**MONITORING REPORT FORM (F-CDM-MR)**
**Version 02.0**

# MONITORING REPORT

| | |
|---|---|
| **Title of the project activity** | Jaroensompong Corporation Rachathewa Landfill Gas to Energy Project |
| **Reference number of the project activity** | 1413 |
| **Version number of the monitoring report** | Version 8.3 |
| **Completion date of the monitoring report** | 29/09/2012 |
| **Registration date of the project activity** | 14/03/2008 |
| **Monitoring period number and duration of this monitoring period** | 14/03/2008 - 31/12/2008<br>(293 days) |
| **Project participant(s)** | - Jaroensompong Co., Ltd.<br>- Mitsubishi UFJ Morgan Stanley Securities Co., Ltd. |
| **Host Party(ies)** | Thailand |
| **Sectoral scope(s) and applied methodology(ies)** | Sectoral scope 13: Waste handling and Disposal<br><br>Consolidated baseline methodology for landfill gas project activities (ACM0001-version 05) |
| **Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD** | 61,312 $tCO_2e$ (293 days) |
| **Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period** | 27,060 $tCO_2e$ (293 days) |

## SECTION A. Description of project activity

### A.1. Purpose and general description of project activity

The Rachathewa landfill site is located 30km east of the Bangkok Metropolitan Area (BMA) and receives approximately 3,500 tons/day or 16,667 cubic meters/day of municipal solid waste (MSW). There are presently no regulatory or contractual requirements for landfill gas (LFG) collection/combustion in Thailand so landfill sites such as Rachathewa are emitting huge quantities of methane gas directly into the atmosphere.

The Project's developer, Jaroensompong Co., Ltd. (JS), has installed a LFG collection system and 1.1MW electricity generator at the Rachathewa site. Recovered LFG is being utilized as a fuel source for the generator. The generated electricity is being sold to the Metropolitan Electricity Authority (MEA) under a power purchase agreement.

The Project is the first in Thailand to utilize LFG for electricity generation on a commercial basis and contributes to sustainable development of the country by mitigating uncontrolled GHG emission from the landfill, preventing on-site fires, controlling the release of volatile organic compounds, reducing undesirable odours, providing greater control of leachate drainage, and physically stabilizing the landfill site. The Project brings the following additional economic, environmental and social benefits:

- Metro-Cat (The authorized caterpillar dealer in Thailand) has transferred LFG generator related technology to Thailand. The company supplied the generator for the Project and, under the contract, is responsible for training staff in generator operation and maintenance.
- The Project promotes most efficient use of local resources, which results in reduction of energy imports.
- Local inhabitant benefit from the improvement of air quality due to lower methane and odour emissions from the landfill.
- The Project has been promoting practical experience in LFG collection and utilization. Local staff has been trained and acquired the skills required to operate LFG collection and utilization equipment.

Detail description of the installed equipment is provided below.

**LFG collection system**

JS has utilized its waste management experience to design a LFG collection system for the Project based on horizontal lines and wells. Rather than the traditional vertical system for the closed landfill site, the company concluded that the horizontal design technology is more appropriate for the characteristics of Thai MSW and country's climatic conditions. The MSW contains high moisture. During the long rainy season, there is a continuous influx of rainwater into the landfill site. The wells of a vertical system would be prone to flooding under such conditions.

As was mentioned in foregoing section, the Project has been only utilizing LFG from Site 1. LFG is recovered at the outer edges and at the center of the landfill. The collectors include a system for drainage and collection of leachate at the outer edges of the landfill. They are constructed using PVC and HDPE piping to allow for settlement.

The horizontal collectors and other points are connected by laterals to a main header system. This is the area where LFG gas is drawn to under a vacuum created by the blower.

Condensate is removed from the system using a process which begins from the recovery system. Here, sloping laterals and headers are used to provide drainage into condensate traps, knockout collectors, and tanks. The condensate is then drained back into the landfill.

**LFG utilization system**
JS has installed a power plant with a capacity of 1.1MW.

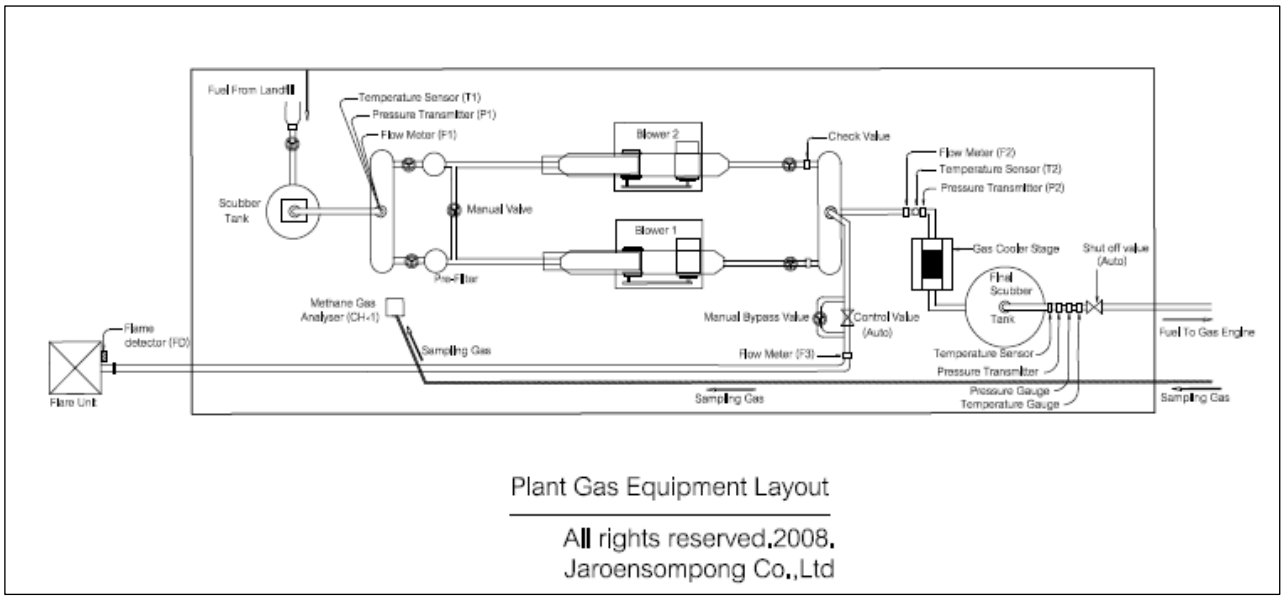
Corrosive elements and contaminants are removed from the LFG using a system composed of condensate tanks and filter tanks.

JS conducted a two-year pilot project to examine the potential of commercial LFG collection/utilization for electricity generation. The pilot project utilized two old engines that had been modified from diesel to gas. The information gathered from the pilot project provided the basis for the final design of the Project.

**Flaring system**
The Project has installed a flaring system to burn excess LFG that is not used in power generation. An open flare system was selected over an enclosed flare system because it is a less expensive approach for flaring.

The Project employed an advanced foreign technology for electricity generation. As the first landfill site to use this state of the art technology in Thailand, the Project represents an important case for technology transfer.

Figure 1: Process Flow Diagram (PFD)




The Project has started on August 1, 2004. The construction has completed on June 2005 and the commercial operation has started on March 3, 2006.

It is estimated that the Project will generate 518,305 $tCO_2e$ of emission reductions over a 10-year period with an average of 51,830 $tCO_2e$/yr. Total emission reductions achieved in this monitoring period is 27,060 $tCO_2e$.

**A.2. Location of project activity**
**A.2.1. Host Party**
The Kingdom of Thailand

**A.2.2. Region/State/Province**
Samuthprakarn

**A.2.3. City/Town/Community**
Rachathewa, Bangplee

**A.2.4. Detail of Physical Location**
The Project is located at the Rachathewa landfill area, about 30 km east of BMA. The area in the vicinity of the landfill is primarily industrial, with numerous heavy industrial compounds and some agricultural and residential establishments. The Rachathewa landfill site occupies some 40 hectares and includes ancillary facilities necessary to support its operations. It also includes a buffer zone around the disposal area. The landfill site has been separated into two sites.

**Site 1**
Operations commenced on Site 1 in December 1999. The site was capped and closed in November 2001. The area contains approximately 2.5 million tons of newly disposed solid waste and 2.2 million tons of old solid waste relocated from the On-Nuch landfill site,

**Site 2**
Site 2 commenced operations in December 2001 and was closed in December 2006. It is estimated that this disposal site will contain approximately 6 million tons of solid waste by the end of 2006.

LFG collection and its utilization for electricity generation are implemented at Site 1.

**A.3. Parties and project participant(s)**

| Party involved ((host) indicates a host Party) | Private and/or public entity(ies) project participants (as applicable) | Indicate if the Party involved wishes to be considered as project participant (Yes/No) |
|---|---|---|
| Thailand (host) | Jaroensompong Co., Ltd. (private entity) | No |
| Japan | Mitsubishi UFJ Morgan Stanley Securities[1] Co., Ltd. (Private entity) | No |

**A.4. Reference of applied methodology**
The approved baseline and monitoring methodology applied to the Project Activity is:
ACM0001 "Consolidated baseline methodology for landfill gas project activities" (version 05)

The methodology referred to calculate the grid emission factor is:
AMS I.D "Grid connected renewable electricity generation" (version 11)

The tool used for demonstration and assessment of the additionality of the Project Activity is:
"Tool for the demonstration and assessment of additionality (version 03)"

[1] The former name of above captioned was Mitsubishi UFJ Securities, a project participant of this registered project from the beginning of CDM development.

