

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

The MP 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°C, moisture could be neglected due to its very low influence on final results and thus, the measurement in wet or dry basis are not important (as reflected in the amendments to ACM0001, version 9.1 onwards). In case where the LFG temperature exceeds 60°C, the same basis for both CH_4 concentration and flow measurement will be considered according to the tools.

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

Transmission and Distribution Losses (TDL_y)

According to page 55 of the registered PDD, version 20.5, the Transmission and Distribution Losses ($TDL_{k,y}$) value applied in this project is 7.39% for 2016 and 7.74% for 2017 onwards respectively. This value was reported in the Tenaga Nasional Berhad (TNB)[4] Annual Report 2016[5].

Operation and Management Structure for Monitoring

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

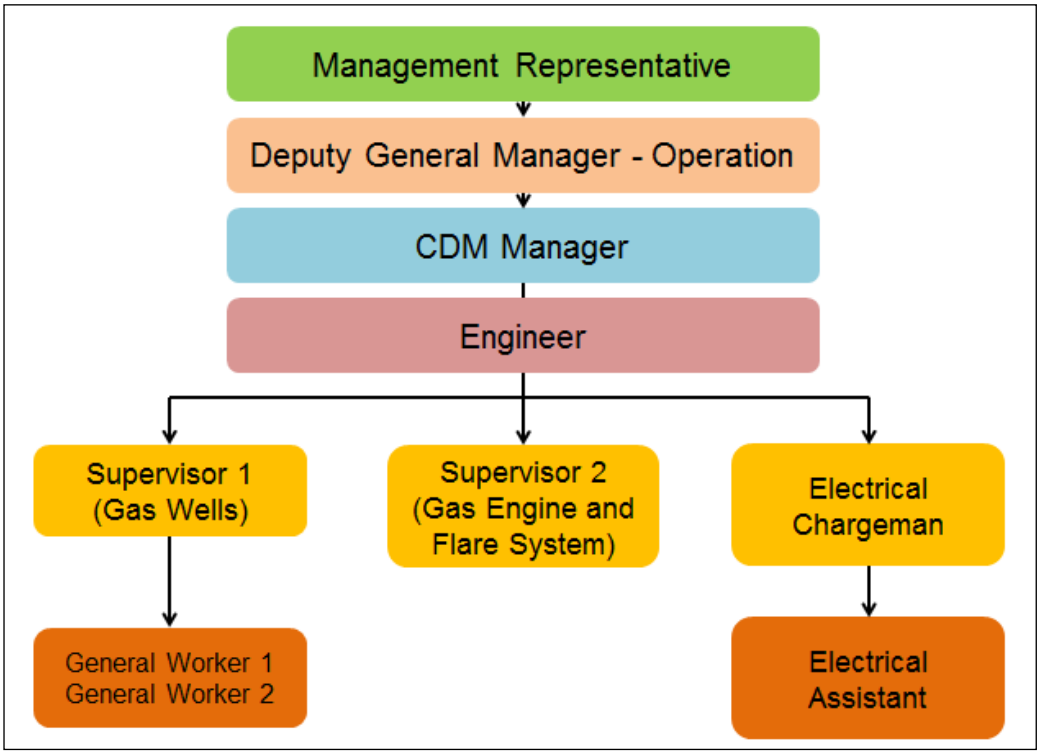


Figure 9: Organisational Structure for CDM Monitoring for BTSL LFG Recovery and Utilisation Project

[4] Tenaga Nasional Berhad is the largest electricity provider in Malaysia and is responsible for the grid transmission and distribution in Peninsular Malaysia.
[5] https://www.tnb.com.my/assets/annual_report/TNB_Annual_Report_2016.pdf

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
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 charge man

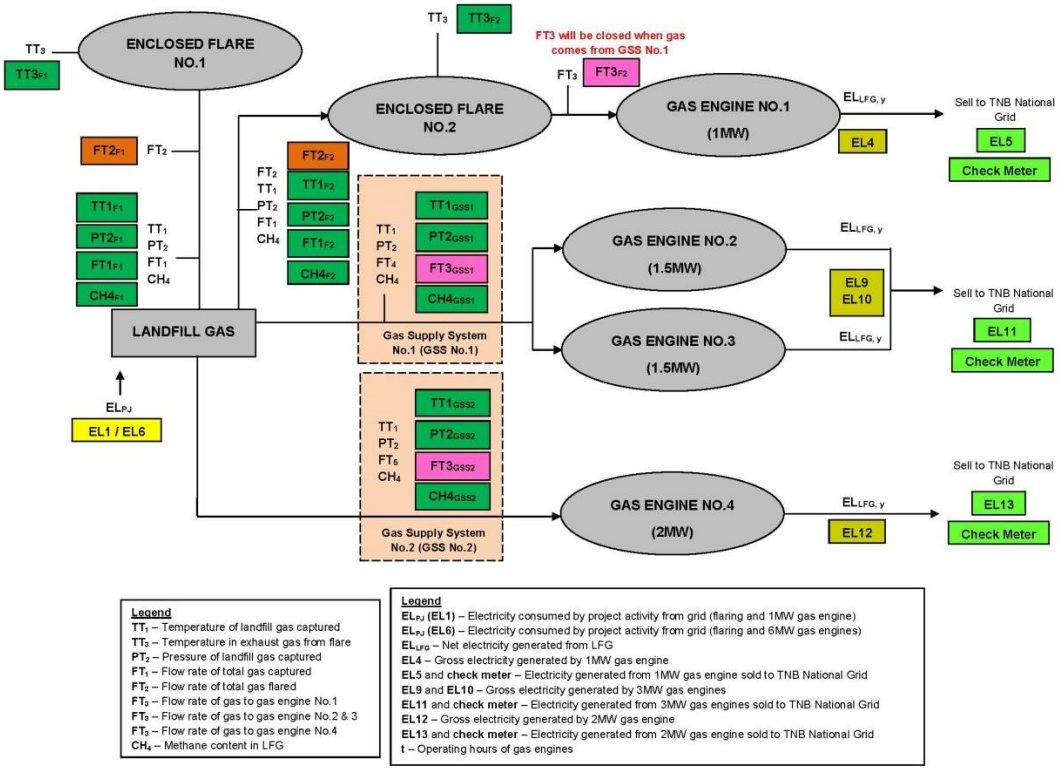
The team is overall headed by the MR who oversees the entire CDM monitoring implementation. The MR receives direct updates and support from the site staff headed by the Deputy General Manager - Operation. The Deputy General Manager – Operation is supported by the CDM Manager who is the key coordinator 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 14/08/2017.

Relevant Monitoring Points

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

Period: 28/08/2016 – 03/01/2017 – Before the conversion of $FT3_{F2}$ to GSSF1 and stopped of Flare No. 1



Period: 04/01/2017 – 31/12/2017 – After the conversion of $FT3_{F2}$ to GSSF1 and stop of Flare No. 1

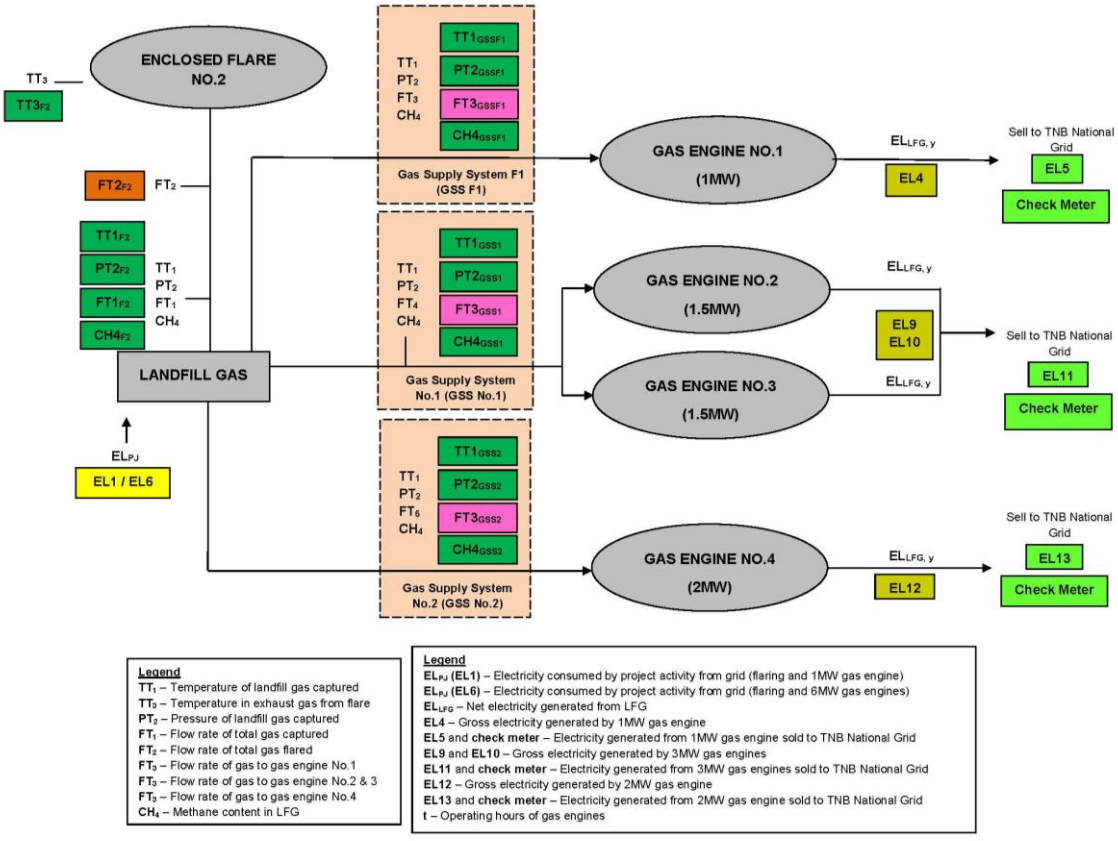


Figure 10: Key Parameters Monitored under the CDM Monitoring Plan

Before the conversion of Flare No. 1 to GSSF1 (28/08/2016 – 03/01/2017), the landfill gas is captured and send to Enclosed Flare No.1, No. 2, Gas Supply System No. 1 (GSS No.1) and Gas Supply System No.2 (GSS No.2). Flow rate of total gas flared by Enclosed Flare No.1 is monitored by FT2 while flow rate of gas to flared by Enclosed Flare No.2 is monitored by FT1 and FT2. Flow rate of gas to Gas Engines No. 1 which is attached to Enclosed Flare No. 2 is monitored by FT3, the lower value of FT1 compared to FT2 + FT3 will be applied for calculation. Flow rate of gas to Gas Engines No. 2 & 3 and 4 are monitored by $FT3_{GSS1}$ (GSS No.1) and $FT3_{GSS2}$ (GSS No.2) respectively.

After the conversion, landfill gas is captured and send to Enclosed Flare No.2, Gas Supply System F1 (GSS F1), Gas Supply System No. 1 (GSS No.1) and Gas Supply System No.2 (GSS No.2). Flow rate of total gas flared by Enclosed Flare No.2 is monitored by FT2 while flow rate of gas to gas engines are monitored by $FT3_{GSSF1}$ (GSSF1), $FT3_{GSS1}$ (GSS No.1) and $FT3_{GSS2}$ (GSS No.2) respectively.

The gross electricity generated by each gas engines are monitored using EL4, EL9, EL10 and EL12. The amount will be compared with EL5, EL11 and EL13 which are managed by Tenaga National Berhad to obtain the lower amount so that the result is conservative.

As data will be captured separately in the flaring and power generation system (Flare No.2, Gas Engine No.1 and so forth), a specific subscript will be assigned to the monitoring parameters of the different equipment installed.

Relevant regulations on LFG project activities shall be monitored and updated upon renewal of each crediting period. Changes to regulations, if any will be converted to the amount of methane in the LFG which is flared in the baseline due to a requirement in year *y* ($F_{CH4,BL,R,y}$).

Data Recording and Documentation

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

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

Manual Recording – Data in Hardcopy:
Daily monitoring log sheets and record books (manual recording)

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

As a back-up data recording system, the on-site workers were required to manually record certain monitored parameters in daily monitoring log sheets. These records were filed and kept in the office which can be accessible by the CDM Manager and technicians whenever necessary. These log sheets (in hard copies) were scanned for electronic filing on a monthly basis.

A summary of the data directly monitored is tabulated below:

Table 2: CDM Monitoring Parameters, Frequency and Archiving

Parameter	CDM ID	Equipment ID	Monitoring equipment	Recording frequency	Documentations	Data archive
Temperature	T_t ($T_{TT1,F1}$) T_t ($T_{TT1,F2}$) T_t ($T_{TT1,GSS1}$) T_t ($T_{TT1,GSS2}$) T_t ($T_{TT1,GSSF1}$)	$TT_{1,Flare\ No.1/Flare\ No.2/GSS1/GSS2/GSSF1}$	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	$T_{EG,m}$ ($T_{Flare,F1}$) $T_{EG,m}$ ($T_{Flare,F2}$)	$TT_{3,Flare\ No.1/Flare\ No.2}$	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_t ($P_{PT2,F1}$) P_t ($P_{PT2,F2}$) P_t ($P_{PT2,GSS1}$) P_t ($P_{PT2,GSS2}$) P_t ($P_{PT2,GSSF1}$)	$PT_{2,Flare\ No.1/Flare\ No.2/GSS1/GSS2/GSSF1}$	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	$V_{t,wb}$ ($LFG_{total,\ Flare\ No.1/Flare\ No.2,y}$) $V_{t,wb}$ ($LFG_{flare,\ Flare\ No.1/Flare\ No.2,y}$) $V_{t,wb}$ ($LFG_{electricity,Flare\ No.2/GSS,y}$)	$FT_{1,Flare\ No.1/Flare\ No.2}$ $FT_{2,Flare\ No.1/Flare\ No.2}$ $FT_{3,Flare\ No.2/GSS1/GSS2/GSSF1}$	V-Cone Differential Pressure Flow meter	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	$V_{CH4,m,db}$ ($W_{CH4,Flare\ No.1/Flare\ No.2/GSS,y}$)	$CH_{4,Flare\ No.1/Flare\ No.2/GSS1/GSS2/GSSF1}$	Continuous Infrared Gas Analyser	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into PDF format for archiving

Parameter	CDM ID	Equipment ID	Monitoring equipment	Recording frequency	Documentations	Data archive
Electricity consumed by the project	$EG_{PJ,y}$ ($EL_{PJ,y}$)	EL_{PJ} (EL1, 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	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.1,y}$) $EG_{PJ,y}$ ($EL_{LFG,GE\ No.2,y}$) $EG_{PJ,y}$ ($EL_{LFG,GE\ No.3,y}$) $EG_{PJ,y}$ ($EL_{LFG,GE\ No.4,y}$)	$EL_{LFG,GE\ No.1}$ (EL4) $EL_{LFG,GE\ No.2}$ (EL9) $EL_{LFG,GE\ No.3}$ (EL10) $EL_{LFG,GE\ No.4}$ (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
	$EG_{PJ,y}$ ($EL_{LFG,y}$)	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	T_t	$TT_{1,Flare\ No.1}$	T_t ($T_{TT1,F1}$)	^0C	PR Electronics	5335A	100944768	≤ ± 0.05% of span	0-100°C	13/01/2016 & CTT 1012-16 (28/08/2016 - 03/01/2017)	12/01/2017	Annually
2	Temperature Transmitter	$T_{EG,m}$	$TT_{3,Flare\ No.1}$	$T_{EG,m}$ ($T_{Flare,F1}$)	^0C	PR Electronics	5335A	110910943	≤ ± 0.05% of span	0-1200^{0}C	07/06/2016 & CTT 1202-16 (28/08/2016 - 03/01/2017)	06/06/2017	Annually
3	Pressure Sensor	P_t	$PT_{2,Flare\ No.1}$	P_t ($P_{PT2,F1}$)	kPa	Rosemount	3051TG1A2B21AB4 E5M5Q4	02492864	±0.25%	0-2 to 0-207 kPa	13/01/2016 & CTP 1067-16 (28/08/2016 - 03/01/2017)	12/01/2017	Annually
4	Flow Meter	$V_{t,wb}$	$FT_{1,Flare\ No.1}$	$V_{t,wb}$ ($LFG_{total,Flare\ No.1,y}$)	NM^3/hr	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	3051 / KVS10IIKC23FSN	4972946 / FT119 (8102101)	±1%	3-5000Nm^3/h	12/05/2015 & CTP 1406-15 (28/08/2016 - 03/01/2017)	11/05/2017	24 months
5	Flow Meter	$V_{t,wb}$	$FT_{2,Flare\ No.1}$	$V_{t,wb}$ ($LFG_{flare,Flare\ No.1,y}$)	NM^3/hr	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	3051 / KVS10IIKC23FSN	02768008 / FT120 (8102102)	±1%	3-5000Nm^3/h	20/11/2014 & CTP 1755-14 (28/08/2016 - 03/01/2017)	19/11/2016	24 months
Gas Analysers													
6	CH_4 Meter	$V_{CH4,m,db}$	$CH_{4,Flare\ No.1}$	$V_{CH4,m,db}$ ($W_{CH4,Flare\ No.1,y}$)	%	Guardian Plus	97460	33436	±2% of full scale	0-100%	07/06/2016 & CTM 1230-16 (28/08/2016 - 03/01/2017)	06/06/2017	Annually

Span Gas			
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

Note: Flare No.1 has stopped operation started from 03/01/2017 and has been converted to GSSF1, the equipment ID for $TT_{1,Flare\ No.1}$, $PT_{2,Flare\ No.1}$, and $CH_{4,Flare\ No.1}$ was converted to $TT_{1,GSSF1}$, $PT_{2,GSSF1}$, and $CH_{4,GSSF1}$ respectively. The equipment ID for $FT_{1,Flare\ No.1}$, $FT_{2,Flare\ No.1}$, and $TT_{3,\ Flare\ No.\ 1}$ are used for backup purposes.

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	T_t	$TT_{1,Flare\ No.2}$	T_t ($T_{TT1,F2}$)	^0C	Honeywell	STT25M-0-EN0-000-000-000-00-3D	B839917437	±0.5% of span	0-100°C	07/06/2016 & CTT 1203-16 (28/08/2016 - 12/09/2017)	06/06/2017	Annually
											13/09/2017 & CTT 1957-17 (13/09/2017 - 31/12/2017)	12/09/2018	Annually
2	Temperature Transmitter	$T_{EG,m}$	$TT_{3,Flare\ No.2}$	$T_{EG,m}$ ($T_{Flare,F2}$)	^0C	Honeywell	STT25M-0-EN0-000-000-000-00-3D	B838901937	±0.5% of span	0-1200°C	07/06/2016 & CTT 1204-16 (28/08/2016 - 12/09/2017)	06/06/2017	Annually
											13/09/2017 & CTT 1956-17 (13/09/2017-31/12/2017)	12/09/2018	Annually
3	Pressure Sensor	P_t	$PT_{2,Flare\ No.2}$	P_t ($P_{PT2,F2}$)	kPa	Rosemount	3051TG1A2B21AB4E5 Q4	5584784	±0.25%	0-40 kpa	07/06/2016 & CTP 2913-16 (28/08/2016 - 12/09/2017)	06/06/2017	Annually
											13/09/2017 & CTP 4820-17 (13/09/2017-31/12/2017)	12/09/2018	Annually
4	Flow Meter	$V_{t,wb}$	$FT_{1,Flare\ No.2}$	$V_{t,wb}$ ($LFG_{total,Flare\ No.2,y}$)	NM^3/hr	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	3051CD1A22A1AM5B4 K5/ KVS10IIKC23FSN	5476626 / FT141 (10031702)	±0.5%	3-5000Nm^3/h	12/05/2015 & CTP 1404-15 (28/08/2016 - 12/09/2017)	11/05/2017	24 months
											13/09/2017 & CTP 4819-17 (13/09/2017-31/12/2017)	12/09/2019	24 months
5	Flow Meter	$V_{t,wb}$	$FT_{2,Flare\ No.2}$	$V_{t,wb}$ ($LFG_{flare,Flare\ No.2,y}$)	NM^3/hr	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	3051CD1A22A1AM5K5 Q4 / KVS10IIKC23FSN	5476627 / FT140 (10031701)	±0.5%	3-5000Nm^3/h	12/05/2015 & CTP 1405-15 (28/08/2016 - 12/09/2017)	11/05/2017	24 months
											13/09/2017 & CTP 4821-17 (13/09/2017-31/12/2017)	12/09/2019	24 months
6	Flow Meter	$V_{t,wb}$	$FT_{3,Flare\ No.2}$	$V_{t,wb}$ ($LFG_{electricity,Flare\ No.2,y}$)	NM^3/hr	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	3051CD1A22A1AM5B4 K5Q4 / KVS08IIKC23FSN	02768007 / FT161 (11011001)	±0.5%	200-2000Nm^3/h	20/11/2014 & CTP 1754-14 (28/08/2016 - 04/01/2017)	19/11/2016	24 months
											05/01/2017 & CTP 1006-17 (05/01/2017 - 31/05/2017)	04/01/2019	24 months
Gas Analysers													
7	CH_4 Meter	$V_{CH4,m,db}$	$CH_{4,Flare\ No.2}$	$V_{CH4,m,db}$ ($W_{CH4,Flare\ No.2,y}$)	%	Guardian Plus	97460	31453	±2% of full scale	0-100%	13/01/2016 & CTM 1031-16 (28/08/2016 - 04/01/2017)	12/01/2017	Annually
											05/01/2017 & CTM 1003-17 (05/01/2017 - 31/12/2017)	04/01/2018	Annually
Power Generation and Electricity Consumption													
8	Power meter	$EG_{PJ,y}$	$EL_{LFG,GE\ No.1}$ (EL4)	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.1,y}$)	kWh (to be converted to MWh)	EDMI Limited	Mk6E	210225256	Class 0.5S	99999999.99kWh	03/10/2014 & SP/RA/2014/505/002 (28/08/2016 - 05/01/2017)	02/10/2016	24 months
											06/01/2017 & SP/RA2017/014/001-001 (06/01/2017 - 31/05/2017)	06/01/2019	24 months
9	Power meter	$EG_{PJ,y}$	EL_{LFG} (EL5)	$EG_{PJ,y}$ ($EL_{LFG,y}$)	kWh	Itron	SL761A071	53099690	Class 0.20	999999999kWh	01/04/2011 & TNBM-QR-064 (28/08/2016 - 31/05/2017)	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 (28/08/2016 - 31/12/2017)	31/03/2016	5 years

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

Note: Gas Engine No.1 was attached to Flare 2 previously, is converted to GSSF1 and was commissioned on 01/06/2017. Equipment ID for $FT_{3,Flare\ No.2}$, was converted to $FT_{3,GSSF1}$. The equipment ID for $EL_{LFG,GE\ No.1\ (EL4)}$ and $EL_{LFG\ (EL5)}$, maintain the same labelling.

