



**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	1.3	
Completion date of this monitoring report	09/05/2019	
Monitoring period number	2	
Duration of this monitoring period	01/01/2018 – 31/12/2018 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	<ul style="list-style-type: none"> 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	171,020 tCO ₂ e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	269,207 tCO ₂ e	

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.

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 2nd monitoring period of 2nd crediting period is from 01/01/2018 to 31/12/2018 (inclusive of both days). The total emission reductions achieved during this monitoring period is **171,020 tCO₂e**.

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

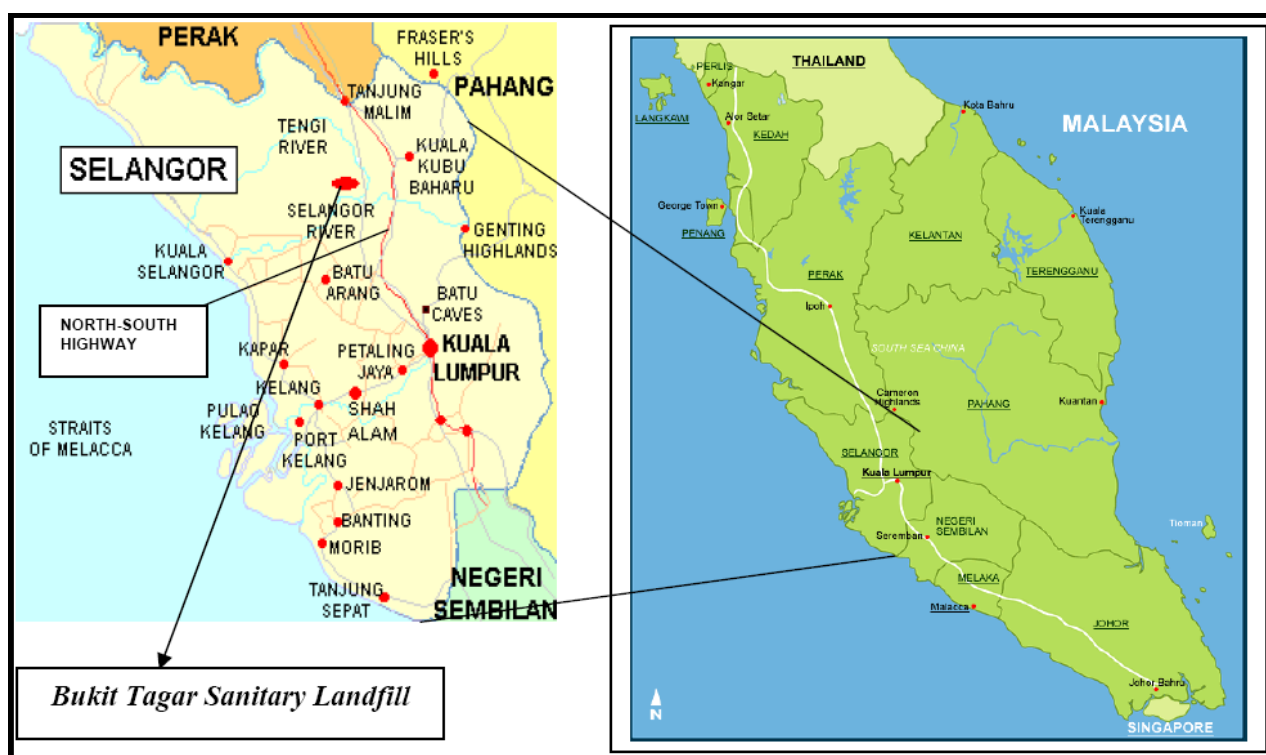


Figure 1: Location of BTSL and Selangor State

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 CO₂ 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)
1 st Crediting Period	28/08/2009 – 27/08/2016 (Both dates inclusive)
2 nd Crediting Period	28/08/2016 – 27/08/2023 (Both dates inclusive)

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

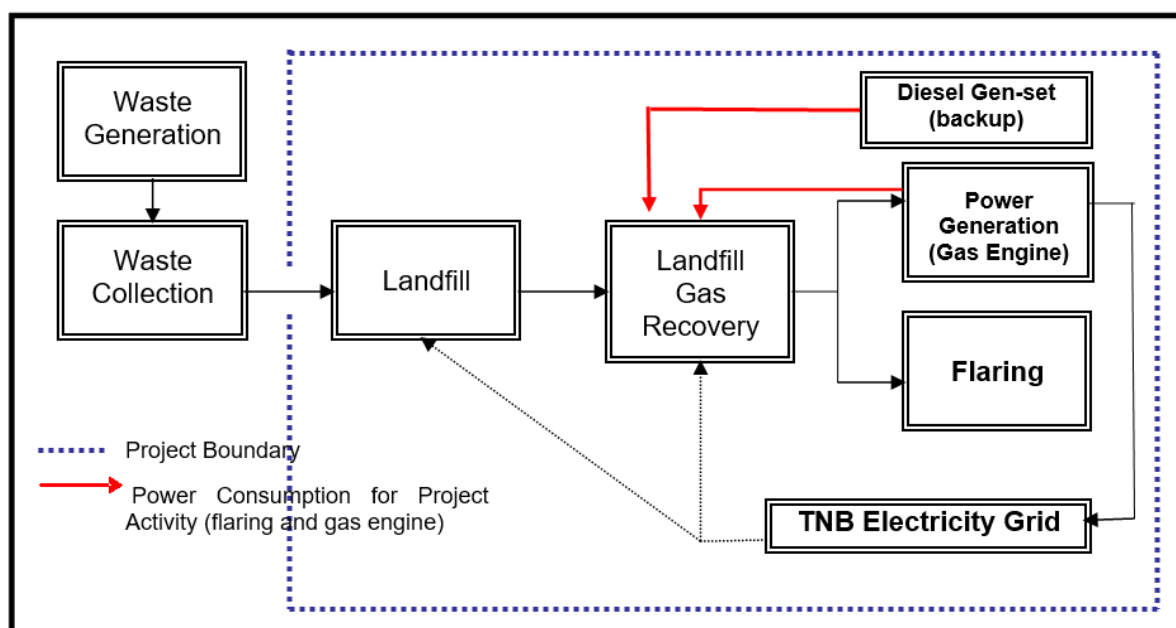
The landfill is being developed in phases. The detail information on the phases is presented as below:

Cell	Status of Filling	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
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 capped in this monitoring period.

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 4: Horizontal Gas Extraction Wells in Phase 1 Cell

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

The 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 Nm³/hr LFG.



Figure 5: High-Temperature Enclosed Flares

Details of Flare No. 2 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°C
Gas blower	Twin-lobe roots blower
Gas analysers	Gas analysers for CH ₄ and O ₂

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.



Figure 6: Gas Engine 2 & 3

The details of Gas Engine No.1 (GSSF1) 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 (H₂S) 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.

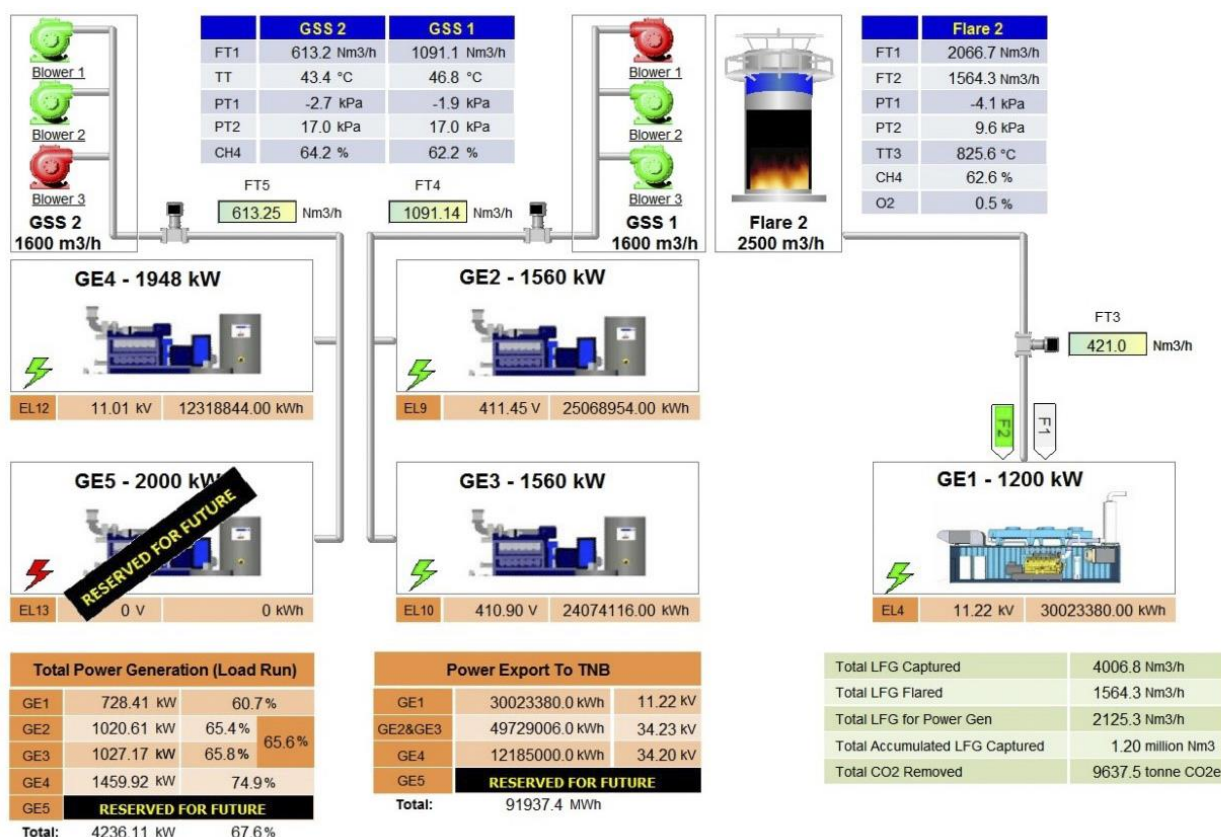


Figure 7: Centralized SCADA Interface

Implementation status of project activity

For the reporting period of 01/01/2018 to 31/12/2018, the key CDM activities implemented are described below:

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 and has started its operation on 07/08/2010 during the 6th monitoring period of 1st crediting 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 88% 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.

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	15%
2	Gas Engine No. 2	58%
3	Gas Engine No. 3	60%
4	Gas Engine No. 4	64%

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

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 converted 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 CH₄ 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 3**.

Transmission and Distribution Losses (TDL_v)

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 7.74% for 2018. This value was reported in the Tenaga Nasional Berhad (TNB)⁴ Annual Report 2016⁵.

Operation and Management Structure for Monitoring

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

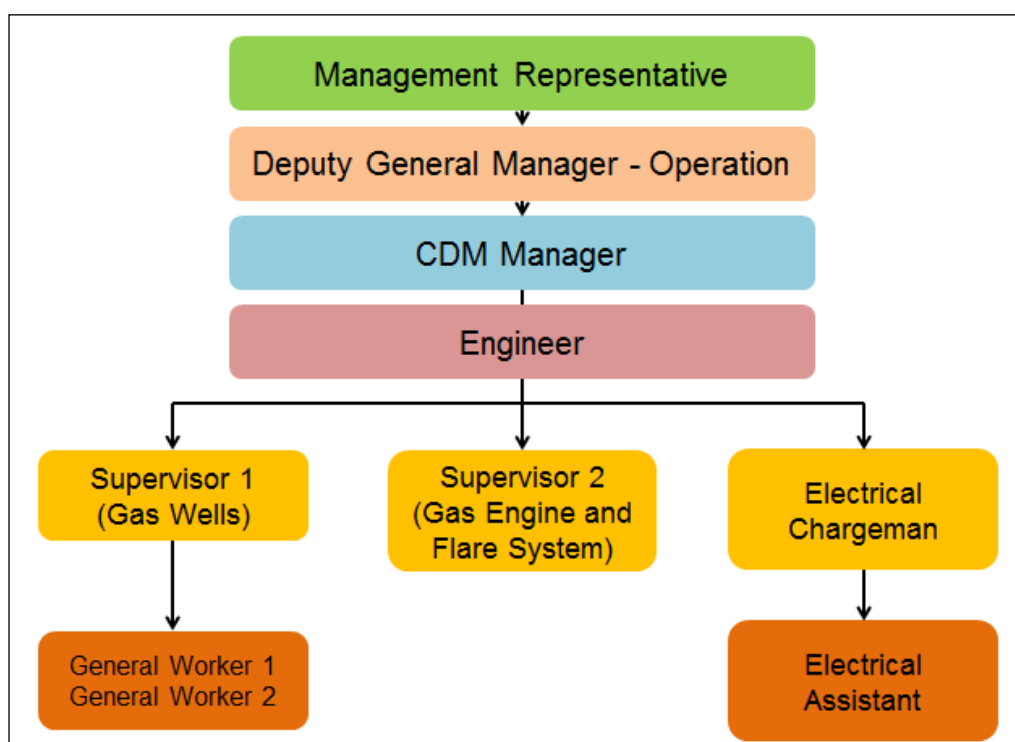


Figure 8: Organisational Structure for CDM Monitoring for BTSL LFG Recovery and Utilisation Project

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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 charginan

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 23/10/2018.

Relevant Monitoring Points

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

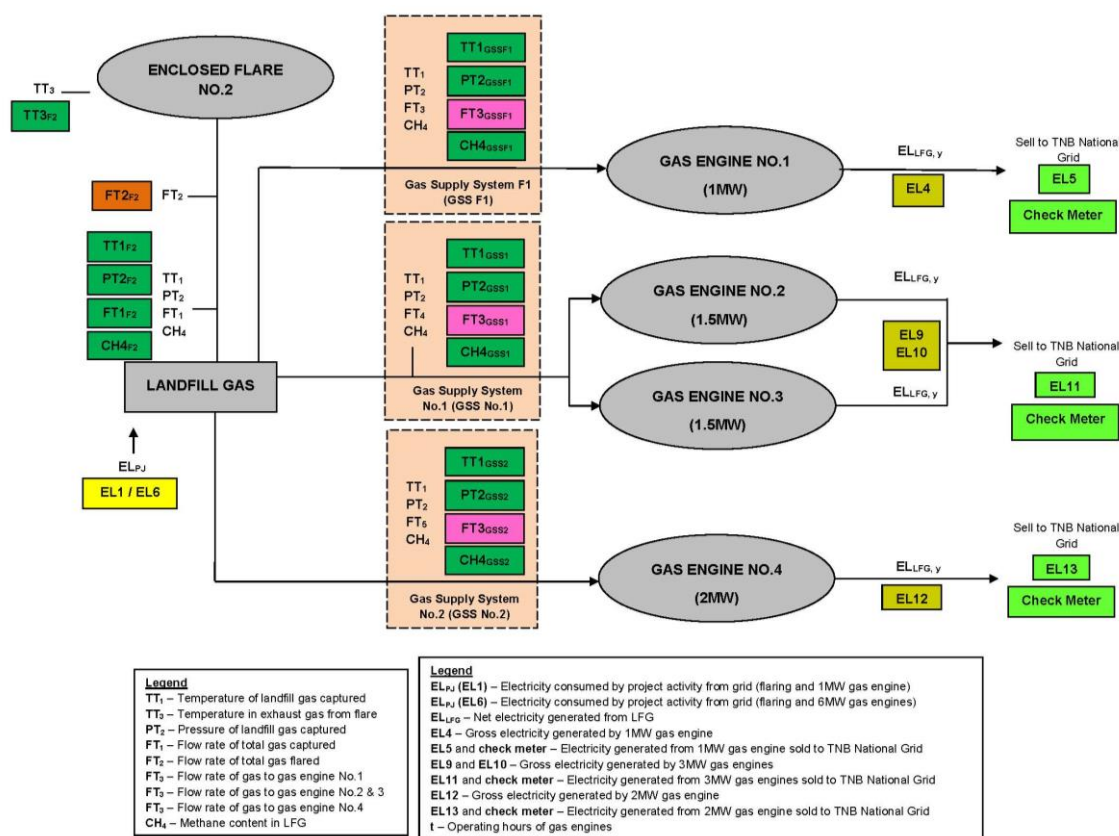


Figure 9: Key Parameters Monitored under the CDM Monitoring Plan

Landfill gas is captured and send to Enclosed Flare No.2, Gas Supply System F1 (GSSF1), 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} (GSS F1), 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, CH₄ 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	$T_t(T_{TT1,F2})$ $T_t(T_{TT1,GSS1})$ $T_t(T_{TT1,GSS2})$ $T_t(T_{TT1,GSSF1})$	TT _{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	$T_{EG,m}(T_{Flare,F2})$	TT _{3,Flare} 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	$P_t(P_{PT2,F2})$ $P_t(P_{PT2,GSS1})$ $P_t(P_{PT2,GSS2})$ $P_t(P_{PT2,GSSF1})$	PT _{2,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

Parameter	CDM ID	Equipment ID	Monitoring equipment	Recording frequency	Documentations	Data archive
Flowrate	$V_{t,wb}$ (LFG _{total} , Flare No.2,y) $V_{t,wb}$ (LFG _{flare} , Flare No.2,y) $V_{t,wb}$ (LFG _{electricity} , Flare No.2/GSS,y)	FT ₁ , Flare No.2 FT ₂ , Flare No.2 FT ₃ , Flare No.2/GSS1/GSS2/GSS F1	V-Cone Differential Pressure Flowmeter	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into PDF format for archiving
Methane Fraction	$V_{CH4,m,db}$ (W _{CH4} , Flare No.2/GSS,y)	CH ₄ , Flare No.2/GSS1/GSS2/GSS F1	Continuous Infrared Gas Analyser	Every 1 min (auto) Daily (manual) – as back-up	Softcopy Hardcopy	(.MDB MS Access database) Daily log sheet will be scanned into PDF format for archiving
Electricity consumed by the project	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)	kWh meter	Daily (manual)	Softcopy (scanned copy) Hardcopy	TNB joint meter reading certificate will be scanned for archiving

Parameter	CDM ID	Equipment ID	Monitoring equipment	Recording frequency	Document ations	Data archive
		TNB check energy meters				

NOTE:

Data recorded by the flow meters were normalised to Nm³ 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 below.

