Monitoring report form for CDM project activity
(Version 07.0)

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

MONITORING REPORT		
Title of the project activity	Daegu Bangcheon-Ri Landfill Gas CDM Project	
UNFCCC reference number of the project activity	0851	
Version number of the PDD applicable to this monitoring report	Version 13.	
Version number of this monitoring report	1.0	
Completion date of this monitoring report	03/02/2020	
Monitoring period number	8th monitoring period	
Duration of this monitoring period	19/08/2018 ~ 18/08/2019	
Monitoring report number for this monitoring period	8th	
Project participants	Daegu Metropolitan City (Project developer) Daesung Eco-Energy Co., Ltd. (Project executer) Korea District Heating Corporation. (Project executer) Ecoeye Co., Ltd. (Project consultant)	
Host Party	Republic of Korea	
Applied methodologies and standardized baselines	ACM0001 ver.15	
Sectoral scopes	Scope 13 : Waste handling disposal	
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
	0 tCO_2e	271,970 tCO_2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	177,888 tCO_2e (19/08/2018 ~ 18/08/2019)	

SECTION A. Description of project activity

A.1. General description of project activity

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Daegu Bangcheon-Ri landfill gases project (Ref.851) was registered as CDM project in 19 Aug 2007. Daegu Bangcheon-Ri Landfill gas CDM Project is a project which captures and refines LFG from the landfill and then the refined LFG is destroyed at LFG flaring system, electricity generation system and thermal system. There is no change for project design after the registration. This project is now on 2nd credit period after 1st credit period.

- **Basic information for the project activity**

Registered	1st Credit period	2nd Credit period	etc
19 Aug 2007	19 Aug 2007 ~ 18 Aug 2014	19 Aug 2014 ~ 18 Aug 2021	-

- **Purpose of the project activity and the measures taken for GHG emission reductions or net GHG removals by sinks**

On aspects of the technology, Daegu Bangcheon-Ri Landfill gas CDM Project could improve the LFG capture efficiency and reuse of alternative energy which reducing CO_2 emissions by replacing fossil fuel. On aspects of environment, this project activity could prevents global warming by controlling methane emission to the atmosphere and also reduces adverse environmental impacts such as odor emission. This project activity is comprised of LFG capturing system and LFG utilization system. The captured and refined LFG is literally destroyed at flaring stacks, gas engines and LFG boilers.

- **Brief description of the installed technology and equipment**

Daegu Bangcheon-Ri Landfill gas CDM Project is designed to minimize methane (CH_4) emission by capturing of LFG and utilizing it. There are 2-main-part installed technology in this project activity. One is LFG capturing system and the other is LFG utilization system. Vertical pipelines are installed to capture LFG into the Wastes and lines are joined and connected to refinery system, which is a part of LFG utilization system. In the utilization system, LFG are refined and supplied to LFG boilers of KDHC (another project participant).

A.2. Location of project activity

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Daegu Bangcheon-Ri Landfill site is located at 820, Dasa-Ro Dasa-Eup, Dalsung-Gun, Daegu Metropolitan City, Korea. Daegu Metropolitan City is located in the centre of Gyeongsangbuk-Do province located in the south-eastern part of Korea. The project site is located on the east longitude 128.5096, the north latitude 35.8814 and surrounded by mountains except the north site.

A.3. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Korea (Host)	**Public entity** Daegu Metropolitan City Korea District Heating Corporation **Private entity** Daesung Eco-Energy Co., Ltd. Ecoeye Co., Ltd.	No

A.4. References to applied methodologies and standardized baselines

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The applied methodology is ACM0001 “Flaring or use of landfill gas” (version 15)

The applied Tools are

- “Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” (version 02)
- “Emissions from solid waste disposal sites” (version 06.0.1)
- “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” (version 01)
- “Tool to calculate the emission factor for an electricity system” (version 04)
- “Project emissions from flaring” (version 02)
- “Tool to determine the mass flow of a greenhouse gas in a gaseous steam” (version 02)
- “Combined tool to identify the baseline scenario and demonstrate additionality” (version 05)

For more information on applied methodology and applicable tools please refer to the following link. (http://cdm.unfccc.int/methodologies/DB/D44X8FH8SFCXREE6037AXJSBGGFVDO)

A.5. Crediting period type and duration

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- Type : Renewable type
- Renewable date : 17/09/2016
- Length of the 2nd crediting period : 19/08/2014 ~ 18/08/2021
- 8th monitoring period : 19/08/2018 ~ 18/08/2019

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

>>
The LFG at the Daegu Bangcheon-Ri Landfill site had been treated as the ‘Simple on-site treatment’ to prevent odor, air pollution and fire prior to the implementation of the project activity. Daegu Bangcheon-Ri Landfill gas CDM Project is a project including LFG captures, refinement and utilization. The project includes vertical collection gas pipes, refinery facility and LFG utilities for energy generation. The refined LFG for the project activity is finally destroyed at Gas engines for electricity generation, at flare stacks in Daegu Bangcheon-Ri landfill and LFG boilers in Korea District Heating Corporation for thermal energy production. The project activity will contribute to reducing methane which may be released to atmosphere.

According to the feasibility study, steady supply of LFG will be available about 20 years. The project has been designed taking into account its expectation. The main features of the LFG facilities are presented below.

As amount of FIQ-201 which monitoring for power generation was 0 Nm3, gas engines didn’t operate during this monitoring period. Especially in summer, LFG generates lower than winter due to the rainy season and heat demands are also lower. During that time, the flaring system of this project could handle the collected LFG at low operating cost comparing to power generation system.

Collected temperature LFG of TI-204, TI-301 and TI-A was applied when it was lower than 60℃ degrees. As per option A of “Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Ver.02.0.0)”, LFG are considered as dry basis.

Korea District Heating Corporation requests Daesung Eco-Energy Co., Ltd. to stop supplying LFG due to its heat capacity (Heat demand in summer is lower than in winter). In the period of supplying stop, Daesung Eco-Energy supply the LFG to flare stack and LFG is burnt.

▶ Technical process

The captured LFG is blown through vertical pipeline. Blower gathers LFG and refinery facilities refine LFG. Refined LFG is stored in the Storage Tank and supplies Korea District Heating Corporation. Korea District Heating Corporation burns LFG to make Heating and supplies its customers.

▶ System diagram

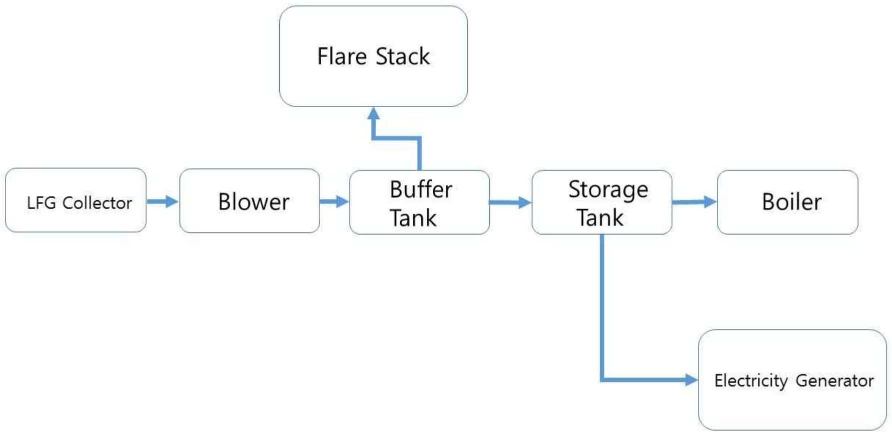

Figure 1 system diagram,

▶ Installed technology

- LFG capturing system

In order to capture LFG, vertical capturing pipes are installed for the project. The type of LFG capturing system is expected to enhance maintenance and LFG capturing efficiency because vertical capturing system has higher capturing efficiency and is easier to maintain and repair system compared to the horizontal capturing system.

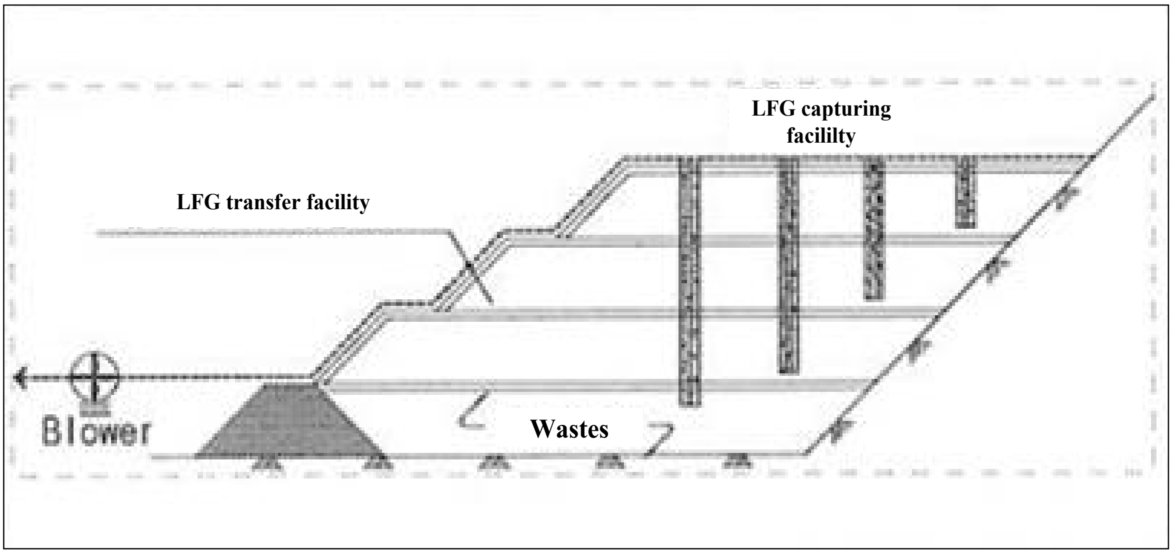

Figure 2 Vertical LFG capturing equipment installation concept

- LFG utilization system

LFG utilization system consists of four parts including LFG capture, refinery facilities, LFG fuel supply facilities, utilization facilities.

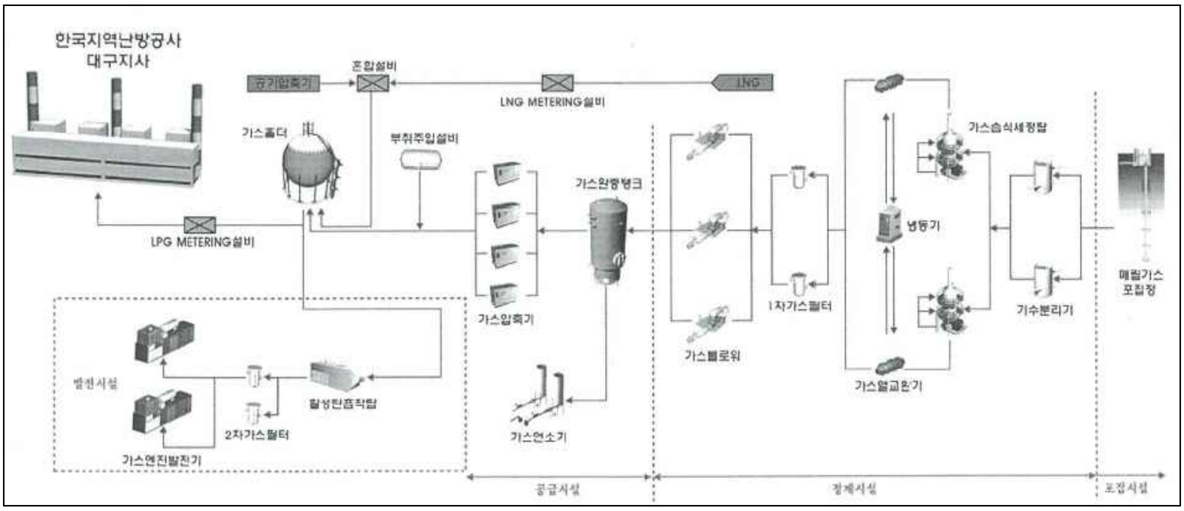

Figure 3 LFG utilization system flow chart

▶ Equipment

1) Blower

Blower is available to adjust LFG capturing pressure and delivery LFG into Buffer tank. Blower type is turbo type, which keeps consistent pressure and has a remarkable efficiency. Three blowers are installed in a project site and one of them is a spare for an emergency situation.