Table 5: List of CDM Monitoring Equipment and Calibration for GSS1 – Gas Engine 2 & 3

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	Tt	$TT_{1,GSS1}$	T_t ($T_{TT1,GSS1}$)	^0C	Honeywell	STT25M-0-ENS-000-000-000-00-3H	b527143837	±1%	0-100°C	07/06/2016 & CTT 1201-16 (28/08/2016 - 12/09/2017)	06/06/2017	Annually
											13/09/2017 7 CTT 1955-17 (13/09/2017-31/12/2017)	12/09/2018	Annually
2	Pressure Sensor	P_t	$PT_{2,GSS1}$	P_t ($P_{PT2,GSS1}$)	kPa	Rosemount	3051TG1A2B21AB4K5 M5	5916057	±0.1%	0-60 kPa	07/06/2016 & CTP 2911-16 (28/08/2016 - 12/09/2017)	06/06/2017	Annually
											13/09/2017 & CTP 4817-17 (13/09/2017 - 31/12/2017)	12/09/2018	Annually
3	Flow Meter	$V_{t, wb}$	$FT_{3,GSS1}$	$V_{t, wb}$ ($LFG_{electricity,GSS1,y}$)	NM^3/hr	Rosemount	3051 CD1A22A1AM5B4DFK 5	5988022	±0.5%	200-2,000 Nm^3/h	07/06/2016 & CTP 2912-16 (28/08/2016 - 31/12/2017)	06/06/2018	24 months
4	CH_4 Meter	$V_{CH4,m,db}$	$CH_{4,GSS1}$	$V_{CH4,m,db}$ ($W_{CH4,GSS1,y}$)	%	Guardian Plus	97460	34140	±2% of full scale	0-100%	07/06/2016 & CTM 1231-16 (28/08/2016 - 09/11/2017)	06/06/2017	Annually
											09/11/2017 & AL-NG/0134/1117 (10/11/2017 - 31/12/2017)	08/11/2018	Annually
Power Generation and Electricity Consumption													
5	Power meter	$EG_{EC,y}$	EL_{PJ} (EL6)	$EG_{EC,y}$ ($EL_{PJ,y}$)	kWh	IME	NEMO 96HDL	2661930098	Class 1 (±1%)	0-250/5A	23/07/2014 & 2661 9300 98 (28/08/2016 - 22/07/2017)	22/07/2017	36 months
6	Power meter	$EG_{PJ,y}$	$EL_{LFG,GE\ No.2}$ (EL9)	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.2,y}$)	kWh	EDMI Limited	Genius	211516862	Class 0.5S	99999999.99kWh	13/05/2015 & SP/RA/2015/209/002 (28/08/2016 - 31/12/2017)	12/05/2017	24 months
7	Power meter	$EG_{PJ,y}$	$EL_{LFG,GE\ No.3}$ (EL10)	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.3,y}$)	kWh	EDMI Limited	Genius	211516863	Class 0.5S	99999999.99kWh	13/05/2015 & SP/RA/2015/209/001-002 (28/08/2016 - 31/12/2017)	12/05/2017	24 months
8	Power meter	$EG_{PJ,y}$	EL_{LFG} (EL11)	$EG_{PJ,y}$ ($EL_{LFG,y}$)	kWh	EDMI Limited	Mk6E	908705152	Class 0.5S	99,999,999kWh	06/12/2009 & TNBM/PJ/09/076 (28/08/2016 - 31/12/2017)	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 (28/08/2016 - 31/12/2017)	05/12/2014	5 years

Table 6: List of CDM Monitoring Equipment and Calibration for GSS2 – Gas Engine 4

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	T_t	$TT_{1,GSS2}$	T_t ($T_{TT1,GSS2}$)	^0C	Autrol	ATT2100-S11HA3E1-M1	ATT21004151000	±0.1%	0-100°C	23/04/2015 & AC1504-137 (28/08/2016 - 04/01/2017)	22/04/2016	Annually
											05/01/2017 & CTT 1005-17 (05/01/2017 - 31/12/2017)	05/01/2018	Annually
2	Pressure Sensor	P_t	$PT_{2,GSS2}$	P_t ($P_{PT2,GSS2}$)	kPa	Autrol	APT3200-G4M11E11S1-M1	APT3200-4150998	±0.075% of span	-100-1,500kPa	23/04/2015 & AC1504-137 (28/08/2016 - 04/01/2017)	22/04/2016	Annually
											05/01/2017 & CTP 1005-17 (05/01/2017 - 31/12/2017)	05/01/2017	Annually
3	Flow Meter	$V_{t, wb}$	$FT_{3,GSS2}$	$V_{t, wb}$ ($LFG_{electricity,GSS2,y}$)	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 (28/08/2016 - 31/12/2017)	22/06/2017	24 months
											10/12/2018 & B718150	09/12/2020	24 months
Gas Analyser													
4	CH_4 Meter	$V_{CH4,m,db}$	$CH_{4,GSS2}$	$V_{CH4,m,db}$ ($W_{CH4,GSS2,y}$)	%	Guardian NG	200950	8154	±2% of full scale	0-100%	08/03/2016 & AL-E/0011/0316 (28/08/2016 - 12/09/2017)	07/03/2017	Annually
						Guardian Plus	97460	33542			13/09/2017 & CTM1337-17 (13/09/2017 - 30/12/2017)	12/09/2018	Annually
Power Generation and Electricity Consumption													
5	Power meter	$EG_{PJ,y}$	$EL_{LFG,GE\ No.4}$ (EL12)	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.4,y}$)	kWh	EDMI	2000-6N00-30A31-04-L00-02A2-1D	213545834	Class 0.5S	99999999.99kWh	04/02/2016 & SP/RA/2016/081/001-001 (28/08/2016 - 31/12/2017)	03/02/2018	24 months
6	Power meter	$EG_{PJ,y}$	EL_{LFG} (EL13)	$EG_{PJ,y}$ ($EL_{LFG,y}$)	kWh	Itron	SL761W071	81480576	Class 0.2S	999999999kWh	14/06/2016 & TNB(B)/PP/UPH-PJ17/6/7-141 (28/08/2016 - 31/12/2017)	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 (28/08/2016 - 31/12/2017)	13/06/2021	5 years

The calibration for GSS2 FT3 was conducted on 10/12/2018. The error from the calibration results is less than the instrument error, as a result, the maximum permissible error of ±2.7% which is the instrument error was applied to FT3 from 23/06/2017 - 31/12/2017 as a conservative approach

Table 7: List of CDM Monitoring Equipment and Calibration for GSS F1

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	T_t	$TT_{1,GSS\ F1}$	T_t ($T_{TT1,\ GSS\ F1}$)	^0C	PR Electronics	5335A	100944768	≤ ± 0.05% of span	0-100°C	05/01/2017 & CTT 1004-17 (01/06/2017 - 31/12/2017)	04/01/2018	Annually
2	Flow Meter	$V_{t,\ wb}$	$FT_{3,\ GSS\ F1}$	$V_{t,\ wb}$ ($LFG_{electricity,GSS\ F1,y}$)	NM^3/hr	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	3051CD1A22A1AM 5B4K5Q4 / KVS08IIKC23FSN	02768007 / FT161 (11011001)	±0.5%	200-2000Nm^3/h	05/01/2017 & CTP 1006-17 (01/06/2017 - 31/12/2017)	04/01/2019	24 months
3	Pressure Sensor	P_t	$PT_{2,\ GSS\ F1}$	P_t ($P_{PT2,\ GSS\ F1}$)	kPa	Rosemount	3051TG1A2B21AB4 E5M5Q4	02492864	±0.25%	0-2 to 0-207 kPa	05/01/2017 & CTP 1004-17 (01/06/2017 - 31/12/2017)	04/01/2018	Annually
Gas Analysers													
4	CH_4 Meter	$V_{CH4,\ m,\ db}$	$CH_{4,\ GSS\ F1}$	$V_{CH4,\ m,\ db}$ ($W_{CH4,GSS\ F1,y}$)	%	Guardian Plus	97460	33436	±2% of full scale	0-100%	07/06/2016 & CTM 1230-16 (01/06/2017 - 12/09/2017)	06/06/2017	Annually
											13/09/2017 & CTM 1338-17 (13/09/2017 - 31/12/2017)	12/09/2018	Annually
Power Generation and Electricity Consumption													
5	Power meter	$EG_{PJ,y}$	$EL_{LFG,GE\ No.1}$ (EL4)	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.1,y}$)	kWh	EDMI Limited	Mk6E	210225256	Class 0.5S	99999999.99kWh	06/01/2017 & SP/RA2017/014/001-001 (01/06/2017 - 31/12/2017)	06/01/2019	24 months
6	Power meter	$EG_{PJ,y}$	EL_{LFG} (EL5)	$EG_{PJ,y}$ ($EL_{LFG,y}$)	kWh	Itron	SL761A071	53099690	Class 0.20	999999999kWh	01/04/2011 & TNBM-QR-064 (01/06/2017 - 31/12/2017)	31/03/2016	5 years
7	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 (28/08/2016 - 31/12/2017)	31/03/2016	5 years

With reference to the CDM validation and verification standard for project activities, version 02.0, section 9.2.6, paragraph 366 (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”, or (b) “Applying the error identified in the delayed calibration test, if the error is beyond the maximum permissible error of the measuring equipment”. During this monitoring period, all the equipment which have delay in calibration, the maximum permissible error (MPE) or the error identified in the delayed in calibration are as listed below:

List of Equipment from Flare 1

1. FT2 - Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to FT2 from 20/11/2016 – 03/01/2017 as a conservative approach.

List of Equipment from Flare 2

1. TT1 – Due to delay calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to TT1 from 07/06/2017 – 12/09/2017 as a conservative approach.
2. TT3 – Due to delay calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to TT3 from 07/06/2017 – 12/09/2017 as a conservative approach.
3. PT2 – Due to delay in calibration, the maximum permissible error of ±0.25% which is the equipment accuracy error was applied to PT2 from 07/06/2017 – 12/09/2017 as a conservative approach.
4. FT1 – Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to FT1 from 12/05/2017 – 12/09/2017 as a conservative approach. FT1 is no longer in comparison with FT2 + FT3 due to the conversion of FT3 to GSSF1 started from 01/06/2017 onwards.
5. FT2 – Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to FT2 from 12/05/2017 – 12/09/2017 as a conservative approach.
6. FT3 – Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to FT3 from 20/11/2016 – 04/01/2017 as a conservative approach.
7. EL4 – Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to EL4 from 03/10/2016 – 05/01/2017 as a conservative approach.

List of Equipment from GSS1

1. TT1 – Due to delay in calibration, the maximum permissible error of ±1.0% which is the equipment accuracy error was applied to TT1 from 07/06/2017 – 12/09/2017 as a conservative approach.
2. PT2 – Due to delay in calibration, the maximum permissible error of ±0.1% which is the equipment accuracy error was applied to PT2 from 07/06/2017 - 12/09/2017 as a conservative approach.
3. CH4 – Due to delay in calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH4 from 07/06/2017 – 09/11/2017 as a conservative approach.
4. EL6 – Due to delay in calibration, the maximum permissible error of ±1.0% which is the equipment accuracy error was applied to EL6 from 23/07/2017 – 31/12/2017 as a conservative approach.
5. EL9 – Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to EL9 from 13/05/2017 – 31/12/2017 as a conservative approach.
6. EL10 – Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to EL10 from 13/05/2017 – 31/12/2017 as a conservative approach.

List of Equipment from GSS2

1. TT1 – Due to delay in calibration, the maximum permissible error of ±0.13% which is the equipment accuracy error was applied to TT1 from 28/08/2016 – 04/01/2017 as a conservative approach.
2. PT2 – Due to delay in calibration, the error identified in the delayed of calibration is beyond the maximum permissible error of ±0.4% which is the equipment accuracy error was applied to PT2 from 28/08/2016 – 04/01/2017 as a conservative approach.

3. CH4 – Due to delay in calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH_4 from 08/03/2017 - 12/09/2017 as a conservative approach.
4. FT3 - Due to delay in calibration, the maximum permissible error of ±2.7% which is the equipment accuracy error was applied to FT3 from 23/06/2017 - 31/12/2017 as a conservative approach.

List of Equipment from GSS F1

1. CH4 – Due to delay in calibration, the maximum permissible error of ±2.0% which is the equipment accuracy error was applied to CH4 from 07/06/2017 – 12/09/2017 as a conservative approach.

With reference to the CDM validation and verification standard for project activities, version 01.0, section 9.2.6, paragraph 371, "If the results of the delayed calibration are not available, or the calibration has not been conducted at the time of the verification, the DOE, prior to finalizing the verification, shall request the project participants to conduct the required calibration and shall determine whether the project participants have calculated GHG emission reductions or net anthropogenic GHG removals conservatively using the approach mentioned in paragraph 369 above".

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

List of Equipment from Flare 2

2. 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 delay in calibration, the maximum permissible error of ±0.2% which is the equipment accuracy error was applied to EL5 from 28/08/2016 – 31/12/2017 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 delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to EL11 from 28/08/2016 – 31/12/2017 as a conservative approach.

Data Collection (for the whole monitoring period)

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

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)

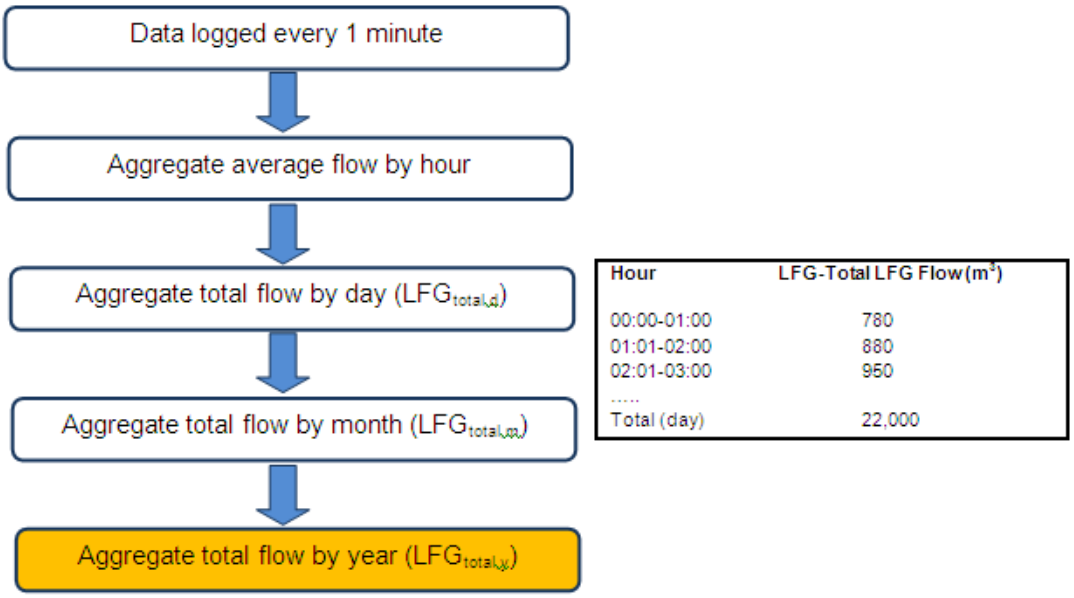


Figure 11: Example of Data Aggregation for Continuous Monitoring

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.

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

Types of back-up	Frequency	Back-up location
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 C10-4, 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:

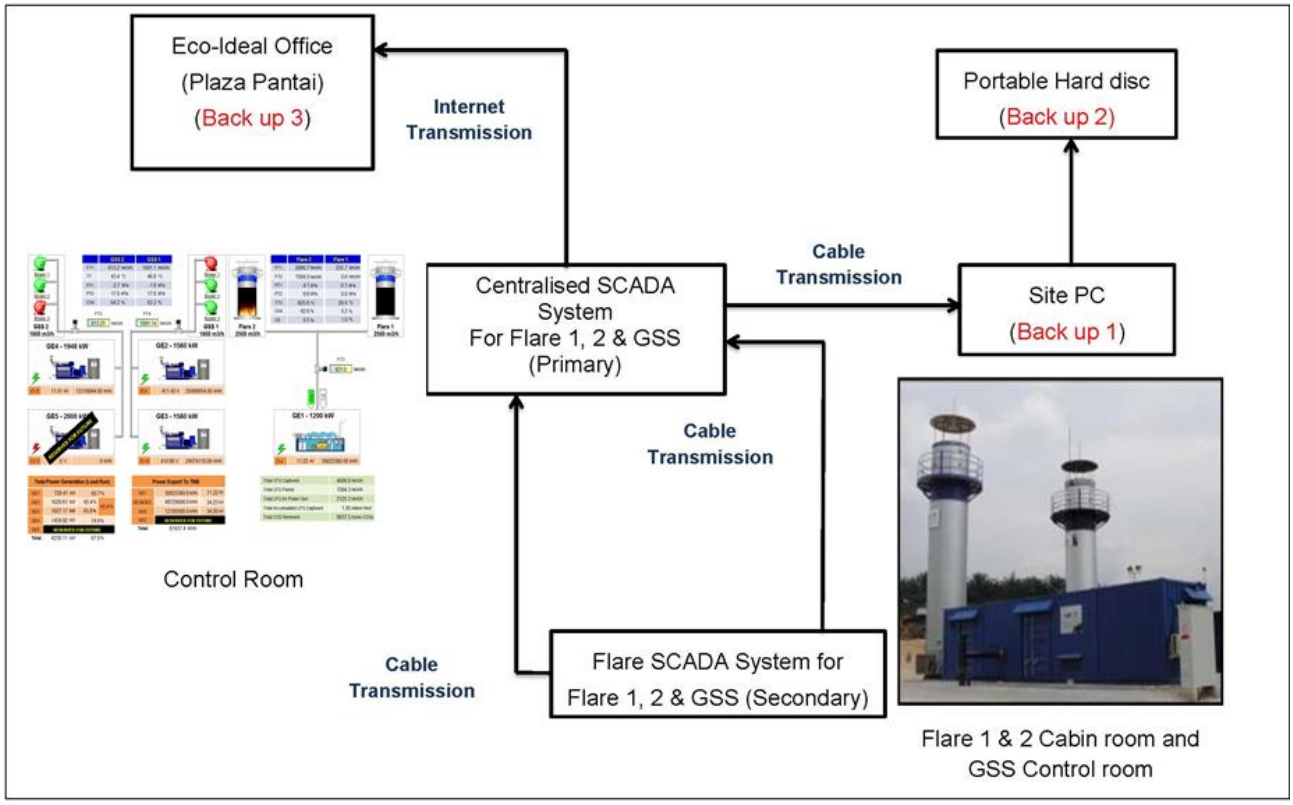


Figure 12: Automatic Data Back-Up for Flaring System at BTSL

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 1st monitoring period of 2nd crediting period was conducted by the consultant (Eco-Ideal Consulting Sdn. Bhd.):

- Audit No. 14 – 12/10/2017

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 12/10/2017.

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

No.	Description	Date	No. of participants
1	Landfill Gas Operation – Refresher Training	09/02/2017	6
2	Safety Training – Landfill Gas / Operation	18/04/2017	5
3	Gas Engine – MMC Panel	19/05/2017	6
4	Control Panel – Generation Meter / AUX	25/07/2017	6

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

ACM0001: "Flaring or use of landfill gas" (Version 18.0)

Data / Parameter	OX_{top_layer}
Unit	Dimensionless
Description	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data	Consistent with how oxidation is accounted for in the methodological tool "Emissions from solid waste disposal sites"
Value(s) applied)	0.1
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

Data / Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
Description	Global Warming Potential (GWP) for CH_4
Source of data	IPCC
Value(s) applied)	25
Choice of data or measurement methods and procedures	Shall be updated according to any future COP/MOP decisions
Purpose of data	Baseline emissions calculation
Additional comment	25 for the second commitment period. Shall be updated according to any future COP/MOP decisions

Data / Parameter	η_{PJ}
Unit	Dimensionless
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	-
Value(s) applied)	90%
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	Technical specification of the LFG capture system to be installed (if available) or a default value of 90%

Data / Parameter	$\varphi_{default}$
Unit	-
Description	Default value for the model correction factor to account for model uncertainties
Source of data	-
Value(s) applied)	0.75
Choice of data or measurement methods and procedures	-
Purpose of da	Baseline emissions calculation
Additional comment	$\Phi_y = \varphi_{default}$. 0.75 for Application A, humid/wet conditions

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	Based on an extensive review of published literature on this subject, including the “IPCC 2006 Guidelines for National Greenhouse Gas Inventories”
Value(s) applied)	0.1
Choice of data or measurement methods and procedures	-
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	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	0.5
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

Data / Parameter	$DOC_{f,default}$
Unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that decomposes in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	0.5
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	$DOC_{f,y} = DOC_{f,default}$

Data / Parameter	$MCF_{default}$
Unit	-
Description	Methane Correction Factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied)	1.0
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	$MCF_y = MCF_{default}$.

Data / Parameter	DOC_j
Unit	-
Description	Fraction of degradable organic carbon in the waste type *j* (weight fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 2.4 and 2.5)
Value(s) applied)	The following values for the different waste types *j* are applied:
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

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

<table>
<tr><td>Data / Parameter</td><td>kj</td></tr>
<tr><td>Unit</td><td>1/yr</td></tr>
<tr><td>Description</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Value(s) applied)</td><td>The following values for the different waste types j is applied:

Default values for k_j
<table>
<tr><th colspan="2" rowspan="2">Waste type j</th><th>Tropical (MAT > 20°C)</th></tr>
<tr><th>Wet (MAP > 1,000 mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.40</td></tr>
</table>
Note: MAT – mean annual temperature, MAP – mean annual precipitation, PET – potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration.</td></tr>
<tr><td>Choice of data or measurement methods and procedures</td><td>-</td></tr>
<tr><td>Purpose of data</td><td>Baseline emissions calculation</td></tr>
<tr><td>Additional comment</td><td>-</td></tr>
</table>

"Project emissions from flaring" (Version 02.0.0)

Data / Parameter	$SPEC_{flare}$
Unit	Temperature - °C Flow rate or heat flux – kg/h or m^3/h
Description	Manufacturer's flare specifications for temperature and flow rate and maintenance schedule
Source of data	Flare manufacturer
Value(s) applied)	Minimum and maximum operating temperature = 0 to 1,200°C Minimum and maximum inlet flow rate = 0 – 2,500 Nm^3/h
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

"Baseline, project and/ or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 02.0)

Data / Parameter	$TDL_{k,y}$
Unit	-
Description	Average technical transmission and distribution losses for providing electricity to source *k* in year *y*
Source of data	Tenaga Nasional Berhad (TNB) Annual Report 2016[6] in page 61
Value(s) applied)	7.74%
Choice of data or measurement methods and procedures	Average calculated from year 2014 – 2016 2014 – 8.15% 2015 – 7.68% 2016 – 7.39%
Purpose of data	Project emissions calculation and baseline emissions
Additional comment	For the project emission calculation, TDL of 7.74% is applied from 2017 onwards. 7.74% is calculated from the average of TDL from year 2014 – 2016, the % of the average TDL calculated is higher if compare to TDL in year 2016. This can be concluded that the TDL 7.74% apply for project emission from 2017 onwards is considered conservative approach.