Table 3: List of CDM Monitoring Equipment and Calibration for Flare No.2

No	Item	Parameters	Equipment ID	CDM Monitoring ID	Unit	Manufacturer	Model No.	Serial No.	Accuracy	Range	Last Calibration Date & Cert No.	Recommended Next Calibration Date	Recommended Frequency of Calibration
Flare System													
1	Temperature Transmitter	Temperature (T)	TT _{1,Flare No.2}	T _t (T _{TT1,F2})	°C	Honeywell	STT25M-0-EN0-000-000-000-00-3D	B839917437	±0.5% of span	0-100°C	13/09/2017 & CTT 1957-17 (01/01/2018 - 10/10/2018)	12/09/2018	Annually
											11/10/2018 & CTT 3123-18 (11/10/2018 - 31/12/2018)	10/10/2019	Annually
2	Temperature Transmitter	Flare Temperature (T _{flare,y})	TT _{3,Flare No.2}	T _{EG,m} (T _{Flare,F2})	°C	Honeywell	STT25M-0-EN0-000-000-000-00-3D	B838901937	±0.5% of span	0-1200°C	13/09/2017 & CTT 1956-17 (01/01/2018 - 10/10/2018)	12/09/2018	Annually
											11/10/2018 & CTT 3124-18 (11/10/2018 - 31/12/2018)	10/10/2019	Annually
3	Pressure Sensor	Pressure Transmitter (P)	PT _{2,Flare No.2}	P _t (P _{PT2,F2})	kPa	Rosemount	3051TG1A2B21AB4E5Q4	5584784	±0.25%	0-40 kpa	13/09/2017 & CTP 4820-17 (01/01/2018 - 10/10/2018)	12/09/2018	Annually
											11/10/2018 & CTP 5488-18 (11/10/2018 - 31/12/2018)	10/10/2019	Annually
4	Flow Meter	Total Biogas Flow Rate (LFG _{total,y})	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	3051CD1A22A1AM5B4K5/ KVS10I1KC23FSN	5476626 / FT141 (10031702)	±0.5%	3-5000Nm ³ /h	13/09/2017 & CTP 4819-17 (01/01/2018 - 24/05/2018)	12/09/2019	24 months
							3051 / KVS10I1KC23FSN	4972946 / FT119 (8102101)	±1%		04/06/2018 & CTP 3706 - 18 (25/05/2018 - 31/12/2018)	03/06/2020	24 months
5	Flow Meter	Flaring Biogas Flow Rate (LFG _{flare,y})	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	3051CD1A22A1AM5K5Q4 / KVS10I1KC23FSN	5476627 / FT140 (10031701)	±0.5%	3-5000Nm ³ /h	13/09/2017 & CTP 4821-17 (01/01/2018 - 03/06/2018)	12/09/2019	24 months
											04/06/2018 & CTP3705 - 18 (04/06/2018 - 31/12/2018)	03/06/2020	24 months
Gas Analysers													
6	CH ₄ Meter	Methane fraction of LFG	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%	05/01/2017 & CTM 1003-17 (01/01/2018 - 03/06/2018)	04/01/2018	Annually
											04/06/2018 & CTM 1296-18 (04/06/2018 - 31/12/2018)	03/06/2019	Annually
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										

Notes:

1. FT1 – there was a change of FT1 (from serial number of 5476626 to 4972946) on 25/05/2018 due to unstable reading of FT1 caused by lightning strike.

During this monitoring period, maximum permission error are applied for the equipment which has an delay calibration as conservative approach is as listed below:

1. TT1 - the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to TT1 from 13/09/2018 - 10/10/2018.
2. TT3 - the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to TT3 from 13/09/2018 - 10/10/2018.
3. PT2 - the maximum permissible error of ±0.25% which is the equipment accuracy error was applied to PT2 from 13/09/2018 - 10/10/2018.
4. CH4 - the maximum permissible error of ±2.0% which is the equipment accuracy error was applied to CH4 from 05/01/2018 - 03/06/2018.

Table 4: List of CDM Monitoring Equipment and Calibration for GSS1 (GE No. 2 and GE No. 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	Recommended Frequency of Calibration
Gas Supply System													
1	Temperature Transmitter	Temperature (T)	TT _{1,GSS1}	T _t (T _{TT1,GSS1})	°C	Honeywell	STT25M-0-ENS-000-000-00-3H	B527143837	±1%	0-100°C	13/09/2017 & CTT 1955-17 (01/01/2018 - 10/10/2018) 11/10/2018 & CTT 3125- 18 (11/10/2018-31/12/2018)	12/09/2018 10/10/2019	Annually Annually
2	Pressure Sensor	Pressure Transmitter (P)	PT _{2,GSS1}	P _t (P _{PT2,GSS1})	kPa	Rosemount	3051TG1A2B21AB4K5 M5	5916057	±0.1%	0-60 kPa	13/09/2017 & CTP 4817-17 (01/01/2018 - 10/10/2018) 11/10/2018 & CTP 5489- 18 (11/10/2018-31/12/2018)	12/09/2018 10/10/2019	Annually Annually
3	Flow Meter	Flow Rate of Total Gas to Energy (LFG _{electricity,y})	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 (01/01/2018 - 10/10/2018) 11/10/2018 & CTP 5490-18 (11/10/2018 - 31/12/2018)	06/06/2018 10/10/2020	24 months 24 months
4	CH ₄ Meter	Methane fraction of LFG	CH _{4,GSS1}	V _{CH4,m,db} (W _{CH4,GSS1,y})	%	Edinburgh	Guardian NG	8154	±2% of full scale	0-100%	09/11/2017 & AL-NG/0134/1117 (01/01/2018 - 10/10/2018)	08/11/2018	Annually
						Guardian Plus	97460	34140			11/10/2018 & CTM1627 (11/10/2018 - 26/12/2018)	10/10/2019	Annually
						Edinburgh	Guardian NG	14464			27/12/2018 & AL-ED/0185-1218 (27/12/2018 - 31/12/2018)	26/12/2019	Annually
Power Generation and Electricity Consumption													
5	Power meter	Grid for project activity	EL _{P,J} (EL6)	EG _{EC,y} (EL _{P,y})	kWh	IME	NEMO 96HDL	2661930098	Class 1 (±1%)	0-250/5A	23/07/2014 & 2661 9300 98 (01/01/2018 - 24/01/2018) 25/01/2018 & SP/RA/2018/065/002 (25/01/2018 - 31/12/2018)	22/07/2017 24/01/2021	36 months 36 months
6	Power meter	Gross generation from GE No.2	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 (01/01/2018 - 24/01/2018) 25/01/2018 & SP/RA/2018/065/003 (25/01/2018 - 31/12/2018)	12/05/2017 24/01/2020	24 months 24 months
7	Power meter	Gross generation from GE No.3	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 (01/01/2018 - 24/01/2018) 25/01/2018 & SP/RA/2018/065/004 (25/01/2018 - 31/12/2018)	12/05/2017 24/01/2020	24 months 24 months
8	Power meter	Electricity sold to grid (MWh) - recorded by grid operator	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 (01/01/2018 - 31/12/2018)	05/12/2014	5 years
9	Power meter	Electricity sell to grid (MWh) - check energy meter recorded by grid operator	-	-	kWh	EDMI Limited	Mk6E	908705154	Class 0.5S	99,999,999kWh	06/12/2009 & TNBM/PJ/09/076 (01/01/2018 - 31/12/2018)	05/12/2014	5 years

During this monitoring period, maximum permission error are applied for the equipment which has an delay calibration as conservative approach is as listed below:

1. TT1 - the maximum permissible error of $\pm 1\%$ which is the equipment accuracy error was applied to TT1 from 13/09/2018 - 10/10/2018.
2. PT2 - the maximum permissible error of $\pm 0.1\%$ which is the equipment accuracy error was applied to PT2 from 13/09/2018 - 10/10/2018.
3. FT3 - the maximum permissible error of 0.5% which is the equipment accuracy error was applied to FT3 from 07/06/2018 - 10/10/2018.
4. EL6 - the maximum permissible error of $\pm 1.0\%$ which is the equipment accuracy error was applied to EL6 from 01/01/2018 - 31/01/2018.
5. EL 9 - the maximum permissible error of $\pm 2.08\%$ which is equipment calibration error was applied to EL9 from 01/01/2018 - 31/01/2018
6. EL10 - the maximum permissible error of $\pm 1.14\%$ which is the equipment calibration error was applied to EL10 from 01/01/2018 - 31/01/2018.
7. EL11 - the maximum permissible error of 0.5% which is the equipment accuracy error was applied to EL11 from 01/01/2018 - 31/12/2018.

Table 5: List of CDM Monitoring Equipment and Calibration for GSS2 (GE No. 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	Temperature (T)	TT _{1,GSS2}	T _i (T _{TT1,GSS2})	°C	Autrol	ATT2100-S11HA3E1-M1	ATT21004151000	±0.1%	0-100°C	05/01/2017 & CTT 1005-17 (01/01/2018 - 03/06/2018)	04/01/2018	Annually
											04/06/2018 & CTT 2120-18 (04/06/2018 - 31/12/2018)	03/06/2019	Annually
2	Pressure Sensor	Pressure Transmitter (P)	PT _{2,GSS2}	P _i (P _{PT2,GSS2})	kPa	Autrol	APT3200-G4M11E11S1-M1	APT3200-4150998	±0.075% of span	-100-1,500kPa	05/01/2017 & CTP 1005-17 (01/01/2018 - 03/06/2018)	04/01/2018	Annually
											04/06/2018 & CTP 3662 -18 (04/06/2018 - 31/12/2018)	03/06/2019	Annually
3	Flow Meter	Flow Rate of Total Gas to Energy (LFG _{electricity,y})	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 (01/01/2018 - 09/12/2018)	22/06/2017	24 months
											10/12/2018 & C150327 (10/12/2018 - 31/12/2018)	09/12/2020	24 months
Gas Analyser													
4	CH ₄ Meter	Methane fraction of LFG	CH _{4,GSS2}	V _{CH4,m,db} (W _{CH4,GSS2,y})	%	Guardian Plus	97460	33542	±2% of full scale	0-100%	13/09/2017 & CTM1337-17 (01/01/2018 - 10/10/2018)	12/09/2018	Annually
											11/10/2018 & CTM 1628-18 (11/10/2018 - 31/12/2018)	10/10/2019	Annually
Power Generation and Electricity Consumption													
5	Power meter	Gross generation from GE No.4	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 (01/01/2018 - 07/08/2018)	03/02/2018	24 months
											08/08/2018 & SP/RA/2018/463/001-001 (08/08/2018 - 31/12/2018)	07/08/2020	24 months
6	Power meter	Electricity sold to grid (MWh) - recorded by grid operator	EL _{LFG} (EL13)	EG _{PJ,y} (EL _{LFG,y})	kWh	ltron	SL761W071	81480576	Class 0.2S	999999999kWh	14/06/2016 & TNB(B)/PP/UPH-PJ17/6/7-141 (01/01/2018 - 31/12/2018)	13/06/2021	5 years
7	Power meter	Electricity sell to grid (MWh) - check energy meter recorded by grid operator	-	-	kWh	ltron	SL761W071	81480578	Class 0.2S	999999999kWh	14/06/2016 & TNB(B)/PP/UPH-PJ17/6/7-141 (01/01/2018 - 31/12/2018)	13/06/2021	5 years

During this monitoring period, maximum permission error are applied for the equipment which has an delay calibration as conservative approach is as listed below:

1. TT1 - the maximum permissible error of ±0.2% which is the equipment calibration error was applied to TT1 from 05/01/2018 – 03/06/2018.
2. PT2 - the maximum permissible error of ±0.4% which is the equipment calibration error was applied to PT2 from 05/01/2018 – 03/06/2018.
3. FT3 - the maximum permissible error of ±2.7% which is the equipment accuracy error was applied to FT3 from 01/01/2018 – 09/12/2018.
4. CH4 - the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH4 from 13/09/2018 – 10/10/2018.
5. EL12 - the maximum permissible error of ±1.17% which is the equipment calibration error was applied to EL12 from 01/02/2018 – 31/08/2018.

Table 6: List of CDM Monitoring Equipment and Calibration for GSSF1 (GE 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
Gas Supply System													
1	Temperature Transmitter	Temperature (T)	TT ₁ , GSS F1	T _t (T _{TT1} , GSS F ₁)	°C	PR Electronics	5335A	100944768	± 0.05% of span	0-100°C	05/01/2017 & CTT 1004-17 (01/01/2018 - 03/06/2018)	04/01/2018	Annually
											04/06/2018 & CTT 2119-18 (04/06/2018 - 31/12/2018)	03/06/2019	Annually
2	Flow Meter	Flow Rate of Total Gas to Energy (LFG _{electricity,y})	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 (01/01/2018 - 31/12/2018)	04/01/2019	24 months
3	Pressure Sensor	Pressure Transmitter (P)	PT ₂ , GSS F1	P _t (P _{PT2} , GSS F ₁)	kPa	Rosemount	3051TG1A2B21AB4 E5M5Q4	02492864	±0.25%	0-2 to 0-207 kPa	05/01/2017 & CTP 1004-17 (01/01/2018 - 03/06/2018)	04/01/2018	Annually
											04/06/2018 & CTP 3661-18 (04/06/2018 - 31/12/2018)	03/06/2019	Annually
Gas Analysers													
4	CH ₄ Meter	Methane fraction of LFG	CH ₄ , GSS F1	V _{CH4, m, db} (W _{CH4,GSS F1,y})	%	Guardian Plus	97460	33436	±2% of full scale	0-100%	13/09/2017 & CTM 1338-17 (01/01/2018 - 06/10/2018)	12/09/2018	Annually
5	Portable CH4 Analyser	Methane fraction of LFG			%	Geotech	GA5000	G505823	±1.5%	0-100%	25/10/2018 & G505823_2/21707 (07/10/2018 - 31/12/2018)	24/10/2019	Annually
Power Generation and Electricity Consumption													
6	Power meter	Total electricity generation (MWh) - recorded by project site (Backup)	EL _{LFG,GE No.1} (EL1)	EG _{P,J,y} (EL _{LFG,GE No.1,y})	kWh	IME Nemo	96HO+	2167890035	Class 0.5S		3/10/2014 & SP/RA/2014/505/001-002 (01/01/2018-24/01/2018)	10/2/2017	36 months
											25/01/2018 & SP/RA/2018/065/001-004 (25/01/2018 - 31/12/2018)	24/01/2021	36 months
7	Power meter	Total electricity generation (MWh) - recorded by project site	EL _{LFG,GE No.1} (EL4)	EG _{P,J,y} (EL _{LFG,GE No.1,y})	kWh	EDMI Limited	Mk6E	210225256	Class 0.5S	99999999.99kWh	06/01/2017 & SP/RA/2017/014/001-001 (01/01/2018 - 31/1/2/2018)	06/01/2019	24 months
8	Power meter	Electricity sell to grid (MWh) - recorded by grid operator	EL _{LFG} (EL5)	EG _{P,J,y} (EL _{LFG,y})	kWh	ltron	SL761A071	53099690	Class 0.20	999999999kWh	01/04/2011 & TNBM-QR-064 (01/01/2018 - 31/12/2018)	31/03/2016	5 years
9	Power meter	Electricity sell to grid (MWh) - check energy meter recorded by grid operator	-	-	kWh	ltron	SL761A071	53099691	Class 0.20	999999999kWh	01/04/2011 & TNBM-QR-064 (01/01/2018 - 31/12/2018)	31/03/2016	5 years

During this monitoring period, maximum permission error are applied for the equipment which has an delay calibration as conservative approach is as listed below:

1. TT1 –the maximum permissible error of ±0.3% which is equipment calibration error was applied to TT1 from 05/01/2018 – 03/06/2018.
2. PT2 –the maximum permissible error of ±0.25% which is the equipment accuracy error was applied to PT2 from 05/01/2018 – 03/06/2018.
3. CH₄ - the maximum permissible error of ±2% which is the equipment accuracy error was applied to CH₄ from 13/09/2018 – 06/10/2018.

CH₄ analyser was malfunctioned started on 07/10/18, and sent for service on 14/11/18, according to approved PDD version 20.5, page 76, in case of temporary situation such as the installed CH₄ gas analyser malfunctioned or giving unrepresentative results due to data logging problem, the V_{CH₄} shall be measured manually with portable gas analyser, as conservative approach, the lower bound of the 95% Confidence Interval will be applied as per guideline.

The CH4 was recorded using portable analyser during the period from 07/10/18 – 31/12/18. 95% CI was performed to the results, and applied in the calculation. Due to delay in calibration of portable analyser, the maximum permissible error of $\pm 1.5\%$ which is the equipment accuracy error was applied to CH4 from 07/10/2018 – 24/10/2018 as a conservative approach.

4. EL5 - the maximum permissible error of $\pm 0.2\%$ which is the equipment accuracy error was applied to EL5 from 01/01/2018 – 31/12/2018.
5. EL1 – As a backup meter.

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 2

1. TT1 – Due to delay calibration, the maximum permissible error of $\pm 0.5\%$ which is the equipment accuracy error was applied to TT1 from 13/09/2018 – 10/10/2018 as a conservative approach.
2. TT3 – Due to delay calibration, the maximum permissible error of $\pm 0.5\%$ which is the equipment accuracy error was applied to TT3 from 13/09/2018 – 10/10/2018 as a conservative approach.
3. PT2 – Due to delay in calibration, the maximum permissible error of $\pm 0.25\%$ which is the equipment accuracy error was applied to PT2 13/09/2018 – 10/10/2018 as a conservative approach.
4. CH4 – Due to delay in calibration, the maximum permissible error of $\pm 2\%$ which is the equipment accuracy error was applied to CH4 from 05/01/2018 – 03/06/2018 as a conservative approach

List of Equipment from GSS1

1. TT1 – Due to delay in calibration, the maximum permissible error of $\pm 1\%$ which is the equipment accuracy error was applied to TT1 from 13/09/2018 – 10/10/2018 as a conservative approach.
2. PT2 – Due to delay in calibration, the maximum permissible error of $\pm 0.1\%$ which is the equipment accuracy error was applied to PT2 from 13/09/2018 - 10/10/2018 as a conservative approach.
3. FT3 – Due to delay in calibration, the maximum permissible error of 0.5% which is the equipment accuracy error was applied to FT3 from 07/06/2018 – 10/10/2018 as a conservative approach.
4. EL6 – Due to delay in calibration, the maximum permissible error of $\pm 1.0\%$ which is the equipment accuracy error was applied to EL6 from 01/01/2018 - 31/01/2018 as a conservative approach.
5. EL9 – Due to delay in calibration, the maximum permissible error of $\pm 0.08\%$ which is the equipment calibration error was applied to EL9 from 01/01/2018 - 31/01/2018 as a conservative approach.
6. EL10 – Due to delay in calibration, the maximum permissible error of $\pm 1.14\%$ which is the equipment calibration error was applied to EL10 from 01/01/2018 - 31/01/2018 as a conservative approach.