The tool used for the determination of project emissions from flaring gases is:
"Methodological Tool to determine project emissions from flaring gases containing methane"

**A.5. Crediting period of project activity**
Type of crediting period: fixed crediting period
Starting date of the crediting period: 14/03/2008
Length of the crediting period: Ten (10) years

**SECTION B. Implementation of project activity**
**B.1. Description of implemented registered project activity**
A summary of the implementation status of the project activity covering this monitoring period is described below:

(1) Main equipment installed and operated at the Project
Metro-Cat has transferred LFG generator related technology to Thailand and supplied the generator for the Project. The Project has utilized its waste management experience to design a LFG collection system for the Project based on horizontal lines and wells. Rather than the traditional vertical system for the closed landfill site, the company concluded that the horizontal design technology is more appropriate for the characteristics of Thai MSW and country's climatic conditions. LFG is recovered at the outer edges and at the center of the landfill. The collectors include a system for drainage and collection of leachate at the outer edges of the landfill. The Project has installed a power plant with a capacity of 1.1MW for electricity generation. The Project has installed a flaring system to burn excess LFG that is not used in power generation. An open flare system was selected over an enclosed flare system because it is a less expensive approach for flaring.

(2) The starting date of the project activity: August 1, 2004

(3) Completion of the construction of the project activity: June 2005

(4) Project commercial operation starting date: March 3, 2006

(5) Actual operation of the project activity during this monitoring period

The details of actual operation during this monitoring period are as follows:-

| No. | Data/Parameter | Unit | Value of parameter |
|---|---|---|---|
| 1 | ERy | tCO2 e | 27,060 |
| 2 | MDproject,y | tCH4 | 1,160 |
| 3 | ELy | MWh | 5,281 |
| 4 | CEFelectricity,y | tCO2e /MWh. | 0.51 |
| 5 | $ET_y$ | TJ | 0 |
| 6 | $MD_{electricity,y}$ | $tCH_4$ | 1,160 |
| 7 | MD thermal, y | $tCH_4$ | 0 |
| 8 | $EL_{EX,LFG}$ | MWh | 5,289 |
| 9 | $EL_{IMP}$ | MWh | 8.0 |
| 10 | $LFG_{flare,y}$ | $m^3$ | Unit : $Nm^3$ : 103,493.76(1) ; $m^3$ : 98,106.27(2) |

| | | | |
|---|---|---|---|
| 11 | $LFG_{electricity,y}$ | $m^3$ | Unit : $Nm^3$ \| $m^3$<br>3,401,435.70 (1) \| 3,224,369.81(2) |
| 12 | $LFG_{thermal, y}$ | $m^3$ | Unit : $Nm^3$ \| $m^3$<br>$0^{(1)}$ \| $0^{(2)}$ |
| 13 | $W_{CH4,y}$ | $m^3CH_4/m^3LFG$ | 0.502 |
| 14 | $D_{CH4}$ | $tCH_4/m^3CH_4$ | 0.00071680 |
| 15 | $PE_{flare,y}$ | $tCO_2e$ | 741.47 |
| 16 | $TM_{RG,h}$ | Kg/h | 5.99 |
| 17 | $\eta_{flare,h}$ | - | 0 |
| 18 | Flare operation parameter | min/h | 0* no flare was detect in each hour |
| 19 | $FV_{RG,h}$ | $m^3/h$ | 16.65 |
| 20 | $fv_{CH4,RG,h}$ | $m^3CH_4/m^3LFG$ | 0.502 |
| 21 | Operation of the energy plant | h | 5,876.9 |
| 22 | $LFG_{total,y}$ | $m^3$ | Unit : $Nm^{3(1)}$ \| $m^{3(2)}$<br>3,650,777.24 \| 3,460,731.57 |

Remark :(1)-The quantity of LFG is reported in "Nm3" at Standard Temperature and Pressure, STP(15c, 1.01325bar)
(2) The quantity of LFG is reported in "$m^3$ " at Standard Temperature and Pressure, STP (0c, 1.01325bar) referred in ACM 0001 version5. These values are converted value. The equation applied for conversion is as follow: PV= nRT, (P1xV1)/T1=(P2xV2)/T2

**B.2. Post registration changes**

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

Not applicable

**B.2.2. Corrections**

Not applicable

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

Not applicable

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

During the verification procedures for the first monitoring period (14 March 2008 - 31 December 2008), a change in an installed capacity of electricity generator of the project activity is described below. The change of the project design of the project activity is submitted with this monitoring report.

**INSTALLED CAPACITY PRIOR TO CHANGE**

Installed capacity of electricity generator described in the registered PDD
Jaroensompong Corporation will install a power plant with a capacity of 1MW.

**INSTALLED CAPACITY AFTER THE CHANGE**

Actual installed capacity of electricity generator
Jaroensompong Co., Ltd. has installed an electricity generator with a capacity of 1100kWe (1.1MW).

The reason for the change is attributed to the fact that the installation of electricity generation in the registered PDD is based on electricity regulations governed by the Metropolitan Electricity Authority (MEA) for Very Small Power Producer (VSPP). Under the regulations of VSPP, the output capacity of electricity generation delivered to MEA must not exceed 1.0MW. Thus, it was planned to install 1MW-

electricity generator at the project site and Power Purchase Agreement (PPA) was signed between Jaroensompong Co., Ltd. and MEA on July 14, 2005.

Capacity of generator installed at the site was, however, 1.1MW according to the specification of equipment, CAT G3516A. This is 10.0% higher than the capacity described in the registered PDD.

**Effect of the change**
The increase in installed capacity (1.1MW) does not impact the scale of CDM project activity and applicability and application of methodology under the project activity has been registered, because a) electricity generation delivered to MEA under the signed contract is limited to 1MW, and b) as demonstrated in the monitoring calculation spreadsheet, net electricity generation of the project activity after deducting parasitic load is less than 1MW.

In addition, the Project is the first commercial LFG utilization to electricity generation in Thailand and technological barrier was chosen to identify barriers of project's additionality. Hence the change in installed capacity would also not affect the additionality of the project activity.

The registered PDD is revised from version 03 on 27/06/2007 uploaded on the UNFCCC website to version 03.5 on 05/06/2012 to be consistent with the actual installed capacity of electricity generation.

**B.2.5. Changes to start date of crediting period**
Not applicable

**B.2.6. Types of changes specific to afforestation or reforestation project activity**
Not applicable

**SECTION C. Description of monitoring system**

In accordance with ACM0001 version 5 that was applied for the Project, the emission reductions achieved by the project activity during a year y were estimated as follows:

$$ER_y = \left(MD_{project,y} - MD_{reg,y}\right) \times GWP_{CH4} + EL_y \times CEF_{electricity,y} - ET_y \times CEF_{thermal,y}$$

where:

| | |
|---|---|
| $ER_y$ | Emission reductions in tones of $CO_2$ equivalents ($tCO_2e$) |
| $MD_{project,y}$ | Amount of methane that would have been destroyed/combusted during the year in tones of methane ($tCH_4$) |
| $MD_{reg,y}$ | Amount of methane that would have been destroyed/combusted during the year in the absence of the project in tones of methane ($tCH_4$) |
| $GWP_{CH4}$ | Global Warming Potential value for methane for the first commitment period is 21 $tCO_2e/tCH_4$ |
| $EL_y$ | Net quantity of electricity exported during year y in megawatt hours (MWh) |
| $CEF_{electricity,y}$ | $CO_2$ emissions intensity of the electricity displaced in $tCO_2e/MWh$ |
| $ET_y$ | Incremental quantity of fossil fuel defined as difference of fossil fuel used in the baseline and fossil fuel used during the project for energy requirement on site under project activity during the year in TJ |
| $CEF_{thermal,y}$ | $CO_2$ emissions intensity of the fuel used to generate thermal/mechanical energy in $tCO_2e/TJ$ |

Net quantity of electricity exported during year y in megawatt hours ($EL_y$) is estimated as follows:

$$EL_y = EL_{EX,LGFG} - EL_{IMP}$$

where:

| | |
|---|---|
| $EL_{EX,LFG}$ | Net quantity of electricity exported during year y produced using landfill gas in megawatt hours (MWh) |
| $EL_{IMP}$ | Net incremental electricity imported, defined as difference of project imports less any imports of electricity in the baseline, to meet the project requirements in megawatt hours (MWh) |

In cases where the $MD_{reg,y}$ is given/defined as a quantity, that quantity will be used.