[6] https://www.tnb.com.my/assets/annual_report/TNB_Annual_Report_2016.pdf

"Tool to calculate the emission factor for an electricity system" (Version 05.0)

Data / Parameter	**$EF_{grid,OM,y}$**
Unit	tCO_2/MWh
Description	Operating margin emission factor for the grid in year *y*
Source of data	2014 Grid connected baseline for Peninsular Malaysia by Green Tech Centre (GTC) CDM Secretariat
Value(s) applied)	0.6532
Choice of data or measurement methods and procedures	The $EF_{grid,OM,y}$ was calculated and published by Green Tech Centre (GTC) CDM Secretariat in 2014 using version 04.0 of the tool. For 2nd crediting period, the emission factor of 2014 is recalculated using W_{OM} = 0.25 according to the "Tool to calculate the emission factor for an electricity system", version 05.0, paragraph 84 (b).
Purpose of data	Calculation of Combined margin emissions factor $EF_{grid,CM,y}$
Additional comment	-

Data / Parameter	**$EF_{grid,BM,y}$**
Unit	tCO_2/MWh
Description	Build margin emission factor for the grid in year *y*
Source of data	2014 Grid connected baseline for Peninsular Malaysia by Green Tech Centre (GTC) CDM Secretariat
Value(s) applied)	0.7350
Choice of data or measurement methods and procedures	The $EF_{grid,BM,y}$ was calculated and published by Green Tech Centre (GTC) CDM Secretariat in 2014 using version 04.0 of the tool. For 2nd crediting period, the emission factor of 2014 is recalculated using W_{BM} = 0.75 according to the "Tool to calculate the emission factor for an electricity system", version 05.0, paragraph 84 (b).
Purpose of data	Calculation of Combined margin emissions factor $EF_{grid,CM,y}$
Additional comment	-

Data / Parameter	**$EF_{grid,CM,y}$**
Unit	tCO_2/MWh
Description	Combined margin emission factor for the grid in year *y*
Source of data	2014 Grid connected baseline for Peninsular Malaysia by Green Tech Centre (GTC) CDM Secretariat
Value(s) applied)	0.7146
Choice of data or measurement methods and procedures	The EFgrid,CM,y is calculated using published data by Green Tech Centre (GTC) CDM Secretariat in 2014 using version 04.0 of the tool. For 2nd crediting period, the emission factor of 2014 is recalculated according to the "Tool to calculate the emission factor for an electricity system", version 05.0
Purpose of data	Baseline and project emissions calculation
Additional comment	-

Data / Parameter	**MM_{H2O}**
Unit	kg/kmol
Description	Molecular mass of H_2O
Source of data	Methodological tool "Tool to determine the mass flow of a greenhousegas in a gaseous stream" *(Version 03.0)*
Value(s) applied)	18.0152
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

Data / Parameter	**R_U**
Unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	Methodological tool "Tool to determine the mass flow of a greenhousegas in a gaseous stream" *(Version 03.0)*
Value(s) applied)	8,314
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

Data / Parameter	**MM_{CO2}**
Unit	kg/kmol
Description	Molecular mass of greenhouse gas CO_2
Source of data	Methodological tool "Tool to determine the mass flow of a greenhousegas in a gaseous stream" *(Version 03.0)*
Value(s) applied)	44.01
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

Data / Parameter	MM_{CH4}
Unit	kg/kmol
Description	Molecular mass of CH_4
Source of data	Methodological tool “Tool to determine the mass flow of a greenhousegas in a gaseous stream” *(Version 03.0)*
Value(s) applied)	16.04
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

Data / Parameter	MM_{O2}
Unit	kg/kmol
Description	Molecular mass of gas O_2
Source of data	Methodological tool “Tool to determine the mass flow of a greenhousegas in a gaseous stream” *(Version 03.0)*
Value(s) applied)	32.00
Choice of data or measurement methods and procedures	-
Purpose of data	Baseline emissions calculation
Additional comment	-

D.2. Data and parameters monitored

ACM0001: "Flaring or use of landfill gas – Version 18.0"

Data / Parameter	Management of SWDS
Unit	-
Description	Management of SWDS
Measured/calculated/default	-
Source of data	Different sources of data available: (a) Origin design of the landfill; (b) Technical specification for the management of the SWDS; or (c) Local or national regulations.
Value(s) of monitored parameter	Local or national regulations, the reporting is based on the environmental monitoring report submitted to Department of Environment
Monitoring equipment	-
Measuring/reading/recording frequency	Annually
Calculation method (if applicable)	Refer to the original design of the landfill to monitor any practice to increase methane generation during the implementation of the project activity. Any change in the management of the SWDS after the implementation of the project activity will be justified by referring to technical or regulatory specifications.
QA/QC procedures	-
Purpose of data/parameter	-
Additional comment	-

<table>
<tr><td>Data / Parameter</td><td>$Op_{j,h}$</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Operation of the equipment that consumes the LFG</td></tr>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Project participant</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>On or Off for flare temperature and gas engine, refer to $T_{EG,m}$
<table>
<tr><th rowspan="2">Months</th><th colspan="2">Operating Time (Hr)</th></tr>
<tr><th>Flare No. 1</th><th>Flare No. 2</th></tr>
<tr><td>28 - 31 Aug 16</td><td>0</td><td>96</td></tr>
<tr><td>September 16</td><td>376</td><td>513</td></tr>
<tr><td>October 16</td><td>229</td><td>744</td></tr>
<tr><td>November 16</td><td>0</td><td>705</td></tr>
<tr><td>December 16</td><td>0</td><td>737</td></tr>
<tr><td>January 17</td><td>0</td><td>739</td></tr>
<tr><td>February 17</td><td></td><td>655</td></tr>
<tr><td>March 17</td><td></td><td>731</td></tr>
<tr><td>April 17</td><td></td><td>713</td></tr>
<tr><td>May 17</td><td></td><td>741</td></tr>
<tr><td>June 17</td><td></td><td>713</td></tr>
<tr><td>July 17</td><td></td><td>726</td></tr>
<tr><td>August 17</td><td></td><td>732</td></tr>
<tr><td>September 17</td><td></td><td>709</td></tr>
<tr><td>October 17</td><td></td><td>741</td></tr>
<tr><td>November 17</td><td></td><td>690</td></tr>
<tr><td>December 17</td><td></td><td>722</td></tr>
<tr><td>Total</td><td>605</td><td>11,405</td></tr>
</table>
<table>
<tr><th rowspan="2">Months</th><th colspan="4">Operating Time (Hr)</th></tr>
<tr><th>Gas Engine No.1</th><th>Gas Engine No.2</th><th>Gas Engine No.3</th><th>Gas Engine No.4</th></tr>
<tr><td>28 - 31 Aug 16</td><td>47</td><td>72</td><td>56</td><td>93</td></tr>
<tr><td>September 16</td><td>529</td><td>679</td><td>707</td><td>489</td></tr>
<tr><td>October 16</td><td>659</td><td>651</td><td>742</td><td>729</td></tr>
<tr><td>November 16</td><td>686</td><td>701</td><td>691</td><td>687</td></tr>
<tr><td>December 16</td><td>730</td><td>732</td><td>735</td><td>416</td></tr>
<tr><td>January 17</td><td>722</td><td>739</td><td>729</td><td>571</td></tr>
<tr><td>February 17</td><td>625</td><td>591</td><td>26</td><td>0</td></tr>
<tr><td>March 17</td><td>692</td><td>658</td><td>203</td><td>0</td></tr>
<tr><td>April 17</td><td>685</td><td>705</td><td>700</td><td>227</td></tr>
<tr><td>May 17</td><td>706</td><td>740</td><td>735</td><td>688</td></tr>
<tr><td>June 17</td><td>684</td><td>718</td><td>497</td><td>655</td></tr>
<tr><td>July 17</td><td>731</td><td>731</td><td>689</td><td>439</td></tr>
<tr><td>August 17</td><td>684</td><td>731</td><td>731</td><td>513</td></tr>
<tr><td>September 17</td><td>540</td><td>427</td><td>587</td><td>665</td></tr>
<tr><td>October 17</td><td>729</td><td>0</td><td>735</td><td>730</td></tr>
<tr><td>November 17</td><td>729</td><td>0</td><td>735</td><td>730</td></tr>
<tr><td>December 17</td><td>741</td><td>370</td><td>0</td><td>741</td></tr>
<tr><td>Total</td><td>10,919</td><td>9,245</td><td>9,298</td><td>8,373</td></tr>
</table></td></tr>
<tr><td>Monitoring equipment</td><td>-</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Hourly</td></tr>
</table>

Calculation method (if applicable)	For each equipment unit using the LFG monitor that the plant is operating in hour h by the monitoring any one or more of the following three parameters: • Temperature – Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; • Flame – Flame detection system is used to ensure that the equipment is in operation; • Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnaces. This option is not applicable to brick kilns Flare temperature will be selected for the monitoring. Gas engine operation hour will be used for cross checking. Opj,h = 0 when: • One of more temperature measurements are missing or below the minimum threshold in hour h (instantaneous measurements are made at least every minute); or • Flame is not detected continuously in hour h (instantaneous measurements are made at least every minute). • No products are generated in the hour h. • If gas engine not in operation. Otherwise, Opj,h = 1.
QA/QC procedures	The operation of the equipment that consume the LFG will be monitored using temperature. The parameter will be measured continuously using temperature transmitter. The transmitter sensor is installed at the middle top of the enclosed flare stack. Minimum operational temperature in the exhaust gas of the enclosed flare is 500°C. The exhaust gas from the enclosed flares is expected to be in the range of 800-1,200°C. Temperatures above 500°C indicate that the flare is operated in a reliable way where the default value of destruction efficiency of 90% is valid. Temperature transmitter shall be tested, calibrated and maintained regularly. The detail information on the temperature is described under $\mathbf{T_{EG,m.}}$ The other method to cross check with the temperature is the operation of gas engines. The operating hour for gas engines is based on actual documented operating hours from site.
Purpose of data/parameter	Baseline emissions calculation
Additional comment	-

Data / Parameter	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.1,y}$, $EL_{LFG,GE\ No.2,y}$, $EL_{LFG,GE\ No.3,y}$, $EL_{LFG,GE\ No.4,y}$)
Unit	MWh
Description	Amount of electricity generated using LFG by the project activity in year *y*
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 electricity generated (MWh) $EG_{PJ,y}$			Total amount of electricity generated (MWh)
	$EL_{LFG,GE\ No.1,y}$	$EL_{LFG,GE\ No.2,y}$ and $EL_{LFG,GE\ No.3,y}$	$EL_{LFG,GE\ No.4,y}$	
28 - 31 Aug 16	46.80	112.65	139.25	298.69
September 16	370.62	1,194.34	590.25	2,155.21
October 16	389.50	1,061.80	918.02	2,369.31
November 16	522.03	1,273.31	940.82	2,736.16
December 16	596.79	1,425.15	517.13	2,539.07
January 17	570.81	1,424.88	706.03	2,701.72
February 17	535.19	656.41	0.01	1,191.61
March 17	566.09	791.01	0.00	1,357.10
April 17	547.07	1,192.14	308.01	2,047.22
May 17	557.85	1,280.54	1,012.37	2,850.76
June 17	578.91	1,058.91	897.65	2,535.47
July 17	586.52	1,197.51	581.14	2,365.17
August 17	534.98	1,399.88	598.14	2,532.99
September 17	415.05	944.59	767.14	2,126.78
October 17	475.49	683.16	1,082.55	2,241.21
November 17	440.05	683.16	1,048.84	2,172.05
December 17	443.58	1,006.86	1,096.39	2,546.83
Total	**8,177**	**17,386**	**11,204**	**36,767**

Monitoring equipment

Item	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.1,y}$) Description (EL4)		$EG_{PJ,y}$ ($EL_{LFG,GE\ No.1,y}$) Description (EL5)	
	28/08/2016 - 31/12/2017		28/08/2016 - 31/12/2017	
			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	06/01/2017	01/04/2011	
Validity	24 months		5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)	

EL4 – Due to delay in calibration, the maximum permissible error of ±1.14% which is the equipment accuracy error was applied to EL4 from 03/10/2016 – 05/01/2017 as a conservative approach.

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 delay in calibration, the maximum permissible error of ±0.2% which is the equipment accuracy error was applied to EL5 from 28/08/2016 – 31/12/2017 as a conservative approach

Item	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.2,y}$) Description (EL9)	$EG_{PJ,y}$ ($EL_{LFG,GE\ No.3,y}$) Description (EL10)
	28/08/2016 - 31/12/2017	28/08/2016 - 31/12/2017
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	13/05/2015	13/05/2015
Validity	24 months	24 months

EL9 and EL 10 – Due to delay in calibration, the maximum permissible error which is the equipment calibration error was applied to EL9 (2.08%) and EL10 (1.14%) from 13/05/2017 – 31/12/2017 as a conservative approach.

Item	$EG_{PJ,y}$ ($EL_{LFG,y}$) Description (EL11)	
	28/08/2016 - 31/12/2017	
	Main energy meter	Check energy meter
Type	EDMI (Mk6E) Power Meter	
Accuracy class	Class 0.5S	
Serial No.	908705152	908705154

	<table><tr><td>Calibration frequency</td><td>5 years</td></tr><tr><td>Date of last calibration</td><td>06/12/2009</td></tr><tr><td>Validity</td><td>5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)</td></tr></table> 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 delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to EL11 from 28/08/2016 – 31/12/2017 as a conservative approach. <table><tr><th rowspan="3">Item</th><th>$EG_{PJ,y}$ ($EL_{LFG,GE\ No.4,y}$) Description (EL12)</th><th colspan="2">$EG_{PJ,y}$ ($EL_{LFG,y}$) Description (EL13)</th></tr><tr><th rowspan="2">28/08/2016 - 31/12/2017</th><th colspan="2">28/08/2016 - 31/12/2017</th></tr><tr><th>Main energy meter</th><th>Check energy meter</th></tr><tr><td>Type</td><td>EDMI Limited (2000-6N00-30A31-04-L00-02A2-1D) Power Meter</td><td colspan="2">Itron (SL761W071) Power Meter</td></tr><tr><td>Accuracy class</td><td>Class 0.5S</td><td colspan="2">Class 0.2S</td></tr><tr><td>Serial No.</td><td>213545834</td><td>81480576</td><td>81480578</td></tr><tr><td>Calibration frequency</td><td>24 months</td><td colspan="2">5 years</td></tr><tr><td>Date of last calibration</td><td>04/02/2016</td><td colspan="2">14/06/2016</td></tr><tr><td>Validity</td><td>24 months</td><td colspan="2">5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)</td></tr></table>
Measuring/reading/recording frequency	Measured continuously with electricity meter installed
Calculation method (if applicable)	N/A
QA/QC procedures	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. 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/parameter	Baseline emissions calculation
Additional comment	-

<table>
<tr><td>Data / Parameter</td><td>$EG_{EC,y}$</td></tr>
<tr><td>Unit</td><td>MWh</td></tr>
<tr><td>Description</td><td>Amount of electricity consumed by the project activity in year y</td></tr>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>Based on continuous measurement by sealed electricity meter installed.

The quantity of electricity consumed by project activity will be recorded by installed electricity meter EL6 which measured the total electricity consumed by the project activity (Flare No. 2, Gas Engine No.1, Gas Engine No.2, Gas Engine No.3, Gas Engine No.4, GSS No.1, GSS No.2 and GSSF1).

In case of temporary situation such as the installed electricity meter mal-functioned (EL6) leading to no readings captured, $EG_{EC,y}$ shall be estimated or calculated as described as below:

1. Using the backup meter EL1 which recorded the actual power consumption for Flare No. 2 and GSSF1;
2. For Gas Engine No. 2, Gas Engine No.3, Gas Engine No.4, GSS1 and GSS2, the power consumption will be estimated using the power rating (technical specifications) of the system involved during the power generation. The power consumed will be calculated based on the operating maximum capacity for the full period, including the 10% addition to account for transmission and distribution losses, according to PRC-2467-02.

In the case, temporary situation where EL1 is mal-functioned leading to no reading captured, the power consumption for Flare No. 1, Flare No. 2 and Gas Engine No.1 will be using the estimated historical data (September 2014 to August 2016) of 56.93 MWh and compared with the calculated future 24 months' data prior the malfunction period and, whichever higher will be applied for the project emission calculation.

The higher power consumption selected for the project emission calculation shall be derived based on 95% confidence interval principles (source: "IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories", page 6.6). The upper bound of 95% confidence interval with reference to the above-mentioned guideline to be applied.

Additional 10% will be added to the upper bound of the interval boundaries calculated to account for transmission and distribution losses, according to PRC-2467-02.</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>
<table>
<tr><th>Months</th><th>Electricity consumed $EG_{EC,y}$ (EL6) (MWh)</th></tr>
<tr><td>28 - 31 Aug 16</td><td>23.70</td></tr>
<tr><td>September 16</td><td>171.21</td></tr>
<tr><td>October 16</td><td>206.70</td></tr>
<tr><td>November 16</td><td>201.87</td></tr>
<tr><td>December 16</td><td>193.17</td></tr>
<tr><td>January 17</td><td>208.61</td></tr>
<tr><td>February 17</td><td>106.17</td></tr>
<tr><td>March 17</td><td>120.22</td></tr>
<tr><td>April 17</td><td>169.19</td></tr>
<tr><td>May 17</td><td>212.24</td></tr>
<tr><td>June 17</td><td>195.38</td></tr>
</table>
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<table>
<tr><td></td><td>
<table>
<tr><td>July 17</td><td>205.90</td></tr>
<tr><td>August 17</td><td>211.14</td></tr>
<tr><td>September 17</td><td>178.91</td></tr>
<tr><td>October 17</td><td>174.04</td></tr>
<tr><td>November 17</td><td>166.22</td></tr>
<tr><td>December 17</td><td>197.98</td></tr>
<tr><td>Total</td><td>2,943</td></tr>
</table>
</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><th rowspan="2">Item</th><th>Electricity consumed from grid for project activity
$EG_{EC,y}$ ($EL_{PJ,y}$) (EL6) (MWh)</th></tr>
<tr><th>28/08/2016 – 31/12/2017</th></tr>
<tr><td>Type</td><td>IME NEMO 96HDL
Power Meter</td></tr>
<tr><td>Accuracy class</td><td>Class 1 (± 1%)</td></tr>
<tr><td>Serial No.</td><td>2661930098</td></tr>
<tr><td>Calibration frequency</td><td>36 months</td></tr>
<tr><td>Date of last calibration</td><td>23/07/2014</td></tr>
<tr><td>Validity</td><td>3 years according to manufacturer’s recommendation</td></tr>
</table>

EL 6 – Due to delay in calibration, the maximum permissible error of ±1% which is the equipment accuracy error was applied to EL6 from 23/07/2017 – 31/12/2017 as a conservative approach. The new calibration for both EL6 was done on 25/01/2018, the error is within the maximum permissible error of ±1%.
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Continuous measurement</td></tr>
<tr><td>Calculation method (if applicable)</td><td>N/A</td></tr>
<tr><td>QA/QC procedures</td><td>Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double-checked by the electricity distribution company</td></tr>
<tr><td>Purpose of data/parameter</td><td>Project emission calculation</td></tr>
<tr><td>Additional comment</td><td>This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process t ($PE_{EC,y}$) using the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”</td></tr>
</table>

"Emissions from solid waste disposal sites" (Version 07.0)

Data / Parameter	f_y
Unit	-
Description	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*
Measured/calculated/default	
Source of data	Onsite records of the gas analyzers.
Value(s) of monitored parameter	
Monitoring equipment	
Measuring/reading/recording frequency	For application A: Once for the crediting period ($f_y = f$)
Calculation method (if applicable)	NA
QA/QC procedures	-
Purpose of data/parameter	Baseline emissions calculation
Additional comment	This is for reporting purposes, and not applied in the ER calculation

Months	**Flare No.1 Value (%)**	**Flare No.2 Value (%)**	**GSS1 Value (%)**	**GSS2 Value (%)**	**GSSF1 Value (%)**
28 - 31 Aug 16	0.00	0.58	0.65	0.63	
September 16	0.56	0.57	0.66	0.62	
October 16	0.52	0.55	0.65	0.63	
November 16	0.00	0.58	0.61	0.63	
December 16	0.00	0.63	0.61	0.63	
January 17		0.60	0.58	0.61	
February 17		0.62	0.63	0.00	
March 17		0.61	0.61	0.00	
April 17		0.59	0.59	0.61	
May 17		0.59	0.61	0.62	
June 17		0.61	0.55	0.58	0.62
July 17		0.58	0.53	0.53	0.57
August 17		0.59	0.53	0.60	0.56
September 17		0.60	0.53	0.63	0.56
October 17		0.60	0.53	0.56	0.57
November 17		0.61	0.63	0.59	0.59
December 17		0.61	0.66	0.54	0.58
Average	**0.54**	**0.60**	**0.60**	**0.60**	**0.58**

"Project emissions from flaring" (Version 02.0.0)

Data / Parameter	$T_{EG,m}$ ($T_{Flare,F1}$, $T_{Flare,F2}$)
Unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute *m*
Measured/calculated/default	Measured
Source of data	Project participant
Value(s) of monitored parameter	

Months	**$T_{EG,m}$ ($T_{Flare,F1}$) (°C)**	**$T_{EG,m}$ ($T_{Flare,F2}$) (°C)**
28 - 31 Aug 16	0.00	674.76
September 16	598.10	794.84
October 16	535.20	795.12
November 16	0.00	799.03
December 16	0.00	847.63
January 17		879.02
February 17		878.88
March 17		870.19
April 17		830.75
May 17		808.89
June 17		714.54
July 17		635.77
August 17		551.73
September 17		637.10
October 17		658.56
November 17		663.44
December 17		656.75
Average	**566.65**	**746.88**

Monitoring equipment

Item	**$T_{EG,m}$ ($T_{Flare,F1}$) Description**
	28/08/2016 – 03/01/2017
Type	PR Electronics (5335A) Temperature Transmitter
Accuracy class	≤ ± 0.05% of span
Serial No.	110910943
Calibration frequency	Annually
Date of last calibration	13/01/2016
Validity	1 year

Item	**$T_{EG,m}$ ($T_{Flare,F2}$) Description**	
	28/08/2016 – 12/09/2017	**13/09/2017 – 31/12/2017**
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	07/06/2016	13/09/2017
Validity	1 year	

	Flare No.2 Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to TT3 from 07/06/2017 – 12/09/2017 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.
Measuring/reading/recording frequency	Once per minute
Calculation method (if applicable)	Measure the temperature of the exhaust gas in the flare by an appropriate temperature measurement equipment. The temperature of the exhaust gas in the flares is measured by temperature transmitters. The exhaust gas from the enclosed flares is expected to be in the range of 800 – 1,200°C. Temperatures above 500°C indicate that the flare is operated in a reliable way where the default value of destruction efficiency of 90% is valid. Minimum operational temperature in the exhaust gas of the enclosed flare is 500°C.
QA/QC procedures	Temperature measurement equipment is calibrated in accordance with the maintenance schedule
Purpose of data/parameter	Baseline emissions calculation
Additional comment	Any unexpected changes such as a sudden increase/drop in temperature will be noted in the site records along with any corrective action that was implemented to correct the issue. Monitoring of this parameter is applicable in case of enclosed flares. Measurements are required to determine if manufacturer's flare specifications for operating temperature are met

Data / Parameter	**$Flame_m$**
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute *m*
Measured/calculated/default	Measured
Source of data	Project participant
Value(s) of monitored parameter	On or Off, refer to $\mathbf{V_{t,wb}}$
Monitoring equipment	Fixed installation optical flame detector: Ultra-violet detector
Measuring/reading/recording frequency	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off.
Calculation method (if applicable)	The flame detection will be monitored and cross checked with the amount of gas sent to flare (FT2) and gas engine (FT3). If there is data for FT2 and FT3, means the flame is on. Equipment will be maintained and calibrated in accordance with manufacturer's recommendations
QA/QC procedures	Baseline emissions calculation
Purpose of data/parameter	Applicable to all flares
Additional comment	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off.