List of Equipment from GSS2

1. TT1 – Due to delay in calibration, the maximum permissible error of $\pm 0.2\%$ which is the equipment calibration error was applied to TT1 from 05/01/2018 – 03/06/2018 as a conservative approach.
2. PT2 – Due to delay in calibration, the maximum permissible error of $\pm 0.4\%$ which is the equipment calibration error was applied to PT2 from 05/01/2018 – 03/06/2018 as a conservative approach.
3. CH4 – Due to delay in calibration, the maximum permissible error of $\pm 2\%$ which is the equipment accuracy error was applied to CH4 from 13/09/2018 – 10/10/2018 as a conservative approach.
4. FT3 - Due to delay in calibration, the maximum permissible error of $\pm 2.7\%$ which is the equipment accuracy error was applied to FT3 from 01/01/2018 – 09/12/2018 as a conservative approach.
5. EL12 - Due to delay in calibration, the maximum permissible error of $\pm 1.17\%$ which is the equipment calibration error was applied to EL12 from 01/02/2018 – 31/08/2018 as a conservative approach

List of Equipment from GSS F1

1. TT1 – Due to delay in calibration, the maximum permissible error of $\pm 0.3\%$ which is the equipment calibration error was applied to TT1 from 05/01/2018 – 03/06/2018 as a conservative approach.
2. PT2 – Due to delay in calibration, the maximum permissible error of $\pm 0.25\%$ which is the equipment accuracy error was applied to PT2 from 05/01/2018 – 03/06/2018 as a conservative approach.

3. CH₄ - the maximum permissible error of $\pm 2\%$ which is the equipment accuracy error was applied to CH₄ from 13/09/2018 - 06/10/2018. CH₄ analyser was malfunctioned started on 07/10/18, and sent for service on 14/11/18, according to approved PDD version 20.5, page 76, in case of temporary situation such as the installed CH₄ gas analyser malfunctioned or giving unrepresentative results due to data logging problem, the VCH₄ shall be measured manually with portable gas analyser, as conservative approach, the lower bound of the 95% Confidence Interval will be applied as per guideline. As a result, the CH₄ was recorded using portable analyser during the period from Oct – Dec 18. 95% CI was performed to the results, and applied in the calculation. Due to delay in calibration of portable analyser, the maximum permissible error of $\pm 1.5\%$ which is the equipment accuracy error was applied to CH₄ from 07/10/2018 – 24/10/2018 as a conservative approach.

With reference to the CDM validation and verification standard for project activities, version 02.0, section 9.2.6, paragraph 368, “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 366 above”.

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

List of Equipment from GSSF1

1. EL5 (Itron, serial no.: 53099690) – The meter is owned by the grid operator, TNB and thus, it is not within the control of the project owner. However, due to delay in calibration, the maximum permissible error of $\pm 0.2\%$ which is the equipment accuracy error was applied to EL5 from 01/01/2018 – 31/12/2018 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 owner. However, due to delay in calibration, the maximum permissible error of $\pm 0.5\%$ which is the equipment accuracy error was applied to EL11 from 01/01/2018 – 31/12/2018 as a conservative approach.

Data Collection (for the whole monitoring period)

Based on the monitoring plan, key flaring parameters (temperature, pressure, flow of gas, CH₄ 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:

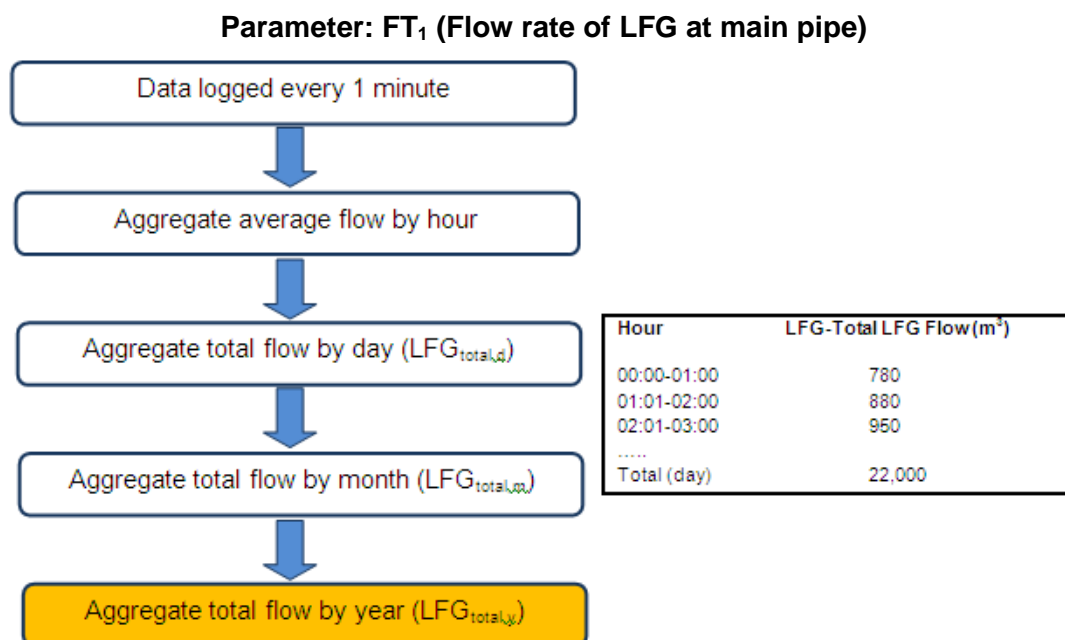


Figure 10: Example of Data Aggregation for Continuous Monitoring

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 % CH₄.

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:

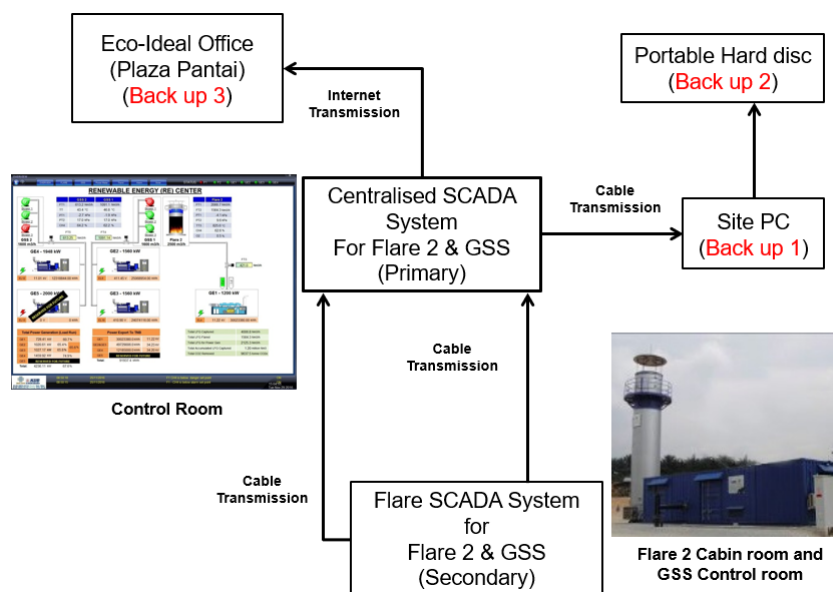


Figure 11: Automatic Data Back-Up for Flaring System at BTSL

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.

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.

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

No.	Description	Date	No. of participants
1	Landfill Gas Operation – Refresher Training for Gas Well Monitoring	15/02/2018	7
2	Landfill Gas- Condensate Pump Maintenance	19/04/2018	7
3	LFG – Flare 2 Blower Maintenance Check	16/07/2018	6
4	Training – Landfill Gas SCADA System Data Log	18/7/2018	7
5	RE – GCP for Gas Engine (Engine Start Up & Monitoring	10/10/2018	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_{CH_4}
Unit	tCO ₂ e/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%

“Emissions from solid waste disposal sites” (Version 07.0)

Data / Parameter	Φ_{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	$\Phi_y = \Phi_{\text{default}} \cdot 0.75$ 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	$\text{DOC}_{f,\text{default}}$
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 <i>j</i> (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)	<p>The following values for the different waste types <i>j</i> are applied:</p> <table border="1"> <thead> <tr> <th>Waste type <i>j</i></th><th>DOC_j (% wet basis)</th></tr> </thead> <tbody> <tr> <td>Wood and wood products</td><td>43</td></tr> <tr> <td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr> <tr> <td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr> <tr> <td>Textiles</td><td>24</td></tr> <tr> <td>Garden, yard and park waste</td><td>20</td></tr> <tr> <td>Glass, plastic, metal, other inert waste</td><td>0</td></tr> </tbody> </table>	Waste type <i>j</i>	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
Waste type <i>j</i>	DOC _j (% wet basis)														
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Garden, yard and park waste	20														
Glass, plastic, metal, other inert waste	0														
Choice of data or measurement methods and procedures	-														
Purpose of data	Baseline emissions calculation														
Additional comment	-														

Data / Parameter	k_j															
Unit	1/yr															
Description	Decay rate for the waste type j															
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)															
Value(s) applied)	<p>The following values for the different waste types j is applied:</p> <p style="text-align: center;">Default values for k_j</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <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> </thead> <tbody> <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> </tbody> </table> <p>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.</p>	Waste type j		Tropical (MAT > 20°C)	Wet (MAP > 1,000 mm)	Slowly degrading	Pulp, paper, cardboard (other than sludge), textiles	0.07	Wood, wood products and straw	0.035	Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.17	Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.40
Waste type j				Tropical (MAT > 20°C)												
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Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.40														
Choice of data or measurement methods and procedures	-															
Purpose of data	Baseline emissions calculation															
Additional comment	-															

“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 <i>k</i> in year <i>y</i>
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.

“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 <i>y</i>
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 2 nd 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	-

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

Data / Parameter	$EF_{grid,BM,y}$
Unit	tCO ₂ /MWh
Description	Build margin emission factor for the grid in year <i>y</i>
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 2 nd 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 <i>y</i>
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 $EF_{grid,CM,y}$ is calculated using published data by Green Tech Centre (GTC) CDM Secretariat in 2014 using version 04.0 of the tool. For 2 nd 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	-

“Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0)

Data / Parameter	MM_{H₂O}
Unit	kg/kmol
Description	Molecular mass of H ₂ O
Source of data	Methodological tool “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (<i>Version 03.0</i>)
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 greenhouse gas in a gaseous stream” (<i>Version 03.0</i>)
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 greenhouse gas in a gaseous stream” (<i>Version 03.0</i>)
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 greenhouse gas in a gaseous stream" (<i>Version 03.0</i>)
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 greenhouse gas in a gaseous stream" (<i>Version 03.0</i>)
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	-

Data / Parameter	Op _{j,h}																													
Unit	-																													
Description	Operation of the equipment that consumes the LFG																													
Measured/calculated/default	Measured																													
Source of data	Project participant																													
Value(s) of monitored parameter	On or Off for flare temperature and gas engine, refer to T _{EG,m} <table border="1"> <thead> <tr> <th rowspan="2">Months</th><th>Operating Time (Hr)</th></tr> <tr> <th>Flare No. 2</th></tr> </thead> <tbody> <tr><td>January 18</td><td>736</td></tr> <tr><td>February 18</td><td>668</td></tr> <tr><td>March 18</td><td>701</td></tr> <tr><td>April 18</td><td>486</td></tr> <tr><td>May 18</td><td>155</td></tr> <tr><td>June 18</td><td>719</td></tr> <tr><td>July 18</td><td>744</td></tr> <tr><td>August 18</td><td>723</td></tr> <tr><td>September 18</td><td>697</td></tr> <tr><td>October 18</td><td>686</td></tr> <tr><td>November 18</td><td>660</td></tr> <tr><td>December 18</td><td>731</td></tr> <tr><td>Total</td><td>7,705</td></tr> </tbody> </table>	Months	Operating Time (Hr)	Flare No. 2	January 18	736	February 18	668	March 18	701	April 18	486	May 18	155	June 18	719	July 18	744	August 18	723	September 18	697	October 18	686	November 18	660	December 18	731	Total	7,705
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Total	7,705																													

	Months	Operating Time (Hr)			
		Gas Engine No.1	Gas Engine No.2	Gas Engine No.3	Gas Engine No.4
	January 18	63	711	0	730
	February 18	0	660	334	657
	March 18	0	698	653	667
	April 18	0	541	390	624
	May 18	0	729	268	688
	June 18	0	231	462	114
	July 18	0	0	731	526
	August 18	0	592	639	683
	September 18	395	104	703	581
	October 18	367	0	318	337
	November 18	1	60	16	0
	December 18	493	731	738	0
	Total	1,319	5,057	5,252	5,607
	Gas Engine No. 4 was stopped operation from Nov – Dec 18 due to electrical and maintenance work.				
Monitoring equipment	-				
Measuring/reading/recording frequency	Hourly				
Calculation method (if applicable)	<p>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:</p> <ul style="list-style-type: none"> • 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 <p>Flare temperature will be selected for the monitoring. Gas engine operation hour will be used for cross checking.</p> <p>Opj,h = 0 when:</p> <ul style="list-style-type: none"> • 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. <p>Otherwise, Opj,h = 1.</p>				
QA/QC procedures	<p>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</p>				

	<p>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 $T_{EG,m}$.</p> <p>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.</p>
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	<p>Data as measured by electricity meters.</p> <p>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.</p>																										
Value(s) of monitored parameter	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>The detailed calculation was shown in the CER calculation sheet under each monthly ‘EL_{PJ}’ tab.</p> <table><tr><th rowspan="2">Months</th><th colspan="3">Net electricity generated (MWh) $EG_{PJ,y}$</th><th rowspan="2">Total amount of electricity generated (MWh)</th></tr><tr><th>$EL_{LFG,GE\ No.1,y}$</th><th>$EL_{LFG,GE\ No.2,y}$ & $EL_{LFG,GE\ No.3,y}$</th><th>$EL_{LFG,GE\ No.4,y}$</th></tr><tr><td>January 2018</td><td>37.59</td><td>883.35</td><td>1,082.76</td><td>2,003.70</td></tr><tr><td>February 2018</td><td>0.00</td><td>971.59</td><td>879.53</td><td>1,851.12</td></tr><tr><td>March 2018</td><td>0.00</td><td>1,244.51</td><td>912.37</td><td>2,156.87</td></tr></table>				Months	Net electricity generated (MWh) $EG_{PJ,y}$			Total amount of electricity generated (MWh)	$EL_{LFG,GE\ No.1,y}$	$EL_{LFG,GE\ No.2,y}$ & $EL_{LFG,GE\ No.3,y}$	$EL_{LFG,GE\ No.4,y}$	January 2018	37.59	883.35	1,082.76	2,003.70	February 2018	0.00	971.59	879.53	1,851.12	March 2018	0.00	1,244.51	912.37	2,156.87
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December 2018	258.42	1,432.96	0.00	1,691.38																																																																			
Total	849.06	9,608.59	7,796.13	18,253.78																																																																			
Monitoring equipment	<table border="1"> <tr> <th rowspan="2">Item</th><th>EG_{PJ,y} (EL_{LFG,GE No.1,y}) Description (EL4)</th><th colspan="2">EG_{PJ,y} (EL_{LFG,GE No.1,y}) Description (EL5) 01/01/2018 – 31/12/2018</th></tr> <tr> <th>01/01/2018 – 31/12/2018</th><th>Main meter</th><th>Check meter</th></tr> <tr> <td>Type</td><td>EDMI Limited (Mk6E) Power Meter</td><td colspan="2">Itron (SL761A071) Power Meter</td></tr> <tr> <td>Accuracy class</td><td>Class 0.5S</td><td colspan="2">Class 0.20</td></tr> <tr> <td>Serial No.</td><td>210225256</td><td>53099690</td><td>53099691</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>06/01/2017</td><td colspan="2">01/04/2011</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> <p>EL5 (Itron, serial no.: 53099690) – The meter is owned by the grid operator, TNB and thus, it is not within the control of the project owner. However, due to delay in calibration, the maximum permissible error of $\pm 0.2\%$ which is the equipment accuracy error was applied to EL5 from 01/01/2018 – 31/12/2018 as a conservative approach.</p> <table border="1"> <tr> <th rowspan="2">Item</th><th colspan="2">EG_{PJ,y} (EL_{LFG,GE No.2,y}) Description (EL9)</th><th colspan="2">EG_{PJ,y} (EL_{LFG,GE No.3,y}) Description (EL10)</th></tr> <tr> <th colspan="2">01/01/2018 – 31/12/2018</th><th colspan="2">01/01/2018 – 31/12/2018</th></tr> <tr> <td>Type</td><td colspan="2">EDMI Limited (Genius) Power Meter</td><td colspan="2">EDMI Limited (Genius) Power Meter</td></tr> <tr> <td>Accuracy class</td><td colspan="2">Class 0.5S</td><td colspan="2">Class 0.5S</td></tr> <tr> <td>Serial No.</td><td colspan="2">211516862</td><td colspan="2">211516863</td></tr> <tr> <td>Calibration frequency</td><td colspan="2">24 months</td><td colspan="2">24 months</td></tr> <tr> <td>Date of last calibration</td><td>13/05/2015</td><td>25/01/2018</td><td>13/05/2015</td><td>25/01/2018</td></tr> <tr> <td>Validity</td><td colspan="2">24 months</td><td colspan="2">24 months</td></tr> </table> <p>EL9 and EL10 – Due to delay in calibration, the maximum permissible error of $\pm 2.08\%$ and $\pm 1.14\%$ respectively which is the equipment calibration error was applied to EL9 and EL10 from 01/01/2018 – 31/01/2018 as a conservative approach.</p>	Item	EG _{PJ,y} (EL _{LFG,GE No.1,y}) Description (EL4)	EG _{PJ,y} (EL _{LFG,GE No.1,y}) Description (EL5) 01/01/2018 – 31/12/2018		01/01/2018 – 31/12/2018	Main meter	Check 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	06/01/2017	01/04/2011		Validity	24 months	5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)		Item	EG _{PJ,y} (EL _{LFG,GE No.2,y}) Description (EL9)		EG _{PJ,y} (EL _{LFG,GE No.3,y}) Description (EL10)		01/01/2018 – 31/12/2018		01/01/2018 – 31/12/2018		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	25/01/2018	13/05/2015	25/01/2018	Validity	24 months		24 months	
Item	EG _{PJ,y} (EL _{LFG,GE No.1,y}) Description (EL4)		EG _{PJ,y} (EL _{LFG,GE No.1,y}) Description (EL5) 01/01/2018 – 31/12/2018																																																																				
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Validity	24 months		24 months																																																																				

	Item	EG_{PJ,y} (EL_{LFG,y}) Description (EL11)			
		01/01/2018 – 31/12/2018			
		Main energy meter	Check energy meter		
	Type	EDMI (Mk6E) Power Meter			
	Accuracy class	Class 0.5S			
	Serial No.	908705152	908705154		
	Calibration frequency	5 years			
	Date of last calibration	06/12/2009			
	Validity	5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)			
	<p>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 owner. However, due to delay in calibration, the maximum permissible error of $\pm 0.5\%$ which is the equipment accuracy error was applied to EL11 from 01/01/2018 – 31/12/2018 as a conservative approach.</p>				
	Item	EG_{PJ,y} (EL_{LFG,GE No.4,y}) Description (EL12)		EG_{PJ,y} (EL_{LFG,y}) Description (EL13)	
		01/01/2018 – 31/12/2018		01/01/2018 – 31/12/2018	
				Main energy meter	Check energy meter
	Type	EDMI Limited (2000-6N00-30A31-04-L00-02A2-1D) Power Meter		Itron (SL761W071) Power Meter	
	Accuracy class	Class 0.5S		Class 0.2S	
	Serial No.	213545834		81480576	81480578
	Calibration frequency	24 months		5 years	
	Date of last calibration	04/02/2016	08/08/2018	14/06/2016	
	Validity	24 months		5 years (Type 2 according to the Malaysian Grid Code, version 1/2010)	
	<p>EL12 - Due to delay in calibration, the maximum permissible error of $\pm 1.17\%$ which is the equipment calibration error was applied to EL12 from 01/02/2018 – 30/08/2018 as a conservative approach.</p>				
Measuring/reading/recording frequency	Measured continuously with electricity meter installed				
Calculation method (if applicable)	N/A				