In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$ and "Adjustment factor" (AF) shall be used and justified, taking into account the project context.

$$MD_{reg,y} = MD_{projoect,y} \times AF$$

Amount of methane that would have been destroyed/combusted during the year ($MD_{project,y}$) can be arrived at by applying the following equation:

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

where:

| | |
|---|---|
| $MD_{flared,y}$ | Quantity of methane destroyed by flaring during year y ($tCH_4$/year) |
| $MD_{electricity,y}$ | Quantity of methane destroyed by generation of electricity during year y ($tCH_4$/year) |
| $MD_{thermal,y}$ | Quantity of methane destroyed by generation of thermal energy during year y ($tCH_4$/year) |

$$MD_{flared,y} = \left(LFG_{flare,y} \times w_{CH4,y} \times D_{CH4}\right) - \left(PE_{flare,y} \div GWP_{CH4}\right)$$

where:

| | |
|---|---|
| $LFG_{flare,y}$ | Quantity of landfill gas fed to the flare during the year measured in cubic meters ($m^3$/year) |
| $w_{CH4,y}$ | Average methane fraction of the landfill gas as measured during the year and expressed as a fraction ($m^3CH_4/m^3LFG$) |
| $D_{CH4}$ | Methane density expressed in tones of methane per cubic meter of methane ($tCH_4/m^3CH_4$) |
| $PE_{flare,y}$ | Project emissions from flaring during the year y ($tCO_2$/year) |

$$PE_{flare,y} = \sum_{h=1}^{8760} TM_{RG,h} \times \left(1 - \eta_{flare,h}\right) \times \frac{GWP_{CH4}}{1000}$$

where:

| | |
|---|---|
| $TM_{RG,h}$ | Mass flow rate of methane in the residual gas in the hour h (kg/h) |
| $\eta_{flare,h}$ | Flare efficiency in hour h |

$$TM_{RG,h} = FV_{RG,h} \times fv_{CH4,RG,h} \times \rho_{CH4,n}$$

where:

| | |
|---|---|
| $FV_{RG,h}$ | Volumetric flow rate of the residual gas in dry basis at normal conditions in hour h ($m^3$/h) |
| $fv_{CH4,RG,h}$ | Volumetric fraction of methane in the residual gas on dry basis in hour h |
| $\rho_{CH4,n}$ | Density of methane at normal conditions (0.716 kg/$m^3$) |

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

where:

| | |
|---|---|
| $LFG_{electricity,y}$ | Quantity of landfill gas into electricity generator during the year y ($m^3$/year) |

$$MD_{thermal,y} = LFG_{thermal,y} \times w_{CH4,y} \times D_{CH4}$$

where:

| | |
|---|---|
| $LFG_{thermal,y}$ | Quantity of landfill gas fed into boiler during the year y ($m^3$/year) |

**a) Raw Data Processing**

Collected raw data from monitoring devices have been processed as per Section Raw Data Processing of Annex 2.4.4.

Other operational data ($EL_{EX,LFG}$, $EL_{IMP}$, $ET_y$, operation of the energy plant) have been processed as per Section Raw Data Processing of Annex 2.4.4

**b) Monitored Data Processing**

Monitored data have been processed as per the calculation method provided in the registered PDD.
The clarification of the conservativeness approach for the quantity of LFG that was adopted for ex-post emission calculation has been established as follows:

Conservative method applied for the ex-post calculation can be justified if LFG utilized for the electricity generation ($LFG_{electricity}$) is less than the total LFG collected ($LFG_{total}$) minus LFG flared ($LFG_{flare}$).

Solution "X" in the formula below should be positive where the LFG used for the electricity generation is less than the results which are calculated as the total LFG collected minus LFG flared.

$X = ( LFG_{total} - LFG_{flare} ) - LFG_{electricity}$

Project participant calculated "X" on a monthly basis and it turned out that the results were all positive. Thus, it is concluded that calculating the emission reductions from the LFG utilized for the electricity generation ($LFG_{electricity}$) is conservative. Calculation results are indicated in the emission reduction calculation spreadsheet.

**c) Data Archiving Protocol**

Collected raw data from monitoring devices have been archived periodically by JS Staff. Others operational data ($EL_{EX,LFG}$, $EL_{IMP}$, $ET_y$, operation of the energy plant) have been archived on monthly basis by JS Staff apart from data from monitoring station.

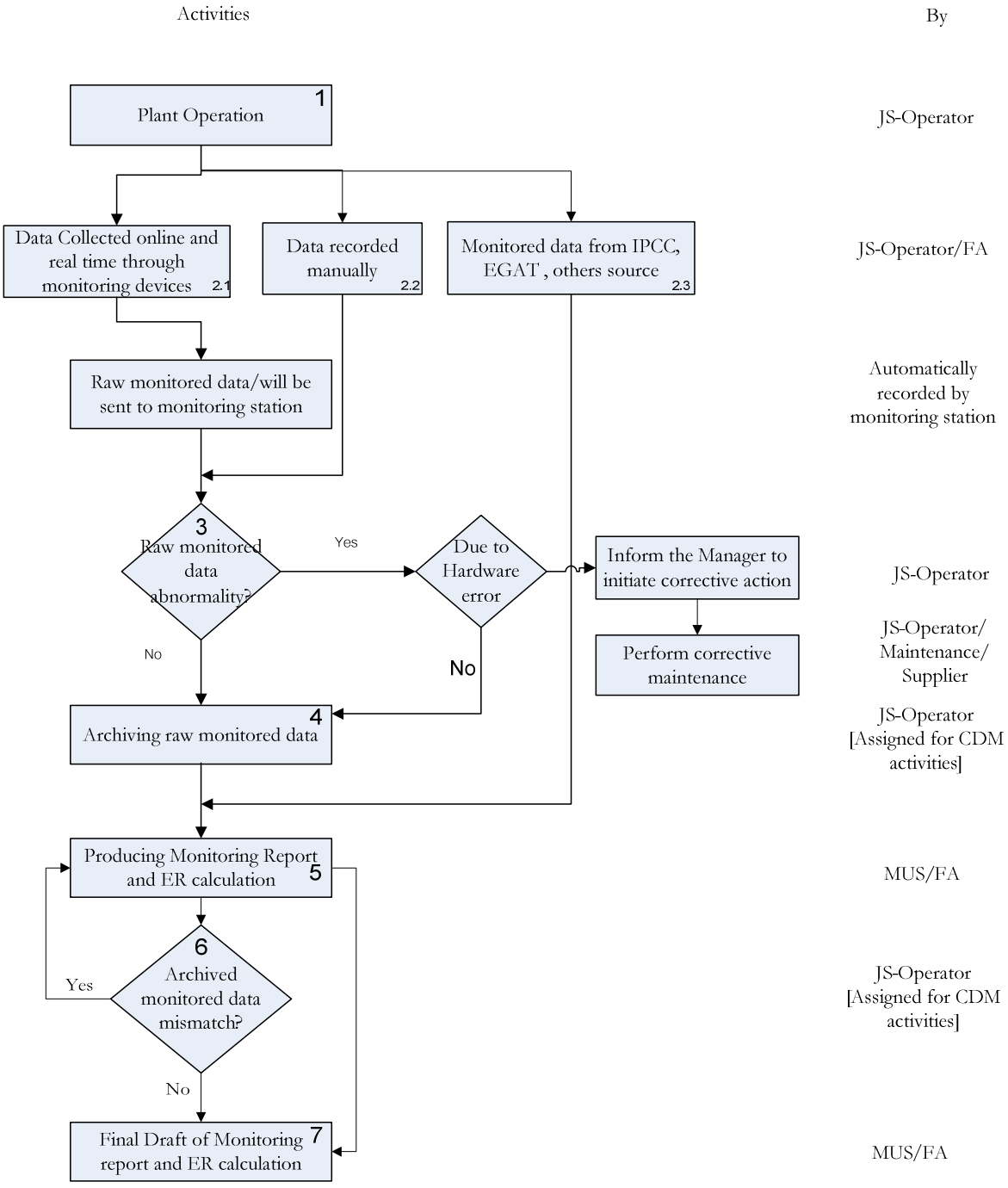
**d) Monitoring Team**

***Monitoring Team***

| ID | Name | Position | Function |
|---|---|---|---|
| 1 | JS Delegate (s) | Operation Manager | Control overall operation of the plant and CDM activities. |
| 2 | JS Staff | Operator | Compiling/Archiving monitored data |
| 3 | MUMSS | Carbon Partner and Advisor | Provide advisory services to JS regarding the CDM transactions and procedures |
| 4 | FA Delegate (s) | Consultant | Assist JS in carrying out monitoring activities |

- MUMSS [i.e. Mitsubishi UFJ Morgan Stanley Securities] is the Carbon Partner/Advisor to JS
- FA [i.e. Full Advantage Co., Ltd. is the CDM Monitoring Consultant hired by MUS in order to assist JS in appropriately conducting its Monitoring Activities

***Monitoring Work Flow***



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

| **Data/Parameter** | **$GWP_{CH4}$** |
|---|---|
| **Unit** | $tCO_2e/tCH_4$ |
| **Description** | Global warming potential for $CH_4$ |
| **Source of data** | IPCC |
| **Value(s) applied** | 21 |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | 21 for the first commitment period. It shall be updated according to any future COP/MOP decisions. |

| **Data/Parameter** | **AF** |
|---|---|
| **Unit** | % |
| **Description** | Adjustment factor |
| **Source of data** | |
| **Value(s) applied** | 0 % |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | There are no enforced regulatory or contractual requirements for LFG collection/utilization in Thailand. |

| **Data/Parameter** | **$EF_{grid}$** |
|---|---|
| **Unit** | $tCO_2/MWh$ |
| **Description** | $CO_2$ emission factor of the grid |
| **Source of data** | EGAT, EPPO |
| **Value(s) applied** | 0.51 $tCO_2/MWh$ |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | Data choice and calculation method as per AMS I.D. Calculated based on the data for the year 2001, 2002 and 2003 which are the most recent data available at the time of the validation. |

| **Data/Parameter** | **$EF_{OM}$** |
|---|---|
| **Unit** | $tCO_2/MWh$ |
| **Description** | $CO_2$ Operating Margin emission factor of the grid |
| **Source of data** | EGAT, EPPO |
| **Value(s) applied** | 0.60 $tCO_2/MWh$ |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | Data choice and calculation method as per AMS I.D. |

| Data/Parameter | $EF_{BM}$ |
|---|---|
| Unit | $tCO_2/MWh$ |
| Description | $CO_2$ Build Margin emission factor of the grid |
| Source of data | EGAT, EPPO |
| Value(s) applied | 0.42 $tCO_2/MWh$ |
| Purpose of data | Calculation of baseline and project emissions |
| Additional comment | Data choice and calculation method as per AMS I.D. |

