Monitoring report form for CDM project activity
(Version 06.0)

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

MONITORING REPORT		
Title of the project activity	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 12	
Version number of this monitoring report	1.0	
Completion date of this monitoring report	01/12/2017	
Monitoring period number	6th monitoring period	
Duration of this monitoring period	19/08/2016 ~ 18/08/2017	
Monitoring report number for this monitoring report	6th	
Project participants	Daegu Metropolitan City Daesung Eco-Energy Co., Ltd. Korea District Heating Corporation. Ecoeye Co., Ltd.	
Host Party	Republic of Korea	
Sectoral scopes	Scope 13 : Waste handling and disposal	
Applied methodologies and standardized baselines	ACM0001 ver.15	
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 tCO2e	258,698 tCO2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	2016.8.19 – 2017.8.18 : 177,493 tCO2e	

SECTION A. Description of project activity

A.1. General description of project activity

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Daegu Bangcheon-Ril 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	-

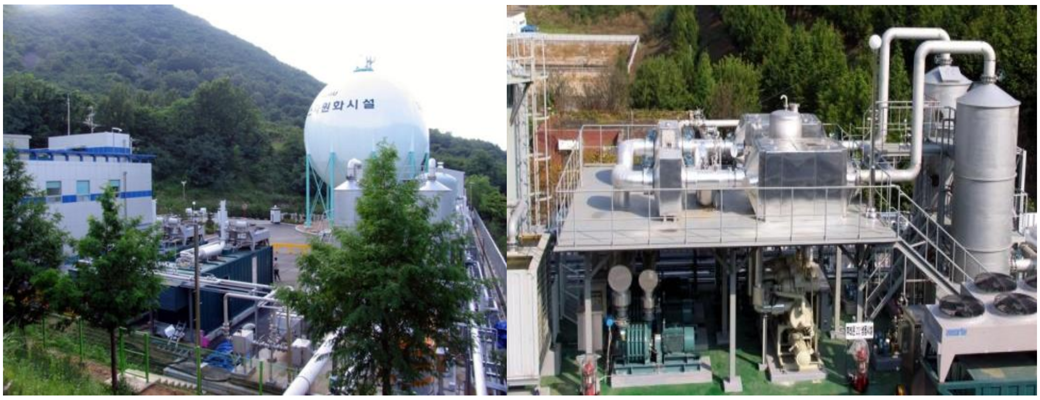

Figure 1. Landscape of Daegu Bancheon-Ri Landfill gas CDM project

- **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 odour 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).

More details about installed technology and equipment is described in Section B below.

- **Total GHG emission reductions or net GHG removals by sinks achieved in this monitoring period**

This is the 6th monitoring period covering 1 years (from 19/08/2017 to 18/08/2016) and total monitored emission reductions is 258,698 tCO_2e.

A.2. Location of project activity

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- **Host Party**

Republic of Korea

- **Region/state/province**

Daegu Metropolitan City

- **City/town/community**

Bangcheon-Ri, Dasa-Eup, Dalsung-Gun

- **Physical/geographical location**

Daegu Bangcheon-Ri Ladfill 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.

The other project site is Korea District Heating Corporatioin(KDHC), which produces thermal energy by using LFG. KDHC is located at 351, Dalseo-daero, Dalseo-gu, Daegu Metropolitan city and the east longitude 128.4897, the north latitude 35.8312.

A.3. arties 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. Reference 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 CO_2 emissions form 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 form flaring” (version 02)
- “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (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
- Renewable date : 17/09/2016
- Length of the 2nd crediting period : 19/08/2014 ~ 18/08/2021
- 6th monitoring period : 19/08/2016 ~ 18/08/2017

SECTION B. Implementation of project activity

B.1. Description of implemented project activity

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Flare stacks, gas engines and LFG Boilers in the project activity are operating for the collected LFG destruction, LFG Boilers is a primary methane destruction facility and others are occasionally operating when heat demand is low in summer season or LFG boilers are repaired.

As amount of FIQ-201 which monitoring for power generation was 0 Nm^3, 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 can handle the collected LFG at low operating cost comparing to power generation system.

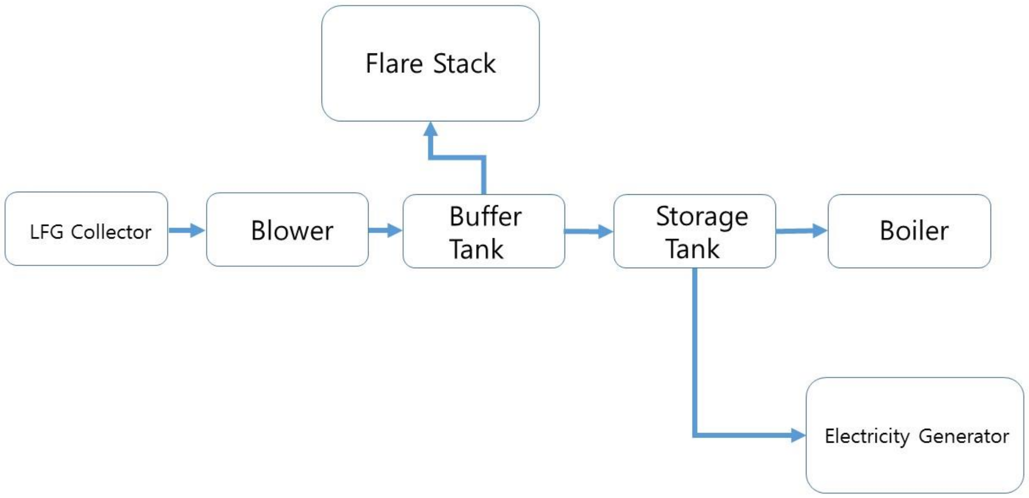
Temperature of collected LFG at TI-204, TI-301 and TI-A installed at flow meters are less than 60°C during this monitoring period. As per option A of "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Ver. 02.0.0)", LFG are considered as dry basis.