QA/QC procedures	<p>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.</p> <p>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.</p> <p>The meters EL5, EL11 and EL13 are owned by the grid operator and thus, they are not within the control of the project owner. The calibration of these meters will be based on the grid operator's requirement and standard practice.</p>
Purpose of data/parameter	Baseline emissions calculation
Additional comment	-

Data / Parameter	EG_{EC,y}
Unit	MWh
Description	Amount of electricity consumed by the project activity in year y
Measured/calculated/default	Measured
Source of data	<p>Based on continuous measurement by sealed electricity meter installed.</p> <p>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 2, Gas Engine No.1, Gas Engine No.2, Gas Engine No.3, and Gas Engine No.4).</p> <p>In case of temporary situation such as the installed electricity meter malfunctioned (EL6) leading to no readings captured, EG_{EC,y} shall be estimated or calculated as described as below:</p> <ol style="list-style-type: none"> 1. Using the backup meter EL1 which recorded the actual power consumption for Flare 2 and GSSF1; 2. For Gas Engine No. 2, Gas Engine No.3, and Gas Engine No.4 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. <p>In the case, temporary situation where EL1 is mal-functioned leading to no reading captured, the power consumption for Flare 1, Flare 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</p>

	the upper bound of the interval boundaries calculated to account for transmission and distribution losses, according to PRC-2467-02.																												
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th>Months</th><th>Electricity consumed $EG_{EC,y}$ (EL6) (MWh)</th></tr> </thead> <tbody> <tr><td>January 2018</td><td>123.85</td></tr> <tr><td>February 2018</td><td>126.06</td></tr> <tr><td>March 2018</td><td>152.45</td></tr> <tr><td>April 2018</td><td>125.79</td></tr> <tr><td>May 2018</td><td>132.45</td></tr> <tr><td>June 2018</td><td>76.92</td></tr> <tr><td>July 2018</td><td>116.72</td></tr> <tr><td>August 2018</td><td>156.36</td></tr> <tr><td>September 2018</td><td>146.55</td></tr> <tr><td>October 2018</td><td>98.74</td></tr> <tr><td>November 2018</td><td>33.13</td></tr> <tr><td>December 2018</td><td>137.63</td></tr> <tr><td>Total</td><td>1,426.65</td></tr> </tbody> </table>	Months	Electricity consumed $EG_{EC,y}$ (EL6) (MWh)	January 2018	123.85	February 2018	126.06	March 2018	152.45	April 2018	125.79	May 2018	132.45	June 2018	76.92	July 2018	116.72	August 2018	156.36	September 2018	146.55	October 2018	98.74	November 2018	33.13	December 2018	137.63	Total	1,426.65
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Validity	3 years according to manufacturer's recommendation																												
Measuring/reading/recording frequency	Continuous measurement																												
Calculation method (if applicable)	N/A																												
QA/QC procedures	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																												
Purpose of data/parameter	Project emission calculation																												
Additional comment	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"																												

“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	<table border="1"> <thead> <tr> <th>Months</th><th>Flare No.2 Value (%)</th><th>GSS1 Value (%)</th><th>GSS2 Value (%)</th><th>GSSF1 Value (%)</th></tr> </thead> <tbody> <tr><td>January 2018</td><td>0.60</td><td>0.68</td><td>0.54</td><td>0.59</td></tr> <tr><td>February 2018</td><td>0.58</td><td>0.68</td><td>0.52</td><td>0.00</td></tr> <tr><td>March 2018</td><td>0.59</td><td>0.65</td><td>0.55</td><td>0.00</td></tr> <tr><td>April 2018</td><td>0.62</td><td>0.63</td><td>0.57</td><td>0.00</td></tr> <tr><td>May 2018</td><td>0.63</td><td>0.54</td><td>0.60</td><td>0.00</td></tr> <tr><td>June 2018</td><td>0.62</td><td>0.54</td><td>0.60</td><td>0.00</td></tr> <tr><td>July 2018</td><td>0.62</td><td>0.67</td><td>0.60</td><td>0.00</td></tr> <tr><td>August 2018</td><td>0.59</td><td>0.61</td><td>0.57</td><td>0.00</td></tr> <tr><td>September 2018</td><td>0.59</td><td>0.62</td><td>0.57</td><td>0.55</td></tr> <tr><td>October 2018</td><td>0.61</td><td>0.62</td><td>0.57</td><td>0.58</td></tr> <tr><td>November 2018</td><td>0.63</td><td>0.58</td><td>0.00</td><td>0.00</td></tr> <tr><td>December 2018</td><td>0.60</td><td>0.51</td><td>0.00</td><td>0.59</td></tr> <tr> <td>Average</td><td>0.61</td><td>0.61</td><td>0.57</td><td>0.58</td></tr> </tbody> </table>	Months	Flare No.2 Value (%)	GSS1 Value (%)	GSS2 Value (%)	GSSF1 Value (%)	January 2018	0.60	0.68	0.54	0.59	February 2018	0.58	0.68	0.52	0.00	March 2018	0.59	0.65	0.55	0.00	April 2018	0.62	0.63	0.57	0.00	May 2018	0.63	0.54	0.60	0.00	June 2018	0.62	0.54	0.60	0.00	July 2018	0.62	0.67	0.60	0.00	August 2018	0.59	0.61	0.57	0.00	September 2018	0.59	0.62	0.57	0.55	October 2018	0.61	0.62	0.57	0.58	November 2018	0.63	0.58	0.00	0.00	December 2018	0.60	0.51	0.00	0.59	Average	0.61	0.61	0.57	0.58
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Monitoring equipment																																																																							
Measuring/reading/recording frequency	For application A: Once for the crediting period ($f_y = f$)																																																																						
Calculation method (if applicable)	N/A																																																																						
QA/QC procedures	-																																																																						
Purpose of data/parameter	Baseline emissions calculation																																																																						
Additional comment	This is for reporting purposes, and not applied in the ER calculation																																																																						

“Project emissions from flaring” (Version 02.0.0)

Data / Parameter	$T_{EG,m}(T_{Flare,F2})$																												
Unit	°C																												
Description	Temperature in the exhaust gas of the enclosed flare in minute <i>m</i>																												
Measured/calculated/default	Measured																												
Source of data	Project participant																												
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th>Months</th><th>$T_{EG,m}(T_{Flare,F2})$ (°C)</th></tr> </thead> <tbody> <tr><td>January 2018</td><td>708.89</td></tr> <tr><td>February 2018</td><td>659.88</td></tr> <tr><td>March 2018</td><td>572.48</td></tr> <tr><td>April 2018</td><td>608.34</td></tr> <tr><td>May 2018</td><td>611.08</td></tr> <tr><td>June 2018</td><td>706.66</td></tr> <tr><td>July 2018</td><td>621.19</td></tr> <tr><td>August 2018</td><td>562.25</td></tr> <tr><td>September 2018</td><td>595.16</td></tr> <tr><td>October 2018</td><td>687.15</td></tr> <tr><td>November 2018</td><td>720.73</td></tr> <tr><td>December 2018</td><td>548.49</td></tr> <tr><td>Average</td><td>633.53</td></tr> </tbody> </table>	Months	$T_{EG,m}(T_{Flare,F2})$ (°C)	January 2018	708.89	February 2018	659.88	March 2018	572.48	April 2018	608.34	May 2018	611.08	June 2018	706.66	July 2018	621.19	August 2018	562.25	September 2018	595.16	October 2018	687.15	November 2018	720.73	December 2018	548.49	Average	633.53
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Date of last calibration	13/09/2017 11/10/2018																												
Validity	1 year																												
Measuring/reading/recording frequency	Once per minute																												
Calculation method (if applicable)	<p>Measure the temperature of the exhaust gas in the flare by an appropriate temperature measurement equipment.</p> <p>The temperature of the exhaust gas in the flares is measured by temperature transmitters.</p> <p>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</p>																												

	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 <i>m</i>
Measured/calculated/default	Measured
Source of data	Project participant
Value(s) of monitored parameter	On or Off, refer to $V_{t,wb}$
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. For this monitoring period, the flame detection is monitored and cross checked with the amount of gas sent to flare (FT2).

“Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0)

Data / Parameter	$V_{t,wb}$ (LFG _{Flare, 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.2, (FT2 _{Flare No.2}), GSS1 (FT3 _{GSS1}), GSS2 (FT3 _{GSS2}), and GSS F1 (FT3 _{GSSF1}).																												
Value(s) of monitored parameter	<p><u>LGF_{total} - Total amount of LFG sent to flare/captured during the project at normal temperature and pressure:</u></p> <p><u>Flare No.2</u> 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.</p> <p>However, as Gas Engine No.1 was converted to GSSF1 which started 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.</p> <table border="1"> <thead> <tr> <th>Months</th><th>$V_{t,wb}$ (LFG_{Flare,Flare No.2,y}) FT_{2, Flare No.2} (Nm³)</th></tr> </thead> <tbody> <tr><td>January 2018</td><td>716,697</td></tr> <tr><td>February 2018</td><td>708,255</td></tr> <tr><td>March 2018</td><td>583,529</td></tr> <tr><td>April 2018</td><td>463,915</td></tr> <tr><td>May 2018</td><td>145,425</td></tr> <tr><td>June 2018</td><td>754,175</td></tr> <tr><td>July 2018</td><td>682,316</td></tr> <tr><td>August 2018</td><td>626,716</td></tr> <tr><td>September 2018</td><td>591,771</td></tr> <tr><td>October 2018</td><td>719,538</td></tr> <tr><td>November 2018</td><td>884,758</td></tr> <tr><td>December 2018</td><td>684,163</td></tr> <tr><td>Total</td><td>7,561,259</td></tr> </tbody> </table> <p><u>GSSF1 (Gas Engine No.1), GSS1 (Gas Engine No.2 and 3) and GSS2 (Gas Engine No.4)</u> 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</p>	Months	$V_{t,wb}$ (LFG _{Flare,Flare No.2,y}) FT _{2, Flare No.2} (Nm ³)	January 2018	716,697	February 2018	708,255	March 2018	583,529	April 2018	463,915	May 2018	145,425	June 2018	754,175	July 2018	682,316	August 2018	626,716	September 2018	591,771	October 2018	719,538	November 2018	884,758	December 2018	684,163	Total	7,561,259
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Total	7,561,259																												

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}) FT _{3, GSS1} (Nm ³)	$V_{t,wb}$ (LFG _{electricity,GSS2,y}) FT _{3, GSS2} (Nm ³)	$V_{t,wb}$ (LFG _{electricity,GSSF1,y}) FT _{3, GSSF1} (Nm ³)
January 2018	454,757	481,180	24,029
February 2018	531,981	416,674	0
March 2018	715,234	433,856	0
April 2018	525,454	418,530	0
May 2018	444,494	453,434	0
June 2018	323,748	65,592	0
July 2018	381,939	332,308	0
August 2018	597,323	453,841	0
September 2018	435,602	386,571	199,314
October 2018	190,506	190,881	189,349
November 2018	29,129	0	0
December 2018	810,995	0	176,385
Total	5,441,164	3,632,865	589,077

Monitoring equipment

Item	Flare No.2, LFG _{flare,Flare No.2,y} (FT _{1, Flare No.2})	
	01/01/2018 – 24/05/2018	25/05/2018 – 31/12/2018
Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	
Accuracy class	± 0.5%	
Serial No.	5476626 (Rosemount) / FT141 (10031702) (Kingways)	4972946 (Rosemount) / FT119 (8102101) (Kingways)
Calibration frequency	24 months	
Date of last calibration	13/09/2017	04/06/2018
Validity	24 months	

Item	Flare No.2, LFG _{flare,Flare No.2,y} (FT _{2, Flare No.2})	
	01/01/2018 – 03/06/2018	04/06/2018 – 31/12/2018
Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone	
Accuracy class	± 0.5%	
Serial No.	5476627 (Rosemount) / FT140 (10031701) (Kingways)	
Calibration frequency	24 months	
Date of last calibration	13/09/2017	04/06/2018
Validity	24 months	

	Item	GSS1, LFG_{electricity,GSS1,y} (FT₃, GSS1)			
		01/01/2018 – 31/12/2018			
	Type	Flow transmitter – Rosemount			
	Accuracy class	± 0.5%			
	Serial No.	5988022			
	Calibration frequency	24 months			
	Date of last calibration	07/06/2016	11/10/2018		
	Validity	24 months			
	Item	GSS2, LFG_{electricity,GSS2,y} (FT₃, GSS2)			
		01/01/2018 – 31/12/2018			
	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	10/12/2018		
	Validity	24 months			
	Item	GSSF1, LFG_{electricity,GSSF1,y} (FT₃, GSSF1)			
		01/01/2018 – 31/12/2018			
	Type	Flow transmitter – Rosemount Differential Pressure Transmitter – Kingways Control Vcone			
	Accuracy class	± 0.5%			
	Serial No.	02768007 (Rosemount) / FT161 (11011001) (Kingways)			
	Calibration frequency	24 months			
	Date of last calibration	05/01/2017			
	Validity	24 months			
	<u>GSS1 (Gas Engine No.2 & 3)</u>				
	FT3 – Due to delay in calibration, the maximum permissible error of ±0.5% which is the equipment accuracy error was applied to FT3 from 07/06/2018 – 10/10/2018 as a conservative approach.				
	<u>GSS2 (Gas Engine No. 4)</u>				
	FT3 - Due to delay in calibration, the maximum permissible error of ±2.7% which is the equipment accuracy error was applied to FT3 from 01/01/2018 – 09/12/2018 as a conservative approach.				
Measuring/reading/recording frequency	Continuous if not specified in the underlying methodology/tool				
Calculation method (if applicable)	-				
QA/QC procedures	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				
Purpose of data/parameter	Baseline emissions calculation				
Additional comment	This parameter is monitored in Option B				

Data / Parameter	$V_{CH_4,m,db}$ ($W_{CH_4,Flare\ No.2,y}$, $W_{CH_4,GSS1,y}$, $W_{CH_4,GSS2,y}$, $W_{CH_4,GSSF1,y}$)																																																																										
Unit	m ³ CH ₄ / m ³ dry gas																																																																										
Description	Volumetric fraction of greenhouse gas CH ₄ in minute <i>m</i> on a dry basis																																																																										
Measured/calculated/default	Measured																																																																										
Source of data	<p>Onsite records of the gas analyzers.</p> <p>In case of temporary situation such as the installed CH₄ gas analyser malfunctioned or giving unrepresentative results due to data logging problem, the V_{CH_4} 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.</p>																																																																										
Value(s) of monitored parameter	<table border="1"> <thead> <tr> <th rowspan="2">Months</th><th colspan="4">Methane Fraction of LFG (%), $V_{CH_4,m,db}$</th></tr> <tr> <th>Flare No.2, $W_{CH_4,Flare\ No.2,y}$</th><th>GSS1, $W_{CH_4,GSS1,y}$</th><th>GSS2, $W_{CH_4,GSS2,y}$</th><th>GSSF1, $W_{CH_4,GSSF1,y}$</th></tr> </thead> <tbody> <tr><td>January 2018</td><td>0.60</td><td>0.68</td><td>0.54</td><td>0.59</td></tr> <tr><td>February 2018</td><td>0.58</td><td>0.68</td><td>0.52</td><td>0.00</td></tr> <tr><td>March 2018</td><td>0.59</td><td>0.65</td><td>0.55</td><td>0.00</td></tr> <tr><td>April 2018</td><td>0.62</td><td>0.63</td><td>0.57</td><td>0.00</td></tr> <tr><td>May 2018</td><td>0.63</td><td>0.54</td><td>0.60</td><td>0.00</td></tr> <tr><td>June 2018</td><td>0.62</td><td>0.54</td><td>0.60</td><td>0.00</td></tr> <tr><td>July 2018</td><td>0.62</td><td>0.67</td><td>0.60</td><td>0.00</td></tr> <tr><td>August 2018</td><td>0.59</td><td>0.61</td><td>0.57</td><td>0.00</td></tr> <tr><td>September 2018</td><td>0.59</td><td>0.62</td><td>0.57</td><td>0.55</td></tr> <tr><td>October 2018</td><td>0.61</td><td>0.62</td><td>0.57</td><td>0.58</td></tr> <tr><td>November 2018</td><td>0.63</td><td>0.58</td><td>0.00</td><td>0.00</td></tr> <tr><td>December 2018</td><td>0.60</td><td>0.51</td><td>0.00</td><td>0.59</td></tr> <tr><td>Average</td><td>0.61</td><td>0.61</td><td>0.57</td><td>0.58</td></tr> </tbody> </table>	Months	Methane Fraction of LFG (%), $V_{CH_4,m,db}$				Flare No.2, $W_{CH_4,Flare\ No.2,y}$	GSS1, $W_{CH_4,GSS1,y}$	GSS2, $W_{CH_4,GSS2,y}$	GSSF1, $W_{CH_4,GSSF1,y}$	January 2018	0.60	0.68	0.54	0.59	February 2018	0.58	0.68	0.52	0.00	March 2018	0.59	0.65	0.55	0.00	April 2018	0.62	0.63	0.57	0.00	May 2018	0.63	0.54	0.60	0.00	June 2018	0.62	0.54	0.60	0.00	July 2018	0.62	0.67	0.60	0.00	August 2018	0.59	0.61	0.57	0.00	September 2018	0.59	0.62	0.57	0.55	October 2018	0.61	0.62	0.57	0.58	November 2018	0.63	0.58	0.00	0.00	December 2018	0.60	0.51	0.00	0.59	Average	0.61	0.61	0.57	0.58
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Monitoring equipment	<table border="1"> <thead> <tr> <th rowspan="2">Item</th><th colspan="2">Flare No.2, $W_{CH_4,Flare\ No.2,y}$ (CH₄, Flare No.2)</th></tr> <tr> <th colspan="2">01/01/2018 – 31/12/2018</th></tr> </thead> <tbody> <tr><td>Type</td><td colspan="2">Guardian Plus (97460) Infra-Red Gas Monitor</td></tr> <tr><td>Accuracy class</td><td colspan="2">± 2%</td></tr> <tr><td>Serial No.</td><td colspan="2">31453</td></tr> <tr><td>Calibration frequency</td><td colspan="2">Annually</td></tr> <tr> <td>Date of last calibration</td><td>05/01/2017</td><td>04/06/2018</td></tr> <tr><td>Validity</td><td colspan="2">1 year</td></tr> </tbody> </table> <p>Flare 2 CH₄ – Due to delay in calibration, the maximum permissible error of which is the equipment accuracy error was applied to CH₄ from 05/01/2018 – 03/06/2018 as a conservative approach.</p>	Item	Flare No.2, $W_{CH_4,Flare\ No.2,y}$ (CH ₄ , Flare No.2)		01/01/2018 – 31/12/2018		Type	Guardian Plus (97460) Infra-Red Gas Monitor		Accuracy class	± 2%		Serial No.	31453		Calibration frequency	Annually		Date of last calibration	05/01/2017	04/06/2018	Validity	1 year																																																				
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Date of last calibration	05/01/2017	04/06/2018																																																																									
Validity	1 year																																																																										

Item	GSS1, $W_{CH_4, GSS1, y}$ ($CH_4, GSS1$)		
	01/01/2018 – 10/10/2018	11/10/2018 – 26/12/2018	27/12/2018 – 31/12/2018
Type	Edinburgh	Guardian Plus (97460) Infra-Red Gas Monitor	Edinburgh
Accuracy class	$\pm 2\%$		
Serial No.	8154	34140	14464
Calibration frequency	Annually		
Date of last calibration	09/11/2017	11/10/2018	27/12/2018
Validity	1 year		

Item	GSS2, $W_{CH_4, GSS2, y}$ ($CH_4, GSS2$)	
	01/01/2018 – 31/12/2018	
Type	Guardian Plus (97460)	
Accuracy class	$\pm 2\%$	
Serial No.	33542	
Calibration frequency	Annually	
Date of last calibration	13/09/2017	11/10/2018
Validity	1 year	

GSS2 (Gas Engine No.4)

CH₄ - Due to delay in calibration, the maximum permissible error of $\pm 2.0\%$ which is the equipment accuracy error was applied to CH₄ 13/09/2018 – 10/10/2018 as a conservative approach.