**D.2. Data and parameters monitored**

<table>
<tr><td>Data/Parameter</td><td>$LFG_{total,y}$</td></tr>
<tr><td>Unit[2]</td><td>$m^3$</td></tr>
<tr><td>Description</td><td>Total amount of landfill gas captured</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured continuously using a flow meter. Data to be aggregated monthly and yearly</td></tr>
<tr><td>Source of data</td><td>On-site measurements</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>3,460,731.57 $m^3$ (3)</td></tr>
<tr><td>Monitoring equipment</td><td>Physical Location: Between Scrubber Tank and Blower
<table>
<tr><td>Device ID</td><td colspan="5">FL-02</td></tr>
<tr><td>Device Name</td><td>Gas Flow Meter</td><td>Serial No.</td><td colspan="3">N1U0139599904</td></tr>
<tr><td>Brand ( Manufacturer)</td><td>Verabar /SIEMENS</td><td>Model</td><td colspan="3">Verabar V100/ 7MF4433-1BA22-146-Z</td></tr>
<tr><td>Instrument Type</td><td colspan="5">Flow sensor/ Differential pressure transmitter</td></tr>
<tr><td>Data Measured</td><td>Inlet flow ($LFG_{total}$)</td><td>PFD ID</td><td colspan="3">Flow meter(F1)</td></tr>
<tr><td>Measuring Range</td><td>from 0</td><td>to 1200</td><td>unit</td><td colspan="2">$m^3$/hr</td></tr>
<tr><td>Appropriateness</td><td>Yes</td><td colspan="2">Accuracy Class</td><td colspan="2">0.075%</td></tr>
</table>
<table>
<tr><td>Calibration Certificate No.:</td><td>Date of calibration:</td><td>Validity of calibration:</td><td>Calibration frequency</td></tr>
<tr><td>RKT-0709036</td><td>15/08/2007</td><td>14/08/2008</td><td>Recommend one year</td></tr>
<tr><td>P08/0238C</td><td>2/8/2008</td><td>1/8/2009</td><td>Recommend one year</td></tr>
</table></td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>Every 5 seconds/minute.<br>The recording frequency of all monitoring parameters was continuously monitored with recording frequency at five-second interval at the beginning of the monitoring period. The recording frequency was then adjusted to one-minute interval since 5 August 2008. The monitored data were aggregated to hourly values for the sake of emission reduction calculation and provided in the spreadsheet.</td></tr>
<tr><td>Calculation method (if applicable)</td><td></td></tr>
<tr><td>QA/QC procedures</td><td>Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline and project emissions</td></tr>
</table>

[2] " $m^3$" shown in the upon table is based on standard temperature and pressure 0c and 1 atm (1.01325 bar)

(3) These parameters (e.g. $LFG_{total,y,}$ $LFG_{flare,y,}$ $LFG_{electricity,y,}$ pressure and temperature) are aggregated monthly. Aggregated data is applicable for all parameters. Please refer to the "Summary" sheet of the "ERC-Emission Reduction Calculation Rev.08_20120924" in the excel file.

| | |
|---|---|
| **Additional comment** | To determine the total amount of landfill gas captured from the project site<br>Installation: Refer to Annex 2.3.4 I,II,III-1 Section 7 and<br>Annex 2.3.4 I,II,III-2 Section 5<br>Operation/Reading Procedure: Refer to Annex 2.3.4. I,II,III-1 Section 4<br>Maintenance Procedure: Annex 2.3.4. I,II,III-1 Section 10 and<br>Annex 2.3.4. I,II,III-2 page 4<br>Calibration Procedure: Annex 2.3.4. I,II,III-1 Section 10<br>Calibration Certificate: Annex 2.4.2. I |

| | |
|---|---|
| **Data/Parameter** | **$LFG_{flare,y}$** |
| **Unit** | $m^3$ |
| **Description** | Amount of landfill gas flared |
| **Measured/Calculated /Default** | Measured continuously using a flow meter. Data to be aggregated monthly and yearly. |
| **Source of data** | On-site measurements |
| **Value(s) of monitored parameter** | 98,106.27 $m^3$ |
| **Monitoring equipment** | Physical Location: Between Blower and Gas Cooler Stage before Gas Engine |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Device ID | FL-01 | | | | | | |
| Device Name | Gas Flow Meter | | Serial No. | N1T1109491336 | | | |
| Brand ( Manufacturer) | Verabar /SIEMENS | | Model | Verabar V100/ 7MF4433-1BA22-146-Z | | | |
| Instrument Type | Flow sensor/ Differential pressure transmitter | | | | | | |
| Data Measured | Flare flow ($LFG_{flare,}$) | | PFD ID | Flow meter (F3) | | | |
| Measuring Range | from | 0 | to | 1200 | unit | $m^3$/hr | |
| Appropriateness | Yes | | Accuracy Class | 0.075% | | | |

| Calibration Certificate No.: | Date of calibration: | Validity of calibration: | Calibration frequency |
|---|---|---|---|
| RKT-0709038 | 26/9/2007 | 25/9/2008 | Recommend one year |
| RKT-0809045 | 18/9/2008 | 17/9/2009 | Recommend one year |

| | |
|---|---|
| **Measuring/Reading/ Recording frequency** | Every 5 seconds/minute |
| **Calculation method (if applicable)** | - |
| **QA/QC procedures** | Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | To determine the amount of landfill gas flared<br>Installation: Refer to Annex 2.3.4 I,II,III-1 Section 7 and<br>Annex 2.3.4 I,II,III-2 Section 5<br>Operation/Reading Procedure: Refer to Annex 2.3.4. I,II,III-1 Section 4<br>Maintenance Procedure: Annex 2.3.4. I,II,III-1 Section 10 and<br>Annex 2.3.4. I,II,III-2 page 4<br>Calibration Procedure: Annex 2.3.4. I,II,III-1 Section 10<br>Calibration Certificate: Annex 2.4.2. III |

<table>
<tr><td>Data/Parameter</td><td>$LFG_{electricity,y}$</td></tr>
<tr><td>Unit</td><td>$m^3$</td></tr>
<tr><td>Description</td><td>Amount of landfill gas combusted in power plant</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured continuously using a flow meter. Data to be aggregated monthly and yearly.</td></tr>
<tr><td>Source of data</td><td>On-site measurements</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>3,224,369.81 $m^3$</td></tr>
<tr><td>Monitoring equipment</td><td>Physical Location: Between Blower and Gas Cooler Stage before Gas Engine
<table>
<tr><td>Device ID</td><td colspan="6">FL-03</td></tr>
<tr><td>Device Name</td><td>Gas Flow Meter</td><td>Serial No.</td><td colspan="4">N1U0139599905</td></tr>
<tr><td>Brand ( Manufacturer)</td><td>Verabar /SIEMENS</td><td>Model</td><td colspan="4">Verabar V100/ 7MF4433-1BA22-146-Z</td></tr>
<tr><td>Instrument Type</td><td colspan="6">Flow sensor/ Differential pressure transmitter</td></tr>
<tr><td>Data Measured</td><td>Outlet flow ($LFG_{electricity}$)</td><td>PFD ID</td><td colspan="4">Flow meter(F2)</td></tr>
<tr><td>Measuring Range</td><td>from</td><td>0</td><td>to</td><td>1200</td><td>unit</td><td>$m^3$/hr</td></tr>
<tr><td>Appropriateness</td><td colspan="2">Yes</td><td colspan="2">Accuracy Class</td><td colspan="2">0.075%</td></tr>
</table>
<table>
<tr><td>Calibration Certificate No.:</td><td>Date of calibration:</td><td>Validity of calibration:</td><td>Calibration frequency</td></tr>
<tr><td>RKT-0709037</td><td>26/09/2007</td><td>25/09/2008</td><td>Recommend one year</td></tr>
<tr><td>RKT-0809044</td><td>18/09/2008</td><td>17/09/2009</td><td>Recommend one year</td></tr>
</table></td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>Every 5 seconds/minute</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline and project emissions</td></tr>
<tr><td>Additional comment</td><td>Installation: Refer to Annex 2.3.4 I,II,III-1 Section 7 and<br>Annex 2.3.4 I,II,III-2 Section 5<br>Operation/Reading Procedure: Refer to Annex 2.3.4. I,II,III-1 Section 4<br>Maintenance Procedure: Annex 2.3.4. I,II,III-1 Section 10 and<br>Annex 2.3.4. I,II,III-2 page 4<br>Calibration Procedure: Annex 2.3.4. I,II,III-1 Section 10<br>Calibration Certificate: Annex 2.4.2. II</td></tr>
</table>

| Data/Parameter | $PE_{flare,y}$ |
|---|---|
| Unit | $tCO_2e$ |
| Description | Project emissions from flaring of the residual gas stream in year y |
| Measured/Calculated /Default | Calculation |
| Source of data | Calculation |
| Value(s) of monitored parameter | 741.42 |
| Monitoring equipment | The quantity of methane in the residual gas flowing into the flare is the product of the volumetric flow rate of the residual gas ($FV_{RG,h}$), the volumetric fraction of methane in the residual gas ($fv_{i,h}$) and the density of methane ($\rho_{CH4,n,h}$) in the same reference condition. |
| Measuring/Reading/ Recording frequency | Refer to $FV_{RG,h}$, $fv_{i,h}$ and $\rho_{CH4,n,h}$ |
| Calculation method (if applicable) | Project emissions from flaring of the residual gas stream are calculated based on the flare efficiency and the mass flow rate of methane in the residual gas stream that is flared. |
| QA/QC procedures | Refer to $FV_{RG,h}$, $fv_{i,h}$ and $\rho_{CH4,n,h}$ |
| Purpose of data | Calculation of project emissions |
| Additional comment | The parameters used for determining the project emissions from flaring of the residual gas stream in year y ($PE_{flare,y}$) will be monitored as per the "Tool to determine project emissions from flaring gases containing Methane" |