Figure 4 Turbo Blower

Equipment	Blower
No. of Equipment	FN-1-05A/B/C (3units)
Type	Turbo
Capacity	75 Nm^3/min
Pressure	3,800 mmAq

2) Filter
Filter separates and removes particles flowing into the pipe with LFG.

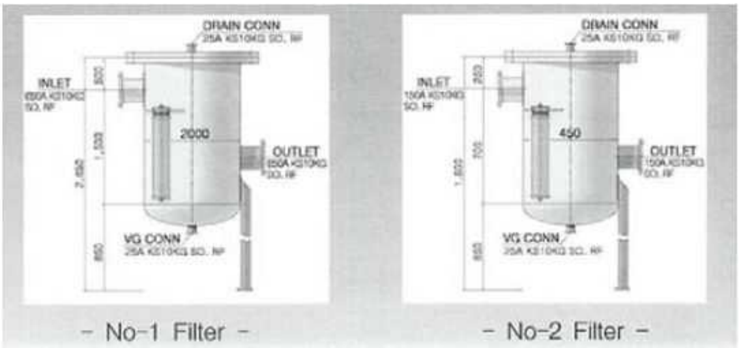

Figure 5 Filter

Equipment	No-1 Filter (before a blower)	No-2 Filter (before gas engine)
No. of Equipment	F-1-01A/B (2units)	F-2-01AB (2units)
Type	Demister	Demister
Capacity	150 Nm^3/min	17 Nm^3/min
Pressure	5μm	0.3μm

3) Scrubber
Scrubber removes acid gas (H_2S, NH_3 etc.) of LFG using solubility, so that the problem of erosion of the facility and pollutant emission can be reduced.

Figure 6 Scrubber

Equipment	SCRUBBER
No. of Equipment	SR-1-02A/B (2units)
Type	Packed Tower with Demister
Capacity	75 Nm^3/min

4) Cooler

Cooler removes moisture from LFG, so that caloric value of the gas is rising and trouble cause of the facility can be removed.

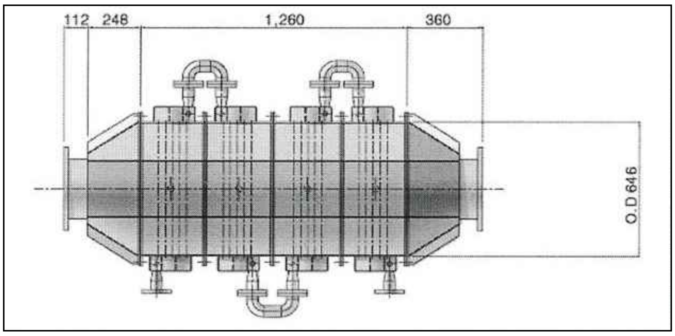

Figure 7 Cooler

Equipment	LFG Cooler
No. of Equipment	CO-1-03A/B (2units)
Type	Fin Tube
Flow Rate	75 Nm^3/min

5) Chiller

Chiller produces chilled water and supplies it to Cooler Tube Side.

Figure 8 Chiller

Equipment	CHILLER
No. of Equipment	CH-1-04 (1units)
Type	Brine-Cooling(Compact)
Capacity	147 RT

6) Gas Engine

Gas Engine generates electricity and generated electricity is for internal use.

Figure 9 Gas Engine

Equipment	GAS ENGINE
No. of Equipment	EN-2-03 A/B (2 units)
Type	Container Type
Capacity	1,500kW (750kW x 2 sets)

7) Flare Stack

Flare stack combusts remaining LFG, and treats LFG so that odour effect can be minimized. There are four flare stacks including two existing flare stacks and two newly installed flare stacks. The type of flare stack applied to this project is Cylindrical Type. Two newly installed flare stacks are installed in 2018 for reducing odour from the landfill.

Figure 10 Flare Stack

Equipment	FLARE STACK	
No. of Equipment	IF-3-01A/B (2 units)	IF-3-01C/D (2 units)
Type	Cylindrical, Open	Cylindrical, Enclosed
Capacity	4,200 (2,100 Nm^3/h x 2 units)	4,000 (2,000 Nm^3/h x 2 units)

8) Gas storage tank

The refined LFG has a medium energy which is subject to fluctuation. The refined LFG is homogenized as a fuel while stored in a gas storage tank.

Figure 11 Gas storage tank

Equipment	BALL TANK
No. of Equipment	T-3-05 (1 unit)
Type	Globular Type

9) LFG boilers

Refined LFG from the landfill is supplied to LFG boilers of KDHC. LFG boilers produce hot water, which is distributed to the end users. The LFG used as a main fuel of base-load in the KDHC.

Equipment	LFG boilers
No. of Equipment	PLB #1,2(LFG) (2 units)
Type	Hot water
Capacity	34.4 Gcal/hr (LNG) 33.0 Gcal/hr (LFG)

▶ **Information on the implementation and actual operation of the project activity**

Item	Date and Details: Item	Date and Details: Date	Date and Details: Details
Overhaul	Gas Compressor	30/08/2018~15/10/2018	Gas compressor A/B - Cleaning oil cooler
		14/09/2018	Gas compressor C – Inspection of Power card, PLC CPU card
		17/09/2018~30/09/2018	Gas compressor A/B – Pipe and valve installation
		17/09/2018	Gas compressor C/D – Pipe and valve installation
		19/11/2018~30/11/2018	Gas compressor A/B –

				Replacement of oil strainer
			03/01/2019~17/01/2019	Gas compressor A – Replacement of Motor shaft and rotor balancing bearing
			10/04/2019~31/05/2019	Gas compressor C – Replacement of Heat Exchange and Cleaning oil cooler
			10/06/2019~31/08/2019	Gas compressor A/B – Replacement of Heat Exchange and Cleaning oil cooler
			26/07/2019~25/08/2019	Gas compressor B – Replacement of Heat Exchange
			08/08/2019~08/09/2019	Gas compressor B – Rotor shaft and IGV & BOV valve check
			17/08/2019~31/08/2019	Gas compressor A – Replacement of oil strainer Gas compressor B – Replacement of IGV & BOV actuator positioner
			23/08/2019~22/09/2019	Gas compressor C - Cleaning Heat Exchange
			27/09/2019~30/11/2019	Gas compressor C – Replacement of bearing, impeller balancing and buffer seal/oil seal
			11/10/2019	Gas compressor A – Replacement of IGV & BOV actuator positioner
			03/12/2019~31/12/2019	Gas compressor B – Inspection of rotor, bearing and shaft

	04/12/2019~31/12/2019	Gas compressor C – Replacement of Heat Exchange
Blower	16/08/2018~31/08/2018	Blower A – Exchange of bearing because of vibration
	11/11/2019~30/11/2019	Blower B - Exchange of bearing because of vibration
	19/11/2019	Blower B – Repair of motor bearing housing
Chiller	07/06/2019	Replacement of oil filter
Air Compressor	10/06/2019	Air compressor A/B - Exchange of oil separator, oil filter, suction filter and line filter
	11/11/2019	Air compressor B – Exchange of fan motor
	23/12/2019	Air compressor B – Exchange of rotor bearing and motor bearing

*All installation was checked by quarter
*Detail contents are described in Maintain report

B.2. Post-registration changes

B.2.1. Temporary deviations from the registered monitoring plan, applied methodologies, standardized baselines or other methodological regulatory documents

>>
N/A

B.2.2. Corrections

>>
N/A

B.2.3. Changes to the start date of the crediting period

>>
N/A

B.2.4. Inclusion of monitoring plan

>>

N/A

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

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N/A

B.2.6. Changes to project design

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PPs have commissioned DOE to carry out the validation for post registration change of the CDM project titled “Daegu Bangcheon-Ri Landfill Gas CDM Project” (hereinafter referred to as the proposed project). The purpose of PRC is to install the additional flare stacks (2 units).

As for the project, two flare stacks with a capacity of 4,200 Nm^3/h(open type, 2,100 Nm^3*2 units) were initially installed on 13/10/2006. However, there was an additional flare stacks (enclosed type, 2,000 Nm^3/h *2 units) installed on 29/05/2018.

Therefore, the list of facilities, systems and equipment described in the PDD has changed due to the addition of two flare stacks (enclosed type, 2,000 Nm^3/h * 2 units) and the actual implementation of 8,200 Nm^3 (2,100 Nm^3 * 2 units, 2,000 Nm^3/h * 2 units). The revised PDD was approved on 25/09/2018 by UNFCCC.

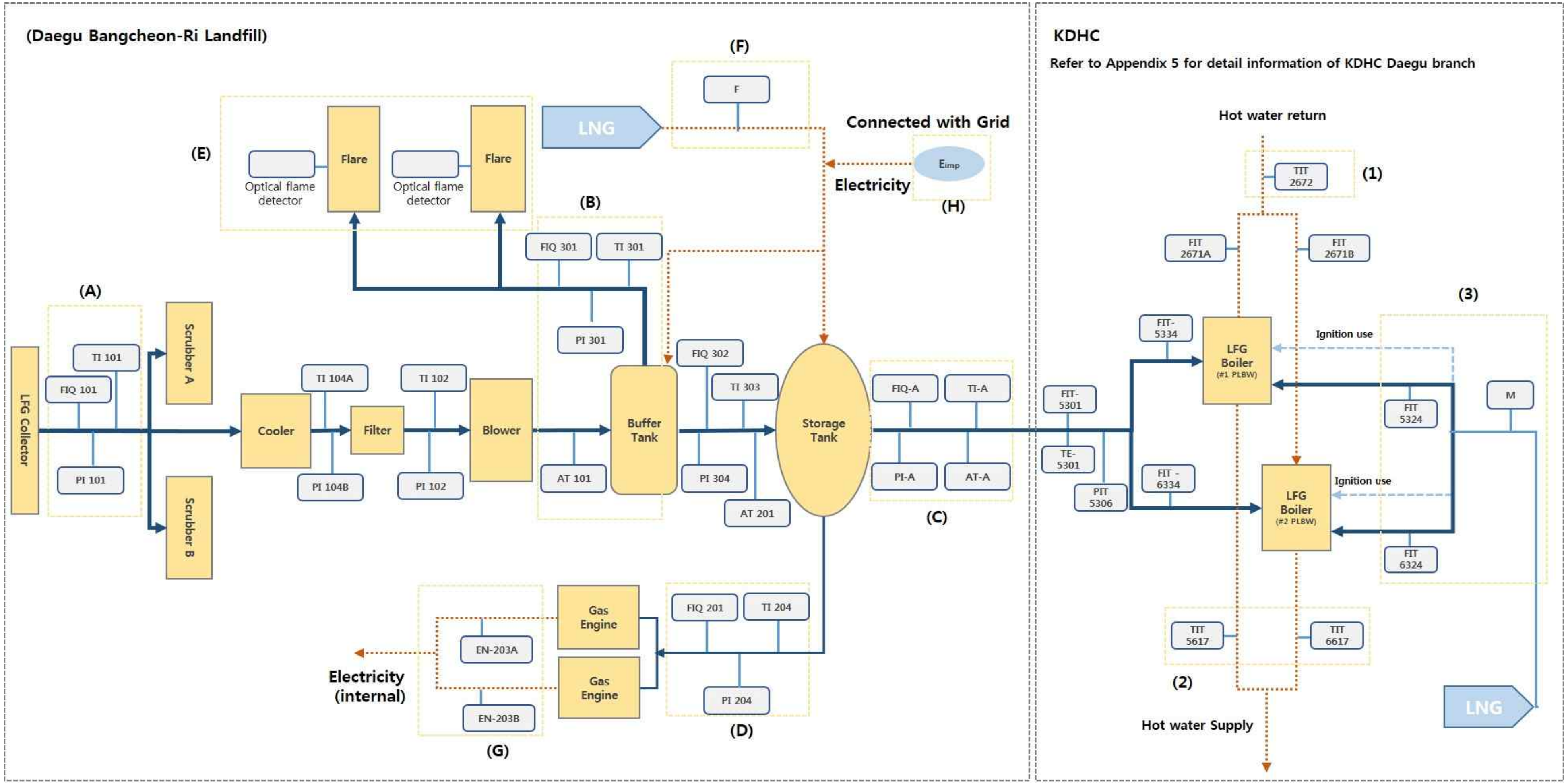
B.2.7. Changes specific to afforestation or reforestation project activity

>>
N/A

SECTION C. Description of monitoring system

>>

All kinds of measuring instruments, including gas analyzer and gas meter, are present. The data collected is registered continuously by the PLC (Programmable Logic Controller). The following equipment is used to monitor the operation of the project and to monitor the emission reduction.