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**

LFG which is captured project site 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**



- **Installed technology**

LFG capturing system

In order to capture LFG, vertical capturing pipes are constructed. Type of LFG capturing system was decided considering characteristic of a step-by-step filling operation. Also, this decision was for maintaining stable and optimum capturing efficiency. Comparing to horizontal capturing system, vertical capturing system has higher capturing efficiency and is easier to maintain and repair the system for each pipe.

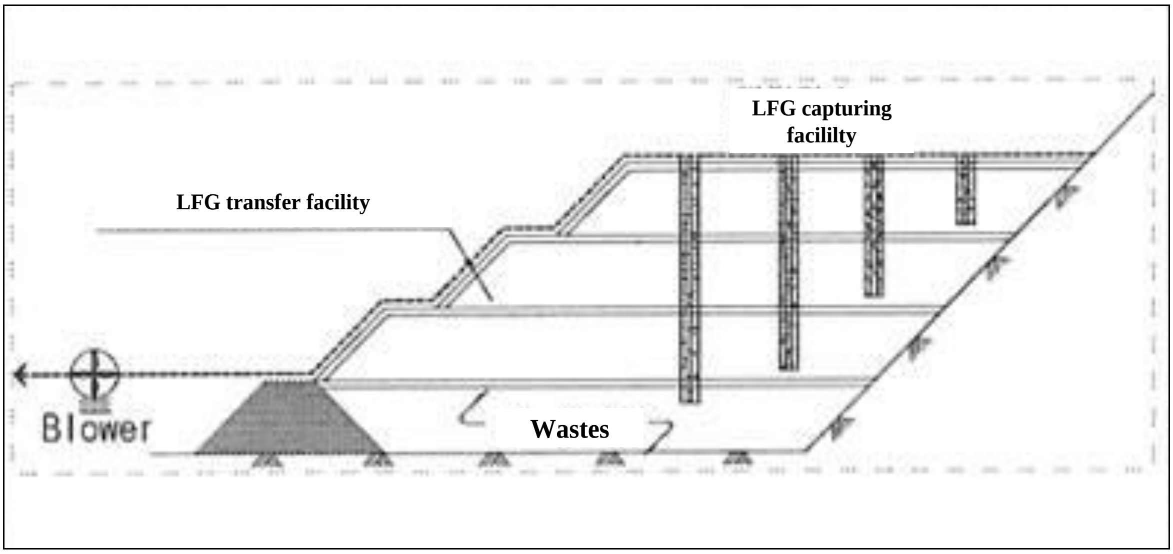


Figure 3. Vertical LFG capturing equipment installation concept

LFG utilization system

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

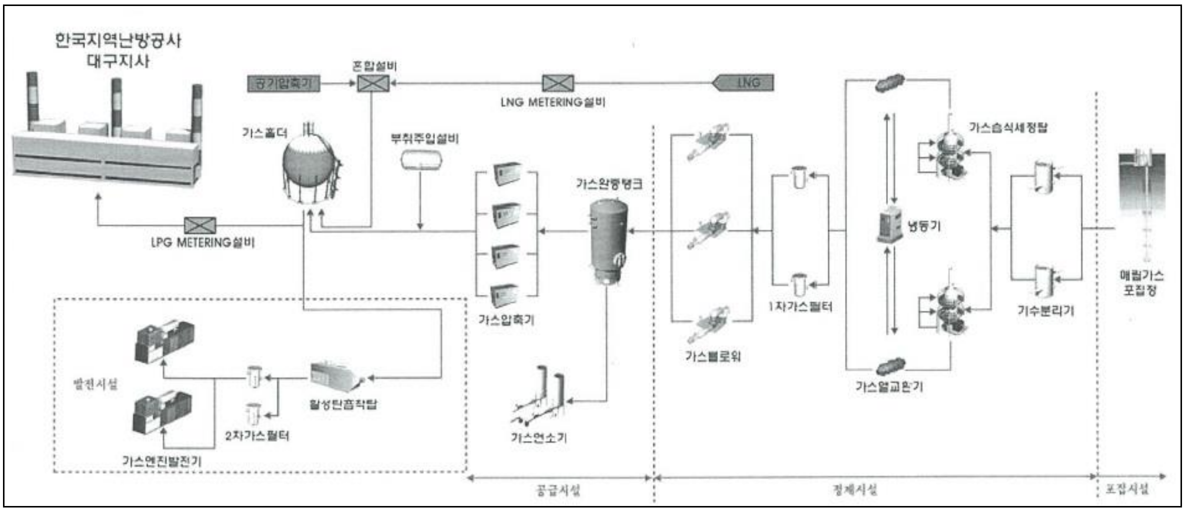


Figure 4. LFG utilization system flow chart

The main features of the LFG facilities are presented as below;

- **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 5. 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.