Data / Parameter	**$V_{t,wb}$ ($LFG_{flare,Flare\ No.1,y}$, $LFG_{total,Flare\ No.2,y}$, $LFG_{flare,Flare\ No.2,y}$, $LFG_{electricity,Flare\ No.2,y}$, $LFG_{electricity,GSS1,y}$, $LFG_{electricity,GSS2,y}$, $LFG_{electricity,GSSF1,y}$)**
Unit	m^3 wet gas/h
Description	Volumetric flow of the gaseous stream in time interval *t* on a wet basis
Measured/calculated/default	Measured
Source of data	Onsite records of the flow meters. There is an independent flow meter to measure the gas sent to Flare No.1 ($FT1_{Flare\ No.1}$, and $FT2_{Flare\ No.1}$), Flare No.2, ($FT1_{Flare\ No.2}$, and $FT2_{Flare\ No.2}$) and gas engines No. 1 ($FT3_{Flare\ No.2}$), GSS1 ($FT3_{GSS1}$), GSS2 ($FT3_{GSS2}$), and GSS F1 ($FT3_{GSSF1}$).
Value(s) of monitored parameter	**Flare No.1** According to ACM0001, version 18, page 15, if the LFG is used for multiple purposes (e.g. flaring or energy generation), and all methane destruction devices are verified to be operational (e.g. by means of flame detector records, energy generated), a single flow meter may be used to record the flow into multiple destruction devices; The total LFG captured was the same as the total LFG flared for Flare No.1 during monitoring period as total LFG captured in Flare No.1 was only sent to the flare. Flare No.1 has stopped operation started from 03/01/2017 and has been converted to GSS F1.

Months	**$V_{t,wb}$ ($LFG_{flare,Flare\ No.1,y}$) ($Nm^3$)**
28 - 31 Aug 16	0
September 16	278,710
October 16	134,282
November 16	0
December 16	0
Total	**412,992**

Flare No.2

According to ACM0001, version 18, page 15, if the LFG is used for multiple purposes (e.g. flaring or energy generation), and all methane destruction devices are verified to be operational (e.g. by means of flame detector records, energy generated), a single flow meter may be used to record the flow into multiple destruction devices; From 28/08/2016 – 31/05/2017, 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.

There will be 2 outcomes for this comparison:

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	$V_{t,wb}$ Flare No.2 Value (Nm^3)			
	$LFG_{total,Flare\ No.2,y}$ FT1	$LFG_{flare,Flare\ No.2,y}$ FT2	$LFG_{eletricity,Flare\ No.2,y}$ FT3	Total of FT2 & FT3
28 – 31 Aug 16	136,021	108,372	16,185	124,557
September 16	1,224,148	939,602	216,129	1,155,731
October 16	1,469,451	1,071,475	281,984	1,353,459
November 16	1,458,196	1,099,084	293,914	1,392,998
December 16	1,563,766	1,179,667	144,781	1,324,448
January 17	1,644,339	1,265,087	311,400	1,576,486
February 17	1,442,052	1,099,138	283,119	1,382,257
March 17	1,576,698	1,204,190	306,670	1,510,860
April 17	1,499,739	1,140,706	304,327	1,445,032
May 17	1,515,427	1,149,633	300,433	1,450,066
June 17		813,205		
July 17		699,128		
August 17		532,577		
September 17		681,666		
October 17		775,485		
November 17		678,593		
December 17		615,609		
Total	**13,529,836**	**15,053,216**	**2,458,942**	**12,715,895**

From the monthly comparison of the FT1 & FT2 + FT3 values above, the lower value between the two is taken for the calculation of CERs (28 Aug 16 – 31 May 17). However, as Gas Engine No.1 is being converted to GSS F1 which starts to operate on 01/06/2017, only one flow meter (FT2) remained for Flare No. 2, therefore, no comparison was done started from June 17 onwards.

Months	$V_{t,wb}$ ($LFG_{flare,Flare\ No.2,y}$) FT2 ($Nm^3$)
28 - 31 Aug 16	108,372
September 16	939,602
October 16	1,071,475
November 16	1,099,084
December 16	1,179,667
January 17	1,265,087
February 17	1,099,138
March 17	1,204,190
April 17	1,140,706
May 17	1,149,633
June 17	813,205
July 17	699,128
August 17	532,577
September 17	681,666
October 17	775,485

November 17	678,593
December 17	615,609
Total	**15,053,216**

GSSF1 (Gas Engine No.1), GSS1 (Gas Engine No.2 and 3) and GSS2 (Gas Engine No.4)

According to ACM0001, version 18, page 15, if the LFG is used for multiple purposes (e.g. flaring or energy generation), and all methane destruction devices are verified to be operational (e.g. by means of flame detector records, energy generated), a single flow meter may be used to record the flow into multiple destruction devices. 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 GSS F1, GSS1 and GSS2 respectively during the monitoring period as total LFG captured in GSSF1 was only sent to Gas Engine No.1, total LFG captured in GSS1 was only sent to Gas Engine No.2 and No.3, and total LFG captured in GSS2 was sent to Gas Engine No.4.

Months	**$V_{t, wb}$ ($LFG_{electricity,GSS1,y}$) (Nm^3)**	**$V_{t, wb}$ ($LFG_{electricity,GSS2,y}$) (Nm^3)**	**$V_{t, wb}$ ($LFG_{electricity,Flare No.2,y}$) ($Nm^3$)**	**$V_{t, wb}$ ($LFG_{electricity,GSSF1,y}$) ($Nm^3$)**
28 - 31 Aug 16	57,874	59,401	16,185	
September 16	680,284	293,501	216,129	
October 16	622,492	436,014	281,984	
November 16	714,667	409,854	293,914	
December 16	788,952	264,243	144,781	
January 17	844,975	328,275	311,400	
February 17	208,530	0	283,119	
March 17	463,282	0	306,670	
April 17	719,780	111,616	304,327	
May 17	749,998	462,997	300,433	
June 17	621,519	405,381		296,514
July 17	764,346	293,888		317,034
August 17	790,027	285,319		293,190
September 17	493,869	368,955		234,273
October 17	385,827	515,734		278,138
November 17	408,046	488,299		252,798
December 17	525,769	495,098		253,423
Total	**9,840,237**	**5,218,575**	**2,458,942**	**1,925,368**

Monitoring equipment

Item	**$V_{t,wb}$ ($LFG_{total,Flare No.1,y}$)**
	28/08/2016 – 03/01/2017
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	12/05/2015
Validity	24 months

Item	$V_{t,wb}$ ($LFG_{total,Flare\ No.2,y}$)	
	28/08/2016 – 12/09/2017	**13/09/2017 – 31/12/2017**
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	12/05/2015	13/09/2017
Validity	24 months	

Flare No. 2

FT1 - Due to delay in calibration, the maximum permissible error ±0.5% which is the equipment accuracy error was applied to FT1 from 12/05/2017 – 12/09/2017 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	$V_{t,wb}$ ($LFG_{Flare,Flare\ No.1,y}$)
	28/08/2016 – 03/01/2017
Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone
Accuracy class	± 1%
Serial No.	02768008 (Rosemount) / FT2 - FT120 (8102102) (Kingways)
Calibration frequency	24 months
Date of last calibration	20/11/2014
Validity	24 months

Flare No. 1

FT2 - Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to FT2 from 20/11/2016 – 03/01/2017 as a conservative approach.

Item	$V_{t,wb}$ ($LFG_{Flare,Flare\ No.2,y}$)	
	28/08/2016 – 12/09/2017	**13/09/2017 – 31/12/2017**
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	12/05/2015	13/09/2017

last calibration		
Validity	24 months	

Flare No. 2

FT2 - Due to delay in calibration. The maximum permissible error ±0.5% which is the equipment accuracy error was applied to FT2 from 12/05/2017 – 12/09/2017 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	$V_{t,wb}$ ($LFG_{Electricity,Flare\ No.2,y}$)	
	28/08/2016 – 04/01/2017	**05/01/2017 – 31/05/2017**
Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	
Accuracy class	± 0.5%	
Serial No.	02768007 (Rosemount) / FT3 - FT161 (11011001) (Kingways)	
Calibration frequency	24 months	
Date of last calibration	20/11/2014	05/01/2017
Validity	24 months	

Flare No. 2

FT3 – Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to FT3 from 20/11/2016 – 03/01/2017 as a conservative approach.

Gas Engine No.1 is being converted to GSS F1 which starts to operate on 01/06/2017, Flow meter (FT3) was converted to $FT3_{GSSF1}$.

Item	$V_{t,wb}$ ($LFG_{Electricity,GSS1,y}$)
	28/08/2016 – 31/12/2017
Type	Flow transmitter – Rosemount
Accuracy class	± 0.5%
Serial No.	5988022
Calibration frequency	24 months
Date of last calibration	07/06/2016
Validity	24 months

Item	$V_{t,wb}$ ($LFG_{Electricity,GSS2,y}$)
	28/06/2016 – 31/12/2017
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

GSS2 (Gas Engine No. 4)

FT3 - Due to delay in calibration, the maximum permissible error of ±2.7% which is the equipment accuracy error was applied to FT3 from 23/06/2017

<table>
<tr><td></td><td>- 31/12/2017 as a conservative approach. The latest calibration was done on 10/12/2018, the error is less than the maximum permissible error of ±2.7%.

<table>
<tr><th rowspan="2">Item</th><th>$V_{t,wb}$ ($LFG_{Electricity,GSSF1,y}$)</th></tr>
<tr><th>01/06/2017 – 31/12/2017</th></tr>
<tr><td>Type</td><td>Flow transmitter – Rosemount
Differential Pressure Transmitter – Kingways Control Vcone</td></tr>
<tr><td>Accuracy class</td><td>± 0.5%</td></tr>
<tr><td>Serial No.</td><td>02768007 (Rosemount) / FT3 - FT161 (11011001) (Kingways)</td></tr>
<tr><td>Calibration frequency</td><td>24 months</td></tr>
<tr><td>Date of last calibration</td><td>05/01/2017</td></tr>
<tr><td>Validity</td><td>24 months</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Continuous if not specified in the underlying methodology/tool</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory for all projects applying large scale methodology(ies). Calibration and frequency of calibration is according to manufacturer’s specifications</td></tr>
<tr><td>Purpose of data/parameter</td><td>Baseline emissions calculation</td></tr>
<tr><td>Additional comment</td><td>This parameter is monitored in Option B</td></tr>
</table>

Data / Parameter	$V_{CH4,m,db}$ ($W_{CH4,Flare\ No.1,y}$, $W_{CH4,Flare\ No.2,y}$, $W_{CH4,GSS1,y}$, $W_{CH4,GSS2,y}$, $W_{CH4,GSSF1,y}$)
Unit	m^3 CH_4 / m^3 dry gas
Description	Volumetric fraction of greenhouse gas CH_4 in minute *m* on a dry basis
Measured/calculated/default	Measured
Source of data	Onsite records of the gas analyzers. In case of temporary situation such as the installed CH_4 gas analyser mal-functioned or giving unrepresentative results due to data logging problem, the V_{CH4} shall be measured manually with portable gas analyser. 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 01). As conservative approach, the lower bound of the 95% Confidence Interval will be applied as per guideline.

Value(s) of monitored parameter

Months	**$V_{CH4,m,db}$ (%)**				
	$W_{CH4,Flare\ No.1,y}$	**$W_{CH4,Flare\ No.2,y}$**	**$W_{CH4,GSS1,y}$**	**$W_{CH4,GSS2,y}$**	**$W_{CH4,GSSF1,y}$**
28 - 31 Aug 16	0.00	0.58	0.65	0.63	
September 16	0.56	0.57	0.66	0.62	
October 16	0.52	0.55	0.65	0.63	
November 16	0.00	0.58	0.61	0.63	
December 16	0.00	0.63	0.61	0.63	
January 17		0.60	0.58	0.61	
February 17		0.62	0.63	0.00	
March 17		0.61	0.61	0.00	
April 17		0.59	0.59	0.61	
May 17		0.59	0.61	0.62	
June 17		0.61	0.55	0.58	0.62
July 17		0.58	0.53	0.53	0.57
August 17		0.59	0.53	0.60	0.56
September 17		0.60	0.53	0.63	0.56
October 17		0.60	0.53	0.56	0.57
November 17		0.61	0.63	0.59	0.59
December 17		0.61	0.66	0.54	0.58
Average	**0.54**	**0.60**	**0.60**	**0.60**	**0.58**

Monitoring equipment

Item	**$V_{CH4,m,db}$ ($W_{CH4,Flare\ No.1,y}$)**
	28/08/2016 – 03/01/2017
Type	Guardian Plus (97460) Infra-Red Gas Monitor
Accuracy class	± 2%
Serial No.	33436
Calibration frequency	Annually

Date of last calibration	07/06/2016
Validity	1 year

Item	$V_{CH4,m,db}$ ($W_{CH4,Flare\ No.2,y}$)	
	28/08/2016 – 04/01/2017	**05/01/2017 – 31/12/2017**
Type	Guardian Plus (97460) Infra-Red Gas Monitor	
Accuracy class	± 2%	
Serial No.	31453	
Calibration frequency	Annually	
Date of last calibration	13/01/2016	05/01/2017
Validity	1 year	

Item	$V_{CH4,m,db}$ ($W_{CH4,GSS1,y}$)	
	28/08/2016 – 09/11/2017	**10/11/2017 – 31/12/2017**
Type	Guardian Plus (97460) Infra-Red Gas Monitor	
Accuracy class	± 2%	
Serial No.	34140	
Calibration frequency	Annually	
Date of last calibration	07/06/2016	08/11/2018
Validity	1 year	

GSS1 (Gas Engine No. 2 & 3)

CH4 – Due to delay in calibration, the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH4 from 07/06/2017 – 09/11/2017 as a conservative approach.

Item	$V_{CH4,m,db}$ ($W_{CH4,GSS2,y}$)	
	28/08/2016 – 12/09/2017	**13/09/2017 – 30/12/2017**
Type	Guardian Ng (200950)	Guardian Plus (97460)
Accuracy class	± 2%	
Serial No.	8154	33542
Calibration frequency	Annually	
Date of last calibration	08/03/2016	13/09/2017
Validity	1 year	

GSS2 (Gas Engine No.4)

CH4 - Due to delay in calibration, the maximum permissible error of ±2.0% which is the equipment accuracy error was applied to CH4 from 08/03/2017 – 12/09/2017 as a conservative approach.

	<table><tr><th rowspan="2">Item</th><th colspan="2">$V_{CH4,m,db}$ ($W_{CH4,GSSF1,y}$)</th></tr><tr><th>01/06/2017 – 12/09/2017</th><th>13/09/2017 – 31/12/2017</th></tr><tr><td>Type</td><td colspan="2">Guardian Plus (97460)</td></tr><tr><td>Accuracy class</td><td colspan="2">± 2%</td></tr><tr><td>Serial No.</td><td colspan="2">33436</td></tr><tr><td>Calibration frequency</td><td colspan="2">Annually</td></tr><tr><td>Date of last calibration</td><td>07/06/2016</td><td>13/09/2017</td></tr><tr><td>Validity</td><td colspan="2">1 year</td></tr></table> **GSSF1 (Gas Engine No.1)** CH4 – Due to delay in calibration, the maximum permissible error of ±2.0% which is the equipment accuracy error was applied to CH4 from 07/06/2017 – 12/09/2017 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/parameter	Baseline emission calculation
Additional comment	-

Data / Parameter	**T_t ($T_{TT1,F1}$, $T_{TT1,F2}$, $T_{TT1,GSS1}$, $T_{TT1,GSS2}$, $T_{TT1,GSSF1}$)**
Unit	°C
Description	Temperature of the gaseous stream in time interval *t*
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) (28/08/2016 – 02/01/2017), Flare No.2 & Gas Engine No.1 (1 meter) (from 28/08/2016 – 31/05/2017), GSSF1 (1 meter) (01/06 – 31/12/2017) 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	T_t (°C)				
	$T_{TT1,F1}$	$T_{TT1,F2}$	$T_{TT1,GSS1}$	$T_{TT1,GSS2}$	$T_{TT1,GSSF1}$
28 – 31 Aug 16	0.00	38.92	49.82	43.67	
September 16	39.18	41.16	46.70	40.04	
October 16	37.32	42.35	45.44	44.21	
November 16	0.00	43.85	45.62	43.29	
December 16	0.00	44.40	46.78	37.74	
January 17		46.65	48.18	42.08	
February 17		43.56	42.41	29.39	
March 17		43.08	42.52	29.89	
April 17		42.66	45.35	44.12	
May 17		42.17	45.71	45.28	
June 17		36.85	44.23	44.19	42.28

	July 17		37.39	47.41	41.34	42.91
	August 17		35.88	49.14	41.37	42.92
	September 17		37.20	44.40	42.08	41.37
	October 17		38.86	48.72	43.68	43.70
	November 17		37.88	43.88	43.88	44.07
	December 17		37.98	45.96	44.89	44.75
	Average	**38.25**	**40.64**	**43.98**	**41.24**	**43.14**

Monitoring equipment

Item	**T_t ($T_{TT1,F1}$)**
	28/08/2016 – 03/01/2017
Type	PR Electronics (5335A) Temperature Transmitter
Accuracy class	≤ ± 0.05% of span
Serial No.	100944768
Calibration frequency	Annually
Date of last calibration	13/01/2016
Validity	1 year

Item	**T_t ($T_{TT1,F2}$)**	
	28/08/2016 – 12/09/2017	**13/09/2017 – 31/12/2017**
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	07/06/2016	13/09/2017
Validity	1 year	

Flare No.2

TT1 - Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to TT1 from 07/06/2017 – 12/09/2017 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	**T_t ($T_{TT1,GSS1}$)**	
	07/06/2016 – 12/09/2017	**13/09/2017 – 31/12/2017**
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	07/06/2016	13/09/2017
Validity	1 year	

GSS1 (Gas Engine No. 2 & 3)

TT1 - Due to delay in calibration, the maximum permissible error of ±1.0% which is the equipment accuracy error was applied to TT1 from 07/06/2017 – 12/09/2017 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

	<table><tr><th rowspan="2">Item</th><th colspan="2">T_t ($T_{TT1,GSS2}$)</th></tr><tr><th>28/08/2016 – 04/01/2017</th><th>05/01/2017 – 31/12/2017</th></tr><tr><td>Type</td><td colspan="2">Autrol (ATT2100-S11HA3E1-M1) Temperature Transmitter</td></tr><tr><td>Accuracy class</td><td colspan="2">± 0.1%</td></tr><tr><td>Serial No.</td><td colspan="2">ATT21004151000</td></tr><tr><td>Calibration frequency</td><td colspan="2">Annually</td></tr><tr><td>Date of last calibration</td><td>23/04/2015</td><td>05/01/2017</td></tr><tr><td>Validity</td><td colspan="2">1 year</td></tr></table> **GSS2 (Gas Engine No. 4)** TT1 - Due to delay in calibration, the maximum permissible error of ±0.13% which is the equipment accuracy error was applied to TT1 from 28/08/2016 – 04/01/2017 as a conservative approach. <table><tr><th rowspan="2">Item</th><th colspan="2">T_t ($T_{TT1,GSSF1}$)</th></tr><tr><th>03/01/2017 – 04/01/2017</th><th>05/01/2017 – 31/12/2017</th></tr><tr><td>Type</td><td colspan="2">PR Electronics (5335A) Temperature Transmitter</td></tr><tr><td>Accuracy class</td><td colspan="2">≤ ± 0.05% of span</td></tr><tr><td>Serial No.</td><td colspan="2">100944768</td></tr><tr><td>Calibration frequency</td><td colspan="2">Annually</td></tr><tr><td>Date of last calibration</td><td>13/01/2016</td><td>05/01/2017</td></tr><tr><td>Validity</td><td colspan="2">1 year</td></tr></table>
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/parameter	Baseline emission calculation
Additional comment	-

Data / Parameter	P_t ($P_{PT2,F1}$, $P_{PT2,F2}$, $P_{PT2,GSS1}$, $P_{PT2,GSS2}$, $P_{PT2,GSSF1}$)
Unit	kPa
Description	Pressure of the gaseous stream in time interval *t*
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)	P_t (kPa)				
	$PT_{PT2,F1}$	$PT_{PT2,F2}$	$PT_{PT2,GSS1}$	$PT_{PT2,GSS2}$	$PT_{PT2,GSSF1}$
28 – 31 Aug 16	0.00	6.21	16.13	15.82	
September 16	3.88	9.44	16.99	13.16	
October 16	2.29	9.53	17.00	16.69	
November 16	0.00	9.86	16.73	16.35	
December 16	0.00	10.01	16.96	10.82	
January 17		11.56	16.97	13.82	
February 17		10.55	15.47	2.39	
March 17		10.49	16.40	3.19	
April 17		10.11	16.98	15.61	
May 17		9.70	17.00	16.02	
June 17		5.20	16.98	15.84	12.44
July 17		4.00	16.99	13.36	12.84
August 17		2.55	16.96	13.13	13.41
September 17		4.32	14.82	16.16	11.73
October 17		5.21	16.89	16.76	14.85
November 17		4.47	16.67	16.75	16.67
December 17		3.91	17.02	16.97	14.95
Average	**3.08**	**7.48**	**16.64**	**13.70**	**13.84**

Absolute pressure (Months)	P_t (kPa)				
	$PT_{PT2,F1}$	$PT_{PT2,F2}$	$PT_{PT2,GSS1}$	$PT_{PT2,GSS2}$	$PT_{PT2,GSSF1}$
28 – 31 Aug 16	101.33	107.53	117.46	117.14	
September 16	105.20	110.77	118.32	114.49	
October 16	103.62	110.86	118.33	118.02	
November 16	101.33	111.19	118.05	117.68	
December 16	101.33	111.33	118.28	112.14	
January 17		112.89	118.30	115.15	
February 17		111.87	116.80	103.72	
March 17		111.81	117.73	104.52	
April 17		111.43	118.30	116.94	
May 17		111.02	118.32	117.34	
June 17		106.53	118.30	117.17	113.77
July 17		105.32	118.31	114.68	114.16

August 17		103.87	118.28	114.45	114.73
September 17		105.65	116.14	117.49	113.05
October 17		106.54	118.21	118.09	116.17
November 17		105.79	117.99	118.08	117.99
December 17		105.23	118.34	118.29	116.28
Average	**102.56**	**108.80**	**117.97**	**115.02**	**115.17**

Referring to the Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 3.0), 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	**P_t ($PT_{PT2,F1}$)**
	28/08/2016 – 03/01/2017
Type	Rosemount (3051TG1A2B21AB4E5M5Q4) Pressure Transmitter
Accuracy class	± 0.25%
Serial No.	02492864
Calibration frequency	Annually
Date of last calibration	13/01/2016
Validity	1 year

Item	**P_t ($PT_{PT2,F2}$)**	
	28/08/2016 – 12/09/2017	**13/09/2017 – 31/12/2017**
Type	Rosemount (3051TG1A2B21AB4E5Q4) Pressure Transmitter	
Accuracy class	± 0.25%	
Serial No.	5584784	
Calibration frequency	Annually	
Date of last calibration	07/06/2016	13/09/2017
Validity	1 year	

Flare No. 2

PT2 - Due to delay in calibration, the maximum permissible error of ±0.25% which is the equipment accuracy error was applied to PT2 from 07/06/2017 – 12/09/2017 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	**P_t ($PT_{PT2,GSS1}$)**	
	07/06/2016 – 12/09/2017	**13/09/2017 – 31/12/2017**
Type	Rosemount (3051TG1A2B21AB4K5M5) Pressure Transmitter	
Accuracy class	± 0.1%	
Serial No.	5916057	
Calibration frequency	Annually	
Date of last calibration	07/06/2016	13/09/2017
Validity	1 year	

GSS1 (Gas Engine No. 2 & 3)

PT2 - Due to delay in calibration, the maximum permissible error of ±0.1% which is the equipment accuracy error was applied to PT2 from 07/06/2017 – 12/09/2017 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	P_t ($PT_{PT2,GSS2}$)	
	28/08/2016 – 04/01/2017	**05/01/2017 – 31/12/2017**
Type	Atrol (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	05/01/2017
Validity	1 year	

GSS2 (Gas Engine No. 4)

PT2 - Due to delay in calibration, the maximum permissible error of ±0.4% which is the equipment accuracy error was applied to PT2 from 28/08/2016 – 04/01/2017 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	P_t ($PT_{PT2,GSSF1}$)	
	03/01/2017 – 04/01/2017	**05/01/2017 – 31/12/2017**
Type	Rosemount (3051TG1A2B21AB4E5M5Q4) Pressure Transmitter	
Accuracy class	± 0.25%	
Serial No.	02492864	
Calibration frequency	Annually	
Date of last calibration	13/01/2016	05/01/2017
Validity	1 year	

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/parameter	Baseline emission calculation
Additional comment	-

Data / Parameter	$P_{H2O,t,Sat}$
Unit	Pa
Description	Saturation pressure of H_2O at temperature T_t in time interval *t*
Measured/calculated/default	Calculated
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 03.0)
Value(s) of monitored parameter	**101,325 Pa**
Monitoring equipment	
Measuring/reading/recording frequency	-
Calculation method (if applicable)	This parameter is solely a function of a gaseous stream temperature T_t and can be found at reference [1] for a total pressure equal to 101,325 Pa
QA/QC procedures	-
Purpose of data/parameter	Baseline emissions calculation
Additional comment	[1] Fundamentals of Classical Thermodynamics; Gordon J. Van Wylen, Richard E. Sonntag and Borgnakke; 4º Edition 1994, John Wiley & Sons, Inc.