<table>
<tr><td rowspan="26">Landfill</td><td rowspan="3">(A)</td><td>FIQ-101</td><td>Flow meter</td><td rowspan="18">Flow meter
- Type : Vortex or Turbine, Rotary flow meter
- Accuracy: ±1.0%(Vortex), ±0.5%(Turbine, Rotary)

Manometer(pressure, transmitter)
- Type : Diaphragm, Volume corrector
- Accuracy: ±0.075%, ±0.25%

Thermometer
- Type: Thermocouple, RTD, Volume corrector
- Accuracy : ±0.2%, ±0.305|t|, ±0.25%

Optical flame detector (Type: UV-IR)
- FD-101, 102 (Accuracy: ±5%)
- FD-103, 104
Operating Temperature Rating: -18℃ ~ 102℃
Maximum Pressure Rating : 5 psi (34.5kPa)

Gas Analyzer
- Repeatability: ±0.5%
- Linearity : 1%
- Measurable Range<table><tr><th>Gas</th><th>Minimum Range</th><th>Maximum range</th></tr><tr><td>CH_4</td><td>0~1000 ppm</td><td>0 ~ 100 vol%</td></tr><tr><td>CO_2</td><td>0~500 ppm</td><td>0 ~ 100 vol%</td></tr><tr><td>O_2(Built-in paramagnet)</td><td>0~5 vol%</td><td>0 ~ 100 vol%</td></tr></table></td></tr>
<tr><td>TI-101</td><td>Thermometer</td></tr>
<tr><td>PI-101</td><td>Manometer</td></tr>
<tr><td rowspan="4">(B)</td><td>FIQ-301</td><td>Flow meter</td></tr>
<tr><td>AT-101</td><td>Gas analyzer</td></tr>
<tr><td>TI-301</td><td>Thermometer</td></tr>
<tr><td>PI-301</td><td>Manometer</td></tr>
<tr><td rowspan="4">(C)</td><td>FIQ-A</td><td>Flow meter</td></tr>
<tr><td>TI-A</td><td>Temperature</td></tr>
<tr><td>PI-A</td><td>Manometer</td></tr>
<tr><td>AT-A</td><td>Gas analyzer</td></tr>
<tr><td rowspan="3">(D)</td><td>FIQ 201</td><td>Flow meter</td></tr>
<tr><td>TI 204</td><td>Thermometer</td></tr>
<tr><td>PI 204</td><td>Manometer</td></tr>
<tr><td rowspan="4">(E)</td><td>FD-101</td><td>Optical flame detector</td></tr>
<tr><td>FD-102</td><td>Optical flame detector</td></tr>
<tr><td>FD-103</td><td>Optical flame detector</td></tr>
<tr><td>FD-104</td><td>Optical flame detector</td></tr>
<tr><td>(F)</td><td>F</td><td>LNG flow meter</td><td>- Type : Rotary
- Accuracy : ±0.5%</td></tr>
<tr><td rowspan="2">(G)</td><td>EN-203A</td><td rowspan="2">Generated electricity indicator</td><td rowspan="2">Generated electricity Indicator on gas engines</td></tr>
<tr><td>EN-203B</td></tr>
<tr><td>(H)</td><td>E_{imp}</td><td>Electricity meter(incoming)</td><td>- Three-phase four-wire system
- 110/190 V 5(2.5)A 60 Hz 0.5 Rank</td></tr>
<tr><td>(1)</td><td>TIT-2672</td><td>Thermometer</td><td>- Accuracy : ±0.25%</td></tr>
<tr><td rowspan="2">(2)</td><td>TIT-5617</td><td>Thermometer</td><td>- Accuracy : ±0.25%</td></tr>
<tr><td>TIT-6617</td><td>Thermometer</td><td>- Accuracy : ±0.25%</td></tr>
<tr><td rowspan="3">(3)</td><td>M</td><td>LNG flow meter</td><td>- Type : Rotary
- Accuracy :
±1% : Qmin ~ 0.2 Qmax
±0.5% : 0.2 Qmin ~ Qmax</td></tr>
<tr><td>FIT-5324</td><td>LNG flow meter</td><td rowspan="2">- Type : Vortex
- Accuracy : ±1%
※Reading Volumes in normalized cubic meters</td></tr>
<tr><td></td><td>FIT-6324</td><td>LNG flow meter</td></tr>
</table>

The monitoring equipment directly involved with emission reduction are named from Group (A) to Group (H) and from Group (1) to Group (3). And there are three gas analyzers in this project as below;

① Behind of the buffer tank(for reference, AT201)

② In front of the buffer tank: The data measured by this gas analyzer will be used to calculate flaring. (AT 101)

③ Behind the gas storage tank (right before supplying gas to user): The data measured by this gas analyzer will be used to calculate heat and electricity generation. (AT-A)

- Technology of LFG utilization transfer

Daegu Bangcheon-Ri landfill is only a landfill in Daegu Metropolitan which has an area of 883.48 Km^2 and 2.5 million people live in. The project is one of the best examples for green gas reduction in Republic of Korea. The project will contribute to enhance the knowledge and spread technology of waste utilization. These knowledge and experience will be an asset for the local area.

1) LFG flow

LFG should be refined for enhancing fuel worth. In process of LFG refinement, captured LFG goes to scrubber for removing acid gas and dust, and then goes to cooler for removing moisture. There are no extra process for adding moisture.

Captured LFG is monitored by FIQ-101 and combusted LFG is monitored by FIQ-201, FIQ-301 and FIQ-A. These flow meters measure LFG flow continuously and the measuring values are recorded hourly. Each volumetric flow rates are normalized its thermometer and manometer.

To calculate baseline emission, FIQ-201, FIQ-301 and FIQ-A is used. In the only case of abnormal situation or to check total volumetric flow rate, FIQ-101 will be used.

Thermometers (TI-204, TI 301 and TI-A) installed around FIQ-201, FIQ-301 and FIQ-A are used for normalization. And these also tell whether the collected LFG are a dry basis. Collected temperature LFG of TI-204, TI-301 and TI-A was applied when it was lower than 60℃ degrees. As per option A of “Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Ver. 02.0.0)”, LFG are considered as dry basis.

That’s the reason that LFG gases are considered as dry basis as option A of “Tool to determine the mass flow of a greenhouse gas in gaseous stream (Ver.02.0.0)”, Relevant evidence are added on ‘Comparing Captured and Used LFG’ in the ER sheet.

2) CH_4 fraction of LFG

The fraction of CH_4 in LFG is measured continuously by using gas analyzers, which are AT-101 and AT-A. The analyzer which is monitoring CH_4 fraction fed to flare is AT-101 and the analyzer which is monitoring CH_4 fraction fed to LFG boilers and gas generators is AT-A. These analyzers measure CH_4 fraction continuously and the measured values are recorded hourly.

3) Flare Operating Check

As developing housing development at nearby Bangcheon-Ri landfill, odour from landfill spreads to resident area and the complaints highly increase in every summer season. In order to reduce the problem, there is a need to introduce two enclosed flare stacks which have high efficiency. Hence, the project activity run four flare stacks including two enclosed and two open type flare stacks.

As for detailed monitoring plan for flare stack system, the same monitoring activity was carried out. FIQ-301, temperature transmitters (TI-301) and manometer (PI-301) were monitored all of flare stacks.

Each flame detector and valve condition at each flare stack is monitored and recording in PLC data. In exceptional case, when flare stacks have breakdowns or regular inspections, these documentary evidences for the exceptional case will be provided to DOE during the verification.

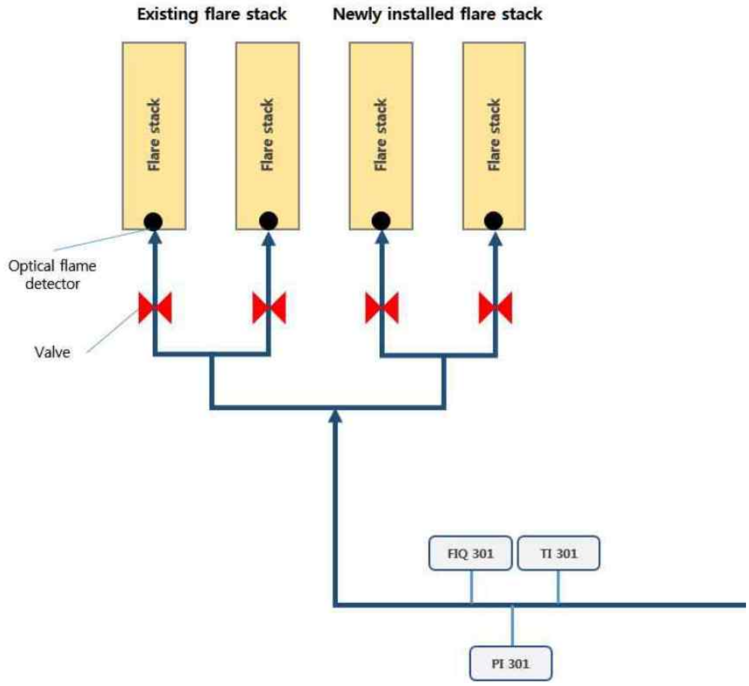


Figure 12 Detailed diagram of flare stacks monitoring

4) LNG usage

The amount of LNG used consists of mainly to parts. First, LNG may be supplied to landfill site and mix with LFG which is supplied to the LFG boilers as fuel to satisfy the operation condition for the LFG boilers. The amount of supplied LNG is continuously measured by flow meter F (FIT-503, FIT-504) and double-checked with Gas bill monthly provided by LNG supplier. Second, LNG are used to ignite LFG boilers, which is located in KDHC, and used as a fuel of LFG boiler at the emergency situation. The amount of supplied LNG is continuously measured by flow meter (M, FIT-5324, FIT-6324) and double-checked with Gas bill monthly provided by LNG supplier.

This appendix describes monitoring plan of LFG boilers in detail. This part is newly added as project emissions for 2nd crediting period. KDHC is charge of monitoring associated with LFG boilers and detail monitoring plan for KDHC is as follows;

Both LFG and LNG are available as the boiler's fuel for producing the heat generation. LNG is also used as ignition in order to start up LFG boilers. Consumption of ignition use was found to influence the project emission.

There are three LNG meters on LFG boilers. One is a main LNG meter of LNG supplier (i.e. M) and others are LNG sub meters (i.e. FIT-5324, FIT6324) of KDHC for measuring LNG fuel. LNG consumption for ignition is an amount which sum of both sub flow meters is deducted from a value of LNG main flow meter.