Item	GSSF1, $W_{CH_4, GSSF1, y}$ ($CH_4, GSSF1$)	
	01/01/2018 – 06/10/2018	07/10/2018 – 31/12/2018
Type	Guardian Plus (97460)	Geotech (GA5000)
Accuracy class	$\pm 2\%$	$\pm 1.5\%$
Serial No.	33436	G505823
Calibration frequency	Annually	Annually
Date of last calibration	13/09/2017	25/10/2018
Validity	1 year	1 year

GSSF1 (Gas Engine No.1)

CH₄ – Due to delay in calibration, the maximum permissible error of $\pm 2.0\%$ which is the equipment accuracy error was applied to CH₄ from 13/09/2018 – 06/10/2018 as a conservative approach. CH₄ analyser was malfunctioned started on 07/10/18, and sent for service on 14/11/2018, according to approved PDD version 20.5, page 76, in case of temporary situation such as the installed CH₄ gas analyser malfunctioned or giving unrepresentative results due to data logging problem, the V_{CH_4} shall be measured manually with portable gas analyser, as conservative approach, the lower bound of the 95% Confidence Interval will be applied as per guideline.

As a result, the CH₄ was recorded using portable analyser during the period from 07/10/18 – 31/12/18. 95% CI was performed to the results, and applied in

	the calculation. Due to delay in calibration of portable analyser, the maximum permissible error of $\pm 1.5\%$ which is the equipment accuracy error was applied to CH ₄ from 07/10/2018 – 24/10/2018 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,F2} , T _{TT1,GSS1} , T _{TT1,GSS2} , T _{TT1,GSSF1})																																																																														
Unit	°C																																																																														
Description	Temperature of the gaseous stream in time interval <i>t</i>																																																																														
Measured/calculated/default	Measured																																																																														
Source of data	Continuous measurement by temperature meter. This parameter was measured separately for both flare and the gas engines, i.e. Flare No.2 (1 meter), 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	<table><tr><th rowspan="2">Months</th><th colspan="4">T_t (°C)</th></tr><tr><th>T_{TT1,F2}</th><th>T_{TT1,GSS1}</th><th>T_{TT1,GSS2}</th><th>T_{TT1,GSSF1}</th></tr><tr><td>January 2018</td><td>36.73</td><td>42.52</td><td>41.93</td><td>40.67</td></tr><tr><td>February 2018</td><td>39.85</td><td>45.16</td><td>43.01</td><td>0.00</td></tr><tr><td>March 2018</td><td>36.94</td><td>46.40</td><td>41.40</td><td>0.00</td></tr><tr><td>April 2018</td><td>37.48</td><td>47.57</td><td>41.35</td><td>0.00</td></tr><tr><td>May 2018</td><td>37.45</td><td>55.30</td><td>41.39</td><td>0.00</td></tr><tr><td>June 2018</td><td>39.56</td><td>53.80</td><td>40.66</td><td>0.00</td></tr><tr><td>July 2018</td><td>37.55</td><td>53.97</td><td>42.54</td><td>0.00</td></tr><tr><td>August 2018</td><td>37.76</td><td>53.48</td><td>43.45</td><td>0.00</td></tr><tr><td>September 2018</td><td>36.57</td><td>47.65</td><td>41.20</td><td>43.87</td></tr><tr><td>October 2018</td><td>39.57</td><td>46.09</td><td>41.09</td><td>44.00</td></tr><tr><td>November 2018</td><td>44.28</td><td>42.25</td><td>0.00</td><td>0.00</td></tr><tr><td>December 2018</td><td>37.95</td><td>47.50</td><td>0.00</td><td>43.70</td></tr><tr><td>Average</td><td>38.47</td><td>48.48</td><td>41.80</td><td>43.06</td></tr></table>					Months	T _t (°C)				T _{TT1,F2}	T _{TT1,GSS1}	T _{TT1,GSS2}	T _{TT1,GSSF1}	January 2018	36.73	42.52	41.93	40.67	February 2018	39.85	45.16	43.01	0.00	March 2018	36.94	46.40	41.40	0.00	April 2018	37.48	47.57	41.35	0.00	May 2018	37.45	55.30	41.39	0.00	June 2018	39.56	53.80	40.66	0.00	July 2018	37.55	53.97	42.54	0.00	August 2018	37.76	53.48	43.45	0.00	September 2018	36.57	47.65	41.20	43.87	October 2018	39.57	46.09	41.09	44.00	November 2018	44.28	42.25	0.00	0.00	December 2018	37.95	47.50	0.00	43.70	Average	38.47	48.48	41.80	43.06
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Monitoring equipment

Item	Flare No.2, T _t (T _{TT1,F2})	
	01/01/2018 -31/12/2018	
Type	Honeywell (STT25M-0-EN0-000-000-00-3D) Temperature Transmitter	
Accuracy class	± 0.5% of span	
Serial No.	B839917437	
Calibration frequency	Annually	
Date of last calibration	13/09/2017	11/10/2018
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 13/09/2018 – 10/10/2018 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	GSS1, T _t (T _{TT1,GSS1})	
	01/01/2018 – 31/12/2018	
Type	Honeywell (STT25M-0-ENS-000-000-00-3H) Temperature Transmitter	
Accuracy class	± 1%	
Serial No.	B527143837	
Calibration frequency	Annually	
Date of last calibration	13/09/2017	11/10/2018
Validity	1 year	

GSS1 (Gas Engine No. 2 & 3)

TT1 - Due to delay in calibration, the maximum permissible error of ±1% which is the equipment accuracy error was applied to TT1 from 13/09/2018 – 10/10/2018 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	GSS2, T _t (T _{TT1,GSS2})	
	01/01/2018 – 31/12/2018	
Type	Autrol (ATT2100-S11HA3E1-M1) Temperature Transmitter	
Accuracy class	± 0.1%	
Serial No.	ATT21004151000	
Calibration frequency	Annually	
Date of last calibration	05/01/2017	04/06/2018
Validity	1 year	

GSS2 (Gas Engine No. 4)

TT1 - Due to delay in calibration, the maximum permissible error of ±0.2% which is the equipment accuracy error was applied to TT1 from 05/01/2018 – 03/06/2018 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

	Item	GSSF1, T _t (T _{TT1,GSSF1})	
		01/01/2018	
	Type	PR Electronics (5335A) Temperature Transmitter	
	Accuracy class	≤ ± 0.05% of span	
	Serial No.	100944768	
	Calibration frequency	Annually	
	Date of last calibration	05/01/2017	04/06/2018
	Validity	1 year	
	<u>GSSF1 (Gas Engine No. 1)</u> TT1 - Due to delay in calibration, the maximum permissible error of ±0.3% which is the equipment accuracy error was applied to TT1 from 05/01/2018 – 03/06/2018 as a conservative approach. However, there was shut down during this period, TT1 was 0, as a result, no MPE applied in the calculation.		
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,F2} , P _{PT2,GSSF1} , P _{PT2,GSSF2} , P _{PT2,GSSF1})				
Unit	kPa				
Description	Pressure of the gaseous stream in time interval <i>t</i>				
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.2 (1 meter), 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	Average Gauge Pressure (Months)	P _t (kPa)			
		PT _{PT2,F2}	PT _{PT2,GSSF1}	PT _{PT2,GSSF2}	PT _{PT2,GSSF1}
	January 2018	5.32	16.70	16.82	11.52
	February 2018	6.23	17.01	16.79	0.00
	March 2018	4.01	16.41	15.89	0.00
	April 2018	5.22	16.15	15.88	0.00
	May 2018	7.10	16.76	16.57	0.00
	June 2018	8.39	16.56	15.14	0.00
	July 2018	6.38	16.80	16.43	0.00
	August 2018	5.93	16.17	16.54	0.00
	September 2018	6.72	16.99	16.07	17.16
	October 2018	10.21	16.30	16.09	17.02

November 2018	14.84	13.74	0.00	0.00
December 2018	8.09	16.99	0.00	16.01
Average	7.37	16.38	16.22	15.43

Average Absolute Pressure (Months)	P _t (kPa)			
	PT _{PT2,F2}	PT _{PT2,GSS1}	PT _{PT2,GSS2}	PT _{PT2,GSSF1}
January 2018	106.64	118.02	118.14	112.85
February 2018	107.55	118.33	118.12	101.33
March 2018	105.33	117.74	117.21	101.33
April 2018	106.55	117.47	117.20	101.33
May 2018	108.42	118.08	117.90	101.33
June 2018	109.71	117.88	116.46	101.33
July 2018	107.71	118.13	117.76	101.33
August 2018	107.25	117.49	117.87	101.33
September 2018	108.05	118.31	117.40	118.48
October 2018	111.53	117.63	117.42	118.35
November 2018	116.16	115.07	101.33	101.33
December 2018	109.41	118.32	101.33	117.34
Average	108.69	117.71	114.84	106.47

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

Monitoring equipment

Item	Flare No.2, P _t (PT _{PT2,F2})	
	01/01/2018 – 31/12/2018	
Type	Rosemount (3051TG1A2B21AB4E5Q4) Pressure Transmitter	
Accuracy class	± 0.25%	
Serial No.	5584784	
Calibration frequency	Annually	
Date of last calibration	13/09/2017	11/10/2018
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 13/09/2018 – 10/10/2018 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	GSS1, P _t (PT _{PT2,GSS1})	
	01/01/2018 – 31/12/2018	
Type	Rosemount (3051TG1A2B21AB4K5M5) Pressure Transmitter	
Accuracy class	± 0.1%	
Serial No.	5916057	
Calibration frequency	Annually	
Date of last calibration	13/09/2017	11/10/2018
Validity	1 year	

GSS1 (Gas Engine No. 2 & 3)

PT2 - Due to delay in calibration, the maximum permissible error of $\pm 0.25\%$ which is the equipment accuracy error was applied to PT2 from 13/09/2018 – 10/10/2018 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	GSS2, P_t (PT_{PT2,GSS2})	
	01/01/2018 – 31/12/2018	
Type	Autrol (APT3200-G4M11E11S1-M1) Pressure Transmitter	
Accuracy class	$\pm 0.075\%$ of span	
Serial No.	APT3200-4150998	
Calibration frequency	Annually	
Date of last calibration	05/01/2017	04/06/2018
Validity	1 year	

GSS2 (Gas Engine No. 4)

PT2 - Due to delay in calibration, the maximum permissible error of $\pm 0.4\%$ which is the equipment accuracy error was applied to PT2 from 05/01/2018 – 03/06/2018 as a conservative approach. The impact of applying this error to the flow normalisation is negligible.

Item	GSSF1, P_t (PT_{PT2,GSSF1})	
	01/01/2018 – 31/12/2018	
Type	Rosemount (3051TG1A2B21AB4E5M5Q4) Pressure Transmitter	
Accuracy class	$\pm 0.25\%$	
Serial No.	02492864	
Calibration frequency	Annually	
Date of last calibration	05/01/2017	04/06/2018
Validity	1 year	

GSSF1 (Gas Engine No. 1)

PT2 - Due to delay in calibration, the maximum permissible error of $\pm 0.25\%$ which is the equipment accuracy error was applied to PT2 from 05/01/2018 – 03/06/2018 as a conservative approach. The impact of applying this error to the flow normalisation is negligible. However, there was shutdown during this period, PT12 was 0, as a result, no MPE applied in the calculation.

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	$P_{H_2O,t,Sat}$
Unit	Pa
Description	Saturation pressure of H ₂ O 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; 4 ^o Edition 1994, John Wiley & Sons, Inc.

Data / Parameter	$V_{CO_2,t,db}$
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_{CO_2} 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	36.8%
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	$V_{O_2,t,db}$
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	0.83%
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 ($Op_{j,h}$).
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 CO₂ 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	0.06
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	EF _{CO₂,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	-

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:

$$BE_y = BE_{CH_4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y}$$

BE_y	=	Baseline emissions in year y (t CO ₂ e/yr)
$BE_{CH_4,y}$	=	Baseline emissions of methane from the SWDS in year y (t CO ₂ e/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)

$$BE_{CH_4} = ((1 - OX_{top_layer}) \times F_{CH_4,PJ,y} - F_{CH_4,BL,y}) \times GWP_{CH_4}$$

$BE_{CH_4,y}$	=	Baseline emissions of methane from the SWDS in year y (t CO ₂ e/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)
$F_{CH_4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH ₄ /yr)
$F_{CH_4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year y (t CH ₄ /yr)
GWP_{CH_4}	=	Global warming potential of CH ₄ (t CO ₂ e/t CH ₄)

$$F_{CH_4,PJ,y} = \eta_{PJ} \times BE_{CH_4,SWDS,y} / GWP_{CH_4}$$

$F_{CH_4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH ₄ /yr)
$BE_{CH_4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y (t CO ₂ e/yr)
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH_4}	=	Global warming potential of CH ₄ (t CO ₂ e/t CH ₄)

$$BE_{CH_4,SWDS,y} = \varphi_y \times (1 - f_y) \times GWP_{CH_4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{f,y} \times MCF_y \times \sum_{x=1}^y \sum_j (W_{j,x} \times DOC_j \times e^{-k_j \times (y-x)} \times (1 - e^{-k_j}))$$

$BE_{CH_4,SWDS,y}$	=	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 ₂ e/yr)
$PE_{CH_4,SWDS,y}$		
$LE_{CH_4,SWDS,y}$		
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)

$$F_{CH_4,flared,y} = F_{CH_4,sent_flare,y} - \frac{PE_{flare,y}}{GWP_{CH_4}}$$

$F_{CH_4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year y (t CH ₄ /yr)
$F_{CH_4,sent_flare,y}$	=	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 ₂ e/yr)
GWP_{CH_4}	=	Global warming potential of CH ₄ (t CO ₂ e/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 $BE_{CH_4,y}$ Flare No.2

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.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	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 Emission Flare No.2
	FT2 Flare No.2,y (Nm³)	WCH4	DCH4 (t/Nm³)	FCH4,sent_flare (tCH4)	PEflare (tCO2e)	GWPCCH4 (tCO2e/tCH4)	FCH4,flared (tCH4)	FCH4, PJ (tCH4)	OX _{top_layer}	BE _{CH4} (tCO2e)	BE _y (tCO2e)
Jan-18	716,697.38	0.60	0.0007157	309.45	787.15	25	277.96	277.96	0.10	6,254.10	6,254.10
Feb-18	708,255.30	0.58	0.0007157	293.53	734.53	25	264.15	264.15	0.10	5,943.28	5,943.28
Mar-18	583,528.75	0.59	0.0007157	246.72	646.27	25	220.87	220.87	0.10	4,969.59	4,969.59
Apr-18	463,914.90	0.62	0.0007157	205.28	540.21	25	183.67	183.67	0.10	4,132.53	4,132.53
May-18	145,425.27	0.63	0.0007157	66.00	165.30	25	59.39	59.39	0.10	1,336.16	1,336.16
Jun-18	754,175.04	0.62	0.0007157	333.02	832.25	25	299.73	299.73	0.10	6,743.83	6,743.83
Jul-18	682,316.27	0.62	0.0007157	303.94	759.88	25	273.54	273.54	0.10	6,154.71	6,154.71
Aug-18	626,716.13	0.59	0.0007157	266.44	751.00	25	236.39	236.39	0.10	5,318.89	5,318.89
Sep-18	591,771.05	0.59	0.0007157	250.06	666.03	25	223.42	223.42	0.10	5,026.90	5,026.90
Oct-18	719,537.76	0.61	0.0007157	312.20	804.97	25	280.00	280.00	0.10	6,300.09	6,300.09
Nov-18	884,757.94	0.63	0.0007157	397.38	1,010.12	25	356.97	356.97	0.10	8,031.87	8,031.87
Dec-18	684,163.28	0.60	0.0007157	293.02	769.49	25	262.24	262.24	0.10	5,900.34	5,900.34

GSS1

Month	$BE_{CH_4} = \left((1 - OX_{top_layer}) \times F_{CH_4,PJ,y} - F_{CH,BL,y} \right) \times GWP_{CH_4}$							
	Density of Methane GSS1	Quantity of Landfill Gas Fed into GSS1	Average methane fraction of the Landfill Gas Fed into GSS1	Amount of methane in LFG used for electricity generation GSS1	Amount of methane in LFG flared/used in project activity GSS1	Global Warming Potential GSS1	Fraction of oxidised methane in LFG in top layer of SWDS in baseline, GSS1	Baseline emissions of methane from SWDS GSS1
	DCH ₄ (t/Nm ³)	FT3 LFG electricity,y (m ³ LFG)	W _{CH₄}	F _{CH₄,EL} (tCH ₄)	F _{CH₄,PJ} (tCH ₄)	GWP _{CH₄} (tCO ₂ e/tCH ₄)	OX _{top_layer}	BE _{CH₄} (tCO ₂ e)
Jan-18	0.0007157	454,757.18	0.68	222.79	222.79	25	0.10	5,012.77
Feb-18	0.0007157	531,980.69	0.68	257.92	257.92	25	0.10	5,803.31
Mar-18	0.0007157	715,234.13	0.65	333.67	333.67	25	0.10	7,507.65
Apr-18	0.0007157	525,454.31	0.63	238.13	238.13	25	0.10	5,357.83
May-18	0.0007157	444,494.44	0.54	173.22	173.22	25	0.10	3,897.37
Jun-18	0.0007157	323,748.41	0.54	125.75	125.75	25	0.10	2,829.31
Jul-18	0.0007157	381,938.75	0.67	181.94	181.94	25	0.10	4,093.73
Aug-18	0.0007157	597,322.66	0.61	258.66	258.66	25	0.10	5,819.79
Sep-18	0.0007157	435,602.48	0.62	193.28	193.28	25	0.10	4,348.74
Oct-18	0.0007157	190,506.44	0.62	84.68	84.68	25	0.10	1,905.31
Nov-18	0.0007157	29,129.21	0.58	12.08	12.08	25	0.10	271.86
Dec-18	0.0007157	810,994.84	0.51	298.03	298.03	25	0.10	6,705.69