Data / Parameter	$V_{CO2,t,db}$
Unit	m^3 gas CO_2 / m^3 dry gas
Description	Volumetric fraction of greenhouse gas CO_2 in the gaseous stream in time interval *t* on a dry basis
Measured/calculated/default	Measured
Source of data	The V_{CO2} shall be measured manually with portable gas analyser. A minimum sampling frequency of one sample per week to be conducted. As conservative approach, the lower bound of the 95% Confidence Interval will be applied for the data collected.
Value(s) of monitored parameter	36.4%
Monitoring equipment	Portable gas analyser
Measuring/reading/recording frequency	Continuous if not specified in the underlying methodology/tool
Calculation method (if applicable)	Continuous gas analyser operating in dry-basis
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period
Purpose of data/parameter	Baseline emissions calculation
Additional comment	-

Data / Parameter	**$V_{O2,t,db}$**
Unit	m^3 gas O_2 / m^3 dry gas
Description	Volumetric fraction of greenhouse gas O_2 in the gaseous stream in time interval *t* on a dry basis
Measured/calculated/default	Measured
Source of data	On site measurement
Value(s) of monitored parameter	0.95%
Monitoring equipment	Continuous gas analyser operating in dry-basis
Measuring/reading/recording frequency	Continuous if not specified in the underlying methodology/tool
Calculation method (if applicable)	-
QA/QC procedures	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period
Purpose of data/parameter	Baseline emissions calculation
Additional comment	-

Data / Parameter	**Status of biogas destruction device**
Unit	-
Description	Operational status of biogas destruction devices
Measured/calculated/default	Measured
Source of data	On-site measurement
Value(s) of monitored parameter	On or Off, refer to $V_{t,wb}$ and operating hour of Gas engines ($\mathbf{Op_{j,h}}$).
Monitoring equipment	Monitoring and documenting may be undertaken by recording the energy production from methane captured or the operation of the flare by means of a flame detector to demonstrate the actual destruction of methane, unless a different method is specified in the underlying methodology/tool. Emission reductions will not accrue for periods in which the destruction device is not operational
Measuring/reading/recording frequency	Continuous if not specified in the underlying methodology/tool
Calculation method (if applicable)	N/A
QA/QC procedures	The operational status will be monitored and cross checked with the amount of gas sent to flare (FT2), and also the operating hour for Gas Engines.
Purpose of data/parameter	Baseline emissions calculation
Additional comment	For flame detector devices, refer to the methodological tool “Project emissions from flaring”

"Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (Version 02)

Data / Parameter	**$FC_{i,j,y}$**
Unit	ton/yr
Description	Quantity of fuel type i combusted in process j during the year y
Measured/calculated/default	Measured
Source of data	Onsite measurements
Value(s) of monitored parameter	2016 - 0.11 ton/yr 2017 – 0.27 ton/yr
Monitoring equipment	Fuel meter
Measuring/reading/recording frequency	Continuously
Calculation method (if applicable)	The measurement from fuel meter is in litre, for the calculation, the amount of diesel in litre will be convert to tonne/year by multiply the density of diesel (kg/l)
QA/QC procedures	The consistency of metered fuel consumption quantities should be cross-checked by an annual energy balance that is based on purchased quantities and stock changes. Where the purchased fuel invoices can be identified specifically for the CDM project, the metered fuel consumption quantities should also be cross-checked with available purchase invoices from the financial records
Purpose of data/parameter	Project emissions calculation
Additional comment	-

Data / Parameter	**$EFCO_{2,i,y}$**
Unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of fuel type i in year y
Measured/calculated/default	Default (Option D was applied in the calculation)
Source of data	Option A will be used if the value is available from the fuel supplier in invoices; Option D will be used if there is no data available from the fuel supplier.
Value(s) of monitored parameter	0.0741
Monitoring equipment	-
Measuring/reading/recording frequency	If the values are provided by fuel supplier, the measurements should be undertaken in line with national or international fuel standards. If the value is according to IPCC default value, any future revision of the IPCC Guidelines should be taken into account.
Calculation method (if applicable)	For a): The CO_2 emission factor should be obtained for each fuel delivery, from which weighted average annual values should be calculated For d): Any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures	-
Purpose of data/parameter	Project emissions calculation
Additional comment	Option D is applied

Data / Parameter	$NCV_{i,y}$
Unit	GJ/ton
Description	Weighted average net calorific value of fuel type i in year y
Measured/calculated/default	Default (Option D was applied in the calculation)
Source of data	Option A will be used if the value is available from the fuel supplier in invoices; Option D will be used if there is no data available from the fuel supplier.
Value(s) of monitored parameter	43
Monitoring equipment	-
Measuring/reading/recording frequency	For a): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For d): Any future revision of the IPCC Guidelines should be taken into account
Calculation method (if applicable)	For a): The NCV emission factor should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For d): Any future revision of the IPCC Guidelines should be taken into account
QA/QC procedures	If option A value is used for the calculation, verify if the values under a) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a) should have ISO17025 accreditation or justify that they can comply with similar quality standards.
Purpose of data/parameter	Project emissions calculation
Additional comment	-

D.3 Implementation of sampling plan

Not applicable

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

The total baseline emissions according to ACM0001 (Version 18.0) were calculated according to the equations below:

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$

BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (t CO_2e/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year *y* (t CO_2/yr)
$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (t CO_2/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (t CO_2/yr)

$$BE_{CH4} = \left(\left(1 - OX_{top\_layer}\right) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$$

$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (t CO_2e/yr)
OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

$$F_{CH4,PJ,y} = \eta_{PJ} \times BE_{CH4,SWDS,y}/GWP_{CH4}$$

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$BE_{CH4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (t CO_2e/yr)
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

$$BE_{CH4,SWDS,y} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^{y} \sum_{j} \left(W_{j,x} \times DOC_j \times e^{-k_j \times (y-x)} \times (1 - e^{-k_j}) \right)$$

$BE_{CH4,SWDS,y}$ $PE_{CH4,SWDS,y}$ $LE_{CH4,SWDS,y}$	=	Baseline, project or leakage methane emissions occurring in year *y* generated from waste disposal at a SWDS during a time period ending in year *y* (t CO_2e/yr)
x	=	Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (x = 1) to year *y* (x = *y*)
y	=	Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)
$DOC_{f,y}$	=	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)
$W_{j,x}$	=	Amount of solid waste type *j* disposed or prevented from disposal in the SWDS in the year *x* (t)

$$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$$

$F_{CH4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year *y* (t CO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

Baseline emissions associated with electricity generation ($BE_{EC,y}$)

$$BE_{EC,y} = \sum_{k} EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y})$$

$BE_{EC,y}$	=	Baseline emissions from electricity consumption in year *y* (t CO_2 / yr)
$EC_{BL,k,y}$	=	Quantity of electricity that would be consumed by the baseline electricity consumer *k* in year *y* (MWh/yr)
$EF_{EF,k,y}$	=	Emission factor for electricity generation for source *k* in year *y* (t CO_2/MWh)
$TDL_{k,y}$	=	Average technical transmission and distribution losses for providing electricity to source *k* in year *y*
k	=	Sources of electricity consumption in the baseline

Determination of $BE_{CH4,y}$

Flare No.1

Month	$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$							$F_{CH4,PJ,y} = F_{CH4,flared,y}$	$BE_{CH4} = \left((1 - OX_{top\_layer}) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$		$BE_y = BE_{CH4,y}$
	Quantity of LFG to Flare No.1	Methane average fraction Flare No.1	Density of Methane Flare No.1	Amount of methane in LFG sent to flare	Project emissions from flaring of residual gas stream	Global Warming Potential Flare No.2	Amount of methane in LFG destroyed by flaring	Amount of methane in LFG flared/used in project activity	Fraction of oxidised methane in LFG in top layer of SWDS in baseline	Baseline emissions of methane from SWDS	Total Baseline Emissions Flare No.1
	FT2 Flare No.1,y (Nm^3)	W_{CH4}	D_{CH4} (t/Nm^3)	$F_{CH4,sent\_flare}$ (t_{CH4})	PE_{flare} (tCO_2e)	GWP_{CH4} (tCO_2e/tCH_4)	$F_{CH4,flared}$ (tCH_4)	$F_{CH4,PJ}$ (tCH_4)	OX_{top_layer}	BE_{CH4} (tCO_2e)	BE_y (tCO_2e)
Aug-16	0.00	0.00	0.0007157	0.00	0.00	25	0.00	0.00	0.10	0.00	0.00
Sep-16	278,710.26	0.56	0.0007157	112.04	293.78	25	100.29	100.29	0.10	2,256.44	2,256.44
Oct-16	134,282.46	0.52	0.0007157	50.42	146.85	25	44.55	44.55	0.10	1,002.29	1,002.29
Nov-16	0.00	0.00	0.0007157	0.00	0.00	25	0.00	0.00	0.10	0.00	0.00
Dec-16	0.00	0.00	0.0007157	0.00	0.00	25	0.00	0.00	0.10	0.00	0.00

Flare No.2

Month	$F_{CH4,flared,y} = F_{CH4,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$							$F_{CH4,EL,y}$				$F_{CH4,PJ,y}$	$BE_{CH4} = \left((1 - OX_{top\_layer}) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$	
	Quantity of LFG to Flare No.2	Methane average fraction Flare No.2	Density of Methane Flare No.2	Amount of methane in LFG sent to Flare No.2	Project emissions from flaring of residual gas stream	Global Warming Potential Flare No.2	Amount of methane in LFG destroyed by flaring	Quantity of Landfill Gas Fed into the GE1	Average methane fraction of the Landfill Gas Fed into the GE1	Density of Methane GE1	Amount of methane in the LFG which is used for electricity generation	Amount of methane in LFG flared/used in project activity	Fraction of oxidised methane in LFG in top layer of SWDS in baseline	Baseline emissions of methane from SWDS
	FT2 Flare No.2,y (Nm^3)	W_{CH4}	D_{CH4} (t/Nm^3)	$F_{CH4,sent\_flare}$ (t_{CH4})	PE_{flare} (tCO_2e)	GWP_{CH4} (tCO_2e/tCH_4)	$F_{CH4,flared}$ (tCH_4)	FT3 LFG electricity,y (m^3 LFG)	W_{CH4}	D_{CH4} (t/Nm^3)	$F_{CH4,EL}$ (tCH_4)	$F_{CH4,PJ}$ (tCH_4)	OX_{top_layer}	BE_{CH4} (tCO_2e)
Aug-16	108,372.42	0.58	0.0007157	44.88	112.52	25	40.38	16,184.60	0.58	0.0007157	6.70	47.08	0.10	1,059.29
Sep-16	939,602.06	0.57	0.0007157	386.42	1,043.10	25	344.70	216,129.20	0.57	0.0007157	88.89	433.58	0.10	9,755.61
Oct-16	1,071,474.56	0.55	0.0007157	420.82	1,052.06	25	378.74	281,984.29	0.55	0.0007157	110.75	489.49	0.10	11,013.51
Nov-16	1,099,083.63	0.58	0.0007157	458.99	1,187.60	25	411.48	293,914.17	0.58	0.0007157	122.74	534.23	0.10	12,020.08
Dec-16	1,179,666.89	0.63	0.0007157	530.37	1,338.07	25	476.85	144,780.70	0.63	0.0007157	65.09	541.94	0.10	12,193.60
Jan-17	1,265,086.53	0.60	0.0007157	541.18	1,351.23	25	487.13	311,399.80	0.60	0.0007157	133.21	620.34	0.10	13,957.69
Feb-17	1,099,138.18	0.62	0.0007157	488.97	1,461.53	25	430.51	283,119.20	0.62	0.0007157	125.95	556.46	0.10	12,520.40
Mar-17	1,204,190.34	0.61	0.0007157	526.27	1,359.92	25	471.87	306,670.13	0.61	0.0007157	134.03	605.90	0.10	13,632.75
Apr-17	1,140,705.62	0.59	0.0007157	485.09	1,227.75	25	435.98	304,326.56	0.59	0.0007157	129.42	565.40	0.10	12,721.52
May-17	1,149,632.68	0.59	0.0007157	486.32	1,238.41	25	436.78	300,433.43	0.59	0.0007157	127.09	563.87	0.10	12,687.14
Jun-17	813,204.95	0.61	0.0007157	353.84	906.12	25	317.60	GE 1 converted to GSSF1				317.60	0.10	7,145.95
Jul-17	699,127.72	0.58	0.0007157	291.67	784.05	25	260.31					260.31	0.10	5,856.95
Aug-17	532,577.25	0.59	0.0007157	226.34	626.21	25	201.29					201.29	0.10	4,529.00
Sep-17	681,666.07	0.60	0.0007157	294.69	761.48	25	264.23					264.23	0.10	5,945.09
Oct-17	775,484.65	0.60	0.0007157	331.79	832.04	25	298.51					298.51	0.10	6,716.50
Nov-17	678,593.45	0.61	0.0007157	295.79	1,764.25	25	225.22					225.22	0.10	5,067.37
Dec-17	615,608.99	0.61	0.0007157	267.20	683.45	25	239.87					239.87	0.10	5,396.98

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 (28 Aug 2016 – 31 May 2017). Details on how the comparison was made and which values were used are explained in Section D.2 above for the parameters $V_{t,wb}$.

GSS1

$$BE_{CH4} = \left((1 - OX_{top\_layer}) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$$

Month	Density of Methane GSS1 DCH4 (t/Nm3)	Quantity of Landfill Gas Fed into GSS1 FT3 LFG electricity,y (m^3 LFG)	Average methane fraction of the Landfill Gas Fed into GSS1 W_{CH_4}	Amount of methane in LFG used for electricity generation GSS1 $F_{CH4,EL}$ (tCH_4)	Amount of methane in LFG flared/used in project activity GSS1 $F_{CH4,PJ}$ (tCH_4)	Global Warming Potential GSS1 GWP_{CH4} (tCO_2e/tCH_4)	Fraction of oxidised methane in LFG in top layer of SWDS in baseline, GSS1 OX_{top_layer}	Baseline emissions of methane from SWDS GSS1 BE_{CH4} (tCO_2e)
Aug-16	0.0007157	57,874.48	0.65	27.09	27.09	25	0.10	609.50
Sep-16	0.0007157	680,283.92	0.66	319.87	319.87	25	0.10	7,197.01
Oct-16	0.0007157	622,492.21	0.65	288.92	288.92	25	0.10	6,500.61
Nov-16	0.0007157	714,667.21	0.61	311.42	311.42	25	0.10	7,006.96
Dec-16	0.0007157	788,952.33	0.61	343.65	343.65	25	0.10	7,732.02
Jan-17	0.0007157	844,975.17	0.58	351.78	351.78	25	0.10	7,915.07
Feb-17	0.0007157	208,529.63	0.63	94.55	94.55	25	0.10	2,127.41
Mar-17	0.0007157	463,281.78	0.61	201.41	201.41	25	0.10	4,531.82
Apr-17	0.0007157	719,779.88	0.59	305.51	305.51	25	0.10	6,873.99
May-17	0.0007157	749,997.52	0.61	328.17	328.17	25	0.10	7,383.87
Jun-17	0.0007157	621,518.84	0.55	242.66	242.66	25	0.10	5,459.84
Jul-17	0.0007157	764,345.57	0.52	283.96	283.96	25	0.10	6,389.12
Aug-17	0.0007157	790,027.30	0.52	295.49	295.49	25	0.10	6,648.55
Sep-17	0.0007157	493,869.00	0.52	185.03	185.03	25	0.10	4,163.26
Oct-17	0.0007157	385,826.76	0.52	143.46	143.46	25	0.10	3,227.79
Nov-17	0.0007157	408,045.94	0.63	182.77	182.77	25	0.10	4,112.24
Dec-17	0.0007157	525,769.27	0.66	247.77	247.77	25	0.10	5,574.83

GSS2

$$BE_{CH4} = \left((1 - OX_{top\_layer}) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$$

Month	Density of Methane GSS2 DCH4 (t/Nm3)	Quantity of Landfill Gas Fed into the GSS2 FT3 LFG electricity,y (m^3 LFG)	Average methane fraction of the Landfill Gas Fed into the GSS2 W_{CH4}	Amount of methane in LFG used for electricity generation GSS2 $F_{CH4,EL}$ (tCH_4)	Amount of methane in LFG flared/used in project activity GSS2 $F_{CH4,PJ}$ (tCH_4)	Global Warming Potential GSS2 GWP_{CH4} (tCO_2e/tCH_4)	Fraction of oxidised methane in LFG in top layer of SWDS in baseline GSS2 OX_{top_layer}	Baseline emissions of methane from SWDS GSS2 BE_{CH4} (tCO_2e)
Aug-16	0.0007157	59,400.96	0.63	26.76	26.76	25	0.1	602.13
Sep-16	0.0007157	293,501.07	0.62	130.80	130.80	25	0.1	2,943.05
Oct-16	0.0007157	436,014.11	0.63	195.16	195.16	25	0.1	4,391.09
Nov-16	0.0007157	409,853.80	0.63	185.67	185.67	25	0.1	4,177.53
Dec-16	0.0007157	264,242.61	0.63	119.13	119.13	25	0.1	2,680.46
Jan-17	0.0007157	328,275.25	0.61	143.18	143.18	25	0.1	3,221.48
Feb-17	0.0007157	0.00	0.00	0.00	0.00	25	0.1	0.00
Mar-17	0.0007157	0.00	0.00	0.00	0.00	25	0.1	0.00
Apr-17	0.0007157	111,615.97	0.60	48.09	48.09	25	0.1	1,081.97
May-17	0.0007157	462,997.30	0.61	201.92	201.92	25	0.1	4,543.15
Jun-17	0.0007157	405,380.77	0.57	164.34	164.34	25	0.1	3,697.71
Jul-17	0.0007157	293,888.27	0.52	110.16	110.16	25	0.1	2,478.54
Aug-17	0.0007157	285,319.24	0.59	120.39	120.39	25	0.1	2,708.74
Sep-17	0.0007157	368,955.39	0.62	164.14	164.14	25	0.1	3,693.18
Oct-17	0.0007157	515,734.20	0.56	206.85	206.85	25	0.1	4,654.11
Nov-17	0.0007157	488,298.57	0.56	195.20	195.20	25	0.1	4,392.10
Dec-17	0.0007157	495,097.87	0.54	192.88	192.88	25	0.1	4,339.71

GSSF1

$$BE_{CH4} = \left((1 - OX_{top\_layer}) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4}$$

Month	Density of Methane GSSF1 DCH4 (t/Nm3)	Quantity of Landfill Gas Fed into GSSF1 FT3 LFG electricity,y (m^3 LFG)	Average methane fraction of the Landfill Gas Fed into GSSF1 W_{CH_4}	Amount of methane in LFG used for electricity generation GSSF1 $F_{CH4,EL}$ (tCH_4)	Amount of methane in LFG flared/used in project activity GSSF1 $F_{CH4,PJ}$ (tCH_4)	Global Warming Potential GSSF1 GWP_{CH4} (tCO_2e/tCH_4)	Fraction of oxidised methane in LFG in top layer of SWDS in baseline, GSSF1 OX_{top_layer}	Baseline emissions of methane from SWDS GSSF1 BE_{CH4} (tCO_2e)
Jun-17	0.0007157	296,513.53	0.62	131.03	131.03	25	0.10	2,948.10
Jul-17	0.0007157	317,033.54	0.57	128.25	128.25	25	0.10	2,885.57
Aug-17	0.0007157	293,189.81	0.56	118.48	118.48	25	0.10	2,665.88
Sep-17	0.0007157	234,272.71	0.56	93.34	93.34	25	0.10	2,100.06
Oct-17	0.0007157	278,138.49	0.57	113.49	113.49	25	0.10	2,553.58
Nov-17	0.0007157	252,797.78	0.59	107.61	107.61	25	0.10	2,421.27
Dec-17	0.0007157	253,422.60	0.58	105.59	105.59	25	0.10	2,375.78

Determination of $BE_{EC,y}$

Flare No.2

$$BE_{EC,y} = \sum_k EC_{BL,k,y} \times EF_{EF,k,y} \times \left(1 + TDL_{k,y}\right)$$

$$BE_y = BE_{CH4,y} + BE_{EC,y}$$

Month	Quantity of electricity consumed $EC_{BL,k}$ (MWh)	Emission factor for electricity generation $EF_{EL,k}$ (tCO_2/MWh)	Average technical transmission and distribution losses TDL_k (%)	Baseline emission for electricity $BE_{EC,y}$ (tCO_2)	Total Baseline Emission Flare No.2 & GE 1 BE_y (tCO_2e)
Aug-16	46.80	0.7146	0.0739	35.91	1,095.21
Sep-16	370.62	0.7146	0.0739	284.42	10,040.03
Oct-16	389.50	0.7146	0.0739	298.90	11,312.41
Nov-16	522.03	0.7146	0.0739	400.61	12,420.69
Dec-16	596.79	0.7146	0.0739	457.98	12,651.58
Jan-17	570.81	0.7146	0.0774	439.47	14,397.17
Feb-17	535.19	0.7146	0.0774	412.05	12,932.44
Mar-17	566.09	0.7146	0.0774	435.84	14,068.58
Apr-17	547.07	0.7146	0.0774	421.20	13,142.72
May-17	557.85	0.7146	0.0774	429.49	13,116.64
Jun-17	GE1 converted to GSSF1				7,145.95
Jul-17					5,856.95
Aug-17					4,529.00
Sep-17					5,945.09
Oct-17					6,716.50
Nov-17					5,067.37
Dec-17					5,396.98

GSS1

$$BE_{EC,y} = \sum_{k} EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y})$$