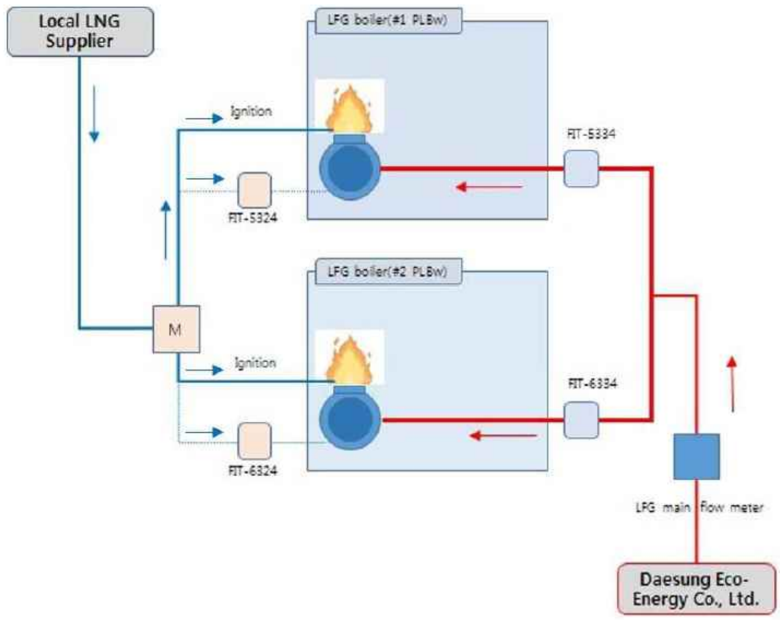


Figure 13 Monitoring diagram of LFG boilers

Quality control(QC) and Quality assurance (QA) procedure

Monitoring equipment and calibration

Measuring equipment for LFG boiler is managed by KDHC and fuel suppliers. Calibration and frequency of calibration are determined as local regulation. Exceptionally the LNG main flow meter(which is a M) is complied with QA/QC of $FC_{LNG,j,y}$.

5) Electricity generation Operating check

LFG which is measured at FIQ-201 is fed to LFG generators. To chek whether electricity generation is operating or not, electricity indicator (EN-203A, EN-203B) was used. According to registered PDD, parameter OP_j needs to be applied but not really needed (Temperature, Flame and Products generated. i.e, result of using of LFG). Generated electiricity was used to chek operating as a result of using LFG in this project.

6) Electricity imported

The imported electricity is used for LFG capturing and treating. The amount of electricity is continuously measured by watt-hour meter (E_{imp}) and double-checked with electricity bill monthly provided by KEPCO.

7) Boiler Operating check

Thermometers including TIT-2672, TIT-5617 and TIT-6617 check wheter LFG boilers is operating or not. The LFG boilers is a type of hot water boiler and operating condition of the LFG boilers could be recognized by checking a difference between inlet and outlet water temperature. LFG boilers designed more than 55℃ temperature rise.

- **Main monitoring equipment**

1) Flow meter

▶ Rotary Flow Meter (LNG flow meter)

- Type : Rotary
- Accuracy: ±0.5%
- Flow range : 0.6 ~ 1600 m^3/h

▶ Turbine Flow Meter(FIQ-A)

- Type : Turbine
- Accuracy: ±0.5%
- Flow range : 13 ~ 40,000 m^3/h

▶ Vortex Flow Meter(FIQ-201)

- Type : Vortex
- Accuracy: ±1.0%
- Flow range : 15 ~ 19 Nm^3/min

▶ Vortex Flow Meter (FIQ-301)

- Type : Vortex
- Accuracy: ±1.0%
- Flow range : 42 ~ 150 Nm^3/min

2) Gas analyzer (AT-A, AT-101)

- Type: Infrared analyzer
- Repeatability: ±0.5%
- Linearity: ±1.0%
- Measurable Range;

Gas	Minimum Range	Maximum range
CH_4	0~1000 ppm	0 ~ 100 vol%
CO_2	0~500 ppm	0 ~ 100 vol%
O_2(Built-in paramagnet)	0~5 vol%	0 ~ 100 vol%

- **Data Collection Procedures**

All monitoring parameters are controlled by an electrical control system which is based on a PLC (Programmable Logic Controller). All the measuring signals are processed by the PLC. The main functions of PLC are described as below.

1) Monitoring Function
All of the status and trouble about the other equipment and PLC are monitored. If there are breakdowns or abnormal status, it is indicated, if necessary, the counterplan of it is also informed.

2) Recording Function
Data about gas flow, temperature and pressure measured by each monitoring equipment is collected and recorded.

3) Accumulation of DATA Function
Recorded data is accumulated and saved in computer.

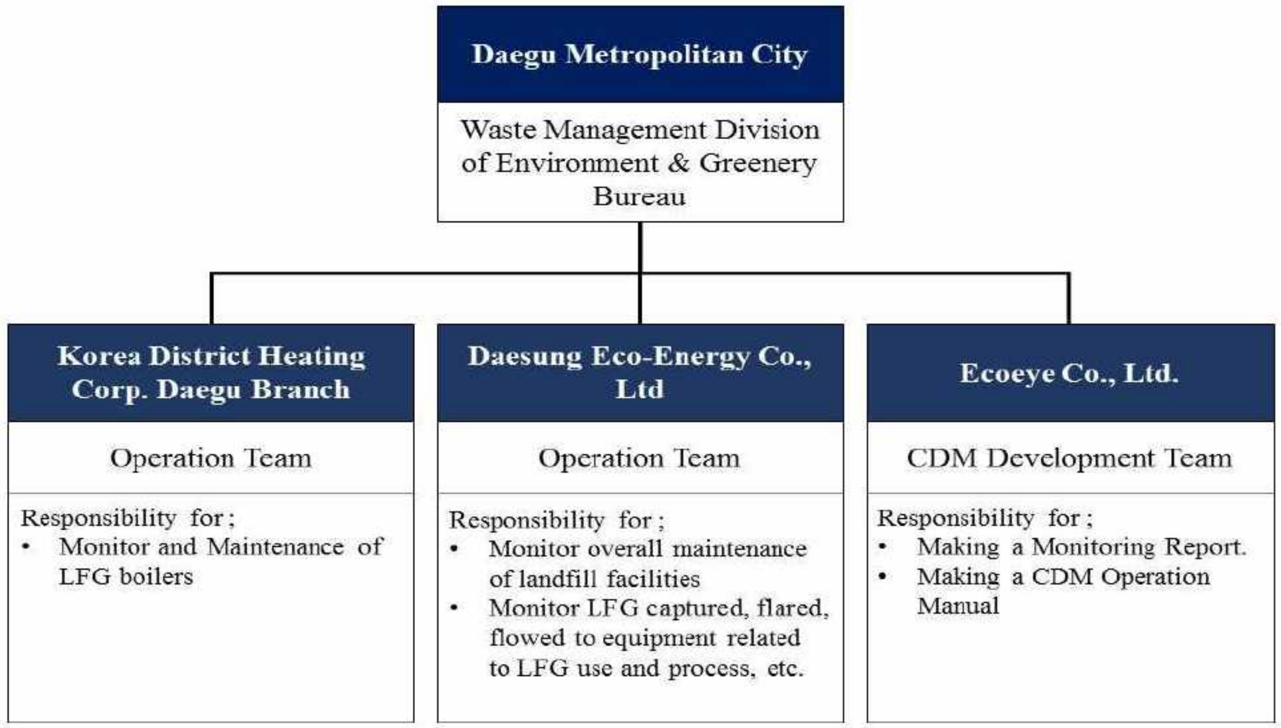
4) Down Loading Function
Saved data is able to download by excel file for monitoring.

Every five minutes, PLC reads data from the server and the data could be checked on MMI program. At the end of each day (at 12:00pm), the data is automatically stored into the PC at operation team. Archiving process of the stored data is as follows;

1) A person in charge of operation who belongs to operation team prints out the data of captured LFG (amount, temperature and pressure, etc.) as document.
2) The team leader of operation team inspects the document.
3) The document gets approval from the executive director.

The archived data are to be kept during the crediting period and two years after.

- **Monitoring Structure**



Responsible department for the monitoring are as follows:

- Responsible person/department for the project :
  Waste management Division of Environment & Greenery Bureau of Daegu metropolitan / city
- Practical and responsible monitoring (about electricity, LFG and LNG) :
  Daesung Eco-Energy Co., Ltd. (Operation Team)
- Practical and responsible monitoring (about LFG boilers) :
  Korea District Heating Corp. Daegu office (Operation Team)
- Making CDM documents (about Monitoring report, CDM operation Manual) :
  Ecoeye. Co., Ltd.

SECTION D. Data and parameters

D.1. Data and parameters fixed ex ante

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”(Version 06.0.1)
Value(s) applied	0.1
Choice of data or measurement methods and procedures	N/A
Purpose of data/parameter	Calculation of baseline emission
Additional comments	N/A

Data/Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
Description	Global warming potential (GWP) of methane

Source of data	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
Value(s) applied	25
Choice of data or measurement methods and procedures	N/A
Purpose of data/parameter	Calculation of baseline emission
Additional comments	N/A

Data/Parameter	$EF_{grid,CM,y}$
Unit	tCO_2e/MWh
Description	Combined margin CO_2 emission factor in year y
Source of data	Calculated
Value(s) applied	0.5421
Choice of data or measurement methods and procedures	This value was calculated according to “Tool to calculate the emission factor for an electricity system” (version04.0). The applied value was derived from “2010, 2011, 2012 Statistics of Electric Power in Korea (2011, 2012, 2013)” (KEPCO) and “2012 Status of Generation facility (published in 2013)” (Korea Power Exchange).
Purpose of data/parameter	Calculation of project emission
Additional comments	N/A

Data/Parameter	ρ_{CH4}
Unit	tCH_4/Nm^3CH_4
Description	Density of CH_4
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream(Ver.02.0.0)
Value(s) applied	0.0007157
Choice of data or measurement methods and procedures	Calculated value at 0℃ and 1atm according to “Tool to determine the mass flow of greenhouse gas in a gaseous stream (Ver.02.0.0)”
Purpose of data/parameter	Calculation of baseline emission
Additional comments	This value is calculated considering 0℃ and 1atm according to “Tool to determine the mass flow of greenhouse gas in a gaseous steam (Ver.02.0.0). The volume metric flow rate which is measured at FIQ-201, FIQ-301 and FIQ-A is already based on 0℃ and 1atm. So, PP doesn’t need to calculate ρ_{CH4} on every hour. The calculation formula is submitted to DOE for verification purpose.

D.2. Data and parameters monitored

Data/Parameter	Management of SWDS
Unit	-
Description	Management of SWDS
Measured/calculated/default	-
Source of data	Use different sources of data: (a) Original design of the landfill; (b) Technical specifications for the management of the SWDS; (c) Local and national regulation

Value(s) of monitored parameter	**(a) Original design of the landfill** There is no change of area of waste disposal (853,400m^2) as per the lasted 'Installation approval of Waste disposal facility'. **(b) Technical specifications for the management of the SWDS** SFR facility was constructed in July 2016. So much combustibles wastes are handled in SRF incineration facility. As a result, dumping waste amounts in the landfill reduced. **(c) Local and national regulation** Daegu Metropolitan City was taking outright ban on dumping illegal waste in April 2016. Those who not get legal license for dumping wastes was prohibited. 2016 amount of MSW so dramatically goes down and its trend continued in 2019.
Monitoring equipment	N/A
Measuring/reading/recording frequency	Recording annually
Calculation method (if applicable)	N/A
QA/QC procedures	N/A
Purpose of data/parameter	N/A
Additional comments	N/A

Year	Expected amount of MSW(ton/year)	Actual amount of MSW (ton/year)	Difference
2014	448,841	466,987	4.04%
2015	452,637	494,887	9.33%
2016	456,323	357,522	-21.65%
2017	460,083	282,632	-38.56%
2018	463,806	301,056	-35.09%
2019	467,565	322,241	-31.08%

Data/Parameter	$OP_{j,h}$
Unit	-
Description	Operation of the equipment that consumes the LFG
Measured/calculated/default	Measured
Source of data	PLC data - Temperature : TIT-2672, TIT-6617, TIT-5617 - Flame Detector : FD-101, FD-102, FD-103, FD-104
Value(s) of monitored parameter	N/A

Monitoring equipment

(1) $F_{CH4,HG}$ (LFG Boiler)