<table>
<tr><td>Data/Parameter</td><td>$fv_{i,h}$</td></tr>
<tr><td>Unit</td><td>-</td></tr>
<tr><td>Description</td><td>Volumetric fraction of component i in the residual gas in the hour h where i = $CH_4$</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured continuously using a continuous gas analyser. Values to be averaged hourly. The same bases (dry or wet) is considered for this measurement and the measurement of the volumetric flow rate of the residual gas ($FV_{RG,h}$) when the residual gas temperature exceed 60℃.</td></tr>
<tr><td>Source of data</td><td>On-site measurements</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>0.502</td></tr>
<tr><td>Monitoring equipment</td><td>Physical Location: Between final condensation tank and gas engine
<table>
<tr><td>Device ID</td><td colspan="5">GA-02</td></tr>
<tr><td>Device Name</td><td>Fixed Type Gas Analyzer</td><td>Serial No.</td><td colspan="3">I-02253</td></tr>
<tr><td>Brand (Manufacturer)</td><td>(HITECH INSTRUMENTS)</td><td>Model</td><td colspan="3">HITOX IR-600</td></tr>
<tr><td>Instrument Type</td><td colspan="5">Gas Analyser</td></tr>
<tr><td>Data Measured</td><td>Methane concentration ($W_{CH4,y}$ )</td><td>PFD ID</td><td colspan="3">Methane Gas Analyzer ($CH_4$)</td></tr>
<tr><td>Measuring Range</td><td>from 0</td><td>to</td><td>100</td><td>unit</td><td>%</td></tr>
<tr><td>Appropriateness</td><td>Yes</td><td colspan="2">Accuracy Class</td><td colspan="2">±2%</td></tr>
</table>
<table>
<tr><td>Calibration Certificate No.:</td><td>Date of calibration:</td><td>Validity of calibration:</td><td>Calibration frequency</td></tr>
<tr><td>E080001</td><td>25/12/2007</td><td>24/12/2008</td><td>Recommend one year</td></tr>
<tr><td>E080003</td><td>04/12/2008</td><td>03/12/2009</td><td>Recommend one year</td></tr>
</table></td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>Every 5 seconds/minute</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Analysers will be periodically calibrated according to the manufacturer’s recommendation. A zero check and a typical value check will be performed by comparison with a standard certified gas.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td>These values will be used for the calculation of project emissions from flaring of residual gas stream in year y ($PE_{flare,\ y}$). $fv_{CH4,h}$ is equivalent to the variable $w_{CH4,y}$ described in the monitoring methodology and also used for the emission reductions calculation. In case only methane content of the residual gas is measure, the remaining part will be considered as $N_2$ as per the guideline in the tool.<br>Installation: Refer to Annex 2.3.4 IV Section 2<br>Operation/Reading Procedure: Refer to Annex 2.3.4. IV Section 3<br>Maintenance Procedure: Refer to Annex 2.3.4. IV Section 4<br>Calibration Procedure: Refer to Annex 2.3.4. IV Section 5<br>Calibration Certificate: Annex 2.4.2. IV</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$FV_{RG,h}$</td></tr>
<tr><td>Unit</td><td>$m^3/h$</td></tr>
<tr><td>Description</td><td>Volumetric flow rate of the residual gas in dry basis at normal condition in the hour h</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured continuously using a flow meter. Values to be averaged hourly. The same bases (dry or wet) is considered for this measurement and the measurement of volumetric fraction of all components in the residual gas ($fv_{i,h}$) when the residual gas temperature exceed 60℃.</td></tr>
<tr><td>Source of data</td><td>On-site measurement</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>16.65</td></tr>
<tr><td>Monitoring equipment</td><td>Physical Location: Between Blower and Gas Cooler Stage before Gas Engine
<table>
<tr><td>Device ID</td><td colspan="6">FL-03</td></tr>
<tr><td>Device Name</td><td>Gas Flow Meter</td><td>Serial No.</td><td colspan="4">N1U0139599905</td></tr>
<tr><td>Brand ( Manufacturer)</td><td>Verabar /SIEMENS</td><td>Model</td><td colspan="4">Verabar V100/ 7MF4433-1BA22-146-Z</td></tr>
<tr><td>Instrument Type</td><td colspan="6">Flow sensor/ Differential pressure transmitter</td></tr>
<tr><td>Data Measured</td><td>Outlet flow ($LFG_{electricity}$)</td><td>PFD ID</td><td colspan="4">Flow meter(F2)</td></tr>
<tr><td>Measuring Range</td><td>from</td><td>0</td><td>to</td><td>1200</td><td>unit</td><td>$m^3/hr$</td></tr>
<tr><td>Appropriateness</td><td colspan="2">Yes</td><td colspan="2">Accuracy Class</td><td colspan="2">0.075%</td></tr>
</table>
<table>
<tr><td>Calibration Certificate No.:</td><td>Date of calibration:</td><td>Validity of calibration:</td><td>Calibration frequency</td></tr>
<tr><td>RKT-0709037</td><td>26/09/2007</td><td>25/09/2008</td><td>Recommend one year</td></tr>
<tr><td>RKT-0809044</td><td>18/09/2008</td><td>17/09/2009</td><td>Recommend one year</td></tr>
</table></td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>Every 5 seconds/minute</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Flow meters will be periodically calibrated according to the manufacturer’s recommendation.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td>These values will be used for the calculation of project emissions from flaring of residual gas stream in year y ($PE_{flare,y}$).<br>Installation: Refer to Annex 2.3.4 I,II,III-1 Section 7 and<br>Annex 2.3.4 I,II,III-2 Section 5<br>Operation/Reading Procedure: Refer to Annex 2.3.4. I,II,III-1 Section 4<br>Maintenance Procedure: Annex 2.3.4. I,II,III-1 Section 10 and<br>Annex 2.3.4. I,II,III-2 page 4<br>Calibration Procedure: Annex 2.3.4. I,II,III-1 Section 10<br>Calibration Certificate: Annex 2.4.2. II</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>Flare operation parameter</td></tr>
<tr><td>Unit</td><td>min/h</td></tr>
<tr><td>Description</td><td>Minutes that flare is detected during the hour h</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured continuously using a flame detector.</td></tr>
<tr><td>Source of data</td><td>On-site measurement</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>0.</td></tr>
<tr><td>Monitoring equipment</td><td>Physical Location: Close to flare unit
<table>
<tr><td>Device ID</td><td colspan="6">n/a</td></tr>
<tr><td>Device Name</td><td>Flame Detector</td><td>Serial No.</td><td colspan="3">945011V</td></tr>
<tr><td>Brand ( Manufacturer)</td><td>USHIO INC.</td><td>Model</td><td colspan="3">SF-102B</td></tr>
<tr><td>Instrument Type</td><td colspan="6">Flame Detector</td></tr>
<tr><td>Data Measured</td><td>Flame</td><td>PFD ID</td><td colspan="3">-</td></tr>
<tr><td>Measuring Range</td><td>from</td><td>-</td><td>to</td><td>-</td><td>unit</td><td>-</td></tr>
</table>
Calibration Certificate: Not required as it is only use for detect ON/OFF signal</td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>Every 5 seconds/minute.<br>Flame detector continuously detects the flame at the flaring system and sends the signal to the monitoring station This parameter has been monitored and recorded at five-second interval at the beginning The recording frequency was then adjusted to one-minute interval since 5 August 2008. The monitored data were aggregated to hourly values for the sake of emission reduction calculation and provided in the spread sheet</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Not required as it is only use for detect ON/OFF signal</td></tr>
<tr><td>QA/QC procedures</td><td>N/A</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td>These values will be used for the calculation of project emissions from flaring of residual gas stream in year y ($PE_{flare, y}$). If is more than 20 min/h during the hour h, 50% of flare efficiency will be applied for the hour h, otherwise 0% will be applied.<br>Operation/Reading Procedure: The detector will detect the flame and then the controller will send the digital signal to data logger automatically.<br>Installation: The flame detector contains a controller and fiber optic to detect the flame. Fiber optic must be installed inside the flare where the flame can be detected. The gap between the detector and the flame is approximately 30 cm.</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$w_{CH4,y}$</td></tr>
<tr><td>Unit</td><td>$m^3CH_4/m^3LFG$</td></tr>
<tr><td>Description</td><td>Methane fraction in the landfill gas</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Before the open flare system is installed, this parameter will be measured periodically using a portable gas analyser. After installation of the open flare system, this parameter will be measured continuously using a continuous gas analyser.</td></tr>
<tr><td>Source of data</td><td>On-site measurements</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>0.502</td></tr>
<tr><td>Monitoring equipment</td><td>Physical Location: Between final condensation tank and gas engine
<table>
<tr><td>Device ID</td><td colspan="5">GA-02</td></tr>
<tr><td>Device Name</td><td>Fixed Type Gas Analyzer</td><td>Serial No.</td><td colspan="3">I-02253</td></tr>
<tr><td>Brand ( Manufacturer)</td><td>(HITECH INSTRUMENTS)</td><td>Model</td><td colspan="3">HITOX IR-600</td></tr>
<tr><td>Instrument Type</td><td colspan="5">Gas Analyser</td></tr>
<tr><td>Data Measured</td><td>Methane concentration ($W_{CH4,y}$ )</td><td>PFD ID</td><td colspan="3">Methane Gas Analyzer ($CH_4$)</td></tr>
<tr><td>Measuring Range</td><td>from</td><td>0</td><td>to</td><td>100</td><td>unit %</td></tr>
<tr><td>Appropriateness</td><td colspan="2">Yes</td><td colspan="2">Accuracy Class</td><td>±2%</td></tr>
</table>
<table>
<tr><td>Calibration Certificate No.:</td><td>Date of calibration:</td><td>Validity of calibration:</td><td>Calibration frequency</td></tr>
<tr><td>E080001</td><td>25/12/2007</td><td>24/12/2008</td><td>Recommend one year</td></tr>
<tr><td>E080003</td><td>04/12/2008</td><td>03/12/2009</td><td>Recommend one year</td></tr>
</table></td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>Every 5 seconds/minute<br>These parameters were continuously monitored with recording frequency at five-second interval at the beginning. The recording frequency was then adjusted to one-minute interval since 5 August 2008. The monitored data were aggregated to hourly values for the sake of emission reduction calculation and provided in the spread sheet.</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Analysers will be periodically calibrated according to the manufacturer’s recommendation. A zero check and a typical value check will be performed by comparison with a standard certified gas.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline and project emissions</td></tr>
<tr><td>Additional comment</td><td>The monitored parameter is also used for $fv_{CH4,h}$ in case this parameter is measured continuously using continuous gas analyser.<br>Installation: Refer to Annex 2.3.4 IV Section 2<br>Operation/Reading Procedure: Refer to Annex 2.3.4. IV Section 3<br>Maintenance Procedure: Refer to Annex 2.3.4. IV Section 4<br>Calibration Procedure: Refer to Annex 2.3.4. IV Section 5<br>Calibration Certificate: Annex 2.4.2. IV</td></tr>
</table>