Month	Quantity of electricity generated GSS 1 $EC_{BL,k}$ (MWh)	Emission factor for electricity generation GSS1 $FE_{EL,k}$ (tCO_2/MWh)	Average technical transmission and distribution losses GSS1 TDL_k	Baseline emission for electricity GSS1 $BE_{EC,y}$ (tCO_2)
Aug-16	112.65	0.7146	0.0739	86.45
Sep-16	1,194.34	0.7146	0.0739	916.55
Oct-16	1,061.80	0.7146	0.0739	814.83
Nov-16	1,273.31	0.7146	0.0739	977.15
Dec-16	1,425.15	0.7146	0.0739	1,093.68
Jan-17	1,424.88	0.7146	0.0774	1,097.03
Feb-17	656.41	0.7146	0.0774	505.38
Mar-17	791.01	0.7146	0.0774	609.01
Apr-17	1,192.14	0.7146	0.0774	917.84
May-17	1,280.54	0.7146	0.0774	985.90
Jun-17	1,058.91	0.7146	0.0774	815.26
Jul-17	1,197.51	0.7146	0.0774	921.98
Aug-17	1,399.88	0.7146	0.0774	1,077.78
Sep-17	944.59	0.7146	0.0774	727.25
Oct-17	683.16	0.7146	0.0774	525.97
Nov-17	683.16	0.7146	0.0774	525.97
Dec-17	1,006.86	0.7146	0.0774	775.19

GSS2

$$BE_{EC,y} = \sum_{k} EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y})$$

Month	Quantity of electricity generated GSS 2 $EC_{BL,k}$ (MWh)	Emission factor for electricity generation GSS2 $EF_{EL,k}$ (tCO_2/MWh)	Average technical transmission and distribution losses GSS2 TDL_k	Baseline emission for electricity GSS2 $BE_{EC,y}$ (tCO_2)
Aug-16	139.25	0.7146	0.0739	106.860
Sep-16	590.25	0.7146	0.0739	452.960
Oct-16	918.02	0.7146	0.0739	704.495
Nov-16	940.82	0.7146	0.0739	721.995
Dec-16	517.13	0.7146	0.0739	396.854
Jan-17	706.03	0.7146	0.0774	543.580
Feb-17	0.01	0.7146	0.0774	0.008
Mar-17	0.00	0.7146	0.0774	0.000
Apr-17	308.01	0.7146	0.0774	237.140
May-17	1,012.37	0.7146	0.0774	779.433
Jun-17	897.65	0.7146	0.0774	691.111
Jul-17	581.14	0.7146	0.0774	447.422
Aug-17	598.14	0.7146	0.0774	460.510
Sep-17	767.14	0.7146	0.0774	590.625
Oct-17	1,082.55	0.7146	0.0774	833.468
Nov-17	1,048.84	0.7146	0.0774	807.510
Dec-17	1,096.39	0.7146	0.0774	844.120

GSSF1

Month	$BE_{EC,y} = \sum_k EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y})$			
	Quantity of electricity generated GSSF1 ECBL,k (MWh)	Emission factor for electricity generation GSSF1 EFEL,k (tCO_2/MWh)	Average technical transmission and distribution losses GSSF1 TDLk	Baseline emission for electricity GSSF1 BEEC,y (tCO_2)
Jun-17	578.91	0.7146	0.0774	445.71
Jul-17	586.52	0.7146	0.0774	451.57
Aug-17	534.98	0.7146	0.0774	411.88
Sep-17	415.05	0.7146	0.0774	319.55
Oct-17	475.49	0.7146	0.0774	366.08
Nov-17	440.05	0.7146	0.0774	338.80
Dec-17	443.58	0.7146	0.0774	341.52

For this project, the following applies:

1. The grid connected baseline 2014 for Peninsula Malaysia was applied to this project and the $EF_{EF,k,y}$ was recalculated to be 0.7146tCO_2/MWh (applied from 28/08/2016 – 31/12/2017) using the latest release of grid emission factor published by Green Tech Centre (GTC) CDM Secretariat, based on the "Tool to calculate the emission factor for an electricity system" (Version 5.0).
2. With reference to ACM0001, Version 18.0, page 21, $\boldsymbol{EC_{BL,k,y}}$ is equivalent to the net amount of electricity generated using LFG in year *y* ($\boldsymbol{EG_{PJ,y}}$). $\boldsymbol{EF_{EL,k,y} = EF_{grid,CM,y}}$ *and therefore*, $\boldsymbol{BE_{EC,y} = \sum EG_{PJ,y} \times EF_{grid,CM,y} \times (1 + TDL_{k,y})}$.
3. 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).

Total baseline emissions

$BE_y = BE_{CH4,y} + BE_{EC,y}$

Month	$BE_{CH4,y}$					$BE_{EC,y}$				Total BE_y
	Flare No.1	Flare No.2	GSS1	GSS2	GSSF1	Flare No.2	GSS1	GSS2	GSSF1	
28/8/2016[1]	0	1,059	609	602	**Commissioned on 1/6/2017**	35	86	106	**Commissioned on 1/6/2017**	2,497
Sep-16	2,256	9,755	7,197	2,943		284	916	452		23,803
Oct-16	1,002	11,013	6,500	4,391		298	814	704		24,722
Nov-16	0	12,020	7,006	4,177		400	977	721		25,301
Dec-16	0	12,193	7,732	2,680		457	1,093	396		24,551
Jan-17	**Decommissioned on 3/1/2017**	13,957	7,915	3,221		439	1,097	543		27,172
Feb-17		12,520	2,127	0		412	505	0		15,564
Mar-17		13,632	4,531	0		435	609	0		19,207
Apr-17		12,721	6,873	1,081		421	917	237		22,250
May-17		12,687	7,383	4,543		429	985	779		26,806
Jun-17		7,145	5,459	3,697	2,948	**Conversion to GSSF1**	815	691	445	21,200
Jul-17		5,856	6,389	2,478	2,885		921	447	451	19,427
Aug-17		4,529	6,648	2,708	2,665		1,077	460	411	18,498
Sep-17		5,945	4,163	3,693	2,100		727	590	319	17,537
Oct-17		6,716	3,227	4,654	2,553		525	833	366	18,874
Nov-17		5,067	4,112	4,392	2,421		525	807	338	17,662
Dec-17		5,396	5,574	4,339	2,375		775	844	341	19,644
Total	**3,258**	**152,211**	**93,445**	**49,599**	**17,947**	**3,610**	**13,364**	**8,610**	**2,671**	**344,715**

Note: The Baseline Emission figure has been rounded down for conservativeness

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

The total project emissions according to ACM0001 (Version 18.0) were estimated according to the equations below:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} + PE_{SP,y}$$

PE_y	=	Project emissions in year *y* (t CO_2/yr)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year *y* (t CO_2/yr)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (t CO_2/yr)
$PE_{DT,y}$	=	Emissions from the distribution of compressed/liquefied LFG using trucks, in year *y* (t CO_2/yr)
$PE_{SP,y}$	=	Emissions from the supply of LFG to consumers through a dedicated pipeline, in year *y* (t CO_2/yr)

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y})$$

$PE_{EC,y}$	=	Project emissions from electricity consumption in year *y* (t CO_2 / yr)
$EC_{PJ,j,y}$	=	Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh/yr)
$EF_{EF,j,y}$	=	Emission factor for electricity generation for source *j* in year *y* (t CO_2/MWh)
$TDL_{j,y}$	=	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
j	=	Sources of electricity consumption in the project

Month	Electricity consumed by project activity $EG_{EC,y}$ (MWh)	Coefficient for grid electricity $EF_{grid,y}$	Transmission and Distribution Losses TDL,y	Total Project Emission for electricity consumed from project activity (tCO2e)
Aug-16	23.70	0.7146	0.0739	18.19
Sep-16	171.21	0.7146	0.0739	131.39
Oct-16	206.70	0.7146	0.0739	158.62
Nov-16	201.87	0.7146	0.0739	154.92
Dec-16	193.17	0.7146	0.0739	148.24
Jan-17	208.61	0.7146	0.0774	160.61
Feb-17	106.17	0.7146	0.0774	81.74
Mar-17	120.22	0.7146	0.0774	92.56
Apr-17	169.19	0.7146	0.0774	130.26
May-17	212.24	0.7146	0.0774	163.41
Jun-17	195.38	0.7146	0.0774	150.42
Jul-17	205.90	0.7146	0.0774	158.52
Aug-17	211.14	0.7146	0.0774	162.56
Sep-17	178.91	0.7146	0.0774	137.74
Oct-17	174.04	0.7146	0.0774	133.99
Nov-17	166.22	0.7146	0.0774	127.98
Dec-17	197.98	0.7146	0.0774	152.43

For this project, the following applies:

1. The grid connected baseline 2014 for Peninsula Malaysia was applied to this project and the $EF_{EF,j,y}$ was recalculated to be 0.7146 tCO_2/MWh (applied from 28/08/2016 – 31/12/2017) using the latest release of grid emission factor published by Green Tech Centre (GTC) CDM Secretariat, based on the "Tool to calculate the emission factor for an electricity system" (Version 5.0).
2. TDL = 7.74% adopted as stated in the registered PDD, version 20.5 page 54 (TNB annual report 2016[7]).

$PE_{FC,j,y}$, for this project, is the emission from diesel backup generators. During the monitoring period, the diesel consumption is consumed for the monthly testing purposes.

Month	Quantity of diesel combusted (Liter)	Diesel Density (kg/l)	Quantity of diesel combusted (t/month)	$COEF_{diesel,y} = NCV_{diesel,j} \times EF_{CO2,diesel,y}$			Total Project Emission from fossil fuel combustion from project activity
				Weighted average net calorific value of diesel (GJ/t)	Weighted average CO_2 emission factor of diesel	CO_2 emission coefficient of diesel (tCO_2/mass of volume unit)	
			FC_{diesel}	$NCV_{diesel,j}$	$EF_{CO2,diesel,y}$	$COEF_{diesel,y}$	(tCO2e)
Aug-16	26.9	0.84	0.02	43	0.0741	3.19	0.07
Sep-16	26.9	0.84	0.02	43	0.0741	3.19	0.07
Oct-16	26.9	0.84	0.02	43	0.0741	3.19	0.07
Nov-16	26.9	0.84	0.02	43	0.0741	3.19	0.07
Dec-16	26.9	0.84	0.02	43	0.0741	3.19	0.07
Jan-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Feb-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Mar-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Apr-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
May-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Jun-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Jul-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Aug-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Sep-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Oct-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Nov-17	26.9	0.84	0.02	43	0.0741	3.19	0.07
Dec-17	26.9	0.84	0.02	43	0.0741	3.19	0.07

Total Project Emissions

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

Month	PE_{EC}	PE_{FC}	Total PE_y
28/8/2016[1]	19	1	20
Sep-16	132	1	133
Oct-16	159	1	160
Nov-16	155	1	156
Dec-16	149	1	150
Jan-17	161	1	162
Feb-17	82	1	83
Mar-17	93	1	94
Apr-17	131	1	132
May-17	164	1	165
Jun-17	151	1	152
Jul-17	159	1	160
Aug-17	163	1	164
Sep-17	138	1	139
Oct-17	134	1	135
Nov-17	128	1	129
Dec-17	153	1	154
Total	**2,271**	**17**	**2,288**

Note: The Project Emission has been rounded up for conservativeness

[7] https://www.tnb.com.my/assets/annual_report/TNB_Annual_Report_2016.pdf

E.3. Calculation of leakage emissions

No leakage emissions.

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

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	**344,715**	**2,288**	**0**	**Not applicable**	**342,427**	**342,427**

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

Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante (t CO_2e)
342,427	**364,568**[8]

E.6. Remarks on increase in achieved emission reductions

The total CERs claimed in the 1st monitoring period of the 2nd crediting period was 6.1% lower as compared to the value reported in the ex-ante calculations.

The total decrease of 6.1% is due to the following reasons:

1. Flare No.1 stopped operation and is converted to GSS F1 which starts operation on 01/06/2017.
2. The operating hour of gas engines are lesser compared to as estimated in PDD, due to a few major shutdowns throughout the year.

[8] Calculated from PDD version 20.5 dated 02/03/2018.

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

Date	Time		Problem Description	Remarks
	Shut Down	Restart		
01/09/2016	00:00	09:55	Proper shutdown - to do testing on Gas EXTRACTION. GSS 1 PT 1 high.	
18/09/2016	11:53	19/09/2016 10:49	Proper shutdown - Oz high. To check on Gas Quality at Phase 1, 2A, 2B.	
19/09/2016	14:22	14:43	Main Flame not detected	
23/09/2016	12:18	28/09/2016 09:30	Proper shutdown to test solenoid valve.	
05/10/2016	20:06	22:00	Oz above danger set point.	
10/10/2016	14:26	27/10/2016 9:36	Proper shutdown - Oz high.	
27/10/2016	12:24	31/10/2016 23:59	Proper shutdown - Oz high.	
01/11/2016	0:00	30/11/2016 23:59	Proper shutdown – Oz high.	
01/12/2016	0:00	31/12/2016 23:59	O2 above danger set point	Free run 5Hz Flare 1
03/01/2017	10:00		Flare 1 permanent shutdown for landfill gas optimisation plan, Flare No. 1 convert to GSSF1	

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

Date	Time		Problem Description	Remarks
	Shut Down	Restart		
31/08/2016	16:57	17:05	Power Surge - TNB.	
	18:56	19:01	Power Surge - TNB.	
18/09/2016	11:53	19/09/2016 10:49	To Service blower # 2 by Hydrocare - bearing damage.	
03/11/2016	18:29	20:39	- TNB Power Surge. Site total shutdown.	
23/11/2016	08:32	18:26	- Proper shutdown - request by Chen Guan for upgrading II KV MV panel. 1 - to coupling 2 numbers new II KV MV panel. 2 - to coupling 1 numbers existing II KV MV panel. 3 - to provide breaker insulation test and relay setting.	
24/11/2016	16:54	17:02	- Power Surge - few seconds. GSS 2 trip.	
28/11/2016	23:07	23:25	- TNB Power Surge few seconds. Blower #1 and #2 trip.	
14/12/2016	9:20	15:30	Proper shutdown requested by Chen Guan	Restart Flare 2
26/12/2016	18:57	19:07	Power surge. Blower 1 and 2 trip	Restart Flare 2
05/01/2017	12:01	13:02	Proper shutdown for CDM equipment calibration by Nectar – FT3, CH4.	Restart Flare 2
31/01/2017	13:45	17:13	Proper shutdown due to TNB upgrading works at PPU.	Restart Flare 2
22/02/2017	17:37	18:31	Power surge. Blower #1 and 2 tripped. Reset	Restart Flare 2
23/02/2017	17:45	19:14	Power surge few seconds	Restart Flare 2
24/02/2017	10:32	11:40	Proper shut down for maintenance and wiring for network switch	Restart Flare 2
02/03/2017	16:48	16:53	TNB power surge	
06/03/2017	07:46	21:32	Proper shutdown for GBS pipe connection to main gas pipe. 2 main pipe connection	

Date	Time		Problem Description	Remarks
	Shut Down	Restart		
			location: Ph 1 and Ph 2A. Chamber and corner near GBS station	
07/03/2017	14:35	17:29	Proper shutdown for purging Gas Booster station new pipe line	
16/04/2017	16:59	17:11	Power surge. Blower #1 and #2 tripped.	Restart Flare 2
13/06/2017	22:00	22:26	UPS Faulty – Swap UPS F2 with computer 1.	
02/07/2017	08:12	12:59	- Power Surge	
03/07/2017	15:07	15:38	- Check Blower 2#.	
10/07/2017	10:15	11:39	- Proper shutdown - to dismantled blower # 2 by Hydrocare. Blower Jammed.	
17/07/2017	14:44	14:48	- Proper shutdown - PTI high. GBS shutdown for testing SMS.	
17/08/2017	12:18	13:49	- Proper shutdown - to do ATS riring work's (power from standby Genset to DG Room).	
13/09/2017	14:55	17:28	- Proper shutdown, for CDM Equipment calibration work's - by Nectar. ① TT1, ② TT3,③ PT2,④ FT1,⑤ FT2.	
23/09/2017	10:34	13:50	- TNB POWER failure.	
	16:03	16:16	- Proper shutdown - to normalize system using TNB power supply.	
26/09/2017	15:02	16:06	- Proper shutdown - To install blower # 2, Repaired unit by Hydrocare.	
18/10/2017	07:53	8:38	- Blower # 1 Jammed.	
13/11/2017	18:20	14/11/2017	- TNB power failure few minutes. Unable to restart immediately due to ignitor coil failure. Replace ignitor coil with spare unit from GSSF1.	
		12:05		
16/11/2017	01:07	11:26	- GBS trip - intet pneumatic valve failure. After inspection found that the cable for pneumatic inlet valve had broken.	

Appendix 3: Details on the downtime of Gas Engine No.1, No.2, No.3 and No.4

Date	Gas Engine No.1 Stopped		Description of Event
	From	To	
31/08/2016	16:57	17:16	Power Surge - TNB.
	18:56	19:16	Power Surge - TNB.
06/09/2016	11:12	17:26	DZR current derating. Engine over speed, over frequency. Derivation power control.
15/9/2016	10:35	18:44	Proper shutdown - Busbar voltage high. LTP shutdown - total.
16/9/2016	09:03	17/9/2016	DZR current derating. Load unstable to replace new cable for current actuator.
		13:19	
18/9/2016	15:40	24/9/2016	Reverse power - to service Ge1 at 1,500 hrs internal - by SPE. F2 blower #1 service by Hydrocare (Bearing Damage).
3/11/2016	18:29	4/11/2016	TNB Power surge. Site total shutdown.
		8:14	
8/11/2016	8:56	17:27	Proper shutdown, requested by Chen Guan for upgrading panel works.
12/11/2016	13:56	14:19	Combustion chamber B3. Change spare unit spark plug.
23/11/2016	08:10	18:53	Proper shutdown – request by Chen Guan for upgrading II KV MV panel. 1. To coupling 2 numbers new II KV MV panel

Date	Gas Engine No.1 Stopped		Description of Event
	From	To	
			2. To coupling 1 numbers existing II KV MV panel. 3. To provide breaker insulation test and relay setting.
24/11/2016	16:54	17:13	Power surge – few seconds. Blower trip.
28/11/2016	23:07	23:59	TNB power surge few seconds. Gen CB trip.
01/12/2016	08:10	15:11	Proper shutdown for scheduled service by SPE. 1500 hrs interval.
06/12/2016	07:01	08:00	TNB power surge few seconds. Gen CB trip
08/12/2016	20:31	20:54	TNB power surge few seconds.
10/12/2016	14:56	15:20	TNB power surge.
	16:33	18:39	TNB power surge.
14/12/2016	09:13	15:38	Proper shutdown request by Chen Guan for electrical work phase 2 upgrade.
15/12/2016	12:02	12:13	TNB power surge (reverse power)
26/12/2016	18:57	19:48	Power surge. Reverse power.
27/12/2016	18:32	19:22	Power surge few seconds. Intake and discharge fan trip.
05/01/2017	11:55	13:11	Proper shutdown for CDM equipment calibration by Nectar. FT3, CH4
06/01/2017	10:33	12:20	Proper shutdown – for meter calibration (EL4) by RA power.
31/01/2017	12:30	23:59	Under voltage + TNB upgrading works at PPU.
01/02/2017	00:00	11:04	Under voltage + TNB upgrading works at PPU
02/02/2017	17:26	17:35	TNB power surge few seconds
03/02/2017	09:25	04/02/2017 18:59	Proper shutdown for schedule service – 1. Scrubber tank 2. Radiator fan 3. GOU Schedule service at 1,500 hrs intervals by SPE
09/02/2017	10:51	15:28	Proper shutdown to clean gas pipe (Flare 1). Modification works flare to GSS
22/02/2017	13:55	15:12	Combustion Chamber A6
	17:37	18:53	Reverse power due to Flare 2 shutdown
23/02/2017	17:45	19:25	Blower trip. Proper shutdown GE1 due to Flare 2 shutdown
24/02/2017	10:28	11:56	Proper shutdown to do maintenance and wiring for network switch Flare 2
25/02/2017	09:45	09:48	Reverse power.
02/03/2017	16:48	3/3/2017 0:02	TNB power surge. Unable to restart immediately due to solenoid valve jammed.
04/03/2017	09:31	09:39	Proper shutdown. Reset tem and GCP panel. GCP panel reading hang.
05/03/2017	19:53	7/3/2017 19:35	Combustion Chamber B4. Change spark plug with KBE's spare unit. Unable to restart immediately due to solenoid valve problem. SPE to come and check.
06/04/2017	10:30	10:38	TNB power surge
10/04/2017	08:53	17:55	Proper shutdown for schedule service by SPE – 1500 hrs interval
16/04/2017	16:59	17:23	Power surge – Blower trip & reverse power
20/04/2017	18:58	21/4/2017 08:23	Proper shutdown due to O2 Flare 2 high
21/04/2017	22:38	22/4/2017 08:56	Reverse power – compressor for solenoid valve faulty
25/04/2017	10:59	13:36	Power surge – mains fault. Restart ok!
07/05/2017	20:08	8/5/2017 23:10	Throttle valve rod – broken. Replace with new rod – SPE.
09/05/2017	14:02	16:55	F2 – FT3 signal connection Flare 2 to FT3 change to GSS F1. Get ready for testing for gas supply from new modified GSSF1 to GE1.
17/05/2017	07:19	08:49	Combustion Chamber A5
	14:16	15:58	Proper shutdown – testing GSS F1

Date	Gas Engine No.1 Stopped		Description of Event
	From	To	
18/05/2017	14:13	17:14	Proper shutdown to do testing flow on GSS F1
31/05/2017	10:42	14:23	Proper shutdown – to do testing on GSS F1
01/06/2017	23:42	2/6/2017 10:47	Combustion chamber B2. Change spark plug
06/06/2017	5:25	8:08	Combustion chamber B3. Change spark plug
08/06/2017	18:45	9/6/2017 11:21	Combustion chamber A1. Unable to restart immediately due to gas mixture jammed. Arrange with SPE. Change spark plug (new unit)
12/06/2017	3:39	4:07	Combustion chamber B6. Change new spark plug
15/06/2017	8:30	15:48	Proper shutdown for schedule service at 1,500 hrs intervals by SPE
26/06/2017	13:06	14:14	Power surge. GSSF1 trip (PT2 high high)
30/06/2017	18:39	19:20	Combustion chamber A2. Change spark plug (new unit).
02/07/2017	8:03	11:37	Power surge
05/07/2017	12:23	12:44	Combustion chamber A5
	19:53	20:28	Combustion chamber A5. Change spark plug – new.
06/07/2017	1:02	1:23	T461 combustion chamber A1. Change spark plug (new unit)
15/07/2017	4:24	13:45	Overspeed. Throttle valve rod broken. Arrange with SPE to change new part
19/07/2017	13:30	13:54	Combustion chamber B1 – change spark plug (new)
26/07/2017	20:02	20:17	Jacket water GK inlet sensor faulty
	21:09	22:26	Jacket water GK inlet sensor faulty. Clean sensor, restart ok!
31/07/2017	8:44	8:58	Proper shutdown. Reset GCP “scada hang”
06/08/2017	6:49	7:26	GSSF1 – CH4 analyser faulty. Hose, sampling gas leaking.
07/08/2017	15:00	15:18	GSSF1 – CH4 analyser faulty. Hose, sampling gas leaking.
080/8/2017	13:48	13:55	Fault T201 receiver. Restart ok!
09/08/2017	15:21	15:38	Fault T201 receiver. Restart ok!
	21:16	21:58	Fault T201 receiver. Restart ok!
10/08/2017	9:36	9:56	Combustion chamber A4. Change spark plug (new)
	12:23	12:35	Fault T201 receiver. Restart ok!
	13:31	14:21	Fault T201 receiver. Restart ok!
12/08/2017	10:42	11:00	T201 receiver high. Restart ok!
16/08/2017	14:26	17:16	T201 receiver high.
17/08/2017	08:35	19/08/2017 14:57	GE1 normal service at 1,500 hrs internal by SPE
22/08/2017	12:17	13:31	Proper shutdown to check on throttle valve and ignition box position
06/09/2017	23:23	07/09/2017 9:27	Reverse power. Air compressor faulty. Change spark plug B5 (new unit).
12/09/2017	14:03	14:08	Power reduction due to throttle valve.
13/09/2017	15:25	16:24	Proper shutdown to change throttle valve and rod by SPE
19/09/2017	15:06	26/09/2017 18:32	Earth fault. Checked + found generation cable – red phase problem. To replace faulty cable by Chen Guan.
08/10/2017	23:48	09/10/2017 01:09	- Combustion chamber B6. Change new spark plug.
14/10/2017	08:34	09:20	- Power surge - Gen CB open
	13:21	13:59	- Power reduction due to throttle valve.
21/10/2017	11:04	11:34	- Proper shutdown - to install contactor for discharge fan.
27/10/2017	08:50	22:40	- Proper shutdown - normal service at 1,500 hrs internal by SPE.
28/10/2017	10:35	10:54	- Power reduction due to throttle valve.
13/11/2017	15:36	15:46	- Power reduction due to throttle valve.
	18:20	14/11/2017	

Date	Gas Engine No.1 Stopped		Description of Event
	From	To	
		11:27	- TNB power failure few minutes. Unable to restart immediately due to battery weak.
16/11/2017	10:58	17:20	- GBS trip - inlet pneumatic valve failure. After inspection found that the cable for pneumatic inlet valve had broken.