Tag	TIT-2672
Type	Temperature transmitter
Accuracy class	± 0.25%
Serial number	TIT-2672
Past Calibration Date	09/09/2015
Calibration frequency	3 years
Date of last calibration	30/08/2018
Validity	30/08/2018 ~ 29/08/2021

Tag	TIT-5617
Type	Temperature transmitter
Accuracy class	± 0.25%
Serial number	TIT-5617
Past Calibration Date	02/09/2015
Calibration frequency	3 years
Date of last calibration	30/08/2018
Validity	30/08/2018 ~ 29/08/2021

Tag	TIT-6617
Type	Temperature transmitter
Accuracy class	± 0.25%
Serial number	TIT-6617
Past Calibration Date	02/09/2015
Calibration frequency	3 years
Date of last calibration	30/08/2018
Validity	30/08/2018 ~ 29/08/2021

(2) $F_{CH4,flared}$ (Flare stack)

Tag	FD-101
Type	UV-IR
Accuracy class	± 5%
Serial number	53131
Calibration frequency	3 years
Date of last calibration	24/05/2016
Validity	24/05/2016~23/05/2019

Tag	FD-102
Type	UV-IR
Accuracy class	± 5%
Serial number	53067
Calibration frequency	3 years
Date of last calibration	24/05/2016
Validity	24/05/2016~23/05/2019

Tag	FD-103
Type	UV-IR
Accuracy class	± 5%
Serial number	241556
Calibration frequency	40,000 hours
Date of last calibration	01/02/2018
Validity	01/02/2018~31/01/2022

Tag	FD-104
Type	UV-IR
Accuracy class	± 5%
Serial number	241568
Calibration frequency	40,000 hours
Date of last calibration	01/02/2018
Validity	01/02/2018~31/01/2022

Measuring/reading/recording frequency	TIT-2672, TIT-5617, TIT-6617 : Recording hourly FD-101, FD-102, FD-103, FD-104 : Measuring minutely
Calculation method (if applicable)	N/A
QA/QC procedures	Temperature transmitter and UV-IR (Flame Detector) are subject to a regular maintenance and testing regime to ensure accuracy.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Regarding O_P of Boiler, changes of over 55℃ between inlet and outlet were recognize operation of LFG boilers according to the LFG boiler's design.

Data/Parameter	$EG_{EC,y}$
Unit	MWh
Description	Amount of electricity consumed by the activity in year y
Measured/calculated/default	Measured
Source of data	PLC data(E_{imp}) and KEPCO data (Electricity bill)
Value(s) of monitored parameter	19/08/2018 ~ 31/12/2018 : 2,346 MWh 01/01/2019 ~ 18/08/2019 : 5,965 MWh This values are in $EC_{PJ, grid}$ sheet of the Daegu 8th ER sheet.
Monitoring equipment	Tag: E_{imp} Type: Three-phase four-wire Accuracy class: ± 0.5% Serial number: 02162018282 Calibration frequency: 7 years Date of last calibration: 08/07/2016 Validity: 08/07/2016~07/07/2023
Measuring/reading/recording frequency	Measuring and recording hourly on PLC data Reading monthly in Electricity bill data
Calculation method (if applicable)	N/A
QA/QC procedures	Electricity meter is calibrated every 7 years. This value was double-checked with the invoice from KEPCO (Supplier) and the bigger value was used to calculate project emission ($EC_{PJ, grid}$).
Purpose of data/parameter	Calculation of project emission
Additional comments	The calculation formula of project emission is below. $PE_{EC} = EC_{PJ,grid} * EF_{EL,grid} * (1+TDL_{grid})$ In this formula, there is no $EG_{EC, y}$ parameter. However, when the PDD is considered, the $EG_{EC,y}$ parameter will be $EC_{PJ,grid}$.

Data/Parameter	$Flame_m$
Unit	-
Description	Flame detection of flare stack in the minute *m*
Measured/calculated/default	Measured
Source of data	PLC data (FD-101, FD-102, FD-103, FD-104)
Value(s) of monitored parameter	-

Monitoring equipment	Tag: FD-101 Type: UV-IR Accuracy class: ± 5% Serial number: 53131 Calibration frequency: 3 years Date of last calibration: 24/05/2016 Validity: 24/05/2016~23/05/2019 Tag: FD-102 Type: UV-IR Accuracy class: ± 5% Serial number: 53067 Calibration frequency: 3 years Date of last calibration: 24/05/2016 Validity: 24/05/2016~23/05/2019 Tag: FD-103 Type: UV-IR Accuracy class: ± 5% Serial number: 241556 Calibration frequency: 40,000 hours Date of last calibration: 01/02/2018 Validity: 01/02/2018~31/01/2022 Tag: FD-104 Type: UV-IR Accuracy class: ± 5% Serial number: 241568 Calibration frequency: 40,000 hours Date of last calibration: 01/02/2018 Validity: 01/02/2018~31/01/2022
Measuring/reading/recording frequency	Recording minutely
Calculation method (if applicable)	N/A
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations or local regulation.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	This parameter is used to confirm flare stack operating.

Data/Parameter	$V_{t,db}$
Unit	Nm^3dry gas/h
Description	Volumetric flow of the gaseous stream in a time interval *t* on a dry basis
Measured/calculated/default	Measured
Source of data	PLC data (FIQ-201, FIQ-301, FIQ-A)
Value(s) of monitored parameter	**FIQ-201** 19/08/2018~31/12/2018 : 0 Nm^3 01/01/2019~18/08/2019 : 0 Nm^3 **FIQ-301** 19/08/2018~31/12/2018 : 9,805,718 Nm^3 01/01/2019~18/08/2019 : 3,334,395 Nm^3 **FIQ-A** 19/08/2018~31/12/2018 : 10,685,038 Nm^3 01/01/2019~18/08/2019 : 33,187,080 Nm^3

<table>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Tag</td><td>FIQ-201</td></tr>
<tr><td>Type</td><td>Vortex</td></tr>
<tr><td>Accuracy class</td><td>1.0%</td></tr>
<tr><td>Serial number</td><td>C10-S1000HN</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>06/08/2014</td></tr>
<tr><td>Validity</td><td>06/08/2014~05/08/2022</td></tr>
</table>
<table>
<tr><td>Tag</td><td>FIQ-301</td></tr>
<tr><td>Type</td><td>Vortex</td></tr>
<tr><td>Accuracy class</td><td>1.0%</td></tr>
<tr><td>Serial number</td><td>DE26015G</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>06/08/2014</td></tr>
<tr><td>Validity</td><td>06/08/2014~05/08/2022</td></tr>
</table>
<table>
<tr><td>Tag</td><td>FIQ-A</td></tr>
<tr><td>Type</td><td>Turbine</td></tr>
<tr><td>Accuracy class</td><td>0.5%</td></tr>
<tr><td>Serial number</td><td>DE28024G</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>20/08/2012</td></tr>
<tr><td>Validity</td><td>20/08/2012~19/08/2020</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measuring hourly</td></tr>
<tr><td>Calculation method (if applicable)</td><td>N/A</td></tr>
<tr><td>QA/QC procedures</td><td>This monitoring equipment is calibrated every 8 years.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>Flaring, power generator and LFG Boilers in the project activity are operating for the collected LFG destruction, LFG Boilers is a primary methane destruction facility. Others are operating when heat demands are low in summer season. Especially in summer, flaring system can handle the LFG at low operating cost comparing to power generation system. For this reason, gas engines didn’t operate and FIQ-201 for measuring power generation measured at 0 Nm^3 during the monitoring period.

Thermometers (TI-204, TI-301 and TI-A) installed around FIQ-201, FIQ-301, FIQ-A are used for normalization. And these also tell whether the collected LFG are a dry basis. Temperature of collected LFG at TI-204, TI-301 and TI-A are less than 60℃ during this monitoring period. As per option A of “Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Ver.02.0.0)”, the collected LFG are considered as dry basis.</td></tr>
</table>

Data/Parameter	$v_{CH4,t,db}$
Unit	Nm^3_{CH4}/Nm^3 dry gas (or %)
Description	Volumetric fraction of CH_4 in a time interval *t* on a dry basis
Measured/calculated/default	Measured
Source of data	PLC data (AT-101, AT-A)

<table>
<tr><td>Value(s) of monitored parameter</td><td>AT-101
19/08/2018~31/12/2018 : 50.59 %
01/01/2019~18/08/2019 : 48.16 %

AT-A (related with FIQ-A)
19/08/2018~31/12/2018 : 49.13 %
01/01/2019~18/08/2019 : 47 %

AT-A (related with FIQ-201)
19/08/2018~31/12/2018 : 0 %
01/01/2019~18/08/2019 : 0 %</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Tag</td><td>AT-101</td></tr>
<tr><td>Type</td><td>Infrared analyzer</td></tr>
<tr><td>Serial number</td><td>A1E5039T</td></tr>
<tr><td>Calibration frequency</td><td>5 years</td></tr>
<tr><td>Date of last calibration</td><td>03/05/2016</td></tr>
<tr><td>Validity</td><td>03/05/2016~02/05/2021</td></tr>
</table>
<table>
<tr><td>Tag</td><td>AT-A</td></tr>
<tr><td>Type</td><td>Infrared analyzer</td></tr>
<tr><td>Serial number</td><td>N5L0895</td></tr>
<tr><td>Calibration frequency</td><td>5 years</td></tr>
<tr><td>Date of last calibration</td><td>28/10/2015</td></tr>
<tr><td>Validity</td><td>28/10/2015~27/10/2020</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measuring hourly</td></tr>
<tr><td>Calculation method (if applicable)</td><td>N/A</td></tr>
<tr><td>QA/QC procedures</td><td>Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>AT-A (the fraction of methane) is related with FIQ-A and FIQ-201. The values of monitored parameter above is calculated using weighted-average with volumetric flow rate. AT-A for FIQ-201 is regard as “0%” because flow of FIQ-201 measured “0” Nm^3 during 8th monitoring period.

Thermometers (TI-204, TI-301 and TI-A) installed around FIQ-201, FIQ-301, FIQ-A are used for normalization. And these also tell whether the collected LFG are a dry basis. Collected temperature LFG of TI-204, TI-301 and TI-A was applied when it was lower than 60 degrees. As per option A of “Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Ver.02.0.0)”, LFG are considered as dry basis.</td></tr>
</table>

Data/Parameter	P_t
Unit	Pa
Description	Pressure of the gaseous stream in time interval *t*
Measured/calculated/default	Measured
Source of data	PLC (PI-204, PI-301, PI-A)
Value(s) of monitored parameter	-