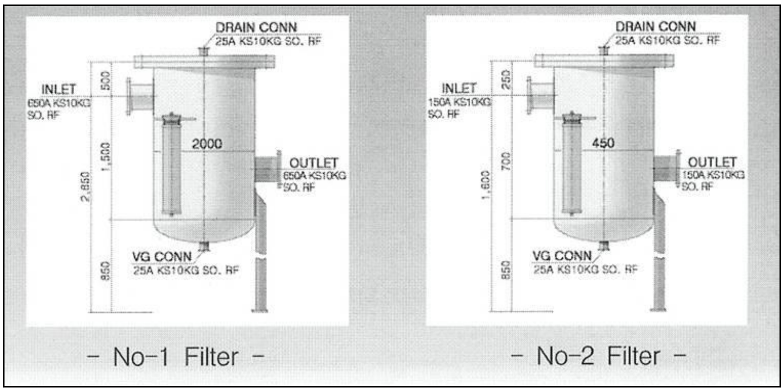


Figure 6. Filter

Equipment	No-1 Filter (before a blower)	No-2 Filter (before gas engine)
No. of Equipment	F-1-01A/B (2units)	F-2-01A/B (2units)
Type	Demister	Demister
Capacity	150 Nm^3/min	17 Nm^3/min
Filtration Element	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 7. 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.

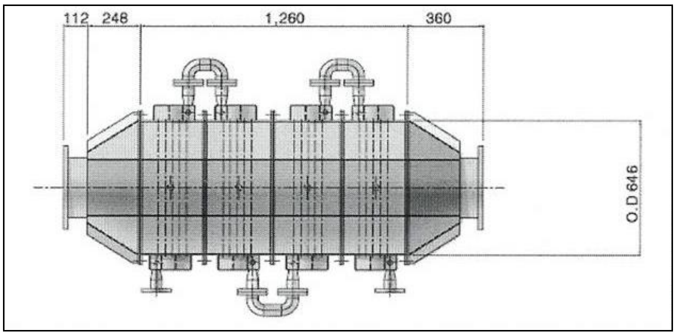


Figure 8. Cooler

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 9. Chiller

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

6) Gas Engine

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

Figure 10. Gas Engine

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

7) Flare Stack

Flare stack combusts remaining LFG, and treats LFG in an emergency so that odour effect can be minimized. The type of flare stack applied to this project is Cylindrical Type.

Figure 11. Flare Stack

Equipment	FLARE STACK
No. of Equipment	IF-3-01A/B (2 units)
Type	Cylindrical

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 12. Gas storage tank

Equipment	BALL TANK
No. of Equipment	T-3-05 (1unit)
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)
Capacity	34.4 Gcal/hr (LNG) 33.0 Gcal/hr (LFG)
Type	Hot water

B.2. Post-registration changes

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

>>
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 applied standards or tools

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N/A

B.2.6. Changes to project design

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N/A

SECTION C. Description of monitoring system

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- **Description of the monitoring system**

All kinds of measuring instruments, including gas analyser 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.