| Data/Parameter | **T** |
|---|---|
| **Unit** | $^{O}C$ |
| **Description** | Temperature of the landfill gas |
| **Measured/Calculated /Default** | Measured periodically to determine the density of methane ($D_{CH4}$) using a thermocouple. |
| **Source of data** | On-site measurements |
| **Value(s) of monitored parameter** | 61.79 |

**Monitoring equipment**

Physical Location of TE-01 and TE-03: Close to FL-02

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Device ID | TE-01, TE-03 | | | | | | |
| Device Name | Temperature Controller with PT100 | | ID No.(TE-01) IDNo.( TE-03) | | T07216/PT07081, T08151/PT08133 | | |
| Brand ( Manufacturer) | (SHIMAX with FW System) | | Model | | Pt100N MAC3D-MCF-NN-NTN with FWP-7A-4.8x30 (S4) | | |
| Instrument Type | Thermocouple and RTD with temperature Controller | | | | | | |
| Data Measured | Temperature | | PFD ID | | Temperature Sensor(T1) | | |
| Operating period of equipment | TE01 (from 14/03/2008 to 21/07/2008) TE03 (from 22/07/2008 to 31/12/2008) | | | | | | |
| Measuring Range | from | -50 | to | 400 | Unit C | | |
| Appropriateness | Yes | | Accuracy Class | | ±0.3% | | |

| Device ID | Calibration Certificate No.: | Date of calibration: | Validity of calibration: | Calibration frequency |
|---|---|---|---|---|
| TE-01 | T-0710080 | 18/10/2007 | 17/10/2008 | Recommend one year |
| TE-03 | T-0807154 | 22/07/2008 | 21/07/2009 | Recommend one year |

Physical Location of TE-01, TE-02: Close to FL-03

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Device ID | TE-01, TE-02 | | | | | | |
| Device Name | Temperature Controller with PT100 | | ID No.(TE-01) ID No.( TE-02) | | T07216/PT07081 T08003/PT08015 | | |
| Brand | (SHIMAX with FW System) | | Model | | Pt100N MAC3D-MCF-NN-NTN with FWP-7A-4.8x30 (S4) | | |
| Instrument Type | Thermocouple and RTD with temperature Controller | | | | | | |
| Data Measured | Temperature | | PFD ID | | Temperature Sensor(T2) | | |
| Operating period of equipment | TE02 (from 14/03/2008 to 29/12/2008) TE01 (from 30/12/2008 to 31/12/2008) | | | | | | |
| Measuring Range | from | -50 | to | 400 | unit | C | |
| Appropriateness | Yes | | Accuracy Class | | ±0.3% | | |

| Device ID | Calibration Certificate No.: | Date of calibration: | Validity of calibration: | Calibration frequency |
|---|---|---|---|---|
| TE-01 | T08/0674C | 30/12/2008 | 29/12/2009 | Recommend one year |
| TE-02 | T-0801059 | 10/01/2008 | 09/01/2009 | Recommend one year |

| | |
|---|---|
| **Measuring/Reading/ Recording frequency** | Every 5 seconds/minute |
| **Calculation method (if applicable)** | - |
| **QA/QC procedures** | Maintenance Free. Only replacement. |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | To determine the density of methane ($D_{CH4}$) using a thermocouple.<br>Installation: Refer to Annex 2.3.4 VI,VII-1 and Annex 2.3.4 VI,VII-2<br>Operation/Reading Procedure: Refer to Annex 2.3.4. VI,VII-1 and Annex 2.3.4 VI,VII-2<br>Calibration Procedure: The device has been periodically calibrated respect to each calibration method<br>Calibration Certificate: Annex 2.4.2. VI and VII |

| Data/Parameter | p |
|---|---|
| Unit | Pressure of the landfill gas |
| Description | Pa |
| Measured/Calculated /Default | Measured periodically to determine the density of methane ($D_{CH4}$) using a pressure transmitter |
| Source of data | On-site measurements |
| Value(s) of monitored parameter | 40,079.76 |

**Monitoring equipment**

Physical Location of PR-01, PR-03 : Close to FL-02

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Device ID | PR-01, PR-03 | | | | | | |
| Device Name | Pressure Transmitter | | Serial No. (PR-01) Serial No.(PR-03) | | 1107030328 0702080001 | | |
| Brand (Manufacturer) | (NAGANO ) | | Model | | ADZ-SML-10.0 | | |
| Instrument Type | Pressure Transmitter | | | | | | |
| Data Measured | Pressure (bar) | | PFD ID | | Pressure Transmitter (P1) | | |
| Operating period of equipment | PR01 (from 14/03/2008 to 01/08/2008) PR03 (from 02/08/2008 to 31/12/2008) | | | | | | |
| Measuring Range | from | -1 | to | 1 | unit | bar | |
| Appropriateness | Yes | | Accuracy Class | | ±0.50% | | |

| Device ID | Calibration Certificate No.: | Date of calibration: | Validity of calibration: | Calibration frequency |
|---|---|---|---|---|
| PR-01 | CAL0069-07Q0077 | 03/08/2007 | 02/08/2008 | Recommend one year |
| PR-03 | P08/0239C | 02/08/2008 | 01/08/2009 | Recommend one year |

Physical Location of PR-01, PR-02: Close to FL-03

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Device ID | PR-01, PR-02 | | | | | | |
| Device Name | Pressure Transmitter | | Serial No. (PR-01) Serial No. (PR-02) | | 1107030328 1107030324 | | |
| Brand ( Manufacturer) | (NAGANO ) | | Model | | ADZ-SML-10.0 | | |
| Instrument Type | Pressure Transmitter | | | | | | |
| Data Measured | Pressure (PSI) | | PFD ID | | Pressure Transmitter (P2) | | |
| Operating period of equipment | PR02 (from 14/03/2008 to 29/12/2008) PR01 (from 30/12/08/2008 to 31/12/2008) | | | | | | |
| Measuring Range | from | -14.7 | to | 14.7 | unit | PSI | |
| Appropriateness | Yes | | Accuracy Class | | ±0.50% | | |

| Device ID | Calibration Certificate No.: | Date of calibration: | Validity of calibration: | Calibration frequency |
|---|---|---|---|---|
| PR-01 | P08/0550C | 30/12/2008 | 29/12/2009 | Recommend one year |
| PR-02 | 08P2 | 02/01/2008 | 01/01/2009 | Recommend one year |

| | |
|---|---|
| **Measuring/Reading/ Recording frequency** | Every 5 seconds/minute |
| **Calculation method (if applicable)** | - |
| **QA/QC procedures** | Maintenance Free. Only replacement. |

| | |
|---|---|
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | to determine the density of methane ($D_{CH4}$) using a pressure transmitter<br>Installation: Refer to Annex 2.3.4. VIII,IX<br>Operation/Reading Procedure: Refer to Annex 2.3.4. VIII,IX<br>Calibration Procedure: The device has been periodically calibrated respect to each calibration method<br>Calibration Certificate: Annex 2.4.2. VIII and IX |