<table>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Tag</td><td colspan="2">PI-204</td></tr>
<tr><td>Type</td><td colspan="2">Diaphragm</td></tr>
<tr><td>Accuracy class</td><td colspan="2">± 0.075%</td></tr>
<tr><td>Serial number</td><td colspan="2">91F625744</td></tr>
<tr><td>Calibration frequency</td><td colspan="2">1 month</td></tr>
<tr><td>Date of last calibration</td><td colspan="2">20/09/2019</td></tr>
<tr><td>Validity</td><td>20/08/2018~19/09/2018
21/09/2018~20/10/2018
19/10/2018~18/11/2018
20/11/2018~19/12/2018
21/12/2018~20/01/2019
18/01/2019~17/02/2019
20/02/2019~19/03/2019</td><td>20/03/2019~19/04/2019
19/04/2019~18/05/2019
20/05/2019~19/06/2019
20/06/2019~19/07/2019
18/07/2019~17/08/2019
22/08/2019~21/09/2019</td></tr>
<tr><td>Delayed period</td><td colspan="2">20/09/2018,19/11/2018,20/12/2018,
18/02/2019~19/02/2019, 19/05/2019,
18/08/2019~21/08/2019</td></tr>
</table>
<table>
<tr><td>Tag</td><td colspan="2">PI-301</td></tr>
<tr><td>Type</td><td colspan="2">Diaphragm</td></tr>
<tr><td>Accuracy class</td><td colspan="2">± 0.075%</td></tr>
<tr><td>Serial number</td><td colspan="2">91F347307</td></tr>
<tr><td>Calibration frequency</td><td colspan="2">1 month</td></tr>
<tr><td>Date of last calibration</td><td colspan="2">20/09/2019</td></tr>
<tr><td>Validity</td><td>20/08/2018~19/09/2018
21/09/2018~20/10/2018
19/10/2018~18/11/2018
20/11/2018~19/12/2018
21/12/2018~20/01/2019
18/01/2019~17/02/2019
20/02/2019~19/03/2019</td><td>20/03/2019~19/04/2019
19/04/2019~18/05/2019
20/05/2019~19/06/2019
20/06/2019~19/07/2019
18/07/2019~17/08/2019
22/08/2019~21/09/2019</td></tr>
<tr><td>Delayed period</td><td colspan="2">20/09/2018,19/11/2018,20/12/2018,
18/02/2019~19/02/2019, 19/05/2019,
18/08/2019~21/08/2019</td></tr>
</table>
<table>
<tr><td>Tag</td><td colspan="2">PI-A(B)</td></tr>
<tr><td>Type</td><td colspan="2">Diaphragm</td></tr>
<tr><td>Accuracy class</td><td colspan="2">± 0.25%</td></tr>
<tr><td>Serial number</td><td colspan="2">85069921</td></tr>
<tr><td>Calibration frequency</td><td colspan="2">1 month</td></tr>
<tr><td>Date of last calibration</td><td colspan="2">20/09/2019</td></tr>
<tr><td>Validity</td><td>20/08/2018~19/09/2018
21/09/2018~20/10/2018
19/10/2018~18/11/2018
20/11/2018~19/12/2018
21/12/2018~20/01/2019
18/01/2019~17/02/2019
20/02/2019~19/03/2019</td><td>20/03/2019~19/04/2019
19/04/2019~18/05/2019
20/05/2019~19/06/2019
20/06/2019~19/07/2019
18/07/2019~17/08/2019
22/08/2019~21/09/2019</td></tr>
<tr><td>Delayed period</td><td colspan="2">20/09/2018,19/11/2018,20/12/2018,
18/02/2019~19/02/2019, 19/05/2019,
18/08/2019~21/08/2019</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Hourly</td></tr>
<tr><td>Calculation method
(if applicable)</td><td>N/A</td></tr>
</table>

QA/QC procedures	N/A
Purpose of data/parameter	Calculation of project emissions
Additional comments	Manometer is applied to volumetric flow rate automatically to convert 0℃, 1atm.

Data/Parameter	T_t
Unit	℃ or K
Description	The temperature of the gaseous stream (LFG) in time interval *t.*
Measured/calculated/default	Measured
Source of data	PLC data(The thermocouple : 201, TI-301, TI-A)
Value(s) of monitored parameter	-
Monitoring equipment	Tag: TI-204 Type: RTD Accuracy class: ± 0.305|t| Serial number: 10020523 Calibration frequency: 2 years Date of last calibration: 10020523 Validity: 27/06/2018~26/06/2020 Tag: TI-301 Type: RTD Accuracy class: ± 0.305|t| Serial number: 1002059 Calibration frequency: 2 years Date of last calibration: 27/06/2018 Validity: 27/06/2018~26/06/2020 Tag: TI-A Type: RTD Accuracy class: ± 0.25% Serial number: 08506921 Calibration frequency: 2 years Date of last calibration: 25/06/2018 Validity: 25/06/2018~24/06/2020
Measuring/reading/recording frequency	Measuring hourly
Calculation method (if applicable)	N/A
QA/QC procedures	Flow meters are subject to a regular maintenance and testing regime to ensure accuracy
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Thermometers (TI-204, TI-301 and TI-A) installed around FIQ-201, FIQ-301, FIQ-A are used for normalization. And these also tell whether the collected LFG are a dry basis. Collected temperature LFG of TI-204, TI-301 and TI-A was applied when it was lower than 60℃ degrees. As per option A of “Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Ver.02.0.0)”, LFG are considered as dry basis. Thermometer is applied to volumetric flow rate automatically to convert 0℃, 1atm.

Data/Parameter	$FC_{LNG,j,y}$
Unit	Nm^3/yr

<table>
<tr><td>Description</td><td>Quantity of LNG combusted in process j during the year y</td></tr>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>PLC data(F) and Daesung energy corporation (LNG supplier) data (LNG bill)</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>19/08/2018~31/12/2018 : 10,500 Nm^3
01/01/2019~18/08/2019 : 324,973 Nm^3</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Tag</td><td>F (FIQ-503)</td></tr>
<tr><td>Type</td><td>Rotary</td></tr>
<tr><td>Accuracy class</td><td>± 0.5%</td></tr>
<tr><td>Serial number</td><td>20505437</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>24/09/2016</td></tr>
<tr><td>Validity</td><td>24/09/2016~23/09/2024</td></tr>
</table>
<table>
<tr><td>Tag</td><td>F (FIQ-504)</td></tr>
<tr><td>Type</td><td>Rotary</td></tr>
<tr><td>Accuracy class</td><td>± 0.5%</td></tr>
<tr><td>Serial number</td><td>20505438</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>23/09/2016</td></tr>
<tr><td>Validity</td><td>23/09/2016~22/09/2024</td></tr>
</table>
<table>
<tr><td>Tag</td><td>M-Before</td></tr>
<tr><td>Type</td><td>Turbine</td></tr>
<tr><td>Accuracy class</td><td>± 1%</td></tr>
<tr><td>Serial number</td><td>520128</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>28/09/2010</td></tr>
<tr><td>Validity</td><td>28/09/2010~27/09/2018</td></tr>
</table>
<table>
<tr><td>Tag</td><td>M-After</td></tr>
<tr><td>Type</td><td>Turbine / Gas Volume Corrector</td></tr>
<tr><td>Accuracy class</td><td>± 1%</td></tr>
<tr><td>Serial number</td><td>18050302003</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>03/05/2018</td></tr>
<tr><td>Validity</td><td>03/05/2018~02/05/2026</td></tr>
</table>
<table>
<tr><td>Tag</td><td>FIT-5324</td></tr>
<tr><td>Type</td><td>Vortex</td></tr>
<tr><td>Accuracy class</td><td>± 1%</td></tr>
<tr><td>Serial number</td><td>C15-S0540HN</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>28/04/2015</td></tr>
<tr><td>Validity</td><td>28/04/2015~27/04/2023</td></tr>
</table>
<table>
<tr><td>Tag</td><td>FIT-6324</td></tr>
<tr><td>Type</td><td>Vortex</td></tr>
<tr><td>Accuracy class</td><td>± 1%</td></tr>
<tr><td>Serial number</td><td>C15-S0442HN</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>14/05/2015</td></tr>
<tr><td>Validity</td><td>14/05/2015~13/05/2023</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Measuring hourly</td></tr>
<tr><td>Calculation method
(if applicable)</td><td>N/A</td></tr>
</table>

QA/QC procedures	LNG meters are calibrated or displaced every 8 years by LNG supplier as "Measures Act". This value was double-checked with the invoice from Daesung energy corporation (LNG Supplier) and the bigger value are used to calculate project emission ($FC_{LNG, j, y}$).
Purpose of data/parameter	Calculation of project emissions
Additional comments	FIT-5324 and FIT-6324 are included to monitor point from 2nd crediting period. These two meters were installed to check volumetric flow rate of LNG for LNG ignition consumption of LFG boilers.

Data/Parameter	$NCV_{LNG, y}$
Unit	GJ/Nm^3
Description	Weighted average net calorific value of LNG in year y
Measured/calculated/default	Measured/calculated
Source of data	Invoices of LNG supplier
Value(s) of monitored parameter	19/08/2018 ~ 31/12/2018 : 0.04242 01/01/2019 ~ 18/08/2019 : 0.04256
Monitoring equipment	N/A
Measuring/reading/recording frequency	Reading monthly
Calculation method (if applicable)	N/A
QA/QC procedures	N/A
Purpose of data/parameter	Calculation of project emissions
Additional comments	Information for net calorific value of LNG is posted by the LNG supplier. https://cyber.daesungenergy.com/charge/solvAvgMJ#

Data/Parameter	$EF_{CO2,LNG,y}$
Unit	tCO_2/GJ
Description	Weighted average CO_2 emission factor of LNG in year y
Measured/calculated/default	Default
Source of data	IPCC default values at the lower limit of the uncertainty at a 95% confidence interval as provided in table 1.4 of Chapter 1 of Vol.2 (Energy) of 2006 IPCC Guidelines on National GHG Inventories.
Value(s) of monitored parameter	0.0583
Monitoring equipment	N/A
Measuring/reading/recording frequency	Reading any future revision of the IPCC Guidelines should be taken into account
Calculation method (if applicable)	N/A
QA/QC procedures	N/A
Purpose of data/parameter	Calculation of project emissions
Additional comments	There is no information of CO_2 emission factor in invoice from fuel supplier. PP decided to choose option (d), which is 2006 IPCC default values,

Data/Parameter	$TDL_{j, y}$
Unit	%
Description	Average technical transmission and distribution losses for providing electricity to source j in year y.
Measured/calculated/default	Measured
Source of data	KEPCO
Value(s) of monitored parameter	19/08/2018~31/12/2018 : 3.56 % 01/01/2019~18/08/2019 : 3.56 %

Monitoring equipment	N/A
Measuring/reading/recording frequency	Monthly reading
Calculation method (if applicable)	N/A
QA/QC procedures	N/A
Purpose of data/parameter	Calculation of project emissions
Additional comments	These values are from 'Statistics of Electric Power in Korea', published on May 2019 by Korea electric power corporation.

D.3. Implementation of sampling plan

>>
N/A

SECTION E. Calculation of emission reductions or net anthropogenic removals

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

>>
Temperature of collected LFG at TI-204, TI-301 and TI-A are less than 60℃ during this monitoring periods. As per option A of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Ver.02.0.0)", LFG are considered as dry basis.

- Calculations for all formula used and calculation of baseline emissions

$BE_{,y} = BE_{CH4,y}$

The total sum of Methane destroyed.

BE_y	tCO_2eq	Baseline emissions in year y
$BE_{CH4,y}$	tCO_2eq	Baseline emissions of methane from the SWDS in year y

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

$BE_{CH4,y}$	tCO_2eq	Baseline emissions of methane from the SWDS in year y
OX_{top_layer}	Constant	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline
$F_{CH4,PJ,y}$	tCH_4	Amount of methane in the LFG which is flared and/or used in the project activity in year y
$F_{CH4,BL,y}$	tCH_4	Amount of methane in the LFG that would be flared in the baseline in year y
GWP_{CH4}	tCO_2/tCH_4	Global warming potential of CH_4

1) $F_{CH4,BL,y} = F_{CH,PJ,\ y} \times 20\%$

$F_{CH4,BLy}$	tCH_4	Amount of methane in the LFG that would be flared in the baseline in year y
$F_{CH4,PJ,y}$	tCH_4	Amount of methane in the LFG which is flared and/or used in the project activity in year y
20%	Constant	Fraction of LFG that is required to be flared due to a requirement in year y

2) $F_{CH4,PJ,\ y} = F_{CH4,flared,y} + F_{CH4,EL,y} + F_{CH4,HG,y}$

$F_{CH4,PJ,y}$	tCH_4	Amount of methane in the LFG which is flared and/or used in the project activity in year y
$F_{CH4,flared,y}$	tCH_4	Amount of methane in the LFG which is destroyed by flaring in year y

$F_{CH4,EL,y}$	tCH_4	Amount of methane in the LFG which is used for electricity generation in year y
$F_{CH4,HG,y}$	tCH_4	Amount of methane in the LFG which is used for heat generation in year y

2-1) $F_{CH4,flared,\ y} = F_{CH4,sent\_flare,y} - PE_{flare,\ y} / GWP_{CH4}$

$F_{CH4,flared,y}$	tCH_4	Amount of methane in the LFG which is destroyed by flaring in year y
$F_{CH4,sent\_flare,y}$	tCH_4	Amount of methane in the LFG which is sent to the flare in year y
$PE_{flare,\ y}$	tCO_2	Project emissions from flaring of the residual gas stream in year y
GWP_{CH4}	tCO_2/tCH_4	Global warming potential of CH_4

2-1-1) $F_{CH4,\ sent\_flare,t} = V_{flare,\ t,\ db} \times v_{CH4,t,db} \times \rho_{CH4,t}$

$F_{CH4,sent\_flare,t}$	tCH_4	Mass flow of CH4 in the LFG which is sent to flare in time interval t
$V_{flare,\ t,\ db}$	m^3 dry LFG	Volumetric flow of the LFG which is destroyed by flaring in time interval t on a dry basis
$v_{CH4,t,db}$	m^3CH_4/m^3 dry LFG	Volumetric fraction of CH4 in the LFG in time interval t on a dry basis
$\rho_{CH4,t}$	tCH_4/m^3CH_4	Density of CH_4 in time interval t

※ $\rho_{CH4,t}$ is fixed as 0.0007157 because $V_{t,db}$ is already converted by 0℃ and 1atm

※ All parameter about $F_{CH4,\ sent\_flare,\ t}$ is considered as normal condition (0℃ and 1atm)

※ $V_{flare,t,\ db}$ is considered as by dry basis because TI-301, temperature of FIQ-301 show less than 60℃ during this monitoring period.

