Monitoring report form

(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" 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 monitoring report	1.0	
Completion date of the monitoring report	09/02/2017	
Monitoring period number and duration of this monitoring period	5th monitoring period, The first and last days are included (19/08/2014 ~ 18/08/2016)	
Project participant(s)	Daegu Metropolitan City Daesung Eco-Energy Co., Ltd. Korea District Heating Corporation. Ecoeye Co., Ltd.	
Host Party	Republic of Korea	
Sectoral scope(s)	Scope 13 : Waste handling and disposal	
Selected methodology(ies)	ACM0001 ver.15	
Selected standardized baseline(s)	N/A	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	355,383 tCO2e 2014.8.19 – 2015.8.18 : 177,823 tCO2e 2015.8.19 – 2016.8.18 : 177,560 tCO2e (Estimated Emission Reduction, which is described in PDD page 50)	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	0 tCO_2e	501,878 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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

Daegu Bangcheon-Ri Landfill gas CDM Project is the project which captures and refines LFG and then refined LFG is supplied to the boiler of Korea District Heating Corporation.(KDHC) to produce thermal energy.

Measures taken for GHG emission reductions are divided in 2parts. First is baseline emission, which is divided 3part also, and Second is project emission, which is amount of LNG and Electricity supplied to operate project activity.

Emission Reduction = Baseline Emission – Project Emission

These factors are described with detail in section E below.

· Brief description of the installed technology and equipment

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 part of LFG utilization system. In the Utilization system, LFG are refined and supplied to KDHC. More details about installed technology and equipment is described in Section B below.

Daegu Bangcheon-Ri Landfill site is located in 820, Dasa-ro, Dasa-Eup, Dalsung-Gun, Daegu Metropolitan City, Republic of Korea. The total project area is 1,373,732m^2. Before operation of CDM project, the treatment of landfill gas from Daegu Bangcheon-Ri Landfill site had been managed the 'simple on-site treatment' to prevent odour, air pollution and fire. The landfill gas is composed of methane(CH_4), which is one of major greenhouse gases and has 21 times higher global warning potential(GWP) compare to carbon dioxide(CO_2) and GWP of methane was changed to 25 times from 2013. It was applied in Daegu 5th ER sheet. Therefore, Daegu Bangcheon-Ri Landfill gas CDM Project is designed to minimize methane(CH_4) emission by capturing of LFG and utilizing it.

· Relevant dates for the project activity

Item	Completion of Construction	Electricity equipment test period	Starting Date of Operation
Date	30/09/2006	07/06/2006 ~ 06/08/2006	10/10/2006

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

This is the 5th monitoring period covering 2 year (from 19/08/2014 to 18/08/2016) and monitored emission reductions is 501,878 tCO_2e.

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

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 Corporation(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.