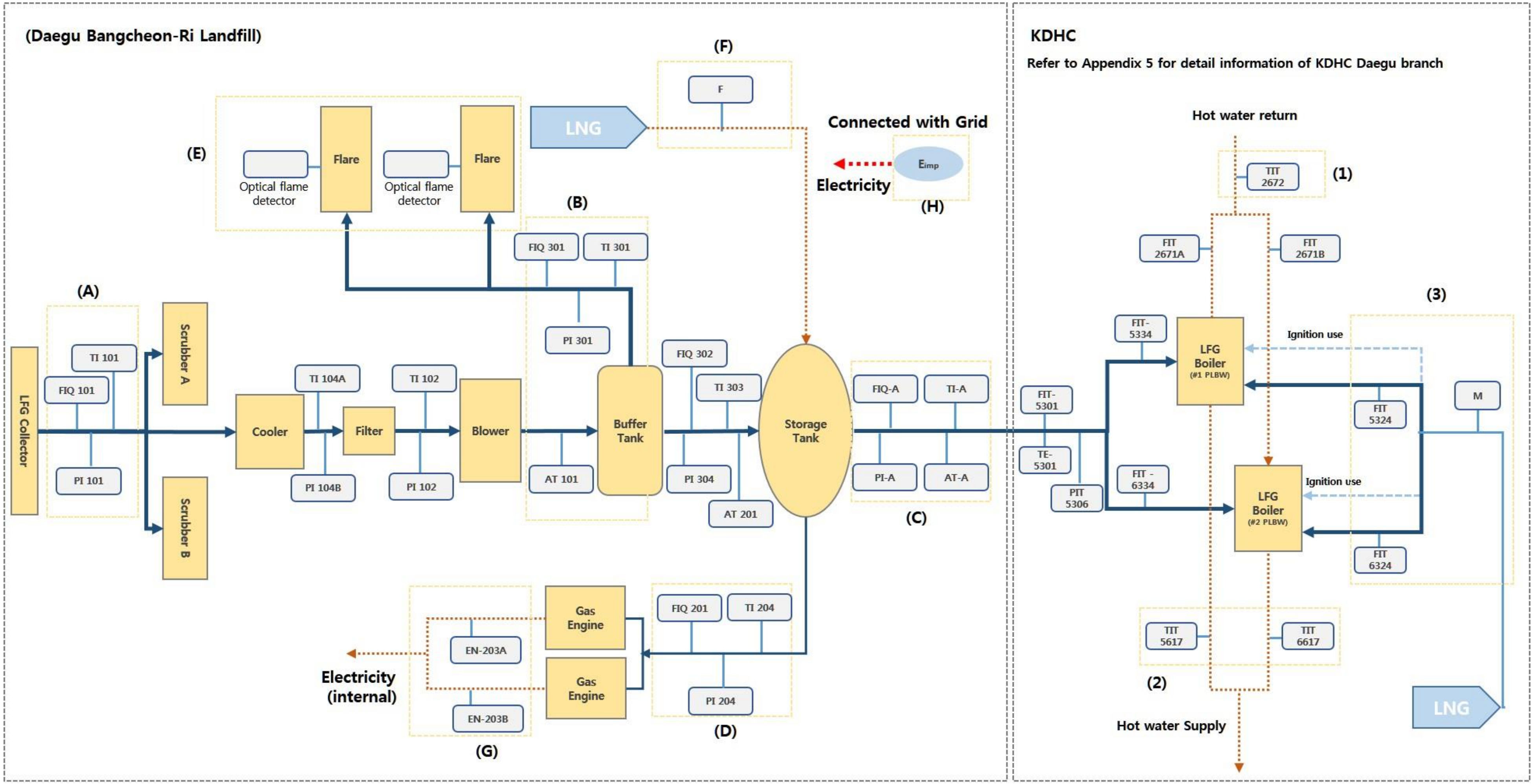


Figure 13. Diagram of monitoring points

<table>
<tr><th>Site</th><th>Group</th><th>Tag No.</th><th>Equipment</th><th>Detail</th></tr>
<tr><td rowspan="20">Landfill</td><td rowspan="3">(A)</td><td>FIQ 101</td><td>Flow meter</td><td rowspan="16">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
- Accuracy : ± 5%

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="2">(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>(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 rowspan="6">KDHC</td><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 Qmax ~ 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>FIT-6324</td><td>LNG flow meter</td></tr>
</table>

Table 3. Monitoring points and related parameters

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. Temperature of collected LFG at TI-204, TI-301 and TI-A are less than 60°C 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)”, 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 a 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 analyser which is monitoring CH_4 fraction fed to flare is AT-101 and the analyser 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

LFG which is measured at FIQ-301 is fed to LFG flare stack. To check whether flaring is operating or not, flame detector (FD-101 and FD-102) was used. According to registered PDD, parameter OP_j could select one of the operating signal. (Temperature, Flame and Products generated. i.e. result of using of LFG) Flame was used to check operating as a result of using LFG in this project.

4) LNG usage

The amount of LNG used is consist of mainly two 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.

5) Electricity generation Operating check

LFG which is measured at FIQ-201 is fed to LFG generators. To check whether electricity generation is operating or not, electricity indicator (EN-203A, EN-203B) was used. According to registered PDD, parameter OP_j could select one of the operating signal. (Temperature, Flame and Products generated. i.e. result of using of LFG) Generated electricity was used to check 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 Electric bill monthly provided by KEPCO.

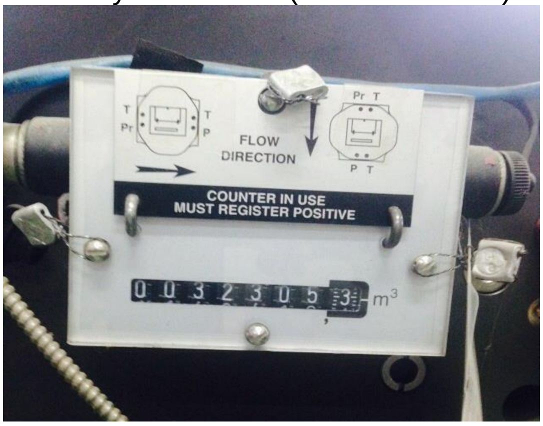
7) Boiler Operating check

Thermometers including TIT-2672, TIT-5617 and TIT-6617 check whether 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 ~ 40,000m^3/h

► Vortex Flow Meter(FIQ-201)

- Type : Vortex
- Accuracy : ± 1.0%
- flow range : 15 ~ 19 Nm3/min

► Vortex Flow Meter(FIQ-301)

- Type : Vortex
- Accuracy : ± 1.0%
- Flow range : 42 ~ 150 Nm3/min

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

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

Gas	Minimum range	Maximum range
CO_2	0 ~ 500 ppm	0 ~ 100vol%
CH_4	0 ~ 1000 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.