Date	Gas Engine No.2 Stopped		Description of Event
	From	To	
29/08/2016	17:34	30/8/2016 17:50	GSS 1 PT 1 high. Proper shutdown GE2 to service flame arrester.
31/08/2016	16:57	17:30	Power Surge - TNB.
	18:56	19:25	Power Surge - TNB.
03/09/2016	09:17	09:39	GSS 1 trip due to CH_4 low. Restart ok!
04/09/2016	09:03	09:12	H116 Ext. Quick stop with heat removal. Safety Chain.
05/09/2016	11:48	12:50	GSS 1 trip due to CH_4 low. Restart ok!
25/09/2016	06:23	09:42	Oz high. Proper shutdown to check on Gas Quality.
	11:53	15:02	Proper shutdown (Oz high).
	17:31	26/9/2016 09:01	Proper shutdown (Oz high).
28/09/2016	21:48	29/9/2016 16:25	Proper shutdown due to (Oz high).
07/10/2016	20:28	10/10/2016 10:30	Proper shutdown - Oz high.
10/10/2016	12:03	12:11	Safety Chain
15/10/2016	19:08	19:29	Safety Chain
17/10/2016	11:07	11:20	Proper shutdown - Oz high.
01/11/2016	19:09	19:22	GSS1 trip. CH4 below danger set point.
03/11/2016	18:47	19:00	TNB power surge. Total site shutdown
23/11/2016	08:06	19:13	Proper shutdown – request by Chen Guan for upgrading II KV MV panel. 1. To coupling 2 numbers new II KV MV panel 2. To coupling 1 numbers existing II KV MV panel. 3. To provide breaker insulation test and relay setting.
28/11/2016	22:06	22:17	Safety chain
	23:34	23:40	TNB power surge few seconds. Gen CB trip. GSS1 blower #3 trip.
29/11/2016	09:00	09:04	Safety chain. Under voltage.
06/12/2016	06:58	07:40	TNB power surge few seconds. GSS1 blower #3 trip. Gen CB trip
08/12/2016	20:26	20:43	TNB power surge few seconds.
10/12/2016	14:53	15:34	TNB power surge
	16:31	16:39	TNB power surge
14/12/2016	08:13	19:03	To service at 1,500 hrs by SPE
	21:07	21:24	Combustion chamber B7 faulty
15/12/2016	11:58	12:19	TNB power surge
27/12/2016	18:31	19:09	Power surge few seconds
	19:22	20:04	GSS1 trip. Gas analyser error. Restart ok!
01/01/2017	09:07	09:12	Gas pressure. Gas control system
02/01/2017	01:21	01:34	Gas pressure gas control system
17/01/2017	22:31	22:35	Under voltage
31/01/2017	13:36	17:19	Proper shutdown due to TNB upgrading works at PPU
01/02/2017	09:25	09:29	Proper shutdown for checking on Engine.
	13:12	13:43	Under voltage. Safety chain. Restart ok!
02/02/2017	10:43	04/02/2017 21:44	Proper shutdown for schedule service – 1. Scrubber tank 2. Radiator fan 3. GOU – by SPE
06/02/2017	11:02	11:10	Proper shutdown to change spark plug A7

Date	Gas Engine No.2 Stopped		Description of Event
	From	To	
08/02/2017	20:15	20:26	Combustion chamber A1
13/02/2017	13:36	13:45	Combustion chamber A4. Change spark plug.
16/02/2017	15:47	15:56	Combustion chamber B1. Change spare unit spark plug. Combustion chamber A1. Change spare unit spark plug.
18/02/2017	12:19	13:58	Combustion chamber A8, A6. Change spark plug
20/02/2017	08:13	19:12	Proper shutdown. Schedule service at 1,500 intervals by SPE
23/02/2017	21:17	11:24	Receiver temperature high. Restart Gas Engine + checking on system
25/02/2017	14:51	22:41	Proper shutdown due to HT pump leaking. SPE to swap HT pump with GE3. Restart ok!
26/02/2017	00:28	00:57	Combustion chamber B6. Change spark plug.
05/03/2017	01:03	02:42	- Combustion chamber B8.
06/03/2017	07:08	07/03/2017 18:35	- Proper shutdown for GBS pipe connection to main gas pipe. 2 main pipe connection location: Ph 1 and Ph 2A chamber and corner near GBS station.
08/03/2017	17:50	18:33	- Combustion chamber A5.
20/03/2017	17:31	19:00	- Power surge - GSS 1 lost connection. Unable to restart immediately due to network card damage. Change network card.
25/03/2017	11:18	27/03/2017 10:51	- Proper shutdown - due to GDU problem.
30/03/2017	16:39	17:01	- Combustion chamber B3. Change spark plug - spare unit.
06/04/2017	10:24	10:50	- TNB Power Surge.
27/04/2017	08:26	12:17	- Proper shutdown - for maintenance work's by KBE's. Maintenance works for spot light at shunt Reactor area. Relay calibration - by RA POWER.
28/04/2017	08:19	20:29	- Proper shutdown - for schedule service at 1500 hrs interval - by SPE.
	21:11	21:21	- Combustion chamber B6. Change spark plug - spare unit.
11/05/2017	10:41	11:21	- To check on throttle valve.
17/05/2017	14:00	14:12	- Combustion chamber B8.
22/05/2017	13:15	13:23	- Proper shutdown - to reset GSS 1. Motor Blower # 2 jammed. Swap with motor blower # 1 - by Hyrocare,
04/06/2017	02:06	03:21	- GSS 1 trip - CH_4 low - low.P 124 gas pressure gas control system.
09/06/2017	18:18	18:46	- Combustion chamber A2. Change new spark plug.
22/06/2017	14:46	14:51	- Earth fault limit.
	18:08	18:14	- Earth fault limit.
26/06/2017	08:01	08:21	- GSS 1 trip - CH_4 below danger set point.
	09:15	09:31	- GSS 1 trip - CH_4 below danger set point.
	12:57	13:24	- Power surge.Gen CB trip.
30/06/2017	13:25	15:16	- Combustion chamber B4 - Change spark plug (new unit).
02/07/2017	08:02	10:13	- Power Surge
04/07/2017	09:15	17:44	- Proper shutdown for schedule service at 1,500 hrs by SPE.
09/07/2017	16:14	16:25	- Combustion Chamber A5. Change spark plug (new unit).
17/07/2017	10:35	12:50	- Proper shutdown - SPE to check valve clearance.
21/07/2017	06:52	07:23	- Combustion Chamber A1. Change spark plug (new unit).
	13:33	15:32	- Combustion Chamber b8. Change spark plug (Used unit).
26/07/2017	20:49	20:59	- Combustion Chamber A4 faulty. Change spark plug (new unit).
02/08/2017	10:38	13:01	- For relay calibration work & by RA Power.7 unit's relay.
16/08/2017	04:35	11:19	- Combustion Chamber B7 replace new spark plug.
19/08/2017	09:55	11:31	- Swap ignition box with GE1 to testing GE1 ignition Chamber A3.

Date	Gas Engine No.2 Stopped		Description of Event
	From	To	
	16:02	16:40	- To check on throttle valve faund that one way valve problem SPE to replace new unit. Change spark plug A8.
22/08/2017	14:19	14:47	- Proper shutdown - to change / replace one way valve by SPE.
04/09/2017	12:00	13:05	- Combustion chamber B5. Change spark plug new unit.
05/09/2017	01:55	22:07	- Combustion chamber A6 - Unable to restart immediately due to spark plug. Change spark plug (new unit).GE 2 service by SPE at 1,500 hrs internals.
13/09/2017	06:25	14:42	- Combustion chamber B2. Change new spark plug.Shutdown for CDM Equipment calibration work's - by Nector. GSS 1 ① TT1, ② PT2, ③ CH4.
13/09/2017	15:37	15:45	- Combustion chamber B3. Change new spark plug.
17/09/2017	12:41	13:08	- power reduction due to throttle valve. Combustion chamber B7. Change new spark plug.
20/09/2017	09:15	30/09/2017 23:59	- Proper shutdown - Major overhaul maintenance works, 30 000 hrs.
10/10/2017	00:00	31/10/2017 23:59	- Major overhaul maintenance works.30 000 hours.
01/11/2017	00:00	30/11/2017 23:59	- Major overhaul maintenance works.30 000 hours by SPE. Found that cam shaft problem and need to replace.

Date	Gas Engine No.3 Stopped		Description of Event
	From	To	
28/08/2016	07:33	29/08/2016 17:18	Proper shutdown, to service at 1.500 hrs by SPE. Critical fault - check engine.
30/08/2016	08:48	17:25	Proper shutdown - to service flame arrester – GSS 1
31/08/2016	16:57	17:35	Power Surge - TNB.
	18:56	19:30	Power Surge - TNB.
03/09/2016	09:17	09:41	GSS 1 trip due to CH_4 low.
	16:06	16:12	Combustion chamber A3.
04/09/2016	09:03	09:41	H 116 Ext. Quick stop with heat removal. Safety Chain.
05/09/2016	11:48	12:52	GSS 1 trip due to CH_4 low.
30/09/2016	21:26	23:59	Proper shutdown (Oz high).
01/10/2016	00:00	09:02	Proper shutdown - Oz high.
	13:16	13:23	Combustion chamber A3.
10/10/2016	12:03	14:22	Safety Chain
12/10/2016	18:28	13/10/2016 15:20	Proper shutdown - Oz high.
15/10/2016	19:08	19:34	Safety Chain
01/11/2016	19:09	19:26	GSS1 trip. CH4 below danger set point.
02/11/2016	08:11	16:29	Proper shutdown to service GE3 at 1,500 hrs interval
03/11/2016	18:47	19:51	TNB power surge. Total site shutdown
23/11/2016	09:06	19:28	Proper shutdown – request by Chen Guan for upgrading II KV MV panel. 1. To coupling 2 numbers new II KV MV panel 2. To coupling 1 numbers existing II KV MV panel. 3. To provide breaker insulation test and relay setting.
28/11/2016	22:06	22:21	Safety chain
	23:34	23:54	TNB power surge few seconds. Gen CB trip. GSS1 blower #3 trip.
29/11/2016	09:00	09:09	Safety chain. Under voltage.
01/01/2017	09:07	09:29	- Gas pressure Gas control system.
02/01/2017	01:21	01:37	- Gas pressure Gas control system.
09/01/2017	22:02	22:13	- Combustion Chamber A7. Change spark plug - spare unit.

Date	Gas Engine No.3 Stopped		Description of Event
	From	To	
11/01/2017	08:13	16:46	- Proper shutdown for Schedule service 1500 hrs internal - by SPE.
	22:18	22:25	- Combustion Chamber A3 faulty. Change with spark plug - spare unit.
17/01/2017	22:31	22:38	- Under voltage.
24/01/2017	11:02	11:42	- Proper shutdown to change new air filter by SPE.
27/01/2017	12:54	14:45	- Combustion Chamber A7. Change spark plug.
31/01/2017	13:37	17:28	- Proper shutdown due to TNB upgrading works at PPU.
01/02/2017	13:12	13:44	- Under voltage. Safety chain.
02/02/2017	10:44	28/02/2017 23:59	- Proper shutdown for schedule service: 1. Scrubber tank 2. Radiator Fan 3.GDU - by SPE. SPE to check on crunck shaft scratch.after Inspection found that sceatch at crunck shaft tritical. Crunck shaft send to MWM Singapore for service / repair/ inspection.
01/03/2017	00:00	23/03/2017 02:37	- Cam shaft problem, Replaced with new unit. By SPE / MWM Singapore.
23/03/2017	06:11	13:41	- Bellow - HT Radiator Fan leaking. SPE to come and change with new unit
	18:01	18:28	- Combustion chamber A8. Change spark plug with spare unit.
27/03/2017	8:43	19:22	- Proper shutdown - for service at 50 hrs after change cam shaft.
	21:14	21:33	- Combustion chamber A6. Change spark plug with KBE's spare unit.
30/03/2017	12:45	13:21	- Bearing alternator, A temperature high. SPE greasing alternator. Restart Gas Engine 3.
06/04/2017	14:24	16:00	- To change crankcase hose by SPE.
08/04/2017	12:20	16:24	- Proper shutdown - power reduction due to jaket water Engine outlet, temperature high. HT Radiator Fan damage - SPE to change with new unit.
09/04/2017	13:09	17:00	- Proper shutdown - power reduction due to jaket water Engine outlet, temperature high. HT Radiator Fan damage - SPE to change with new unit.
11/04/2017	13:20	14:37	- Generator Bearing A, Temperature high.
14/04/2017	13:55	14:27	- Generator Bearing A, Temperature high.
27/04/2017	09:05	17:14	- Proper shutdown - for maintenance work's by KBE's. Maintenance works for spot light at shunt Reactor area. Relay calibration - by RA POWER.
29/04/2017	12:59	13:50	- Combustion chamber B7. Change with KBE's spare unit.
22/05/2017	13:16	13:24	- Proper shutdown - to reset GSS 1. Motor Blower # 2 jammed. Swap with motor blower # 1 - by Hyrocare,
31/05/2017	08:19	17:16	- Proper shutdown - for schedule service by SPE. Service at 1,500 hrs internal.
04/06/2017	02:06	03:23	- P 124 Gas pressure gas control system. GSS 1 trip - CH_4 Low - Low.
09/06/2017	02:33	02:48	- Combustion chamber B7. Change spark plug. (New unit).
13/06/2017	12:41	13:08	- Combustion chamber B5. Change spark plug.
14/06/2017	09:09	09:14	- Combustion chamber A3. Change spark plug.(Used unit).
20/06/2017	03:18	03:29	- Jacket water Engine outlet, Reduce load at 50%.
21/06/2017	16:21	16:27	- Proper shutdown - To change spark plug A4 (New unit).
22/06/2017	14:54	15:04	- Earth fault - limit.
	18:08	18:18	- Earth fault - limit.
23/06/2017	08:35	28/06/2017 16:45	- Power reduction due to throttle valve. Exhaust turbo changer leaking.
29/06/2017	03:54	04:05	- T 206 jaket water engine outlet.
	07:22	14:09	- Jaket water engine outlet.
	15:47	16:06	- Combustion chamber B7. Change spark plug. (New unit).

Date	Gas Engine No.3 Stopped		Description of Event
	From	To	
02/07/2017	08:02	10:18	- Power Surge
06/07/2017	07:22	17:25	- Proper shutdown. SPE to check on exhaust leaking.
	21:22	21:54	- Combustion Chamber A7. Change spark plug (new unit).
10/07/2017	01:14	01:35	- Combustion Chamber B5. Change spark plug (new unit).
	13:06	16:28	- Proper shutdown. SPE to check on exhaust leaking - by SPE.
15/07/2017	18:09	23:27	- Combustion Chamber B7. Change spark plug (new unit). Unable to restart immediately due to throttle valve.
18/07/2017	14:41	14:53	- Combustion Chamber A5. Change spark plug (new unit).
20/07/2017	06:50	07:24	- Combustion Chamber B8. Change spark plug (new unit).
26/07/2017	14:15	14:25	- Power reduction due to throttle valve.
27/07/2017	08:21	8:30	- Reset TEM (Scada Hang).
	12:27	28/07/2017 23:33	- Exhaust Leak Problem (A SIDE).
31/07/2017	16:43	17:01	- Jacket water outlet HT radiator fan 1 & 2 trip.
02/08/2017	10:39	12:56	- For relay calibration work & by RA Power.7 unit's relay.
	08:28	19:16	- Proper shutdown - GE 3 normal service at 1,500 hrs internal by SPE.
05/09/2017	14:04	16:54	- Safety chain. Change spark plug (new unit). Crankcase sensor faulty - swap with GE 2.Restart OK!
13/09/2017	12:06	14:10	- Proper shutdown for CDM equipment calibration work's - by Nector. GSS 1: ①TTI, ②PT2, ③CH4. Change spark plug B7.
21/09/2017	10:05	23/09/2017 19:40	- Proper shutdown - for pre - treatment service. Done together with GE2 / GE1,Carbon change / Radiator GDU service.
24/09/2017	01:55	10:15	- Low water level, HT - Top up HT pipe line.
25/09/2017	23:32	28/09/2017 16:41	- Major problem. Shunt reactor on Fire !! To check with Chen Guan / ABB on cable (Generation) status.
16/10/2017	13:38	16:04	- Proper shutdown - to do testing on PC / Program Gsst. Hard disc corrupt. To replace primary filter for moisture separator. Jacket water engine outlet - temp high. 2 Unit HT Radiator Fan faulty.
20/10/2017	08:34	15:15	- Proper shutdown - for normal service CH 1,500 hrs internal - by SPE.
	22:00	22:12	- Combustion chamber A3. Change new spark plug.
30/10/2017	09:22	10:07	- Proper shutdown.
04/11/2017	11:52	12:28	- Fault P124 gas pressure GSS 2 trip.
13/11/2017	18:20	19:01	- TNB power failure few minutes.
14/11/2017	10:49	15/11/2017 11:27	- Proper shutdown - for TNB work. Unable to restart immediately due to combustion unstable. Engine unable to taking load. Arrange with SPE.
16/11/2017	10:57	12:52	- GBS trip - intet pneumatic valve failure. After inspection found that the cable for pneumatic inlet valve had broken.
17/11/2017	14:41	16:29	- TNB Power Surge.
27/11/2017	12:47	12:56	- Combustion chamber B7. Change spark plug (spare unit GE 2).

Date	Gas Engine No.4 Stopped		Description of Event
	From	To	
31/08/2016	16:57	19:45	Power Surge - TNB. Unable to restart immediately due to GSS fault.
	22:05	23:03	Power Surge - TNB.
01/09/2016	08:53	08:58	Message red alarm engine.
	12:20	12:24	Status X20 - module faulty.
	18:49	19:06	GSS 2 trip due to CH_4 low.
02/09/2016	16:06	16:56	Proper shutdown - request by WZS / MTU to check on GE 4.
02/09/2016	23:57	03/9/2016	Red alarm engine. Message stop.
		01:23	
03/09/2016	19:27	19:31	Module Faulty.
04/09/2016	17:17	06/09/2016	SM 668 Lo T - Exhaust A9 (FC 112409). WZS to change spark plug A9.
		16:27	
06/09/2016	17:43	17:48	GSS 2 trip - CH_4 below danger set point.
	18:17	18:21	Engine Red alarm - crankcase high pressure.
	18:49	18:58	GSS 2 trip (CH_4 low). Engine red alarm.
	20:11	07/09/2016	Engine Red alarm - LOT - exhaust.
		09:40	
07/09/2016	13:11	13:22	GSS 2 trip (CH_4 low low).
08/09/2016	22:07	10/09/2016	Red alarm engine - unable to restart immediately due to GSS 2 faulty. Interlinx to come and check on program setting. Adjust PT 1 setting to positive value.
		12:37	
12/09/2016	08:49	13/09/2016	Red alarm engine. AL combustion alarm red. LOLO T - Exhaust A2.
		13:18	
13/09/2016	19:05	19:10	LOLO T - Exhaust E7.
	19:32	21:13	Module Faulty.
14/09/2016	05:37	09:24	LOLO T - Exhanst A1.
	19:57	10:15	LOLO T - Exhanst A1. Clean spark plug - change with spare unit.
	20:08	20:13	Module Faulty.
16/09/2016	15:09	17/09/2016	GSS 2 trip - CH_4 below danger set point. LOLO T- Exhanst A1. Bio change spark plug with used spark plug. Clean and install.
		09:40	
19/09/2016	07:57	08:21	Module Faulty.
	09:47	09:51	Module Faulty
20/09/2016	17:05	17:48	GSS 2 trip (CH_4 low).
	19:19	19:35	GSS 2 trip (CH_4 low).
	21:09	21:37	GSS 2 trip (CH_4 low).
21/09/2016	00:35	06:50	GSS 2 trip (CH_4 low).
	10:41	10:51	Red alarm engine.
	11:06	21:35	Proper shutdown - service by WZS / MTU.
22/09/2016	01:28	01:35	Combustion chamber A3.
	12:09	23/09/2016	Proper shutdown - to service GDU, radiator fan + scrubber tank by WZS.
		18:05	
25/09/2016	09:46	09:55	GSS 2 trip (CH_4 low).
26/09/2016	18:36	18:48	HIHI T - Exhanst A3.
	22:18	22:43	HIHI T - Exhanst A3. Change spark plug with spare unit.
27/09/2016	08:52	09:06	HIHI T - Exhanst A3.
27/09/2016	16:58	28/09/2016	Communication lost. Red alarm engine. WZS / MTU to come and check.
		15:39	
29/09/2016	09:12	17:58	Proper shutdown - to change new spark plug 10 units. Unable to restart immediately due to gas pressure low.
01/10/2016	22:37	22:46	S M 11 status X 20 - module faulty.
02/10/2016	01:40	01:51	LOLO T - Exhaust B4.