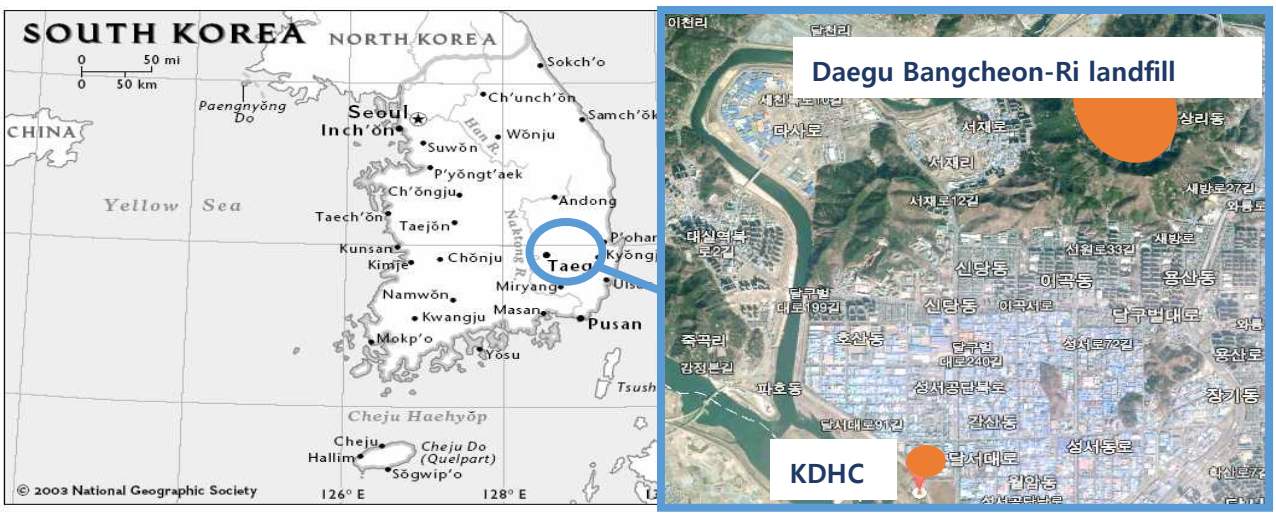

Figure 2. Location of Daegu Bangcheon-Ri Landfill site

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate whether the Party involved wishes to be considered as project participant (yes/no)
Republic of Korea (Host)	Daegu Metropolitan City Korea District Heating Corporation. Daesung Eco-Energy Co., Ltd. Ecoeye Co., Ltd.	No

A.4. Reference of applied methodology and standardized baseline

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- **Indicate the exact reference and refer to the UNFCCC CDM website**

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 of project activity

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- **Type :** Renewable
- **Renewable date :** 17/09/2016
- **Length of the 2nd crediting period :** 19/08/2014 ~ 18/08/2021
- **5th monitoring period :** 19/08/2014 ~ 18/08/2016

A.6. Contact information of responsible persons/entities

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Name	Position	Is the person a PP in Appendix 1?	PP which is involved in	E-mail
Myung-min Kim	Consultant	Yes	ECOEYE Co., Ltd	Ky08715@ecoeye.com

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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- **Information on the implementation status of the project activity**

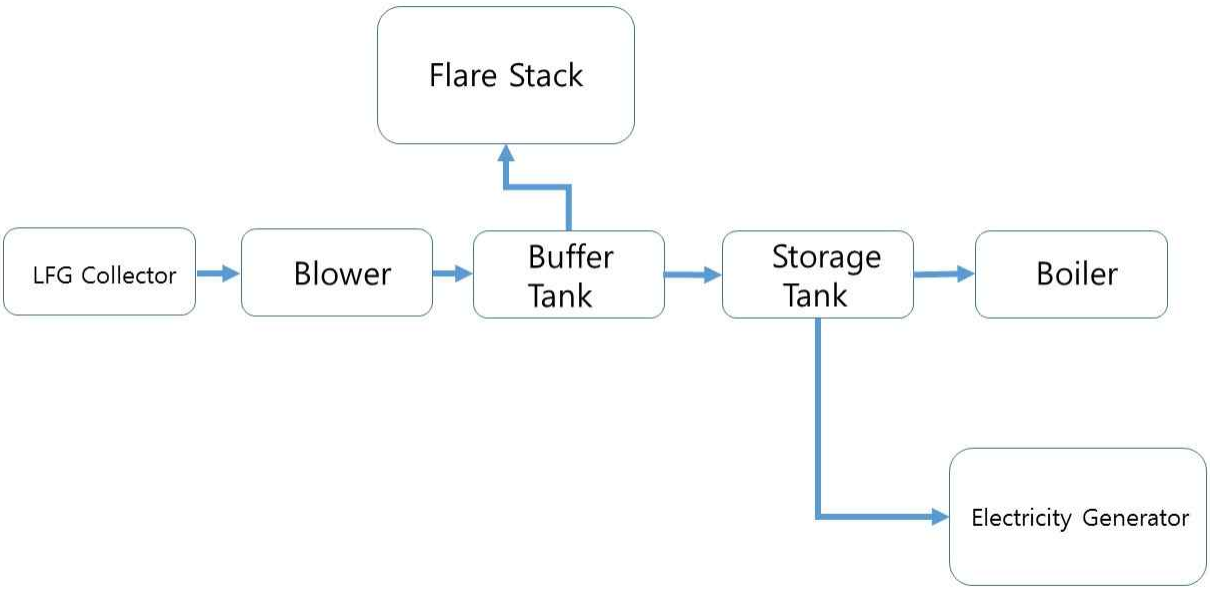
Item	Date and Details		
Data Error	Measuring Point	Date	Details
	FIQ-A	02/09/2014	Data was recorded on 21,712 but it considered 0 “zero”
		16/01/2015	Data was recorded on 118,880 but it considered 0 “zero”
		12/03/2015	Data was recorded on 874,880,336 but it considered 0 “zero”
		25/04/2015	Data was recorded on 21,013 but it considered 0 “zero”
	AT-A	18/05/2015	Data was recorded on 44,329 but it considered 0 “zero”
		03/07/2016	Data was recorded on 1,784 but it considered 0 “zero”