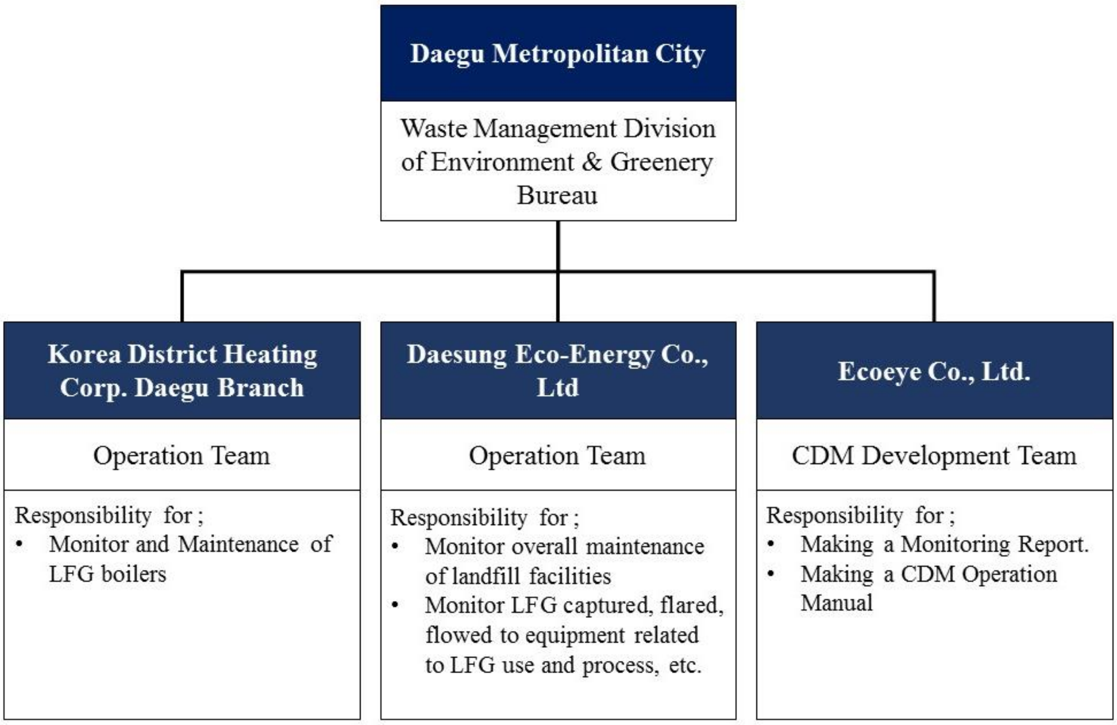
4) Down Loading Function
Saved data is able to download by excel file for monitoring.

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" (version 04.0). 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℃, 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 flowrate 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(853,400 ㎡) 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 result dumping waste amount 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 2017. (see table below)
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

Source	**2016**	**2017**
Original design (Area of waste disposal)	853,400 ㎡	853,400 ㎡
Technical specification for the management of the SWDS	SRF incineration facility was constructed	SRF incineration facility was constructed
Local and national regulation	Ban on illegal waste	Ban on illegal waste
Actual amount of MSW (ton/year)	357,522	-

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)
Value(s) of monitored parameter	N/A
Monitoring equipment	see below
Measuring/reading/recording frequency:	Recording hourly (TIT-2672, TIT-5617, TIT-6617) Measuring minutely (FD-101, FD-102)

Monitoring equipment:

$F_{CH4,HG}$ (Boiler)

Tag	TIT-2672
Type	Temperature transmitter
Accuracy class	± 0.25%
Serial number	TIT-2672
Past Calibration Date	28/08/2012
Calibration frequency	3 years
Date of last calibration	09/09/2015
Validity	09/09/2015~08/09/2018
Delayed date	-

Tag	TIT-5617
Type	Temperature transmitter
Accuracy class	± 0.25%
Serial number	TIT-5617
Past Calibration Date	28/08/2012
Calibration frequency	3 years
Date of last calibration	02/09/2015
Validity	02/09/2015~01/09/2018
Delayed date	02/09/2015~01/09/2018

Tag	TIT-6617
Type	Temperature transmitter
Accuracy class	± 0.25%
Serial number	TIT-6617
Past Calibration Date	11/09/2012
Calibration frequency	3 years
Date of last calibration	02/09/2015
Validity	02/09/2015~01/09/2018

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

Tag	FD-101
Type	UV-IR
Accuracy class	± 5%
Serial number	53131
Calibration frequency	3 years
Date of last calibration	14/12/2015
Validity	14/12/2015~13/12/2018

Tag	FD-102
Type	UV-IR
Accuracy class	± 5%
Serial number	53067
Calibration frequency	3 years
Date of last calibration	14/12/2015
Validity	14/12/2015~13/12/2018

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:	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/Aug/16 ~ 31/Dec/16 : 3,153 MWh 01/Jan/17 ~ 18/Aug/17 : 4,570 MWh This value is in $EC_{PJ,grid}$ sheet in the Daegu 6th ER sheet.
Monitoring equipment	Tag: E_{imp} Type: Three-phase four-wire Accuracy class: ± 0.5% Serial number: 25102000031 Calibration frequency: 7 years Date of last calibration: 09/08/2013 Validity: 09/08/2013~08/08/2020
Measuring/reading/recording frequency:	Measuring and recording hourly –PLC data Reading monthly – 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:	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)
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: 14/12/2015 Validity: 14/12/2015~13/12/2018 Tag: FD-102 Type: UV-IR Accuracy class: ± 5 % Serial number: 53067 Calibration frequency: 3 years Date of last calibration: 14/12/2015 Validity: 14/12/2015~13/12/2018
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:	Calculation of baseline emissions
Additional comments:	This parameter is used to confirm flare stack operating.

Data/parameter:	$V_{t,db}$
Unit	Nm^3 dry 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** 19/08/2016~31/12/2016 : 0 Nm3 01/01/2017~18/08/2017 : 0 Nm3 **FIQ-301** 19/08/2016~31/12/2016 : 2,068,482 Nm3 01/01/2017~18/08/2017 : 5,084,040 Nm3 **FIQ-A** 19/08/2016~31/12/2016 : 17,659,332 Nm3 01/01/2017~18/08/2017 : 26,057,712 Nm3

Monitoring equipment	Tag: FIQ-201 Type: Vortex Accuracy: 1.0% Serial number: C10-S1000HN Calibration frequency: 8 years Date of last calibration: 11/08/2014 Validity: 11/08/2014~10/08/2022 Tag: FIQ-301 Type: Vortex Accuracy: 1.0% Serial number: DE26015G Calibration frequency: 8 years Date of last calibration: 11/08/2014 Validity: 11/08/2014~10/08/2022 Tag: FIQ-A Type: Turbine Accuracy: 0.5% Serial number: 10517644 Calibration frequency: 8 years Date of last calibration: 29/02/2012 Validity: 29/02/2012~28/02/2020
Measuring/reading/recording frequency:	Measuring hourly
Calculation method (if applicable):	N/A
QA/QC procedures:	This monitoring equipment is calibrated every 8 years.
Purpose of data:	Calculation of baseline emissions
Additional comments:	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 Nm3 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°C 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)", LFG are considered as dry basis.