<table>
<tr><td>Data/Parameter</td><td>$EL_{EX,LFG}$</td></tr>
<tr><td>Unit</td><td>MWh</td></tr>
<tr><td>Description</td><td>Total amount of electricity exported out of the project boundary</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured continuously using an electricity meter.</td></tr>
<tr><td>Source of data</td><td>On-site measurements</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>5,289</td></tr>
<tr><td>Monitoring equipment</td><td>Physical Location: MEA 24 kv Transmission Line
<table>
<tr><td>Device ID</td><td colspan="4">Electricity Meter</td></tr>
<tr><td>Device Name</td><td>Electricity Meter</td><td>Meter No.</td><td colspan="2">PK-201103 ( Refer to MEA’s meter number)</td></tr>
<tr><td>Brand (Manufacturer)</td><td>ELSTER</td><td>Model</td><td colspan="2">A1RL+</td></tr>
<tr><td>Instrument Type</td><td colspan="4">Electricity Meter</td></tr>
<tr><td>Data Measured</td><td>$EL_{EX,LFG}$<br>$EL_{IMP}$</td><td>PFD ID</td><td colspan="2">-</td></tr>
<tr><td>Specification</td><td colspan="2">TOU METER with internal Modem 3P/3Wire 5A, 120V, 3Phase, 3 Wire</td><td>unit</td><td>KWh , kW</td></tr>
<tr><td>Appropriateness</td><td>Yes</td><td colspan="2">Accuracy Class</td><td>Refer to MEA’s meter number</td></tr>
</table>
<table>
<tr><td>Appropriateness</td><td>Yes</td></tr>
</table>
<table>
<tr><td>Test reference No.:</td><td>Date of calibration/test:</td><td>Validity of calibration:</td><td>Calibration frequency</td></tr>
<tr><td>1182/50</td><td>27/12/2007 (date of test)</td><td>26/12/2008</td><td>Periodically*</td></tr>
<tr><td>Factory test(MEA internal document)</td><td>12/6/2008</td><td>11/6/2009</td><td>Periodically*</td></tr>
</table>
Remark: Since the calibration frequency has not been found in both MEA document and manual of electricity meter, The test of electricity meter will be carried out periodically in order to maintain accuracy of billing.</td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>Every 5 seconds/minute</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Flow meters will be subject to a regular maintenance and testing regime to ensure accuracy. Amount of electricity exported will be double checked with receipt of sale. The data was monthly cross-checked against the MEA statement.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comment</td><td>Installation: The Electricity meter has been installed by MEA (Refer to Annex 2.3.4 X Section 7)<br>Operation/Reading Procedure: Automatically Operate<br>Maintenance Procedure: Maintenance Free. Only replacement<br>Calibration Procedure: Electricity Meter has been calibrated properly before operation (factory calibrated ) by MEA<br>Calibration Certificate: Annex 2.4.2 X</td></tr>
</table>

<table>
<tr><td>Data/Parameter</td><td>$EL_{IMP}$</td></tr>
<tr><td>Unit</td><td>MWh</td></tr>
<tr><td>Description</td><td>Total amount of electricity imported to meet project requirement</td></tr>
<tr><td>Measured/Calculated /Default</td><td>Measured continuously using an electricity meter.</td></tr>
<tr><td>Source of data</td><td>On-site measurements</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>8.00</td></tr>
<tr><td>Monitoring equipment</td><td>Electricity meter belongs to MEA.
<table>
<tr><td>Device ID</td><td colspan="4">Electricity Meter</td></tr>
<tr><td>Device Name</td><td>Electricity Meter</td><td>Meter No.</td><td colspan="2">PK-201103 ( Refer to MEA’s meter number)</td></tr>
<tr><td>Brand (Manufacturer)</td><td>ELSTER</td><td>Model</td><td colspan="2">A1RL+</td></tr>
<tr><td>Instrument Type</td><td colspan="4">Electricity Meter</td></tr>
<tr><td>Data Measured</td><td>$EL_{EX,LFG}$<br>$EL_{IMP}$</td><td>PFD ID</td><td colspan="2">-</td></tr>
<tr><td>Specification</td><td colspan="2">TOU METER with internal Modem 3P/3Wire 5A, 120V, 3Phase, 3 Wire</td><td>unit</td><td>KWh , kW</td></tr>
<tr><td>Appropriateness</td><td>Yes</td><td>Accuracy Class</td><td colspan="2">Refer to MEA’s meter number</td></tr>
</table>
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<tr><td>Test reference No.:</td><td>Date of calibration/test:</td><td>Validity of calibration:</td><td>Calibration frequency</td></tr>
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<tr><td>Factory test (MEA internal document)</td><td>12/6/2008</td><td>11/6/2009</td><td>Periodically*</td></tr>
</table>
Remark: Since the calibration frequency has not been found in both MEA document and manual of electricity meter, The test of electricity meter will be carried out periodically in order to maintain accuracy of billing. In addition, the meter belongs to MEA (a government agency), the calibration is periodically performed by MEA officer.</td></tr>
<tr><td>Measuring/Reading/ Recording frequency</td><td>Monthly</td></tr>
<tr><td>Calculation method (if applicable)</td><td>-</td></tr>
<tr><td>QA/QC procedures</td><td>Amount of electricity exported will be double checked with receipt of sale. An operation at the project site recorded the data that was cross-checked against the MEA’s invoice.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Additional comment</td><td>The records of any electricity imported in the baseline should be recorded at the start of the project</td></tr>
</table>

| | |
|---|---|
| **Data/Parameter** | **$ET_y$** |
| **Unit** | TJ |
| **Description** | Thermal energy used in landfill during project |
| **Measured/Calculated /Default** | If fossil fuel is used, the quantity of fossil fuel used will be measured using weight or volume meters. |
| **Source of data** | On-site measurements |
| **Value(s) of monitored parameter** | 0<br>(No thermal use in the plant) |
| **Monitoring equipment** | - |
| **Measuring/Reading/ Recording frequency** | - |
| **Calculation method (if applicable)** | - |
| **QA/QC procedures** | - |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | It is not expected any thermal energy will be used for the Project Activity. However, this variable will be monitored. |

| | |
|---|---|
| **Data/Parameter** | **$CEF_{thermal,y}$** |
| **Unit** | $tCO_2/TJ$ |
| **Description** | $CO_2$ emission intensity of the thermal energy |
| **Measured/Calculated /Default** | Calculated |
| **Source of data** | On-site measurements |
| **Value(s) of monitored parameter** | 0 |
| **Monitoring equipment** | - |
| **Measuring/Reading/ Recording frequency** | - |
| **Calculation method (if applicable)** | - |
| **QA/QC procedures** | - |
| **Purpose of data** | Calculation of project emissions |
| **Additional comment** | If fossil fuel is used, CO2 emission intensity of the thermal energy will be calculated with local data of NCV and/or IPCC default values. |

| | |
|---|---|
| **Data/Parameter** | **-** |
| **Unit** | - |
| **Description** | Regulatory requirements relating to landfill gas projects |
| **Measured/Calculated /Default** | - |
| **Source of data** | Local/national data |
| **Value(s) of monitored parameter** | The information will be recorded annually. |
| **Monitoring equipment** | - |
| **Measuring/Reading/ Recording frequency** | Yearly |
| **Calculation method (if applicable)** | - |
| **QA/QC procedures** | - |
| **Purpose of data** | - |
| **Additional comment** | - |

| | |
|---|---|
| **Data/Parameter** | **-** |
| **Unit** | hours |
| **Description** | Operation of the energy plant |
| **Measured/Calculated /Default** | Recorded annually |
| **Source of data** | On-site measurements |
| **Value(s) of monitored parameter** | 5,876.90 |
| **Monitoring equipment** | Count by analog gauge |
| **Measuring/Reading/ Recording frequency** | hours |
| **Calculation method (if applicable)** | - |
| **QA/QC procedures** | - |
| **Purpose of data** | Calculation of baseline and project emissions |
| **Additional comment** | This is monitored to ensure methane destruction is claimed for methane used in electricity plant when it is operational. |

### D.3. Implementation of sampling plan

Not applicable as the monitoring parameters in section D.2 is not applied a sampling approach.

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

According to the consolidated baseline methodology for landfill gas project activities (ACM0001-version 05), the equations provided in this methodology are not divided into 'baseline emission', 'project emission' and leakage. Figures used for calculating emission reduction of the project activity are determined and calculated in the baseline emissions calculation.