Korea District Heating Corporation requests Daesung Eco-Energy Co., Ltd. to stop supplying LFG due to its heat capacity (Heat demand is lower in Summer then 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.

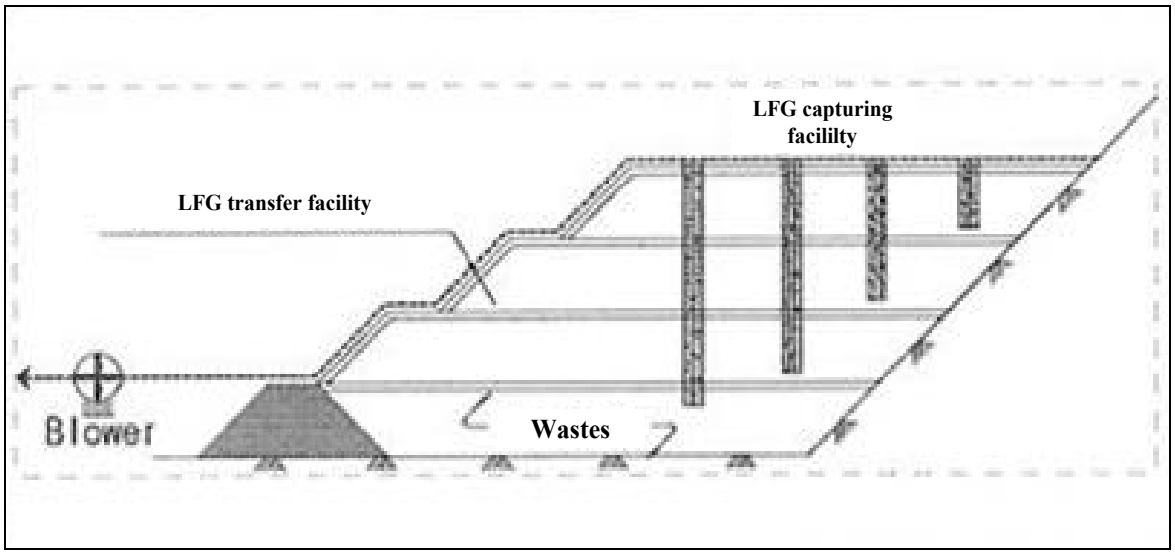


Figure 3. Vertical LFG capturing equipment installation concept

LFG utilization system

LFG utilization system mainly consists of 4 parts, LFG capture, refinery facilities, LFG fuel supply facilities and utilization facilities.