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)

Value(s) of monitored parameter	**AT-101** 19/08/2016~31/12/2016 : 51.63 % 01/01/2017~18/08/2017 : 49.58 % **AT-A (related with FIQ-A)** 19/08/2016~31/12/2016 : 43.96 % 01/01/2017~18/08/2017 : 45.79 % **AT-A (related with FIQ-201)** 19/08/2016~31/12/2016 : 0 % 01/01/2017~18/08/2017 : 0 %
Monitoring equipment	Tag: AT-101 Type: Infrared analyzer Serial number: A1E5039T Past calibration date: 16/05/2011 Calibration frequency: 5 years Date of last calibration: 03/05/2016 Validity: 03/05/2016~02/05/2021 Tag: AT-A (A) Type: Infrared analyzer Serial number: A6C0597T Calibration frequency: 5 years Date of last calibration: 11/10/2012 Validity: 11/10/2012~10/10/2017 Tag: AT-A (B) Type: Infrared analyzer Serial number: N5L0895 Calibration frequency: 5 years Date of last calibration: 10/06/2016 Validity: 10/06/2016~09/06/2021
Measuring/reading/recording frequency:	Measuring hourly
Calculation method (if applicable):	N/A
QA/QC procedures:	Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.
Purpose of data:	Calculation of baseline emissions
Additional comments:	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 also measured “0” Nm3 during 6th 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°C 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)”, LFG are considered as dry basis.

Data/parameter:	P_t
Unit	Pa
Description	Pressure of the gaseous stream in time interval *t*

<table>
<tr><td>Measured/calculated/default</td><td>Measured</td></tr>
<tr><td>Source of data</td><td>PLC (PI-204, PI-301, PI-A)</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>-</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Tag</td><td>PI-204</td></tr>
<tr><td>Type</td><td>Diaphragm</td></tr>
<tr><td>Accuracy</td><td>± 0.075%</td></tr>
<tr><td>Serial number</td><td>91F625744</td></tr>
<tr><td>Past calibration date</td><td>12/08/2014, 24/06/2016</td></tr>
<tr><td>Calibration frequency</td><td>1 month</td></tr>
<tr><td>Date of last calibration</td><td>22/07/2016</td></tr>
<tr><td>Validity</td><td>22/07/2016~21/08/2016</td></tr>
</table>
<table>
<tr><td>Tag</td><td>PI-301</td></tr>
<tr><td>Type</td><td>Diaphragm</td></tr>
<tr><td>Accuracy</td><td>± 0.075%</td></tr>
<tr><td>Serial number</td><td>91F347307</td></tr>
<tr><td>Past calibration date</td><td>12/08/2014, 24/06/2016</td></tr>
<tr><td>Calibration frequency</td><td>1 month</td></tr>
<tr><td>Date of last calibration</td><td>22/07/2016</td></tr>
<tr><td>Validity</td><td>22/07/2016~21/08/2016</td></tr>
</table>
<table>
<tr><td>Tag</td><td>PI-A (A)</td><td>PI-A (B)</td></tr>
<tr><td>Type</td><td>Diaphragm</td><td>Diaphragm</td></tr>
<tr><td>Accuracy</td><td>± 0.25%</td><td>± 0.25%</td></tr>
<tr><td>Serial number</td><td>09507363</td><td>08506921</td></tr>
<tr><td>Calibration frequency</td><td>1 month</td><td>1 month</td></tr>
<tr><td>Date of last calibration</td><td>12/08/2014</td><td>24/06/2016
22/07/2016</td></tr>
<tr><td>Validity</td><td>12/08/2014~11/09/2014</td><td>24/06/2016~23/07/2016
22/07/2016~21/08/2016</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency:</td><td>Hourly</td></tr>
<tr><td>Calculation method (if applicable):</td><td>-</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 comments:</td><td>Manometer is applied to volumetric flowrate automatically to convert 0℃, 1atm.</td></tr>
</table>

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 : TI-201, TI-301, TI-A)
Value(s) of monitored parameter	-

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

Tag	TI-204
Type	RTD
Accuracy	± 0.305|t|
Serial number	10020523
Past calibration date	11/08/2014
Calibration frequency	2 years
Date of last calibration	22/07/2016
Validity	22/07/2016~21/07/2018

Tag	TI-301
Type	RTD
Accuracy	± 0.305|t|
Serial number	06010670
Past calibration date	08/08/2014
Calibration frequency	2 years
Date of last calibration	22/07/2016
Validity	22/07/2016~21/07/2018

Tag	TI-A (B)
Type	RTD
Accuracy	±0.25%
Serial number	08506921
Calibration frequency	2 years
Date of last calibration	26/07/2016
Validity	26/07/2016~25/07/2018

</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 are subject to a regular maintenance and testing regime to ensure accuracy</td></tr>
<tr><td>Purpose of data:</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments:</td><td>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°C 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)”, LFG are considered as dry basis.