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

Detail computation is presented in Annex 3.4 and computation summary is as follow[4];

**ERC-Emission Reduction Calculation**

| ER = | $(MD_{project}$ - | $MD_{reg})$ x | $GWP_{CH4}$ | EL x | $CEF_{electricity}$ | ET x | $CEF_{thermal,m}$ |
|---|---|---|---|---|---|---|---|
| 27,060 | 1,160 | 0 | 21 | 5,281 | 0.51 | 0 | 0 |
| *unit : $tCO_2e$* | *$tCH_4$* | *$tCH_4$* | *$tCO_2e/tCH4$* | *MWh* | *tCO2e/MWh* | *TJ* | *$tCO_2e/TJ$* |

| $MD_{reg}$ = | $MD_{project}$ | AF |
|---|---|---|
| 0 | 1,160 | 0 |
| *unit : $tCH_4$* | *$tCH_4$* | |

| $MD_{project,y}$ = | $MD_{flare}$ + | $MD_{electricity}$ + | $MD_{thermal}$ |
|---|---|---|---|
| 1,160 | 0 | 1,160 | 0 |
| *unit : $tCH_4$* | *$tCH_4$* | *$tCH_4$* | *$tCH_4$* |

| ELy = | $EL_{EX,LGFG}$ - | $EL_{IMP}$ |
|---|---|---|
| 5,281 | 5,289 | 8.0 |
| *unit : MWh* | *MWh* | *MWh* |

| $MD_{flare}$ = | $(LFG_{flare}$ | $w_{CH4,y}$ * | $D_{CH4})$ - | ( $PE_{flare}$ | $GWP_{CH4}$ ) |
|---|---|---|---|---|---|
| 0 | 98,106.27 | 0.502 | 0.0007168 | 741.42 | 21 |
| *unit : $tCH_4$* | *$Nm^3$* | *$m^3 CH_4/m^3 LFG$* | *$tCH_4/Nm^3 CH_4$* | *$tCO_2e$* | *$tCO_2e/tCH4$* |

| $MD_{electricity}$ | $LFG_{electricity}$ | $w_{CH4,y}$ * | $D_{CH4}$ |
|---|---|---|---|
| 1,160 | 3,224,369.81 | 0.502 | 0.0007168 |
| *unit : $tCH_4$* | *$Nm^3$* | *$m^3 CH_4/m^3 LFG$* | *$tCH_4/Nm^3 CH_4$* |

| $MD_{thermal}$ = | $LFG_{thermal}$ | $w_{CH4}$ * | $D_{CH4}$ |
|---|---|---|---|
| 0 | 0 | 0.502 | 0.0007168 |
| *unit : $tCH_4$* | *$Nm^3$* | *$m^3 CH_4/m^3 LFG$* | *$tCH_4/Nm^3 CH_4$* |

| $PE_{flare}$ | $\sum_{h=1}^{8760} TM_{RG,h}$ * | $(1-\eta_{flare,h})$ * | $GWP_{CH4}$ / | 1000 |
|---|---|---|---|---|
| 741.42 | 35,305.77 | 1 | 0.021 | |
| *unit : $tCO_2$* | *kg* | | | |

| $TM_{RG,h}$ | $FV_{RG,h}$ * | $fv_{CH4,RG,h}$ * | $\rho_{CH4,n}$ |
|---|---|---|---|
| 5.99 | 16.65 | 0.502 | 0.7168 |
| *unit : kg/h* | *$Nm^3/h$* | *$m^3 CH_4/m^3 LFG$* | *$kg/Nm^3$* |

Remark : - Total hour of LFG sent to flare = 5,894.00 hours

-Following to registered PDD, the unit of LFG in ablove calculation is reported in "$m^3$",

At STP referred in ACM0001 Version05 ( 0 degree Celsius and 1.01325 bar ).

[4] Reference source of emission reduction calculation of this project activity is demonstrated in the "JS annual ER 08" spreadsheet of the "ERC-Emission Reduction Calculation Rev.08_20120924" of the excel file.

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

Project emission is calculated as per section C of the Monitoring Report and the registered PDD. Under the project activity, the emission from the open flaring system is counted as the project emission. As per the "Methodological Tool to determine project emissions from flaring gases containing methane" and the registered PDD, the default value of 50% was chosen as the flare efficiency. Flame detector has been installed to continuously monitor the flare operation parameter and to decide the flare efficiency, i.e. 50% or 0%.

**E.3. Calculation of leakage**

No leakage effects need to be accounted under ACM0001 version 5.

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

| Time Period | Baseline emissions or baseline net GHG removals by sinks ($tCO_2e$) | Project emissions or actual net GHG removals by sinks ($tCO_{2e}$) | Leakage ($tCO_2e$) | Emission reductions or net anthropogenic GHG removals by sinks ($tCO_2e$) |
|---|---|---|---|---|
| **Total** | 27,060 | 0 | 0 | 27,060 |

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

| Item | Values estimated in ex-ante calculation of registered PDD | Actual values achieved during this monitoring period |
|---|---|---|
| **Emission reductions or GHG removals by sinks ($tCO_2e$)** | 61,312 (293 days) | 27,060 (293 days) |

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

It is required to compare the actual emission reduction claimed in the monitoring period with the values estimated in the registered PDD and explain on any significant "increase" as per EB48 Annex 68 para 10 (viii). While the amount of emission reductions claimed under the project activity is less than what was estimated in the registered PDD, the comparison of the actual emission reductions and estimated volumes is presented in the table below as a redundant procedure.

The decrease in the claimed emission reduction is mainly due to the difference between the amount of LFG collected and LFG flared ex-post and those of estimated ex-ante. In the registered PDD, it was forecasted that about 23% of total LFG would be utilized for the electricity generation and the rest 77% for the flaring, whereas under the actual operation, these was no LFG that was flared. The monitored methane content that was adopted for ex-post calculation is lower than ex-ante estimated value. The lower methane content, the more LFG flow sent to gas engine. This contributed to the increase in ex-post amount of LFG utilized for electricity generation compared to that of ex-ante.

| ID | Data/Parameter | Unit | Value | |
|---|---|---|---|---|
| | | | Ex-ante (293 days) | Ex-post (293 days,14 March 2008 to 31 December 2008) |
| 1 | $ER_y$ | $tCO_2e$ | 61,312 | 27,060 |
| 2 | $MD_{project,y}$ | $tCH_4$ | 2,766 | 1,160 |
| 3 | $MD_{reg,y}$ | $tCH_4$ | 0 | 0 |
| 4 | $GWP_{CH4}$ | $tCO_2e/tCH_4$ | 21 | |
| 5 | $EL_y$ | MWh | 6,341 | 5,281 |
| 6 | $CEF_{electricity,y}$ | $tCO_{2e}$ /MWh. | 0.51 | 0.51 |
| 7 | $ET_y$ | TJ | 0 | |
| 8 | $CEF_{thermal,y}$ | $tCO_2e$/ TJ | 0 | |
| 9 | $MD_{flare,y}$ | $tCH_4$ | 1,425 | 0 |
| 10 | $MD_{electricity,y}$ | $tCH_4$ | 1,341 | 1,160 |
| 11 | MD thermal, y | $tCH_4$ | 0 | |
| 12 | $EL_{EX,LFG}$ | MWh | 6,341 | 5,289 |
| 13 | $EL_{IMP}$ | MWh | 0 | 8.0 |
| 14 | $LFG_{flare,y}$ | $m^3$ | 6,895,306 | Unit : $Nm^3$ / $m^3$ : 103,493(1) / 98,106(2) |
| 15 | $LFG_{electricity,y}$ | $m^3$ | 3,246,935 | Unit : $Nm^3$ / $m^3$ : 3,401,435 (1) / 3,224,369(2) |
| 16 | $LFG_{thermal,y}$ | $m^3$ | 0Unit : $Nm^3$ / $m^3$ : 0(1) / 0(2) | |
| 17 | $W_{CH4,y}$ | $m^3CH_4/m^3LFG$ | 0.576 | 0.502 |
| 18 | $D_{CH4}$ | $tCH_4/m^3CH_4$ | 0.00071680 | 0.00071680 |
| 19 | $PE_{flare,y}$ | $tCO_2e$ | 29,859 | 741 |
| 20 | $TM_{RG,h}$ | Kg/h | 405.51 | 5.99 |
| 21 | $\eta_{flare,h}$ | - | 0.5 | 0 |
| 22 | Flare operation parameter | min/h | 60 | 0* no flare was detect in each hour |
| 23 | $FV_{RG,h}$ | $m^3/h$ | 983.25 | 16.65 |
| 24 | $fv_{CH4,RG,h}$ | $m^3CH_4/m^3LFG$ | 0.576 | 0.502 |
| 25 | $\rho_{CH4,n}$ | $kg/m^3$ | 0.7168 | 0.7168 |
| 26 | Operation of the energy plant | h | 7,032 | 5,894 |
| 27 | $LFG_{total,y}$ | $m^3$ | 10,142,241 | Unit : $Nm^{3(1)}$ / $m^{3(2)}$ : 3,650,777 / 3,460,731 |

Remark :(1)-The quantity of LFG is reported in "Nm3" at Standard Temperature and Pressure, STP(15c, 1.01325bar)
(2) The quantity of LFG is reported in "$m^3$ " at Standard Temperature and Pressure, STP (0c, 1.01325bar) referred in ACM 0001 version5. These values are converted value. The equation applied for conversion is as follow: PV= nRT, (P1xV1)/T1=(P2xV2)/T2

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**History of the document**

| Version | Date | Nature of revision |
|---|---|---|
| 02.0 | EB 66<br>13 March 2012 | Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20). |
| 01 | EB 54, Annex 34<br>28 May 2010 | Initial adoption. |
| **Decision Class**: Regulatory<br>**Document Type**: Form<br>**Business Function**: Issuance | | |