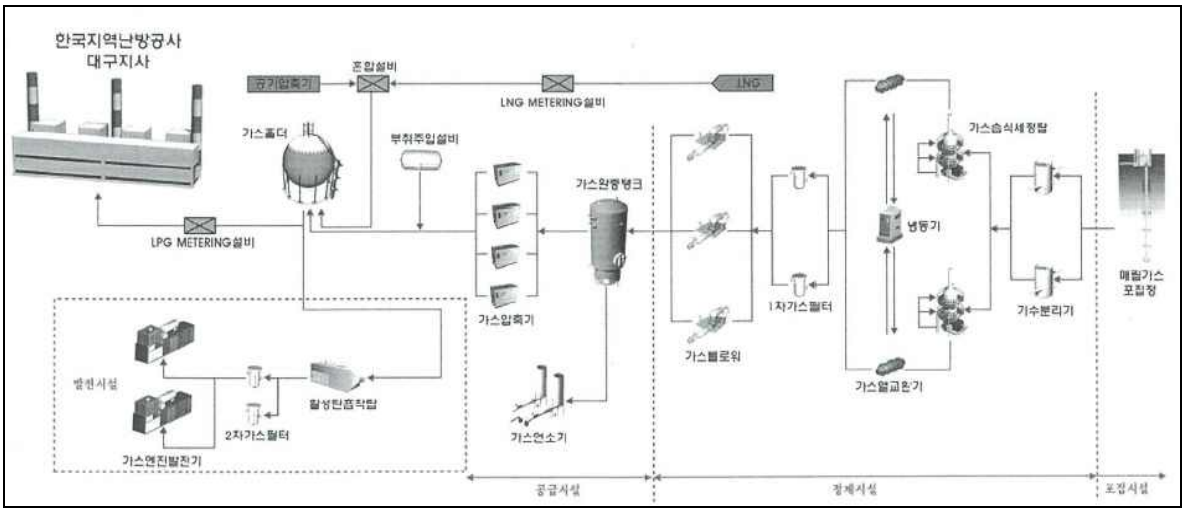


Figure 4. LFG utilization system flow chart

The main features of the LFG facilities are presented 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.

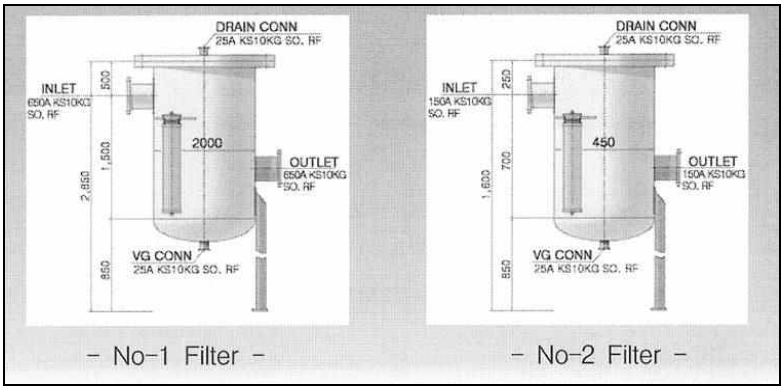


Figure 6. Filter

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.

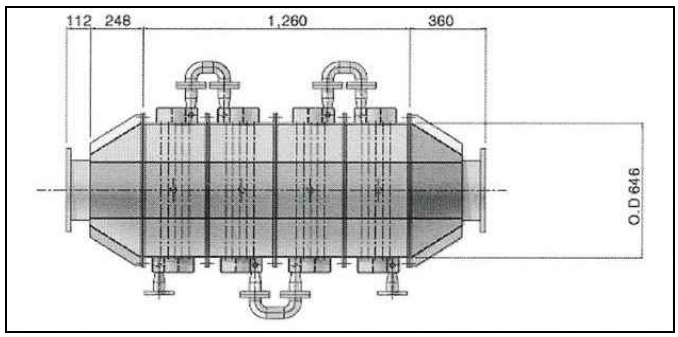


Figure 8. Cooler

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 registered monitoring plan, applied methodology or applied standardized baseline

>>
N/A

B.2.2. Corrections

>>

N/A

B.2.3 Changes to start date of crediting period

>>
N/A

B.2.4 Inclusion of a monitoring plan to the registered PDD that was not included at registration

>>
N/A

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

>>
N/A

B.2.6. Changes to project design of registered project activity

>>
N/A

B.2.7. Types of changes specific to afforestation or reforestation project activity