2-1-2)

$$PE_{flare,m,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3}$$

$PE_{flare,y}$	tCO_2e	Project emissions form flaring of the residual gas stream in year y
$F_{CH4,RG,m}$	kg	Mass flow of methane in the LFG in the minute m
$\eta_{flare,m}$	%	Flare efficiency in minute m
GWP_{CH4}	tCO_2e/tCH_4	Global Warming Potential of methane valid for the commitment period

2-2) $F_{CH4,EL,t} = V_{t,db} \times v_{CH4,t,db} \times \rho_{CH4,t}$

$F_{CH4,t}$	tCH_4	Amount of CH_4 combusted in Electricity generator
$V_{t,db}$	m^3 dry LFG	Volumetric flow of the LFG (used for electricity generation) in time interval t on a dry basis
$v_{CH4,t,db}$	m^3CH_4/m^3 dry LFG	Volumetric fraction of CH4 in the LFG in time interval t on a dry basis
$\rho_{CH4,t}$	tCH_4/m^3CH_4	Density of CH4 in time interval t

※ This formula is used to calculate $F_{CH4,EL,y}$

※ $\rho_{CH4,\ t}$ is fixed as 0.0007157 because $V_{t,db}$ is already converted by 0℃ and 1atm.

※ All parameter about $F_{CH4,t}$ is considered as normal condition. (0℃ and 1atm)

※ $V_{t,\ db}$ is considered as by dry basis because TI-204, temperature of FIQ-201 show less than 60℃ during this monitoring period.

2-3) $F_{CH4,\ HG,t} = V_{t,db} \times v_{CH4,t,db} \times \rho_{CH4,t}$

$F_{CH4,flared,t}$	tCH_4	Amount of landfill gas combusted in boiler
$V_{t,db}$	m^3 dry LFG	Volumetric flow of the LFG (used for heat generation) in time interval t on a dry basis
$v_{CH4,t,db}$	m^3CH_4/m^3 dry LFG	Volumetric fraction of CH4 in the LFG in time interval t on a dry basis
$\rho_{CH4,t}$	tCH_4/m^3CH_4	Density of CH4 in time interval t

※ This formula is used to calculate $F_{CH4,HG,y}$

※ $\rho_{CH4,\ t}$ is fixed as 0.0007157 because $V_{t,db}$ is already converted by 0℃ and 1atm

※ All parameter about $F_{CH4,t}$ is considered as normal condition (0℃ and 1atm)

※ $V_{t,\ db}$ is considered as by dry basis because TI-A, temperature of FIQ-A show less than 60℃ during this monitoring period.

The detail information related with BE is described below.

► $BE=BE_{CH4}$

Period	BE	=	BE_{CH4}
Unit	tCO_2eq		tCO_2eq
2018-08-19 ~ 2018-12-31	79,764	=	79,764
2019-01-01 ~ 2019-08-18	197,706	=	197,706
Total	277,470		277,470

► $BE_{CH4} = ((1-OX_{top\_layer}) \times F_{CH4,PJ} – F_{CH4,BL}) \times GWP_{CH4}$

Period	BE_{CH4}	OX_{top_layer}	$F_{CH4,PJ}$	$F_{CH4,BL}$	GWP_{CH4}
Unit	tCO_2eq	Constant	tCH_4	tCH_4	tCO_2/tCH_4
2018-08-19 ~ 2018-12-31	79,764	0.1	4,558	912	25
2019-01-01 ~ 2019-08-18	197,706	0.1	11,297	2,259	25
Total	277,470				

1) $F_{CH4,B} = F_{CH,PJ} \times 20\%$

Period	$F_{CH4,BL}$	$F_{CH4,PJ}$
Unit	tCH_4	tCH_4
2018-08-19 ~ 2018-12-31	912	4,558
2019-01-01 ~ 2019-08-18	2,259	11,297
Total	3,171	15,855

2) $F_{CH4,PJ} = F_{CH4,flared} + F_{CH4,EL} + F_{CH4,HG}$

Period	$F_{CH4,PJ}$	$F_{CH4,flared}$	$F_{CH4,EL}$	$F_{CH4,HG}$
Unit	tCH_4	tCH_4	tCH_4	tCH_4
2018-08-19 ~ 2018-12-31	4,558	1,356	0	3,202
2019-01-01 ~ 2019-08-18	11,297	292	0	11,006
Total	15,855			

2-1) $F_{CH4,flared} = F_{CH4,sent\_flare} - PE_{flare} / GWP_{CH4}$

Period	$F_{CH4,flared}$	$F_{CH4,sent\_flare}$	PE_{flare}	GWP_{CH4}
Unit	tCH_4	tCH_4	tCO_2	tCO_2/tCH_4
2018-08-19 ~ 2018-12-31	1,356	2,713	33,908	25
2019-01-01 ~ 2019-08-18	292	583	7,292	25
Total	1,648			

2-1-1) $F_{CH4,\ sent\_flare} = V_{flare,\ db} \times v_{CH4,\ db} \times \rho_{CH4}$

※ The detail calculation is in Daegu 8th ER sheet ($F_{CH4,\ sent,\ flare,\ h}$ Sheet)

2-1-2) $PE_{flare} = GWP_{CH4} \times v_{CH4,\ db} \times \rho_{CH4}$

※ The detail calculation is in Daegu 8th ER sheet ($F_{CH4,\ sent,\ flare,\ h}$ Sheet)

2-2) $F_{CH4,\ EL} = V_{db} \times v_{CH4,\ db} \times \rho_{CH4}$

※ The detail calculation is in Daegu 8th ER sheet ($F_{CH4,\ EL,\ h}$ Sheet)

2-3) $F_{CH4,\ HG} = V_{db} \times v_{CH4,\ db} \times \rho_{CH4}$

※ The detail calculation is in Daegu 8th ER sheet ($F_{CH4,\ HG,\ h}$ Sheet)

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

>>

- Calculations for all formulae used and calculation of project emissions

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

PE_y	tCO_2eq	Project emissions in year y
$PE_{EC,y}$	tCO_2eq	Emissions from consumption of electricity due to the project activity in year y
$PE_{FC,y}$	tCO_2eq	Emissions form consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year y

※ There are 2 Electricity generator, #1 and #2. $BE_{EC,y}$ are calculated separately.

1) $PE_{EC,\ y} = EC_{PJ,\ grid,y} \times EF_{EL,grid,y} \times (1 + TDL_{grid,y})$

$PE_{EC,y}$	tCO_2eq	Project emissions form electricity consumption in year y
$EC_{PJ,grid,y}$	MWh	Quantity of electricity consumed by the project electricity consumption source *j* in year y
$EF_{EL,grid,y}$	tCO_2/MWh	Emission factor for electricity generation for source grid in year y
$TDL_{grid,y}$	%	Average technical transmission and distribution losses for providing to source *j* in year y

2) $PE_{FC,\ y} = FC_{LNG,\ y} \times COEF_{LNG,\ y}$

$PE_{FC,y}$	tCO_2eq	Emissions form consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year y
$FC_{LNG,y}$	Nm^3	Quantity of LNG combusted in process *j* during the year y
$COEF_{LNG,y}$	tCO_2/Nm^3	CO_2 emission coefficient of LNG in year y

2-1) $COEF_{LNG,\ y} = NCV_{LNG,\ y} \times EF_{CO2,\ LNG,\ y}$

$COEF_{LNG,y}$	tCO_2/Nm^3	CO_2 emission coefficient of LNG in year y
$NCV_{LNG,y}$	GJ/Nm^3	Net calorific value of the LNG in year y
$EF_{CO2,LNG,y}$	tCO_2/GJ	CO_2 emission factor of LNG in year y

The detail information related with PE is described as below.

► $PE = PE_{EC} + PE_{FC}$

Period	PE	PE_{EC}	PE_{FC}
Unit	tCO_2eq	tCO_2eq	tCO_2eq
2018-08-19 ~ 2018-12-31	1,344	1,318	26
2019-01-01 ~ 2019-08-18	4,156	3,349	807
Total	5,500		

1) $PE_{EC} = EC_{PJ,\ grid} \times EF_{EL,\ grid} \times (1 + TDL_{,\ grid})$

Period	PE_{EC}	$EC_{PJ,grid}$	$EF_{EL,grid}$	1	$TDL_{,grid}$
Unit	tCO_2eq	MWh	tCO_2/MWh	Constant	%
2018-08-19 ~ 2018-12-31	1,318	2,346	0.5421	1	3.56%
2019-01-01 ~ 2019-08-18	3,349	5,965	0.5421	1	3.56%
Total	4,667	8,311			

2) $PE_{FC} = FC_{LNG} \times COEF_{LNG}$

Period	PE_{FC}	FC_{LNG}	$COEF_{LNG}$
Unit	tCO_2eq	Nm^3	tCO_2/Nm^3
2018-08-19 ~ 2018-12-31	26	10,500	0.002473
2019-01-01 ~ 2019-08-18	807	324,973	0.002481
Total	833	335,473	

2-1) $COEF_{LNG} = NCV_{LNG} \times EF_{CO2,\ LNG}$

Period	$COEF_{LNG}$	NCV_{LNG}	$EF_{CO2,LNG}$
Unit	tCO_2/Nm^3	GJ/Nm^3	tCO_2/GJ
2018-08-19 ~ 2018-12-31	0.002473	0.04242	0.0583
2019-01-01 ~ 2019-08-18	0.002481	0.04256	0.0583

E.3. Calculation of leakage emissions

>>
N/A

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

	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	**Project GHG emissions or actual net GHG removals (t CO_2e)**	**Leakage GHG emissions (t CO_2e)**	**GHG emission reductions or net anthropogenic GHG removals (t CO_2e)**		
				Before 01/01/2013	**From 01/01/2013**	**Total amount**
Total	277,470	5,500	0	0	271,970	271,970

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

Amount achieved during this monitoring period ($t\ CO_2e$)	Amount estimated ex ante for this monitoring period in the PDD ($t\ CO_2e$)
271,970 tCO2e	177,888 tCO2e (Estimated Emission Reduction, which is illustrated in PDD page 50)

E.5.1. Explanation of calculation of "amount estimated ex ante for this monitoring period in the PDD"

>>

The actual emission reductions of the project activity will be calculated and claimed as the ex-post monitoring parameters during the 2nd crediting period. Ex-ante estimation of emission reductions is calculated according to ACM0001 (Version 15). Every methodological tools and formula mentioned in above sections of the PDD are applied for the ex-ante estimation of emission reduction.