GSS2

Month	$BE_{CH_4} = \left((1 - OX_{top_layer}) \times F_{CH_4,PJ,y} - F_{CH,BL,y} \right) \times GWP_{CH_4}$							
	Density of Methane GSS2	Quantity of Landfill Gas Fed into the GSS2	Average methane fraction of the Landfill Gas Fed into the GSS2	Amount of methane in LFG used for electricity generation GSS2	Amount of methane in LFG flared/used in project activity GSS2	Global Warming Potential GSS2	Fraction of oxidised methane in LFG in top layer of SWDS in baseline GSS2	Baseline emissions of methane from SWDS GSS2
	DCH4 (t/Nm3)	FT3 LFG electricity,y (m ³ LFG)	WCH4	FCH4,EL (tCH ₄)	FCH4, PJ (tCH ₄)	GWPCH4 (tCO ₂ e/tCH ₄)	OX _{top_layer}	BE _{CH4} (tCO ₂ e)
Jan-18	0.0007157	481,179.61	0.54	185.10	185.10	25	0.1	4,164.70
Feb-18	0.0007157	416,673.53	0.52	155.54	155.54	25	0.1	3,499.65
Mar-18	0.0007157	433,856.10	0.55	169.57	169.57	25	0.1	3,815.32
Apr-18	0.0007157	418,529.62	0.57	170.40	170.40	25	0.1	3,833.92
May-18	0.0007157	453,434.34	0.60	193.69	193.69	25	0.1	4,357.95
Jun-18	0.0007157	65,591.88	0.60	28.39	28.39	25	0.1	638.72
Jul-18	0.0007157	332,307.88	0.60	143.67	143.67	25	0.1	3,232.50
Aug-18	0.0007157	453,840.93	0.57	185.65	185.65	25	0.1	4,177.02
Sep-18	0.0007157	386,570.52	0.57	157.97	157.97	25	0.1	3,554.40
Oct-18	0.0007157	190,880.59	0.57	77.75	77.75	25	0.1	1,749.43
Nov-18	0.0007157	0.00	0.00	0.00	0.00	25	0.1	0.00
Dec-18	0.0007157	0.00	0.00	0.00	0.00	25	0.1	0.00

GSSF1

Month	$BE_{CH_4} = ((1 - OX_{top_layer}) \times F_{CH_4,PJ,y} - F_{CH,BL,y}) \times GWP_{CH_4}$							
	Density of Methane GSSF1	Quantity of Landfill Gas Fed into GSSF1	Average methane fraction of the Landfill Gas Fed into GSSF1	Amount of methane in LFG used for electricity generation GSSF1	Amount of methane in LFG flared/used in project activity GSSF1	Global Warming Potential GSSF1	Fraction of oxidised methane in LFG in top layer of SWDS in baseline, GSSF1	Baseline emissions of methane from SWDS GSSF1
	DCH ₄ (t/Nm ³)	FT3 LFG electricity,y (m ³ LFG)	W _{CH₄}	F _{CH₄,EL} (tCH ₄)	F _{CH₄, PJ} (tCH ₄)	GWP _{CH₄} (tCO ₂ e/tCH ₄)	OX _{top_layer}	BE _{CH₄} (tCO ₂ e)
Jan-18	0.0007157	24,029.10	0.59	10.20	10.20	25	0.10	229.40
Feb-18	0.0007157	0.00	0.00	0.00	0.00	25	0.10	0.00
Mar-18	0.0007157	0.00	0.00	0.00	0.00	25	0.10	0.00
Apr-18	0.0007157	0.00	0.00	0.00	0.00	25	0.10	0.00
May-18	0.0007157	0.00	0.00	0.00	0.00	25	0.10	0.00
Jun-18	0.0007157	0.00	0.00	0.00	0.00	25	0.10	0.00
Jul-18	0.0007157	0.00	0.00	0.00	0.00	25	0.10	0.00
Aug-18	0.0007157	0.00	0.00	0.00	0.00	25	0.10	0.00
Sep-18	0.0007157	199,314.49	0.55	78.68	78.68	25	0.10	1,770.30
Oct-18	0.0007157	188,436.93	0.58	78.11	78.11	25	0.10	1,757.44
Nov-18	0.0007157	0.00	0.00	0.00	0.00	25	0.10	0.00
Dec-18	0.0007157	176,384.83	0.59	74.23	74.23	25	0.10	1,670.09

Determination of $BE_{EC,y}$ GSS1

Month	$BE_{EC,y} = \sum_k EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y})$			
	Quantity of electricity generated GSS 1	Emission factor for electricity generation GSS1	Average technical transmission and distribution losses GSS1	Baseline emission for electricity GSS1
	$EC_{BL,k}$ (MWh)	$FE_{EL,k}$ (tCO ₂ /MWh)	TDL_k	$BE_{EC,y}$ (tCO ₂)
Jan-18	883.35	0.7146	0.0774	680.10
Feb-18	971.59	0.7146	0.0774	748.03
Mar-18	1,244.51	0.7146	0.0774	958.16
Apr-18	913.90	0.7146	0.0774	703.62
May-18	826.86	0.7146	0.0774	636.61
Jun-18	579.99	0.7146	0.0774	446.54
Jul-18	661.03	0.7146	0.0774	508.93
Aug-18	1,004.82	0.7146	0.0774	773.62
Sep-18	721.01	0.7146	0.0774	555.11
Oct-18	315.68	0.7146	0.0774	243.04
Nov-18	52.90	0.7146	0.0774	40.73
Dec-18	1,432.96	0.7146	0.0774	1,103.25

GSS2

Month	$BE_{EC,y} = \sum_k EC_{BL,k,y} \times EF_{EF,k,y} \times (1 + TDL_{k,y})$			
	Quantity of electricity generated	Emission factor for electricity generation	Average technical transmission and distribution losses	Baseline emission for electricity
	GSS 2	GSS2	GSS2	GSS2
	ECBL,k (MWh)	EFEL,k (tCO ₂ /MWh)	TDLk	BE _{EC,y} (tCO ₂)
Jan-18	1,082.76	0.7146	0.0774	833.63
Feb-18	879.53	0.7146	0.0774	677.16
Mar-18	912.37	0.7146	0.0774	702.44
Apr-18	915.20	0.7146	0.0774	704.62
May-18	1,012.01	0.7146	0.0774	779.15
Jun-18	123.24	0.7146	0.0774	94.88
Jul-18	726.98	0.7146	0.0774	559.71
Aug-18	946.83	0.7146	0.0774	728.97
Sep-18	840.36	0.7146	0.0774	647.00
Oct-18	356.86	0.7146	0.0774	274.75
Nov-18	0.00	0.7146	0.0774	0.00
Dec-18	0.00	0.7146	0.0774	0.00

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	Emission factor for electricity generation GSSF1	Average technical transmission and distribution losses GSSF1	Baseline emission for electricity GSSF1
	$EC_{BL,k}$ (MWh)	$EF_{EL,k}$ (tCO ₂ /MWh)	TDL_k	$BE_{EC,y}$ (tCO ₂)
Jan-18	37.59	0.7146	0.0774	28.94
Feb-18	0.00	0.7146	0.0774	0.00
Mar-18	0.00	0.7146	0.0774	0.00
Apr-18	0.00	0.7146	0.0774	0.00
May-18	0.00	0.7146	0.0774	0.00
Jun-18	0.00	0.7146	0.0774	0.00
Jul-18	0.00	0.7146	0.0774	0.00
Aug-18	0.00	0.7146	0.0774	0.00
Sep-18	285.96	0.7146	0.0774	220.17
Oct-18	267.08	0.7146	0.0774	205.63
Nov-18	0.00	0.7146	0.0774	0.00
Dec-18	258.42	0.7146	0.0774	198.96

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 0.7146 tCO₂/MWh (applied from 01/01/2018 – 31/12/2018) is ex-ante data.
2. With reference to ACM0001, Version 18.0, page 21, $EC_{BL,k,y}$ is equivalent to the net amount of electricity generated using LFG in year y ($EG_{PJ,y}$). $EF_{EL,k,y} = EF_{grid,CM,y}$ and therefore, $BE_{EC,y} = \sum EG_{PJ,y} \times EF_{grid,CM,y} \times (1 + TDL_{k,y})$.
3. The total electricity generated ($EL_{LFG,y}$) is the amount based on the monthly invoices to the grid operator (Tenaga Nasional Berhad (TNB)) which is also the lower reading from the comparison between (EL4 + EL9 + EL10 + EL12) and (EL5 + EL11 + EL13).

Total Baseline Emissions

$$BE_y = BE_{CH_4,y} + BE_{EC,y}$$

Month	BE _{CH₄,y}				BE _{EC,y}			Total B _{Ey}
	Flare No.2	GSS1	GSS2	GSSF1	GSS1	GSS2	GSSF1	
Jan-18	6,254	5,012	4,164	229	680	833	28	17,200
Feb-18	5,943	5,803	3,499	0	748	677	0	16,670
Mar-18	4,969	7,507	3,815	0	958	702	0	17,951
Apr-18	4,132	5,357	3,833	0	703	704	0	14,729
May-18	1,336	3,897	4,357	0	636	779	0	11,005
Jun-18	6,743	2,829	638	0	446	94	0	10,750
Jul-18	6,154	4,093	3,232	0	508	559	0	14,546
Aug-18	5,318	5,819	4,177	0	773	728	0	16,815
Sep-18	5,026	4,348	3,554	1,770	555	646	220	16,119
Oct-18	6,300	1,905	1,749	1,757	243	274	205	12,433
Nov-18	8,031	271	0	0	40	0	0	8,342
Dec-18	5,900	6,705	0	1,670	1,103	0	198	15,576
Total	66,106	53,546	33,018	5,426	7,393	5,996	651	172,136

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 ELPJ,y (MWh)	Coefficient for grid electricity EF grid,y	Transmission and Distribution Losses TDL,y	Total Project Emission from electricity consumed from project activity (tCO ₂ e)
Jan-18	123.85	0.7146	0.0774	95.35
Feb-18	126.06	0.7146	0.0774	97.05
Mar-18	152.45	0.7146	0.0774	117.37
Apr-18	125.79	0.7146	0.0774	96.85
May-18	132.45	0.7146	0.0774	101.97
Jun-18	76.92	0.7146	0.0774	59.22
Jul-18	116.72	0.7146	0.0774	89.86
Aug-18	156.36	0.7146	0.0774	120.39
Sep-18	146.55	0.7146	0.0774	112.83
Oct-18	98.74	0.7146	0.0774	76.02
Nov-18	33.13	0.7146	0.0774	25.51
Dec-18	137.63	0.7146	0.0774	105.96

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 tCO₂/MWh (applied from 01/01/2018 – 31/12/2018) which is ex-ante data.
2. TDL = 7.74% adopted as stated in the registered PDD, version 20.5 page 54 (TNB annual report 2016⁷).

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

$PE_{FC,j,y}$, for this project, is the emission from diesel backup generators.

Month	Quantity of diesel combusted (Liter)	Diesel Density (kg/l)	Quantity of diesel combusted (t/month)	$COEF_{diesel,y} = NCV_{diesel,j} \times EF_{CO_2,diesel,y}$			Total Project Emission from diesel combusted from project activity (tCO ₂ e)
				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}	$NCV_{diesel,j}$	$EF_{CO_2,diesel,y}$	$COEF_{diesel,y}$	
Jan-18	8	0.84	0.01	43	0.0741	3.19	0.02
Feb-18	6	0.84	0.01	43	0.0741	3.19	0.02
Mar-18	5	0.84	0.00	43	0.0741	3.19	0.01
Apr-18	4	0.84	0.00	43	0.0741	3.19	0.01
May-18	6	0.84	0.01	43	0.0741	3.19	0.02
Jun-18	4	0.84	0.00	43	0.0741	3.19	0.01
Jul-18	5	0.84	0.00	43	0.0741	3.19	0.01
Aug-18	7	0.84	0.01	43	0.0741	3.19	0.02
Sep-18	4	0.84	0.00	43	0.0741	3.19	0.01
Oct-18	4	0.84	0.00	43	0.0741	3.19	0.01
Nov-18	12	0.84	0.01	43	0.0741	3.19	0.03
Dec-18	3	0.84	0.00	43	0.0741	3.19	0.01

Total Project Emissions

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

Month	PE_{EC}	PE_{FC}	Total PE_y
Jan-18	96	1	97
Feb-18	98	1	99
Mar-18	118	1	119
Apr-18	97	1	98
May-18	102	1	103
Jun-18	60	1	61
Jul-18	90	1	91
Aug-18	121	1	122
Sep-18	113	1	114
Oct-18	77	1	78
Nov-18	26	1	27
Dec-18	106	1	107
Total	1,104	12	1,116

Note: The project emission has been rounded up for conservativeness

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 ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	172,136	1,116	0	N/A	171,020	171,020

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 ₂ e)	Amount estimated ex ante (t CO ₂ e)
171,020	269,207⁸

E.6. Remarks on increase in achieved emission reductions

The total CERs claimed in the 2nd monitoring period of 2nd crediting period was 36.5% lower as compared to the value reported in the ex-ante calculations.

The total decrease of 36.5% is due to the following reasons:

1. Several shutdowns to Flare No.2 due to lightning strike in April and May 2018.
2. Major overhaul for GSSF1 (Gas Engine No.1) from 04/01/18 – 31/08/18, 23/10/18 – 07/12/18.
3. Several shutdowns to Gas Engine No.2 and Gas Engine No.3 of GSS1 in 17-30/04/18, 01-08/05/18, 01/07/18 – 07/08/18, 01-31/10/18, and 01-28/11/18 due to lightning strike and repair works.
4. Gas Engine No.4 of GSS2 shutdown in 06-30/06/18, and 15/10/18 – 31/12/18 for maintenance and repair work at DG room.

⁸ Obtained from PDD version 20.5 dated 02/03/2018.

Appendix 1: Details on the downtime of Flare No.2

Date	Time		Problem Description
	Shutdown	Restart	
24/01/2018	14:42	17:48	Proper shutdown - to install blower #1, repaired unit by Hydrocare.
25/01/2018	10:28	14:56	Unify to install pressure gauge at main pipe line (450 mm).
28/01/2018	18:49	19:19	TNB power failure - few minutes.
03/03/2018	14:33	19:31	TNB power surge few second.
05/03/2018	11:11	06/03/2018	O ₂ above danger set point. Main gas pipe leaking - found damage main pipe @ Ph 2B Repair work by Unify on 06.03.18.
		17:59	
13/03/2018	09:30	13:37	Proper shutdown. Main gas pipe leaking repair works by Unify. 2 nd repair work @ Ph 2B. Total shutdown.
06/04/2018	16:22	16:29	TNB Power surge few seconds. Blower #2 trip.
18/04/2018	16:01	20/04/2018	Lightning strike @ RE Center. Major all system tripped. Unable to restart. Major components to check for damages.
		16:06	
23/04/2018	9:26	14:33	Proper shutdown - to testing Input / Output module and communication module on GSS 1.
	15:22	18:15	Proper shutdown - to testing Input / Output module and communication module on GSS 1.
24/04/2018	9:17	30/04/2018	PLC problem - modules 1x network/2x PLC I/O module - install and test at GSS 1 - to run gas engine.
		23:59	
01/05/2018	0:00	25/05/2018	Lightning strike @ RE center. Major all system tripped. Unable to restart. Major components to check for damage.
		12:57	
04/06/2018	11:42	13:01	Proper shutdown for CDM Equipment Calibration by Nectar. i. CH ₄ , ii. FT 1, iii. FT 2.
08/08/2018	10:52	11:42	Proper shutdown to service HT VCB at SSU LTP - by RA POWER. (Site Total shutdown).
	13:25	13:28	Proper shutdown - to normalize power source from standby Genset to TNB power source.
25/09/2018	16:21	17:25	O ₂ above danger set point.
29/09/2018	10:41	17:09	Proper shutdown - Requested by TNB for repairing work (VCB) at Pencawang Elektrik Pelupusan Sampah. Shutdown for GSS3 cable installation work from MSB to GSS3 feeder Pillar.
30/09/2018	14:05	21:33	Proper shutdown for GSS3 cable installation work from MSB to GSS3 Feeder Pillar.
02/10/2018	2:50	4:15	TNB works to normalize power at PE Pelupusan Sampah for the consumer. Panel change, together with generation panel.
06/10/2018	14:54	15:03	TNB install export meter (new) at PE Pelupusan Sampah.
	18:52	19:08	TNB install export meter (new) at PE Pelupusan Sampah.
	20:02	20:09	TNB install export meter (new) at PE Pelupusan Sampah.
11/10/2018	11:15	12:50	Proper shutdown for CDM Calibration equipment. i. TTI, ii. PT2, iii. FT3, iv. CH ₄ .
22/10/2018	19:02	20:20	Emergency shutdown for landfill Cell Phase 3 problem, Vertical drain.
25/10/2018	9:54	26/10/2018	Proper shutdown - for GSS 3, main pipe connection to existing system.
		17:24	
05/11/2018	10:30	19:28	GSS 3 pipe connection (new) to existing main pipe.
08/11/2018	8:32	9:00	Electrical works - Chen Guan, new MSB Panel for GSS 3 Power supply / new building extension.
	20:03	20:12	Electrical works - Chen Guan, new MSB Panel for GSS 3 Power supply / new building extension.
01/12/2018	8:11	8:42	CH ₄ below danger set point.
	9:01	10:12	CH ₄ below danger set point.
16/12/2018	15:15	15:58	GBS Trip - O ₂ above danger set point.
17/12/2018	9:30	12:55	O ₂ above danger set point. GBS trip.
21/12/2018	16:28	16:37	TNB Power surge, few seconds.