Thermometer is applied to volumetric flowrate automatically to convert 0℃, 1atm.</td></tr>
</table>

Data/parameter:	$FC_{LNG,j,y}$
Unit	Nm^3/yr
Description	Quantity of LNG combusted in process j during the year y
Measured/calculated/default	Measured
Source of data	PLC data(F) and Dae sung energy corporation(LNG supplier)data(LNG bill)
Value(s) of monitored parameter	08/01/2016~31/12/2016 : 0 01/01/2017~18/08/2017 : 18,478

Monitoring equipment	<table><tr><td>Tag</td><td>F (FIQ-503) (B)</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>20536708</td></tr><tr><td>Calibration frequency</td><td>8 years</td></tr><tr><td>Date of last calibration</td><td>16/08/2016</td></tr><tr><td>Validity</td><td>16/08/2016~15/08/2024</td></tr></table><table><tr><td>Tag</td><td>F (FIQ-504) (A)</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>11/08/2010</td></tr><tr><td>Validity</td><td>11/08/2010~10/08/2018</td></tr></table><table><tr><td>Tag</td><td>F (FIQ-504) (B)</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>20536703</td></tr><tr><td>Calibration frequency</td><td>8 years</td></tr><tr><td>Date of last calibration</td><td>16/08/2016</td></tr><tr><td>Validity</td><td>16/08/2016~15/08/2024</td></tr></table><table><tr><td>Tag</td><td>M(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>M(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>
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. LNG meter is calibrated every 8 years. 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:	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 internal procedure.

Data/parameter:	$NCV_{LNG,y}$
Unit	GJ/Nm^3

Description	Weighted average net calorific value of LNG in year y
Measured/calculated/default	Measured
Source of data	Invoices of LNG supplier
Value(s) of monitored parameter	08/19/2016~31/12/2016 : - 01/01/2017~18/08/2017 : 0.04253
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Reading monthly
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Calculation of project emissions
Additional comments:	-

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 upper 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:	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	18/08/2016~31/12/2016 : 3.59 01/01/2017~18/08/2017 : 10
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Monthly reading
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	Calculation of project emissions

Additional comments:	These values are from the page 17 of Statistics of electric power in Korea, which is published on June 2016 by Korea electric power corporation. There is no data of transmission and distribution losses in 2017 and 10% is applied as a conservative manner.

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°C 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 formulae 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

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

$BE_{CH4,y}$	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) $F_{CH4,BL,y} = F_{CH,PJ,y} * 20\%(AF)$

$F_{CH4,BLy}$	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
AF	Constant	Adjusted Factor in this project

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) $F_{CH4,sent\_flare,t} = V_{flare,t,db} * v_{CH4,t,db} * \rho_{CH4,t}$

$F_{CH4,sent\_flare,t}$	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 Ch4 in time interval t, (0.0007157 tCH_4/Nm^3CH_4)

※ $\rho_{CH4,t}$ 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°C during this monitoring period.

2-1-2) $$PE_{flare,m,y} = GWP_{CH4} * \sum_{m=1}^{525600} F_{CH4,RG,m} * (1 - \eta_{flare,m}) * 10^{-3}$$

$PE_{flare,y}$	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) $F_{CH4,EL,t} = V_{t,db} * v_{CH4,t,db} * \rho_{CH4,t}$

$F_{CH4,t}$	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, (0.0007157 tCH_4/Nm^3CH_4)

※ 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°C during this monitoring period.

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

$F_{CH4,flared,t}$	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, (0.0007168 tCH_4/Nm^3CH_4)

※ 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°C during this monitoring period.

After a request for issuance incompleteness, baseline emission was slightly adjusted due to the extraordinary temperature in the TI-301 and TI-A. Baseline emission is changed from 499,578 tCO_2 to 497,399 tCO_2. If temperature of collected LFG at TI-204, TI-301 and TI-A are over 60°C or below 0°C, the LFG flow amounts were not reflected in this baseline emission.

The detail information related with BE is described below.

►$BE=BE_{CH4}$

Period	BE	=	BE_{CH4}
Unit	tCO_2eq		tCO_2eq
2016-08-19 ~ 2016-12-31	102,335	=	102,335
2017-01-01 ~ 2017-08-18	160,906	=	160,906
Total	263,241		263,241

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

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
2016-08-19 ~ 2016-12-31	102,335	0.1	5,848	1,170	25
2017-01-01 ~ 2017-08-18	160,906	0.1	9,195	1,839	25
Total	263,241				

1) $F_{CH4,B} = F_{CH,PJ} * 20\%(AF)$

Period	$F_{CH4,BL}$	$F_{CH4,PJ}$
Unit	tCH_4	tCH_4
2016-08-19 ~ 2016-12-31	1,170	5,848
2017-01-01 ~ 2017-08-18	1,839	9,195
Total	3,008	15,042

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
2016-08-19 ~ 2016-12-31	5,848	345	0	5,502
2017-01-01 ~ 2017-08-18	9,195	738	0	8,457
Total	15,042			

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

2016-08-19 ~ 2016-12-31	345	691	8,634	25
2017-01-01 ~ 2017-08-18	738	1,475	18,438	25
Total	1,038			

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

※ The detail calculation is in Daegu 6th ER sheet ($F_{CH4,sent,flare,h}$ Sheet)

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

※ The detail calculation is in Daegu 6th ER sheet ($F_{CH4,sent,flare,h}$ Sheet)

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

※ The detail calculation is in Daegu 6th ER sheet ($F_{CH4,EL,h}$ Sheet)

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

※ The detail calculation is in Daegu 6th ER sheet ($F_{CH4,HG,h}$ Sheet)

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

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

$PE_{EC,y}$	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
$TDL_{grid,y}$	Constant	Average technical transmission and distribution losses for providing to source *j* in year y

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

$PE_{FC,y}$	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) $COEF_{LNG,y} = NCV_{LNG,y} * EF_{CO2,LNG,y}$

$COEF_{LNG,y}$	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 below.