1. Baseline emission (ex-ante estimation)

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

<Table B-10> Calculation of BE_y

Year	$BE_{CH4,y}$	$BE_{EC,y}$	$BE_{HG,y}$	BE_y (tCO2e)
2014.8.19 – 2015.8.18	182,330	0	0	182,330
2015.8.19 – 2016.8.18	182,067	0	0	182,067
2016.8.19 – 2017.8.18	182,000	0	0	182,000
2017.8.19 – 2018.8.18	182,110	0	0	182,110
2018.8.19 – 2019.8.18	182,395	0	0	182,395
2019.8.19 – 2020.8.18	182,790	0	0	182,790
2020.8.19 – 2021.8.18	183,315	0	0	183,315

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

<Table B-11> Calculation of $BE_{CH4,y}$

Year	$(1-OX_{top\_layer})$	$F_{CH4,PJ,y}$	$F_{CH4,BL,y}$	GWP_{CH4}	$BE_{CH4,y}$ (tCO2e)
2014.8.19 – 2015.8.18	0.9	10,418	2,083	25	182,330
2015.8.19 – 2016.8.18	0.9	10,403	2,080	25	182,067
2016.8.19 – 2017.8.18	0.9	10,400	2,080	25	182,000
2017.8.19 – 2018.8.18	0.9	10,406	2,081	25	182,110
2018.8.19 – 2019.8.18	0.9	10,422	2,084	25	182,395
2019.8.19 – 2020.8.18	0.9	10,444	2,088	25	182,790
2020.8.19 – 2021.8.18	0.9	10,474	2,094	25	183,315

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

Total amount of methane generated from disposal of waste at the SWDS could be calculated by using available data as per equation (11)

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

Parameters for determining $BE_{CH4,SWDS,y}$ are showed as follows;

<Table B-12> Parameters from "Emissions from solid waste disposal sites (ver.06.0.1)"

Parameter		Value
Model correction factor	φ_y	0.75
Global Warming Potential of Methane	GWP_{CH4}	25
Oxidation factor	OX	0.1
Fraction of methane in the SWDS gas	F	0.5
Fraction of degradable organic carbon (DOC) that can decompose	$DOC_{f,y}$	0.5
Methane correction factor	MCF_y	1
Fraction of methane captured at the SWDS and flared, combusted or used in another manner	f_y	0

Detail information for calculating $\boldsymbol{BE_{CH4,SWDS,y}}$ is included in the separate calculation sheet.

Amount of methane in LFG which is flared and/or used in the project activity $F_{CH4,PJ,y}$ is calculated by using the equation (10)

<Table B-13> Calculation of $F_{CH4,PJ,y}$

Year	*$BE_{CH4,SWDS,y}$*	*η_{PJ}*	*GWP_{CH4}*	*$F_{CH4,PJ,y}$ (tCO2e)*
2014.8.19 – 2015.8.18	*410,423*	*63.46%*	*25*	*10,418*
2015.8.19 – 2016.8.18	*409,841*	*63.46%*	*25*	*10,403*
2016.8.19 – 2017.8.18	*409,710*	*63.46%*	*25*	*10,400*
2017.8.19 – 2018.8.18	*409,974*	*63.46%*	*25*	*10,406*
2018.8.19 – 2019.8.18	*410,576*	*63.46%*	*25*	*10,422*
2019.8.19 – 2020.8.18	*411,475*	*63.46%*	*25*	*10,444*
2020.8.19 – 2021.8.18	*412,629*	*63.46%*	*25*	*10,474*

b). $F_{CH4,BL,y} = 20\% \times F_{CH4,PJ,y}$

<Table B-14> Calculation of $F_{CH4,BL,y}$

Year	*$F_{CH4,PJ,y}$*	*20%*	*$F_{CH4,BL.y}$ (tCO2e)*
2014.8.19 – 2015.8.18	*10,418*	*20%*	*2,083*
2015.8.19 – 2016.8.18	*10,403*	*20%*	*2,080*
2016.8.19 – 2017.8.18	*10,400*	*20%*	*2,080*
2017.8.19 – 2018.8.18	*10,406*	*20%*	*2,081*
2018.8.19 – 2019.8.18	*10,422*	*20%*	*2,084*
2019.8.19 – 2020.8.18	*10,444*	*20%*	*2,088*
2020.8.19 – 2021.8.18	*10,474*	*20%*	*2,094*

2) $BE_{EC,y} = \Sigma EC_{BL,k,y} \times EF_{EL,grid,y} \times (1 + TDL_{grid,y})$

This project activity is only involved with methane avoidance in the landfill. There is no baseline emission associated with electricity gerneration in year y ($BE_{EC,y}$).

3) $BE_{HC,y} = NCV_{CH4} \times \Sigma(R_{efficiency,\ h,\ y} \times F_{CH4,HG,dest,j,y} \times EF_{CO2,BL,HG,j})$

This project activity is only involved with methane avoidance. There is no baseline emission associated with heat generation in year y ($BE_{HC,y}$).

2. Project emission

Main source of project emission in the project activity are the consumption of electricity and LNG. The electricity is used for the operation of LFG collection and refine facilities. LNG is supplementary to LFG which have uneven quality of methane seasonally. It assures quality of LFG

as a fuel for energy generation. Amounts of electricity and LNG for the project activity will be recorded and used for ex-post calculation.

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

<Table B-15> Calculation of PE_y

Year	$PE_{EC,y}$	$PE_{FC,y}$	PE_y (tCO2e)
2014.8.19 – 2015.8.18	4,069	438	4,507
2015.8.19 – 2016.8.18	4,069	438	4,507
2016.8.19 – 2017.8.18	4,069	438	4,507
2017.8.19 – 2018.8.18	4,069	438	4,507
2018.8.19 – 2019.8.18	4,069	438	4,507
2019.8.19 – 2020.8.18	4,069	438	4,507
2020.8.19 – 2021.8.18	4,069	438	4,507

a) $PE_{EC, y}$

<Table B-16> Calculation of $PE_{EC,y}$

Year	$EC_{PJ,grid,y}$	$EF_{CO2,CM,y}$	$(1+TDL_{grid,y})$	$PE_{EC,y}$
2014.8.19 – 2015.8.18	7,224	0.5421	1.0392	4,069
2015.8.19 – 2016.8.18	7,224	0.5421	1.0392	4,069
2016.8.19 – 2017.8.18	7,224	0.5421	1.0392	4,069
2017.8.19 – 2018.8.18	7,224	0.5421	1.0392	4,069
2018.8.19 – 2019.8.18	7,224	0.5421	1.0392	4,069
2019.8.19 – 2020.8.18	7,224	0.5421	1.0392	4,069
2020.8.19 – 2021.8.18	7,224	0.5421	1.0392	4,069

b) $PE_{FC, y}$

<Table B-17> Calculation of $PE_{FC,y}$

Year	$FC_{LNG,y}$	$NCV_{LNG,y}$	$EF_{CO2,LNG,y}$	$PE_{FC,y}$
2014.8.19 – 2015.8.18	200,505	0.03898	0.05610	438
2015.8.19 – 2016.8.18	200,505	0.03898	0.05610	438
2016.8.19 – 2017.8.18	200,505	0.03898	0.05610	438
2017.8.19 – 2018.8.18	200,505	0.03898	0.05610	438
2018.8.19 – 2019.8.18	200,505	0.03898	0.05610	438
2019.8.19 – 2020.8.18	200,505	0.03898	0.05610	438
2020.8.19 – 2021.8.18	200,505	0.03898	0.05610	438

3. Leakage

No leakage effects need to be accounted under ACM0001 (version 15)

4. Emission Reduction

Applying the ACM0001 Ver.15 and applicable methodical tools, ex-ante calculation of necessary parameters has been made above and emission reduction for the 2nd crediting period is presented in the following table.

Year	Baseline emissions (t CO_2e)	Project emissions (t CO_2e)	Leakage (t CO_2e)	Emission reductions(t CO_2e)
2014.8.19 – 2015.8.18	182,330	4,507	0	177,823
2015.8.19 – 2016.8.18	182,067	4,507	0	177,560
2016.8.19 – 2017.8.18	182,000	4,507	0	177,493

2017.8.19 – 2018.8.18	*182,110*	*4,507*	*0*	*177,603*
2018.8.19 – 2019.8.18	*182,395*	*4,507*	*0*	*177,888*
2019.8.19 – 2020.8.18	*182,790*	*4,507*	*0*	*178,283*
2020.8.19 – 2021.8.18	*183,315*	*4,507*	*0*	*178,808*
Total	*1,277,077*	*31,549*	*0*	*1,245,458*
Total number of crediting years	*7 years*			
Annual average over the crediting period	*182,430*	*4,507*	*0*	*177,923*

E.6. Remarks on increase in achieved emission reductions

>>

This monitoring report claims the emission reductions of 271,970 tCO_{2e} which is larger than estimated emission reductions of 177,888 tCO_{2e} from the registered PDD. It rose up 53 %. The expected reasons are as follow.

The efficiency value is conservative and end up to affecting these difference between the estimated and actual emission reductions.

Efficiency of the LFG capture system

The main thing comes down to the efficiency of the LFG capture system. At those renewal time, the efficiency 63.46% was reflected in FOD modelling and its efficiency came out feasibility study published in Feb. 2005. But its value is conservative and end up to affecting these difference between the estimated and actual emission reductions.

< Comparing between estimated and actual captured CH_4>

Year	***Baseline CH_4 (tCO_{2e})***		***Estimated CH_4 capture (tCO_{2e})***	***Actual CH_4 capture (tCO_{2e}, MD project)***	***Difference rate***
	Baseline CH_4 (tCO_{2e})	*Effieciency*			
2014	*410,423*	*63.46%*	*260,454*	*370,580*	*42.3%*
2015	*409,841*	*63.46%*	*260,085*	*341,658*	*31.4%*
2016	*409,710*	*63.46%*	*260,002*	*373,731*	*43.7%*
2017	*409,974*	*63.46%*	*260,170*	*368,375*	*41.6%*
2018	*410,576*	*63.46%*	*260,552*	*324,975*	*24.7%*
2019	*259,286*	*63.46%*	*164,543*	*282,425*	*71.6%*

※ Baseline CH4 in 2018 reflected from 1st of January to 18th of August

Given similar landfill in South Korea, these efficiencies of LFG capture system which adopting active collection system also show well over 90% and LFG gas collection efficiency of Bangcheon-Ri landfill is estimated about 89.1 % based on IPCC FOD model as a latest “Final report for LFG generation improving way for Daegu Bangcheon-Ri landfill”.

Daegu Bangcheon-Ri landfill is one of the largest landfill in Korea and have been operating high technical LFG capture and refinery facilities. This project has also adopted active LFG collection system including three blowers for capturing LFG. The efficiency applied in the project, 63.46%, is much lower than those of similar landfills in Korea and its value is very conservative comparing to Yongin landfill adopting simple flaring of LFG, showing 38.3% of the efficiency.

<Efficiency of LFG capture system>

Domestic landfill list	**Efficiency of LFG Capture**	**Type**	**Monitoring period**
Oukcheon	*94.7 (90.8 ~ 98.6)%*	*Active collection system*	*2008~2010*
Dangjin	*94.7 (90.9 ~ 98.5)%*	*Active collection system*	*2009*
Wonju	*91.7%*	*Active collection system*	*2008~2010*
Ansung	*90.8%*	*Active collection system*	*2008~2010*

Yongin	*38.3 (35.6 ~ 41.4%)*	*Simple flaring of LFG*	*2006*

Additional installation of collection well (in 2011)

E.7. Remarks on scale of small-scale project activity

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N/A

Document information

Version	*Date*	*Description*
07.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Add a section on remarks on the observance of the scale limit of small-scale project activity during the crediting period; • Add "changes specific to afforestation or reforestation project activity" as a possible post-registration changes; • Clarify the reporting of net anthropogenic GHG removals for A/R project activities between two commitment periods; • Make editorial improvements.
06.0	7 June 2017	Revision to: • 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: • 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: • 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 *F-CDM-MR* to *CDM-MR-FORM*; • 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.

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