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

Gas Engine No. 1

Date	Gas Engine No. 1		Problem Description
	Shutdown	Restart	
02/01/2018	10:15	14:52	Proper shutdown - for schedule service at 1,500 hrs internal by SPE.
04/01/2018	2:55	31/01/2018 23:59	Main fault - to check generation cable to TNB substation / termination.
01/02/2018	0:00	28/02/2018 23:59	Main fault - to check generation cable to TNB substation / termination.
01/03/2018	0:00	31/03/2018 23:59	Shutdown for major overhaull work at 45,000 hrs internal by SPE.
01/04/2018	0:00	30/04/2018 23:59	Shutdown for major overhaull work at 45,000 hrs internal by SPE.
01/05/2018	0:00	31/05/2018 23:59	Shutdown for major overhaull work at 45,000 hrs internal by SPE.
01/06/2018	0:00	30/06/2018 23:59	Shutdown for major overhaull work at 45,000 hrs internal by SPE.
01/07/2018	0:00	31/07/2018 23:59	Shutdown for major overhaull work at 45,000 hrs internal by SPE.
01/08/2018	0:00	31/08/2018 23:59	Shutdown for major overhaull work at 45,000 hrs internal by SPE.
01/09/2018	0:00	12/09/2018 16:14	Shutdown for major Overhaull work at 45,000 hrs internal by SPE.
12/09/2018	23:53	13/09/2018 00:24	Combustion chamber B4.Restart Ok.
13/09/2018	11:51	11:57	Combustion chamber A5,A6.
15/09/2018	10:31	10:47	Jacket water engine outlet.
16/09/2018	15:13	15:33	Combustion chamber B4.
	19:03	22:21	Combustion chamber B4,B5,A6.Restart Ok.
17/09/2018	23:53	23:59	Combustion chamber A4.
18/09/2018	08:57	09:04	Combustion chamber A8.
	12:14	21:18	Proper shutdown to service at 50 hr internal - after overhaull. To install side channel blower.
28/09/2018	22:00	22:22	Jacket water engine outlet.
29/09/2018	10:40	30/09/2018 23:59	Proper shutdown - Requested by TNB for repairing work (VCB) at Pencawang Elektrik Pelupusan Sampah.Unable to restart.Generation meter need to replace.
01/10/2018	00:00	06/10/2018 21:48	Proper shutdown - requested by TNB for repairing work (VCB) at Pencawang Elektrik Pelupusan Sampah.Unable to restart , due to generation panel and generation meter not ready.
07/10/2018	14:37	14:50	Combustion Chamber A6.
08/10/2018	09:45	11:30	GSSF1 trip. Restart OK.
	14:24	14:31	Combustion Chamber A6 , A5 , B6. Restart Ok.
17/10/2018	02:23	07:20	Combustion Chamber A6, Blower trip.
19/10/2018	17:41	20:00	Critical Fault A1, check engine.
20/10/2018	17:36	17:49	Combustion Chamber A6.
21/10/2018	00:03	09:06	Combustion Chamber B1. Change new spark plug.
	09:39	09:50	Combustion Chamber A3.
	12:50	13:16	Combustion Chamber A2.
	22:04	22/10/2018 07:59	Combustion Chamber B4.
22/10/2018	19:03	22:30	Emergency shutdown for landfill Cell Phase 3 problem, Vertical drain.
23/10/2018	10:38	31/10/2018 23:59	Critical fault, check engine B5.

Date	Gas Engine No. 1		Problem Description
	Shutdown	Restart	
01/11/2018	0:00	30/11/2018	Critical fault, Check engine A5.
		23:59	
01/12/2018	0:00	07/12/2018	Critical fault B5, Check engine.
		19:46	
13/12/2018	09:49	23:13	Proper shutdown - For normal service at 50 hrs interval - by SPE.
14/12/2018	14:26	18:35	Gas pressure Gas control system.
16/12/2018	14:00	14:25	Combustion chamber A6.
	15:17	19:03	GBS trip - O ₂ above danger set point.
17/12/2018	08:03	14:48	O ₂ high - CH ₄ below danger set point.
18/12/2018	10:24	10:38	Proper shutdown - to change gas source from GSSF1 - F2.
19/12/2018	14:51	15:00	Proper shutdown - for normalize gas source from F2 → GSSF1.
20/12/2018	09:10	09:31	Proper shutdown - to check gas pipe line.
21/12/2018	16:27	16:49	TNB power surge , few seconds.
22/12/2018	12:15	12:45	Combustion chamber B5.
	13:52	14:00	Combustion chamber B5.
	14:54	14:58	S200 engine speed.
	16:25	16:48	Combustion chamber B5.
26/12/2018	09:02	29/12/2018	Proper shutdown - to check scrubber tank, intel pipe , and outlet gas pipe line.
		10:16	
29/12/2018	12:03	12:11	Combustion chamber A5,A6,B5,B6. Restart ok.
31/12/2018	09:37	09:47	Proper shutdown - to run engine with side channel blower.

Gas Engine No. 2

Date	Gas Engine No. 2		Problem Description
	Shutdown	Restart	
05/01/2018	03:07	10:26	Proper shutdown - knocking sensor.
15/01/2018	14:52	15:01	Proper shutdown to rack out ACB GE 3 - overhaul by SPE.
18/01/2018	09:18	10:37	Proper shutdown - to swap motor blower # 3.Motor blower # 3 Jammed.
19/01/2018	09:20	09:27	Combustion chamber B3.Change spark plug (Used unit GE3).
25/01/2018	09:14	17:06	Proper shutdown - Relay calibration by RA Power.Maintenance works cutting trees along service to PPU Bukit Tagar by KBE workers.Service 33Kv transformer.
26/01/2018	18:03	19:48	Proper shutdown to check exhaust leaking by SPE.
28/01/2018	18:49	29/01/2018 8:59	TNB power failure - few minutes.Unable to restart immediately due to GSS 1, Pneumatic valve # 1 problem.
03/02/2018	13:28	13:34	Jacket water engine outlet.
12/02/2018	17:06	18:12	Safety Chain.Reset Ok.
15/02/2018	00:18	00:26	Proper shutdown - to rack in breaker ACB GE 3.
	16:19	16:22	Reverse power.
23/02/2018	08:30	19:47	Proper shutdown - to service at 1,500 hrs internal by SPE.
	22:03	22:06	Safety Chain.Reset Ok.
03/03/2018	14:33	20:12	TNB power surge few seconds.
04/03/2018	10:58	11:21	Combustion chamber average.
	12:56	13:08	Combustion chamber B4.
	16:07	16:26	Combustion chamber B6. Change spark plug.
	23:38	05/03/2018 00:25	Combustion chamber average.
05/03/2018	10:02	10:18	Combustion chamber average.
05/03/2018	11:09	06/03/2018 18:27	Combustion chamber average.Main gas pipe leaking - Found damage main pipe @ Ph 2B. Repair work by Unify on 06.03.18.
13/03/2018	09:07	14:56	Proper shutdown - main gas pipe leaking - repair works by Unify.2 nd repair work at Ph 2B.Total shutdown.
25/03/2018	21:56	22:44	T 206 Jacket water engine outlet.
26/03/2018	10:34	13:12	Jacket water engine outlet.HT Radiator fan # 2 trip.
05/04/2018	11:20	11:31	Combustion chamber B6. Change new spark plug.
06/04/2018	14:16	14:32	Jacket water engine outlet. (HT Fan #2 trip).
	16:05	16:19	TNB Power surge few seconds.
	18:24	18:54	Combustion Chamber A2.
09/04/2018	13:29	13:45	Jacket water engine outlet.
12/04/2018	16:42	16:56	Gas pressure gas control system.
18/04/2018	16:03	25/04/2018 19:51	Lightning strike @ RE Center. Major all system tripped. Unable to restart.Major components to check for damages.
27/04/2018	18:39	21:59	TNB power surge
29/04/2018	09:22	09:35	Gas pressure gas control system.
30/04/2018	13:02	14:13	Gas Pressure low. GSS 1 trip.
04/05/2018	09:09	12:31	Proper shutdown - to install blower # 2 at GSS1 (repaired unit)- by Hydrocare.
08/05/2018	00:32	00:43	Combustion chamber A2.
	07:44	08:12	Combustion chamber A2. Change new spark plug.
	14:37	14:45	Proper shutdown - to tighten bolt and nut on Ignition Box.
10/05/2018	12:04	19:02	Proper shutdown to service at 1,500 hrs internal by SPE.
14/05/2018	12:38	12:51	Combustion chamber B8. Change new spark plug.
19/05/2018	10:56	12:59	TNB Power failure. Site total Shutdown.
25/05/2018	22:07	22:46	Combustion chamber. Change spark plug A1 , A8 , & B2.
27/05/2018	14:21	14:29	Combustion chamber A6. Change spark plug.
29/05/2018	20:56	21:08	Combustion chamber A6.Change spark plug.
31/05/2018	08:42	08:49	Combustion chamber B1.Change new spark plug.
	14:23	14:26	Jacket water engine outlet.
03/06/2018	12:15	12:30	Combustion chamber B5 faulty. Change with spare unit.
09/06/2018	05:41	05:59	Jacket water engine outlet.
	12:56	13:06	Proper shutdown - to check on intake air sensor.Restart Ok.
10/06/2018	23:14	30/06/2018 23:59	ZA error code.Speed sensor cable faulty.
01/07/2018	00:00	31/07/2018 23:59	ZA error code.Unable to restart immediately due to HT radiator fan faulty.

Date	Gas Engine No. 2		Problem Description
	Shutdown	Restart	
01/08/2018	00:00	07/08/2018 00:32	ZA erro code.Unable to restart immediately due to HT radiator fan faulty.
08/08/2018	10:52	13:49	Proper shutdown - To service HT VCB at SSU LTP - by RA POWER. (Site Total shutdown).
09/08/2018	16:22	19:27	Proper shutdown.
10/08/2018	15:10	15:36	Proper shutdown - for check and repair blower #3 oil leaking by Hydrocare.
12/08/2018	09:31	09:39	Gas pressure Gas control system (GSS1 trip).
18/08/2018	10:56	11:27	Gas pressure Gas control system.
19/08/2018	10:12	10:23	Gas pressure Gas control system.
20/08/2018	05:04	05:13	Gas pressure Gas control system.
	07:58	14:00	Proper shutdown - to check / service flame arrester due to PT1 high pressure, blower run at full load. To check air compressor condition. To check condensate pipe line at GDU.
29/08/2018	18:19	20:50	Proper shutdown - GSS1 motor blower # 3 jammed. To swap with motor # 1. Test run Ok.
05/09/2018	15:11	30/09/2018 23:59	Proper shutdown - to swap AGCM PLC with GE1.Unable to restart immediately due to short number of Fan for radiator.
01/10/2019	0:00	31/10/2018 23:59	Proper shutdown - to swap AGCM PLC with GE1.Unable to restart immediately due to short number of HT Fan for radiator.
01/11/2018	00:00	28/11/2018 18:50	Shutdown for GE5 / GE6 electrical works at DG Building / PPU Bukit Tagar. Parts of repair works.
29/11/2018	18:28	18:33	TNB power surge.Engine trip.
	20:50	21:03	Combustion chamber A4. Change spark plug.
01/12/2018	03:09	3:12	Deviation Power control.Restart Ok.
	05:59	8:06	Deviation Power control.Restart Ok.
	12:19	13:02	Knocking sensor error bank B.
04/12/2018	08:58	17:30	Proper shutdown - for normal service at 1,500 hrs interval.
07/12/2018	17:17	20:28	Proper shutdown - to swap acuator cable with GE1.
08/12/2018	01:34	01:46	Combustion chamber B4 low temperature
21/12/2018	16:27	17:38	TNB power surge , few seconds.

Gas Engine No. 3

Date	Gas Engine No. 3		Problem Description
	Shutdown	Restart	
01/01/2018	0:00	31/01/2018 23:59	Major overhaull maintenance works 30,000 hours.Target 5 weeks.
01/02/2018	0:00	15/02/2018 3:02	Major overhaull maintenance works, 30,000 hrs.
16/02/2018	14:15	15:11	Low water intercooler circuit.
21/02/2018	09:16	16:15	Proper shutdown - For service at 50 hrs after overhaull by SPE.
22/02/2018	11:33	11:38	Jacket water engine outlet.
03/03/2018	14:33	20:29	TNB Power surge few seconds.
04/03/2018	00:52	08:03	Engine water level low.Release air lock,Ok.
	10:58	11:24	Combustion chamber average.
	13:11	13:31	Combustion chamber average.
	16:07	16:08	Combustion chamber average.
	18:04	18:15	Combustion chamber average.
	23:38	05/03/2018 07:43	Combustion chamber average.Genset CB trip.
05/03/2018	09:38	10:14	Combustion chamber average.
	11:09	06/03/2018 18:32	Combustion chamber average.Main gas pipe leaking - found damaged main pipe @ Ph 2B.Repair work by Unify on 06.03.18.
13/03/2018	09:08	15:00	Proper shutdown - Main gas pipe leaking,repair works by Unify. 2 nd repair work at Ph 2B.Total shutdown.
26/03/2018	10:19	27/03/2018 19:39	Proper shutdown to check exhaust leaking by SPE .Head Gasket leaking - SPE to change.
04/04/2018	13:57	14:01	T206 Jacket water engine outlet. Safety Chain.
	17:34	17:45	Jacket water engine outlet. Safety Chain.
06/04/2018	16:05	16:32	TNB Power Surge few seconds.
12/04/2018	16:42	17:00	Gas Pressure gas control system.
17/04/2018	15:35	30/04/2018 23:59	Jacket water engine outlet - HT Fan #2 trip - Unable to restart immediately due to radiator leaking.
01/05/2018	00:00	08/05/2018 15:03	Lighning strike @ Re center.Major all system tripped.Unable to restart.Major components to check for damage.
09/05/2018	05:39	14/05/2018 19:37	Jacket water engine outlet.HT pump leaking.
15/05/2018	11:05	11:13	Jacket water engine outlet.
19/05/2018	10:56	13:07	TNB power failure.Site total shutdown.
25/05/2018	10:22	31/05/2018 23:59	Proper shutdown - to service at 1,500 hrs internal by SPE.
01/06/2018	00:00	11/06/2018 14:32	Proper shutdown - to service at 1,500 hrs internal by SPE.Unable to restart immediately due to radiator fan problem.
11/06/2018	17:32	17:42	Combustion chamber B3 . Change spark plug.
14/06/2018	03:27	11:19	Proper shutdown - TNB overhead line 33 kv repaining works.
25/06/2018	16:29	20:09	UPS GSS 1 faulty.TNB power surge few seconds.
29/06/2018	15:51	16:00	Combustion chamber A5.
04/07/2018	17:35	17:45	Combustion chamber B2. Change spark plug (Spare unit).
24/07/2018	22:41	22:50	Combustion chamber A6.
30/07/2018	16:20	16:36	Combustion chamber A6. Change spark plug (Spare unit).
31/07/2018	09:39	20:54	Proper shutdown - requested by TNB for maintenance works at PPU Bukit Tagar 33KV right hand busbar and replace OCEF Relay.

Date	Gas Engine No. 3		Problem Description
	Shutdown	Restart	
02/08/2018	13:18	03/08/2018 23:34	Proper shutdown for pre- treatment service : i)GDU , ii)Radiator , iii)Scrubber Tank - by SPE.
04/08/2018	12:58	16:34	Proper shutdown for pre - treatment service, GE2 - Gas Dryer unit (GDU).
08/08/2018	10:53	13:52	Proper shutdown - To service HT VCB at SSU LTP - by RA Power. (Site total shutdown).
09/08/2018	16:23	19:29	Proper shutdown.
10/08/2018	15:11	15:38	Proper shutdown - for check and repair blower #3 oil leaking by Hydrocare.
12/08/2018	09:31	09:42	Gas pressure Gas control system (GSS1 trip).
17/08/2018	12:08	19:30	Proper shutdown - for normal service at 1,500 hrs internal by SPE.
18/08/2018	10:46	11:23	Proper shutdown to check scrubber tank & GDU condition (Water level).
	13:47	14:14	Proper shutdown to check scrubber tank & GDU condition (Water level).
19/08/2018	10:12	10:28	Gas Pressure , gas control system.
20/08/2018	01:13	07:52	Genset CB trip.Reset Ok.
	10:57	14:08	Proper shutdown - to check / service flame arrester due to PT1 high pressure, blower run at full load. To check air compressor condition. To check condensate pipe line at GDU.
25/08/2018	17:24	27/08/2018 09:05	Jacket water engine outlet - level low. Restart Ok.
29/08/2018	18:20	20:52	Proper shutdown - GSS1 motor blower # 3 jammed. To swap with motor # 1. Test run Ok.
19/09/2018	13:29	14:47	Gas Pressure gas control system.GSS1 trip,temperature high - high.Restart Ok.
25/09/2018	10:25	10:55	GSS1 trip.Pneumatic valve failure.Gas pressure gas control system.
27/09/2018	14:39	16:46	UPS GSS1 faulty.Reset Ok.
29/09/2018	10:47	17:42	Proper shutdown - Requested by TNB for repairing work (VCB) at Pencawang Elektrik Pelupusan Sampah. Shutdown for GSS3 cable installation work from MSB to GSS3 Feeder Pillar.
30/09/2018	14:03	21:51	Proper shutdown for GSS3 cable installation work from MSB to GSS3 Feeder Pillar.
01/10/2018	10:47	11:29	Proper shutdown - O ₂ flare 2 high.Unable to restart GBS due to TNB Power shutdown.
	13:35	21:26	Proper shutdown - O ₂ flare 2 high.Unable to restart GBS due to TNB Power shutdown.
02/10/2018	01:59	04:24	TNB works to normalize power at PE Pelupusan Sampah for the consumer.Panel change,together with generation panel.
06/10/2018	14:52	22:23	TNB install export meter (new) at PE Pelupusan Sampah.
11/10/2018	12:31	13:49	Proper shutdown - for CDM Calibration equipment. GSS 1 , i. TTI , ii. PT2 , iii. FT3 , iv. CH ₄ .
15/10/2018	09:18	31/10/2018 23:59	Shutdown for GE5 / GE6 electrical works at DG Building / PPU Bukit Tagar. Parts of repair works.
		30/11/2018 16:48	Shutdown for GE5 / GE6 electrical works at DG Building / PPU Bukit Tagar. Parts of repair works.
04/12/2018	09:05	09:15	Combustion chamber A5 change spark plug.
12/12/2018	11:22	16:28	Proper shutdown - For normal at 1,500 hrs Interval by SPE.
21/12/2018	16:27	17:11	TNB power surge,few seconds.