Date	Gas Engine No.4 Stopped		Description of Event
	From	To	
05/10/2016	08:14	08:22	Module faulty - X 20.
08/10/2016	04:11	07:55	Power surge - TNB. Unable to restart immediately due to HT pump trip.
15/10/2016	12:14	13:27	GSS 2 trip (analyser problem)
16/10/2016	01:12	03:30	S M 11 status X 20 - module faulty.
24/10/2016	18:29	18:33	Main protection. Power surge.
31/10/2016	09:25	09:28	S M 11 status X 20 - module faulty.
01/01/2017	00:00	18:51	- LoLo T-Exhanst A6. Change new spark plug unable to restart immediately Due to communication lost.
02/01/2017	17:51	18:02	- SM 27 - Engine cooling water level low.
03/01/2017	04:27	04:37	- SM 27 - Engine cooling water level low.
	14:50	15:01	- Engine cooling water level low.
04/01/2017	03:10	13:32	- LoLo T-Exhanst A1.WZS to deliver spark plug (spare unit).
	15:55	16:09	- LoLo T-Exhanst A1. Change new spark plug.
05/01/2017	12:42	13:27	- Proper shutdown for CDM equipment calibration - by Nectar.
06/01/2017	10:48	09/01/2017 19:24	- Engine cooling water level low Expansion tank leaking. WZS to repair Expansion tank.
10/01/2017	06:14	06:26	- Engine cooling water level low.
11/01/2017	00:07	09:51	- T-Exhaust B7 HIHI. T-Exhaust A5 LoLo.
	21:35	21:43	- SM 27 - Engine cooling water level low.
12/01/2017	01:42	01:50	- Engine cooling water level low.
	05:31	05:46	- Engine cooling water level low.
	23:35	23:47	- Engine cooling water level low.
13/01/2017	02:13	02:24	- Engine cooling water level low.
	05:52	06:09	- Engine cooling water level low.
14/01/2017	07:47	09:22	- LOLO T-Exhaust A7. Clean spark plug.
17/01/2017	22:27	23:08	- Lo T-Exhaust B9. Change spark plug.
19/01/2017	11:41	13:13	- LOLO T-Exhanst B7. HIHI T-Exhaust A9.Change new spark plug.
	17:16	17:34	- LOLO T-Exhaust A8. Clean spark plug.
	21:18	21:35	- LOLO T-Exhaust A8. Clean spark plug.
21/01/2017	22:08	22/1/2017 0:20	- LOLO T-Exhaust A6. Fault Gas supply system (Change new spark plug). LOLO T-Exhaust A10.
22/01/2017	16:46	17:29	- SM 670 LOLO T-Exhaust A1.
23/01/2017	10:22	18:43	- LOLO T-Exhaust A10.MTM / WZS to come and check on Valve clearance. (Combustion Unstable).
24/01/2017	09:12	09:34	- LOLO T-Exhaust A5. Clean spark plug.
	21:20	21:48	- Lo T-Exhaust B10.Change new spark plug 2 unit (B10,B7).
	22:51	23:06	- LOLO T-Exhaust B7.
25/01/2017	04:27	08:25	- LOLO T-Exhaust B1. Change spark plug.
	13:44	13:47	- PLC communication lost.
	20:27	21:17	- LOLO T-Exhaust A7. Change new spark plug. Emergency cooler failure. Radiator Fan 4 trip.
26/01/2017	00:07	01:21	- LOLO T-Exhaust B9. Clean spark plug.
27/01/2017	00:21	01:51	- LOLO T-Exhaust B5. Change new spark plug.
	03:52	08:12	- LOLO T-Exhaust B9. Change new spark plug.
30/01/2017	08:20	15:41	- LOLO T-Exhaust A3 and A4 .HIHI T-Exhaust A8 and A9. Change and clean spark plug.
	21:35	21:54	- Gas supply system 2 (GSS 2) trip.PT2 high.
31/01/2017	06:30	11:28	- LOLO T-Exhaust A9.
	13:00	23:59	- LOLO T-Exhaust A9. Unable to restart immediately due to spark plug combustion problem. Arrange with WZS / MTU for checking.

Date	Gas Engine No.4 Stopped		Description of Event
	From	To	
01/02/2017	00:00	28/02/2017 23:59	- LOLO T-Exhaust A9. Unable to restart immediately due to spark plug combustion problem. Arrange with WZS / MTU for checking.
01/03/2017	00:00	31/03/2017 23:59	- GE4 Engine problem. Instable combustion Require top overhaul - change major part.
01/04/2017	00:00	23/04/2017 20:17	- GE4 Engine problem. Unstable combustion, Require top overhaul. Change major part.
27/04/2017	12:57	13:57	- Proper shutdown - for greasing alternator by MTU / WZS.
29/04/2017	20:37	30/04/2017 1:29	- GSS 2 trip - blower #1 trip (Overload). Air compressor trip. Unable to restart / reset air compressor. Pneumatic valve (air socket) temporary connected to air compressor GSS 1.
30/04/2017	08:48	9:07	- GSS 2 trip due to blower # 1 trip (Overload).
	11:21	11:34	- Proper shutdown - to normalize Air compressor system - GSS 2.
01/05/2017	05:22	07:59	- GSS 2 trip - blower # 1 trip (overload). Air compressor faulty.
02/05/2017	16:44	16:52	- GSS 2 trip - blower # 1 trip (overload). Air compressor faulty.
03/05/2017	14:58	15:18	- Proper shutdown - to normalize air compressor system (GSS 2).
	16:55	17:34	- GSS 2 trip - CH_4 low-low. Exhaust temperature B9 low-low. Change with old/used spark plug - Restart ok.
	19:39	20:31	- GSS 2 trip due to blower # 1 trip. Air compressor faulty.
	22:37	22:49	- Proper shutdown to change air piping pneumatic valve to compressor system GSS 1.
06/05/2017	23:02	23:29	- GSS 2 trip - CH_4 low-low.
08/05/2017	20:31	21:05	- LOLO t-Exhaust B9-change spark plug with old/used unit, Restart ok.
09/05/2017	08:49	08:57	- GSS 2 trip - blower # 1 trip. Air compressor faulty.
11/05/2017	10:33	11:18	- GSS 2 trip - CH_4 low-low.
	19:25	19:51	- GSS 2 fault - blower # 1 trip (overload).
	23:24	12/05/2017 00:29	- GSS 2 trip.
16/05/2017	15:11	15:15	- GSS 2 trip.
17/05/2017	14:30	19/05/2017 11:11	- PLC communication out of order. Arrange with MTU. GSS - 2 trip due to CH_4 low.
21/05/2017	13:11	13:59	- GSS 2 trip - CH_4 low-low.
22/05/2017	23:34	23/05/2017 00:27	- GSS 2 trip - CH_4 low-low.
26/05/2017	07:01	07:32	- GSS 2 trip - CH_4 low-low.
29/05/2017	05:49	08:31	- GSS 2 trip - CH_4 low-low.
	14:28	14:37	- SM 589 AIESI Activated (FC 948).
01/06/2017	23:25	23:35	- SM 619 HIHI T-Exhaust A10.Back to restart.
02/06/2017	09:36	09:51	- Combustion chamber A10.Change spark plug.
04/06/2017	02:29	06/06/2017 12:40	- Open primary rate Exceeded. Unable to reset fault. Arrange with MTU.
15/06/2017	07:07	07:38	- LoLo T-Exhaust B9 - Change spark plug. (Used unit)
17/06/2017	12:00	12:28	- Gss 2 trip - CH_4 Low - Low,
19/06/2017	09:53	18:00	- Proper shutdown for service at 1,000 hrs internal by WZS / MTU.
22/06/2017	09:52	10:16	- PLC communication out of order.
26/06/2017	13:04	13:23	- Power surge.HT pump trip - Over current.
	20:07	21:06	- SM 32 Gas pressure <min.HT pump trip. Power surge.
01/07/2017	12:09	13:34	- Signal Failure to PLC.
	23:53	02/07/2017 00:04	- Red alarm Engine.

Date	Gas Engine No.4 Stopped		Description of Event
	From	To	
02/07/2017	08:01	08:05	- Power surge
04/07/2017	21:16	21:21	- Gas pressure < MIN.
05/07/2017	20:07	21:45	- Module Faulty - X 20.
06/07/2017	09:04	09/07/2017 19:23	- Proper shutdown - to service GDU, scrubber tank and Radiator Fan by – WZS to check and service on GE 4 turbo changer by MTU & International Turbo.
09/07/2017	23:37	10/07/2017 08:20	- Red alarm engine - Unable to restart immediately due to spark plug problem.
10/07/2017	12:45	12:50	- AL ProAct B Position Error.
	18:44	19:51	- LOLO T-Exhaust A8 - Change spark plug - new unit.
11/07/2017	10:22	13:47	- Proper shutdown ProAct B position error - by MTM.
12/07/2017	10:19	11:17	- AL ProAct B error.
	12:47	13:17	- AL ProAct B error.
13/07/2017	12:17	15:04	- proper shutdown - to check on ProAct B position error - by MTU.
16/07/2017	21:44	17/07/2017 11:27	- Power Surge.Unable to restart immediately due to spark plug problem.
17/07/2017	17:15	17:51	- LOLO T-Exhaust A6.
18/07/2017	00:49	11:36	- LOLO T-Exhaust A6. Change with new spark plug.
21/07/2017	13:15	15:56	- LOLO T-Exhaust B8 LOLO.Change with new spark plug.
	20:15	20:20	- LOLO T-Exhaust A6. Cleaned spark plug.
	21:10	21:25	- LOLO T-Exhaust A6. Change spark plug.
	22:44	22:49	-X 20 Module Faulty.
22/07/2017	04:34	08:34	- LOLO T-Exhaust A6.
24/07/2017	09:29	27/07/2017 14:56	- Fault - Open Primary Rate Exceed (3). Cable faulty - Burn mark cable melted to replace cable.
28/07/2017	00:40	00:56	- Fault - Primary Open rate exceed (3).Ignition cable fault - disconnected & melted (A6) - Major.
	03:50	07:48	- Fault - Primary Open rate exceed (3).Ignition cable fault - disconnected & melted (A6) - Major.
	08:45	31/07/2017 23:59	- Fault - Primary Open rate exceed (3).Ignition cable fault - disconnected & melted (A6) - Major.
01/08/2017	00:00	17:06	- Fault - Primary open Rate Exceed (33).Ignition cable fault and melted (A6) - disconnected (major).
	18:17	18:26	- GSS F1 trip - PTI below danger set point.
	19:14	19:49	- Primary open Rate Exceed (c3).Repaired cable by MTU.
02/08/2017	10:39	12:58	- For relay calibration work's by RA POWER 7 unit's relay.
	14:28	14:38	- GSS trip - PT 2 high.
04/08/2017	13:04	14:55	- Primary open Rate Exceed (c3).SCR fault ODD.
	17:10	05/08/2017 14:20	- Primary open Rate Exceed (c3).SCR fault ODD.
05/08/2017	17:22	07/08/2017 17:34	- Primary open Rate Exceed (c3).SCR fault ODD.
12/08/2017	07:54	08:46	- LOLO T-Exhaust B5. Change spark plug (used unit).
	09:21	09:33	- Gss 2 trip - Blower # 1 trip (over current).
16/08/2017	07:53	07:58	- X20 Module faulty.
18/08/2017	15:18	15:23	- Power Surge - HT pump Trip.
	17:56	18:09	- Power Surge - HT pump Trip.
	18:56	19:03	- Power Surge - HT pump Trip.
20/08/2017	07:04	07:46	- SM 890 SCR fault Even.
	08:42	09:20	- SM 890 SCR fault Even - Ic 92.
	10:07	10:17	- SM 890 SCR fault Even - Ic 92.
	10:56	11:41	- SM 890 SCR fault Even - Ic 92.
	12:26	26/08/2017 14:54	- SM 890 SCR fault Even. Ignition box cable fault and melted. Disconnected. (Major).

Date	Gas Engine No.4 Stopped		Description of Event
	From	To	
26/08/2017	17:10	17:38	- SCR Even - fault. MTU to check on ignition box and ignition cable.
	18:28	18:35	- SCR Even - fault. MTU to check on ignition box and ignition cable.
27/08/2017	10:03	10:08	- X20 - module faulty.
28/08/2017	01:55	02:11	- X20 - module faulty.
	10:19	10:26	- TNB Power Surge.
	22:06	22:17	- Gas Supply System 2 (GSS 2) trip.CH4 Low-Low.
01/09/2017	14:21	15:47	- SM 316 Fault GSS 2 - Blower # 1 trip.
	23:53	02/09/2017 00:03	- X 20 - module faulty.
02/09/2017	19:12	19:17	- X 20 - module faulty.
05/09/2017	15:10	16:54	- Mains Protection (Power Surge).
06/09/2017	09:47	09:56	- Connection to PLC out of order.
10/09/2017	17:42	17:52	- Gas pressure Min.GSS 2 trip.
13/09/2017	13:17	14:34	- Proper shutdown,for CDM Equipment calibration work's by Nectar GSS 2 : ① FT 3 , ② CH4.
23/09/2017	10:31	16:45	- TNB Power failure.
24/09/2017	11:19	11:43	- GSS 2 trip - Blower # 1 trip.
25/09/2017	23:36	26/09/2017 10:56	- Major problem.Shunt Reactor on Five !! To check with Chen Guan / AB13 on cable (Generation) status.
26/09/2017	18:53	19:00	- Mins Protection - Failure.
29/09/2017	04:45	30/09/2017 19:12	- GSS 2 trip - blower # 1. MTU / WZS to check on turbo charger. (ribration and heat problem).
03/10/2017	09:35	09:41	- Main protection - Failure. (TNB POWER SURGE).
	11:14	11:19	- Main protection - Failure.
07/10/2017	01:30	09:04	- HT T - coolant before engine.
12/10/2017	10:24	15:35	- Proper shutdown - GE 4 normal service at 1250 hrs internal by - WZS / MTU.
14/10/2017	08:34	08:47	- Power Surge HT pump trip.
17/10/2017	17:32	17:42	- TNB Power Surge.
29/10/2017	13:39	13:47	- TNB Power Surge.
30/10/2017	14:07	14:18	- TNB Power Surge.
03/11/2017	07:20	08:04	- Main protection.
13/11/2017	18:21	18:42	- TNB power failure few minutes.
14/11/2017	10:53	13:54	- Proper shutdown - for TNB work.
16/11/2017	10:55	13:12	- GBS trip - intet pneumatic valve failure. After inspection found that the cable for pneumatic inlet valve had broken.
17/11/2017	09:57	10:08	- Pro Act B.
	15:53	16:01	- TNB Power Surge.
23/11/2017	23:43	24/11/2017 00:24	- SM 315 fault Gas supply system.
28/11/2017	13:46	14:06	- GSS 2 blower # 1 trip.
	16:44	17:23	- GSS 2 blower # 1 trip.
29/11/2017	11:12	11:25	- GSS 2 blower # 1 trip.
30/11/2017	08:23	15:43	- Proper shutdown for normal service at 1,250 hrs internal by MTU/WZS to replace and install 2 unit wiring hardness,1 unit ignitor coil,1 unit cool level display and 1 unit HT Expansion tank.
	19:32	19:42	- GSS 2 blower # 1 trip.

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 03.0

Referring to the tools, for LFG temperatures below 60 °C, moisture could be neglected due to its very low influence on final results and thus, the measurement in wet or dry basis is not important (as reflected in the amendments to ACM0001, version 9.1 onwards). In the case where the LFG temperature exceeds 60°C, the same basis for both methane concentration and flow measurement will be considered according to the tools.

There are 6 measurement options as tabulated below:

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

During this monitoring period, for Flare No.1 and Flare 2 with LFG temperature exceeding 60°C, option B measurement was selected and was applied in the CER calculation.

Determination of the absolute humidity of the gaseous stream

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

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

Option 2: Simplified calculation without measurement of the moisture content

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

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

Where:

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

Parameter	Formula / description
$p_{H20,t,Sat}$	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
P_t	**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.
MM_{H2O}	18.0152 kg/kmol Default value from the tool
$MM_{t,db}$	$MM_{t,db} = \sum_k (v_{k,t,db} * MM_k)$ 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

Parameter	Formula / description

Data / Parameter:	MM_i
Data unit:	kg/kmol
Description:	Molecular mass of greenhouse gas *i*
Value to be applied:	

Compound	Structure	Molecular mass (kg / kmol)
Carbon dioxide	CO_2	44.01
Methane	CH_4	16.04
Nitrous oxide	N_2O	44.02
Sulfur hexafluoride	SF_6	146.06
Perfluoromethane	CF_4	88.00
Perfluoroethane	C_2F_6	138.01
Perfluoropropane	C_3F_8	188.02
Perfluorobutane	C_4F_{10}	238.03
Perfluorocyclobutane	c-C_4F_8	200.03
Perfluoropentane	C_5F_{12}	288.03
Perfluorohexane	C_6F_{14}	338.04

Any comment:	

Data / Parameter:	MM_k
Data unit:	kg/kmol
Description:	Molecular mass of gas *k*
Value to be applied:	For gases *k* that are greenhouse gases appy values for MM_i.

Compound	Structure	Molecular mass (kg / kmol)
Nitrogen	N_2	28.01
Oxygen	O_2	32.00
Carbon monoxide	CO	28.01
Hydrogen	H_2	2.02
Nitric oxide	NO	30.01
Nitrogen dioxide	NO_2	46.01
Sulfur dioxide	SO_2	64.06

Any comment:	

Option B of measurement options

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

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

Where:

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

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

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

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

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

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)

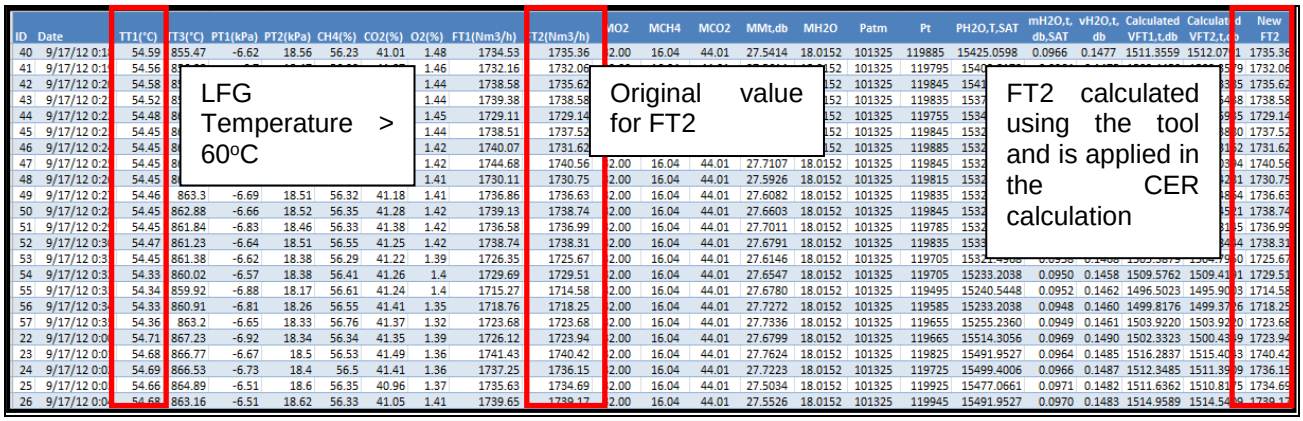
$m_{H2O,t,db}$ = Absolute humidity in the gaseous stream in time interval *t* on a dry basis (kg H_2O/kg dry gas)

$MM_{t,db}$ = 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 03.0.



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	1734.53	1735.36	2.00	16.04	44.01	27.5414	18.0152	101325	119885	15425.0598	0.0966	0.1477	1511.3559	1512.07	1735.36
41	9/17/12 0:1	54.56						1.46	1732.16	1732.06					152	101325	119795	1540					1732.06
42	9/17/12 0:2	54.58						1.44	1738.58	1735.62					152	101325	119845	1541					1735.62
43	9/17/12 0:2	54.52						1.44	1739.38	1738.58					152	101325	119835	1537					1738.58
44	9/17/12 0:2	54.48						1.45	1729.11	1729.14					152	101325	119755	1534					1729.14
45	9/17/12 0:2	54.45						1.44	1738.51	1737.52					152	101325	119845	1532					1737.52
46	9/17/12 0:2	54.45						1.42	1740.07	1731.62					152	101325	119885	1532					1731.62
47	9/17/12 0:2	54.45						1.42	1744.68	1740.56	2.00	16.04	44.01	27.7107	18.0152	101325	119845	1532					1740.56
48	9/17/12 0:2	54.45						1.41	1730.11	1730.75	2.00	16.04	44.01	27.5926	18.0152	101325	119815	1532					1730.75
49	9/17/12 0:2	54.46	863.3	-6.69	18.51	56.32	41.18	1.41	1736.86	1736.63	2.00	16.04	44.01	27.6082	18.0152	101325	119835	1532					1736.63
50	9/17/12 0:2	54.45	862.88	-6.66	18.52	56.35	41.28	1.42	1739.13	1738.74	2.00	16.04	44.01	27.6603	18.0152	101325	119845	1532					1738.74
51	9/17/12 0:2	54.45	861.84	-6.83	18.46	56.33	41.38	1.42	1736.58	1736.99	2.00	16.04	44.01	27.7011	18.0152	101325	119785	1532					1736.99
52	9/17/12 0:3	54.47	861.23	-6.64	18.51	56.55	41.25	1.42	1738.74	1738.31	2.00	16.04	44.01	27.6791	18.0152	101325	119835	1533					1738.31
53	9/17/12 0:3	54.45	861.38	-6.62	18.38	56.29	41.22	1.39	1726.35	1725.67	2.00	16.04	44.01	27.6146	18.0152	101325	119705	1532					1725.67
54	9/17/12 0:3	54.33	860.02	-6.57	18.38	56.41	41.26	1.4	1729.69	1729.51	2.00	16.04	44.01	27.6547	18.0152	101325	119705	15233.2038	0.0950	0.1458	1509.5762	1509.41	1729.51
55	9/17/12 0:3	54.34	859.92	-6.88	18.17	56.61	41.24	1.4	1715.27	1714.58	2.00	16.04	44.01	27.6780	18.0152	101325	119495	15240.5448	0.0952	0.1462	1496.5023	1495.90	1714.58
56	9/17/12 0:3	54.33	860.91	-6.81	18.26	56.55	41.41	1.35	1718.76	1718.25	2.00	16.04	44.01	27.7272	18.0152	101325	119585	15233.2038	0.0948	0.1460	1499.8176	1499.37	1718.25
57	9/17/12 0:3	54.36	863.2	-6.65	18.33	56.76	41.37	1.32	1723.68	1723.68	2.00	16.04	44.01	27.7336	18.0152	101325	119655	15255.2360	0.0949	0.1461	1503.9220	1503.92	1723.68
22	9/17/12 0:0	54.71	867.23	-6.92	18.34	56.34	41.35	1.39	1726.12	1723.94	2.00	16.04	44.01	27.6799	18.0152	101325	119665	15514.3056	0.0969	0.1490	1502.3323	1500.43	1723.94
23	9/17/12 0:0	54.68	866.77	-6.67	18.5	56.53	41.49	1.36	1741.43	1740.42	2.00	16.04	44.01	27.7624	18.0152	101325	119825	15491.9527	0.0964	0.1485	1516.2837	1515.40	1740.42
24	9/17/12 0:0	54.69	866.53	-6.73	18.4	56.5	41.41	1.36	1737.25	1736.15	2.00	16.04	44.01	27.7223	18.0152	101325	119725	15499.4006	0.0966	0.1487	1512.3485	1511.39	1736.15
25	9/17/12 0:0	54.66	864.89	-6.51	18.6	56.35	40.96	1.37	1735.63	1734.69	2.00	16.04	44.01	27.5034	18.0152	101325	119925	15477.0661	0.0971	0.1482	1511.6362	1510.81	1734.69
26	9/17/12 0:0	54.68	863.16	-6.51	18.62	56.33	41.05	1.41	1739.65	1739.17	2.00	16.04	44.01	27.5526	18.0152	101325	119945	15491.9527	0.0970	0.1483	1514.9589	1514.54	1739.17