► $PE = PE_{EC} + PE_{FC}$

Period	PE	PE_{EC}	PE_{FC}
Unit	tCO_2eq	tCO_2eq	tCO_2eq
2016-08-19 ~ 2016-12-31	1,771	1,771	0
2017-01-01 ~ 2017-08-18	2,772	2,726	46
Total	4,543		

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

Period	PE_{EC}	$EC_{PJ,grid}$	$EF_{EL,grid}$	1	$TDL_{,grid}$
Unit	tCO_2eq	MWh	tCO_2/MWh	Constant	%
2016-08-19 ~ 2016-12-31	1,771	3,153	0.5421	1	3.59%
2017-01-01 ~ 2017-08-18	2,726	4,570	0.5421	1	10%
Total	4,497	7,723			

2) $PE_{FC} = FC_{LNG} * COEF_{LNG}$

Period	PE_{FC}	FC_{LNG}	$COEF_{LNG}$
Unit	tCO_2eq	Nm^3	tCO_2/Nm^3
2016-08-19 ~ 2016-12-31	0	0	0
2017-01-01 ~ 2017-08-18	46	18,478	0.002479
Total	46		

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

Period	$COEF_{LNG}$	NCV_{LNG}	$EF_{CO2,LNG}$
Unit	tCO_2/Nm^3	GJ/Nm^3	tCO_2/GJ
2016-08-19 ~ 2016-12-31	0.000000	0.00000	0.0583
2017-01-01 ~ 2017-08-18	0.002479	0.04253	0.0583

E.3. Calculation of leakage emissions

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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	263,241	4,543	0	0	258,698	258,698

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

Amount achieved during this monitoring period ($t\ CO_2e$)	**Amount estimated ex ante ($t\ CO_2e$)**

Amount achieved during this monitoring period ($t\ CO_2e$)	Amount estimated ex ante ($t\ CO_2e$)
258,698 t CO_2e	177,493 tCO2e (Estimated Emission Reduction, which is described in PDD page 50)

E.6. Remarks on increase in achieved emission reductions

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This monitoring report claims the emission reductions of 258,698 tCO_2e which is larger than estimated emission reductions of 177,493 tCO_2e from the registered PDD. It rose up 145.8%.

Efficiency of the LFG capture system

The main thing comes down to the efficiency of the LFG capture system. At renewal those 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 (tCO2e)		Estimated CH_4 capture(tCO2e)	Actual CH_4 capture (tCO2e, MD project)	Difference rate
	Baseline CH_4 (tCO2e)	Efficiency			
2010	420,464	63.46 %	266,826	351,983	31.9 %
2011	420,413	63.46 %	266,794	416,042	55.9 %*
2012	414,082	63.46 %	262,777	377,963	43.8 %
2013	411,540	63.46 %	261,163	371,640	42.3 %
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	380,542	46.4 %
2017	259,463	63.46 %	164,655	229,867	39.6 %

※ Baseline CH4 in 2017 reflected from 1st. Jan to 18th. Aug

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 Bancheon-ri landfill is a one of the largest landfill in Korea and have been operating a 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)**

Daesung Eco-Energy is a company for managing and operating Daegu Bangcheon-ri landfill. The company had significantly invested enhancing the efficiency of LFG capture system. For these efforts or investments, this landfill is well known for the good management and operation of the landfill sector in Korea.

In 2006, this project had started from 105 collection wells. And then 76 collection wells are installed in 2011. These investment can booster LFG captured amounts in 2011. According to the internal report, these 76 collection well would contribute to increase about 36.5 Nm3/min. It can prevent LFG to rapid decrease of LFG captured amounts.

**** Annual precipitation variation (in 2015)**

Daegu region is a wet region of Boreal and Temperate climate and have climate factors as below table;

<Climate Factors of Daegu region>

Climate Factors	Value	Source
Mean Annual Temperature (MAT)	13.2 ℃	Registered PDD
Mean Annual Precipitation (MAP)	1,224.8 mm	Registered PDD
Potential Evapotranspiration (PET)	1,069 mm	Registered PDD

But, Daegu region had been struggling to severe drought in 2015. According to the Korea Meteorological Administration, its annual precipitation recorded 908.5 mm and then rebounded as 1,227.1 mm in 2016. The drought in 2015 would make decay rates of wastes low from wet to dry as per the methodological tool "Emissions from solid waste disposal sites". These end up to decrease of LFG captured amount at those time.

***** Additional installation of collection well (in 2015)**

In Dec 2015, 21 collection wells were also installed and efficiency of the LFG capture system would rise up in 2016. Now, Daegu Bangcheon-ri landfill had have total 202 collection wells. *Given initial 105 collection wells and additional 76 collection well, 21 collection wells were consistent investment and these trigger a large amount of LFG capture.*

As a result, Daesung Eco-Energy and Korea District Heating Corporation, project participants, hope steady supply of LFG as a fuel for LFG Boilers.

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