Gas Engine No. 4

Date	Gas Engine No. 4		Problem Description
	Shutdown	Restart	
10/01/2018	17:44	18:06	Power surge TNB.Restart Ok.
19/01/2018	13:44	14:40	GSS 2 trip.
20/01/2018	15:15	15:20	X20 - module faulty.Reset ok.
	17:38	17:43	X20 - module faulty.Reset ok.
22/01/2018	17:50	17:53	X20 - module faulty.Reset ok.
25/01/2018	09:14	17:01	Proper shutdown - Relay calibration by RA Power.Maintenance works cutting trees along service road to PPU Bukit Tagar by KBE workers.Service 33Kv transformer.
26/01/2018	18:02	18:20	Power surge - GSS 2 trip (PT2 high high).
27/01/2018	20:09	20:35	GSS 2 trip - Blower # 1 trip.Reset ok.
28/01/2018	18:49	21:57	TNB power failure - few seconds.
02/02/2018	08:07	16:19	Proper shutdown - service by WZS / MTU.
09/02/2018	15:55	16:19	Proper shutdown to check MIP aircond faulty.
13/02/2018	02:07	8:45	Coolant pressure before engine high.
15/02/2018	11:51	12:00	GSS 2 trip. Blower # 1 trip.
24/02/2018	09:00	9:17	Connection from alarm logger to PLC out of order.
25/02/2018	04:37	4:50	SM II status X 20 - module faulty.
03/03/2018	14:33	04/03/2018 09:32	TNB power surge few seconds.Unable to restart immediately due to voltage unstable.
04/03/2018	13:25	13:56	LoLo T- Exhaust A9.
	16:07	17:00	LoLo T- Exhaust A9.
	23:38	05/03/2018 00:51	LoLo T- Exhaust A9.
05/03/2018	02:13	07:56	LoLo T- Exhaust A9.Unable tp restart immediately due to CH ₄ unstable.
	10:32	06/03/2018 20:49	LoLo T- Exhaust A9.Main gas pipe leaking - found damaged main pipe @ Ph 2B.Repair work by Unify on 06.03.18.
08/03/2018	10:15	21:52	Proper shutdown - for pre-treatment service : 1.Scrubber Tank 2.Radiator Fan 3.GDU by WZS.
10/03/2018	08:36	08:41	Module Faulty X - 20.
13/03/2018	09:06	15:07	Proper shutdown - Main gas pipe leaking, repair works by Unify. 2 nd repair work @ Ph 2B.Total shutdown.
15/03/2018	15:41	15:49	Power surge few seconds.
20/03/2018	12:45	13:26	P-Coolant before engine high.Radiator fan # 7 trip. Restart Ok.
22/03/2018	13:36	13:52	PLC Connection out of order.Reset Ok.
26/03/2018	23:06	23:13	Module Faulty X - 20.Reset Ok.
05/04/2018	10:43	16:24	Proper shutdown to service at 1,250 hrs Internal - by WZS.
06/04/2018	16:05	16:49	TNB Power failure few seconds.
	18:25	18:35	TNB Power Surge few seconds.
09/04/2018	10:03	11/04/2018 15:55	Proper shutdown - relocate GE4 NER - by WZS.
13/04/2018	21:09	21:19	TNB power Surge (Fault Gas supply system).
16/04/2018	17:44	17:52	TNB Power Surge. GSS 2 trip.
18/04/2018	15:48	15:58	TNB Power Surge. GSS 2 trip.
24/04/2018	08:39	08:52	SM 32 - Gas pressure low.
	09:35	25/04/2018 20:08	Proper shutdown - to perform endoscopic on the engine liner - by MTU. Unable to restart immediately due to battery weak and SCADA program crash.
27/04/2018	18:38	18:50	TNB Power Surge.
02/05/2018	09:48	14:55	Proper shutdown - to do radiator fan wiring modification (trip alarm)- by WZS.
08/05/2018	09:11	10:12	MCB was open.Safety sensor reserve 3.
13/05/2018	01:44	01:49	TNB power surge , few seconds.

Date	Gas Engine No. 4		Problem Description
	Shutdown	Restart	
18/05/2018	11:17	11:29	GSS 2 trip.Blower # 1 trip.
	13:42	14:20	TNB power surge.
19/05/2018	10:53	13:13	TNB power failure.Site total shutdown.
22/05/2018	08:45	11:10	Proper shutdown - Chen Guan relocate battery charger for GE 4.
	15:48	15:54	TNB power surge , few seconds.
23/05/2018	13:30	25/05/2018	Generator under voltage.
		09:45	
01/06/2018	10:23	16:09	Proper shutdown for normal service at 1,250 hrs internal - by WZS.
03/06/2018	15:57	17:51	X-20 module faulty, LoLo A3. SM 93 - Under voltage.Change A3 spark plug.
04/06/2018	10:27	11:53	Proper shutdown - for CDM equipment calibration by - Nectar. i. TT1, ii. PT2.
06/06/2018	09:31	30/06/2018	Proper shutdown - to adjust valve clearance,mapping and check head condition.Unable to restart immediately due to AVR card faulty.(Generator Under Voltage).
		23:59	
01/07/2018	00:00	09/07/2018	Proper shutdown - to adjust valve clearance,mapping and check head condition.Unable to restart immediately due to AVR card faulty.
		16:59	
15/07/2018	07:27	08:25	GSS 2 trip.Air compressor trip.Restart Ok.
22/07/2018	20:17	22:00	GSS 2 trip.Air compressor trip.Restart Ok.
23/07/2018	05:21	05:46	GSS 2 trip.Air compressor trip.Restart Ok.
	09:36	09:44	Proper shutdown to install new unit air compressor.Restart Ok.
31/07/2018	09:35	22:53	Proper shutdown - requested by TNB for maintenance works at PPU Bukit Tagar 33KV right hand busbar and replace OCEF Relay.
01/08/2018	03:00	04:07	X - 20 module faulty.Restart Ok.
06/08/2018	14:22	14:31	Pro Act B position.
08/08/2018	10:56	15:50	Proper shutdown - To service HT VCB at SSU LTP - by RA Power. (Site total shutdown).
09/08/2018	16:24	19:32	Proper shutdown.
14/08/2018	05:19	08:33	X-20 module faulty.
	18:47	18:56	TNB power surge , few seconds.
17/08/2018	14:27	14:35	X-20 module faulty.Restart Ok.
20/08/2018	12:01	12:24	Module faulty X-20.
	14:02	14:13	Module faulty X-20.Reset Ok.
21/08/2018	17:11	17:17	TNB power surge , few seconds.
28/08/2018	09:03	16:40	Proper shutdown - for normal service at 1,250 hrs internal by WZS/MTU.
29/08/2018	19:12	19:21	Module faulty X-20.Reset Ok.
30/08/2018	14:38	31/08/2018	GSS 2 trip.Compressor faulty. Unable to restart immediately due to starter problem.
		23:59	
01/09/2018	00:00	04/09/2018	GSS2 trip.Compressor faulty.Unable to restart immediately due to starter problem.
		17:08	
07/09/2018	12:49	12:57	TNB power surge - few seconds.
	16:13	16:38	TNB power surge - few seconds.
10/09/2018	07:11	12:22	Unable to restart.Busbar Voltage = 0.DG Breaker trip.Reset & Restart GE4.
12/09/2018	02:12	02:39	SM 11 status X-20 module faulty.Reset Ok.
13/09/2018	09:35	09:40	SM 11 status X-20 module faulty.
14/09/2018	08:15	08:20	GSS2 trip.Restart Ok.
	10:59	11:29	Proper shutdown to check SCADA system.To check flow reading.Reset Ok.
	15:12	15:37	Jacket water engine outlet.
	20:42	21:05	GSS2 trip.Blower # 1 trip.Reset ok.
14/09/2018	23:30	15/09/2018	GSS2 trip.PT High - High.
		00:17	
15/09/2018	03:21	06:43	GSS2 trip.PT2 High - High.
	09:18	10:25	GSS2 trip.GDU water level high.Service solenoid valve filter.Test run Ok.
	20:39	23:59	Module faulty X - 20.
26/09/2018	14:31	14:55	GSS2 trip.CH4 Low- Low.Reset Ok.
	18:56	19:14	X 20 module faulty.Reset Ok.

Date	Gas Engine No. 4		Problem Description
	Shutdown	Restart	
28/09/2018	13:32	14:45	Pro Act B.Reset Ok. Restart load at 55%.
29/09/2018	10:44	17:58	Proper shutdown - Requested by TNB for repairing work (VCB) at Pencawang Elektrik Pelupusan Sampah.WZS to install new unit of starter motor. Shutdown for GSS3 cable installation work from MSB to GSS3 Feeder Pillar.
29/09/2018	20:35	30/09/2018 11:17	Proper shutdown- O ₂ Flare 2 high.Unable to restart GBS due to TNB Power shutdown.
30/09/2018	14:01	23:59	Proper shutdown for GSS3 cable installation work from MSB to GSS3 Feeder Pillar.
01/10/2018	00:00	07:46	Proper shutdown for GSS 3 cable Installation work from MSB to GSS 3 feeder pillar.
02/10/2018	02:55	04:22	TNB works to normalize power at PE Pelupusan Sampah for the consumer panel change, together generation panel.
06/10/2018	14:52	15:10	TNB install export meter (new) at PE Pelupusan Sampah.
	18:47	20:19	TNB install export meter (new) at PE Pelupusan Sampah.
07/10/2018	14:34	14:38	X - 20 module faulty.
09/10/2018	13:03	13:54	X - 20 module faulty.
15/10/2018	09:18	31/10/2018 23:59	Shutdown for GE5 / GE6 electrical works at DG Building / PPU Bukit Tagar. Parts of repair works.
01/11/2018	0:00	30/11/2018 23:59	Shutdown for GE5 / GE6 electrical works at DG Building / PPU Bukit Tagar. Parts of repair works.
01/12/2018	0:00	31/12/2018 23:59	Shutdown for GE5 / GE6 electrical works at DG Building / PPU Bukit Tagar. Parts of repair works.

Appendix 3: 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 ACM 0001, 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 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 $m_{H_2O,t,db}$ is assumed to equal to 0. If it is conservative to assume that the gaseous stream is saturated, then $m_{H_2O,t,db}$ is assumed to be equal to the saturation absolute humidity ($m_{H_2O,t,db,sat}$) and is calculated using the equation below:

$$m_{H_2O,t,db,sat} = \frac{P_{H_2O,t,Sat} \times MM_{H_2O}}{(P_t - P_{H_2O,t,Sat}) \times MM_{t,db}}$$

Where:

$m_{H_2O,t,db,sat}$	= Saturation absolute humidity in time interval t on a dry basis (kg H ₂ O/kg dry gas)
$p_{H_2O,t,Sat}$	= Saturation pressure of H ₂ O 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_{H_2O}	= Molecular mass of H ₂ O (kg H ₂ O/kmol H ₂ O)
$MM_{t,db}$	= Molecular mass of the gaseous stream in a time interval t on a dry basis (kg dry gas/kmol dry gas)

Parameter	Formula / description														
$p_{H2O,t,Sat}$	<table><tr><td>1</td><td>2</td><td></td></tr><tr><td>Filonenko/ Ginzburg (1973) and Filonenko et al. (1971)</td><td>0...100</td><td>$p_s = \exp(6.416 + 17.3 \cdot t / (238+t))$,</td></tr></table> <p>$P_s$ – Saturation pressure of H₂O t – LFG Temperature</p>	1	2		Filonenko/ Ginzburg (1973) and Filonenko et al. (1971)	0...100	$p_s = \exp(6.416 + 17.3 \cdot t / (238+t))$,								
1	2														
Filonenko/ Ginzburg (1973) and Filonenko et al. (1971)	0...100	$p_s = \exp(6.416 + 17.3 \cdot t / (238+t))$,													
P_t	<table><tr><td colspan="2">Absolute Pressure</td></tr><tr><td>$P_a = P_g + P_{at}$</td><td></td></tr><tr><td>$P_a = P_g + 101325$</td><td></td></tr><tr><td>where,</td><td></td></tr><tr><td>P_a = Absolute Pressure,</td><td></td></tr><tr><td>P_g = Gauge Pressure,</td><td></td></tr><tr><td>P_{at} = Atmospheric Pressure.</td><td></td></tr></table>	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.	
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MM_{H2O}	18.0152 kg/kmol Default value from the tool														
$MM_{t,db}$	$MM_{t,db} = \sum_k (v_{k,t,db} * MM_k)$ <p>Where:</p> <p>$MM_{t,db}$ = Molecular mass of the gaseous stream in time interval t on a dry basis (kg dry gas/kmol dry gas)</p> <p>$v_{k,t,db}$ = Volumetric fraction of gas k in the gaseous stream in time interval t on a dry basis (m³ gas k/m³ dry gas)</p> <p>MM_k = Molecular mass of gas k (kg/kmol)</p> <p>k = All gases, except H₂O, contained in the gaseous stream (e.g. N₂, CO₂, O₂, CO, H₂, CH₄, N₂O, NO, NO₂, SO₂, SF₆ and PFCs). See available simplification below</p> <p>Default value for $MM_{i,k}$, Gases involve in the calculation are CH₄, CO₂, and O₂</p>														

Parameter	Formula / description																																				
Data / Parameter:	MM_i																																				
Data unit:	kg/kmol																																				
Description:	Molecular mass of greenhouse gas i																																				
Value to be applied:	<table border="1"> <thead> <tr> <th>Compound</th><th>Structure</th><th>Molecular mass (kg / kmol)</th></tr> </thead> <tbody> <tr><td>Carbon dioxide</td><td>CO₂</td><td>44.01</td></tr> <tr><td>Methane</td><td>CH₄</td><td>16.04</td></tr> <tr><td>Nitrous oxide</td><td>N₂O</td><td>44.02</td></tr> <tr><td>Sulfur hexafluoride</td><td>SF₆</td><td>146.06</td></tr> <tr><td>Perfluoromethane</td><td>CF₄</td><td>88.00</td></tr> <tr><td>Perfluoroethane</td><td>C₂F₆</td><td>138.01</td></tr> <tr><td>Perfluoropropane</td><td>C₃F₈</td><td>188.02</td></tr> <tr><td>Perfluorobutane</td><td>C₄F₁₀</td><td>238.03</td></tr> <tr><td>Perfluorocyclobutane</td><td>c-C₄F₈</td><td>200.03</td></tr> <tr><td>Perfluoropentane</td><td>C₅F₁₂</td><td>288.03</td></tr> <tr><td>Perfluorohexane</td><td>C₆F₁₄</td><td>338.04</td></tr> </tbody> </table>	Compound	Structure	Molecular mass (kg / kmol)	Carbon dioxide	CO ₂	44.01	Methane	CH ₄	16.04	Nitrous oxide	N ₂ O	44.02	Sulfur hexafluoride	SF ₆	146.06	Perfluoromethane	CF ₄	88.00	Perfluoroethane	C ₂ F ₆	138.01	Perfluoropropane	C ₃ F ₈	188.02	Perfluorobutane	C ₄ F ₁₀	238.03	Perfluorocyclobutane	c-C ₄ F ₈	200.03	Perfluoropentane	C ₅ F ₁₂	288.03	Perfluorohexane	C ₆ F ₁₄	338.04
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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 apply values for MM_i . <table border="1"> <thead> <tr> <th>Compound</th><th>Structure</th><th>Molecular mass (kg / kmol)</th></tr> </thead> <tbody> <tr><td>Nitrogen</td><td>N₂</td><td>28.01</td></tr> <tr><td>Oxygen</td><td>O₂</td><td>32.00</td></tr> <tr><td>Carbon monoxide</td><td>CO</td><td>28.01</td></tr> <tr><td>Hydrogen</td><td>H₂</td><td>2.02</td></tr> <tr><td>Nitric oxide</td><td>NO</td><td>30.01</td></tr> <tr><td>Nitrogen dioxide</td><td>NO₂</td><td>46.01</td></tr> <tr><td>Sulfur dioxide</td><td>SO₂</td><td>64.06</td></tr> </tbody> </table>	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
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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:

$$V_{t,db} = V_{t,wb} / (1 + v_{H_2O,t,db})$$

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

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

$$v_{H_2O,t,db} = \frac{m_{H_2O,t,db} * MM_{t,db}}{MM_{H_2O}}$$

Where:

- $v_{H_2O,t,db}$ = 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)
- $m_{H_2O,t,db}$ = 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_{H_2O} = Molecular mass of H_2O ($kg H_2O/kmol H_2O$)

The absolute humidity of the gaseous stream ($m_{H_2O,t,db}$) 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)	AO2	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	855.47	-6.62	18.56	56.23	41.01	1.46	1732.16	1732.06	2.00	16.04	44.01	27.5414	18.0152	101325	119795	15425.0598	0.0966	0.1477	1511.3559	1512.07	1732.06
42	9/17/12 0:2	54.58	855.47	-6.62	18.56	56.23	41.01	1.44	1738.58	1735.62	2.00	16.04	44.01	27.5414	18.0152	101325	119845	15425.0598	0.0966	0.1477	1511.3559	1512.07	1735.62
43	9/17/12 0:2	54.52	855.47	-6.62	18.56	56.23	41.01	1.44	1739.38	1738.58	2.00	16.04	44.01	27.5414	18.0152	101325	119835	15425.0598	0.0966	0.1477	1511.3559	1512.07	1738.58
44	9/17/12 0:2	54.48	855.47	-6.62	18.56	56.23	41.01	1.45	1729.11	1729.14	2.00	16.04	44.01	27.5414	18.0152	101325	119755	15425.0598	0.0966	0.1477	1511.3559	1512.07	1729.14
45	9/17/12 0:2	54.45	855.47	-6.62	18.56	56.23	41.01	1.44	1738.51	1737.52	2.00	16.04	44.01	27.5414	18.0152	101325	119845	15425.0598	0.0966	0.1477	1511.3559	1512.07	1737.52
46	9/17/12 0:2	54.45	855.47	-6.62	18.56	56.23	41.01	1.42	1740.07	1731.62	2.00	16.04	44.01	27.5414	18.0152	101325	119885	15425.0598	0.0966	0.1477	1511.3559	1512.07	1731.62
47	9/17/12 0:2	54.45	855.47	-6.62	18.56	56.23	41.01	1.42	1744.68	1740.56	2.00	16.04	44.01	27.5414	18.0152	101325	119845	15425.0598	0.0966	0.1477	1511.3559	1512.07	1740.56
48	9/17/12 0:2	54.45	855.47	-6.62	18.56	56.23	41.01	1.41	1730.11	1730.75	2.00	16.04	44.01	27.5414	18.0152	101325	119815	15425.0598	0.0966	0.1477	1511.3559	1512.07	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	15425.0598	0.0966	0.1477	1511.3559	1512.07	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	15425.0598	0.0966	0.1477	1511.3559	1512.07	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	15425.0598	0.0966	0.1477	1511.3559	1512.07	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	15425.0598	0.0966	0.1477	1511.3559	1512.07	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	15425.0598	0.0966	0.1477	1511.3559	1512.07	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	54.63	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

LFG Temperature
> 60°C

Original value for
FT2

FT2 calculated
using the tool
and is applied in
the CER
calculation

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
06.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 01.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
05.1	4 May 2015	Editorial revision to correct version numbering.
05.0	1 April 2015	Revisions to: <ul style="list-style-type: none"> • Include provisions related to delayed submission of a monitoring plan; • Provisions related to the Host Party; • Remove reference to programme of activities; • Overall editorial improvement.
04.0	25 June 2014	Revisions to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the monitoring report form (these instructions supersede the "Guideline: Completing the monitoring report form" (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for completing the CDM-MR-FORM in A.6 and Appendix 1; • Change the reference number from <i>F-CDM-MR</i> to <i>CDM-MR-FORM</i>; • Editorial improvement.
03.2	5 November 2013	Editorial revision to correct table in page 1.
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB 70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01.0	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: Issuance Keywords: monitoring report		