>>
N/A

SECTION C. Description of monitoring system

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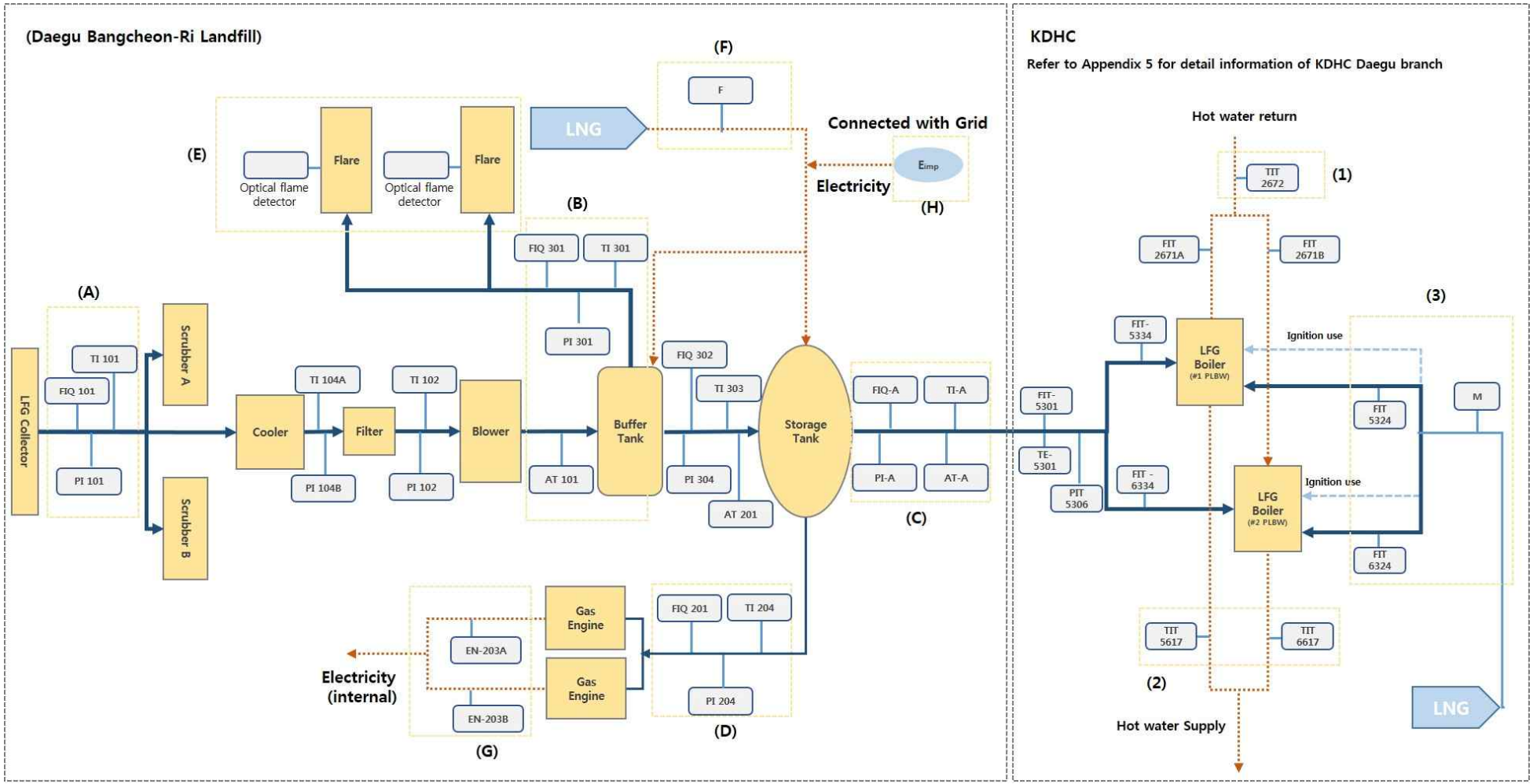
- **Description of the monitoring system**

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.


(Daegu Bangcheon-Ri Landfill)
(A)
LFG Collector
TI 101
FIQ 101
PI 101
Scrubber A
Scrubber B
Cooler
TI 104A
PI 104B
Filter
TI 102
PI 102
Blower
(B)
FIQ 301
TI 301
PI 301
AT 101
Buffer Tank
FIQ 302
TI 303
PI 304
AT 201
Storage Tank
(C)
FIQ-A
TI-A
PI-A
AT-A
(D)
FIQ 201
TI 204
PI 204
Gas Engine
Gas Engine
EN-203A
EN-203B
(G)
Electricity (internal)
(E)
Optical flame detector
Flare
Optical flame detector
Flare
(F)
F
LNG
Connected with Grid
Electricity
Eimp
(H)
KDHC
Refer to Appendix 5 for detail information of KDHC Daegu branch
Hot water return
TIT 2672
(1)
FIT 2671A
FIT 2671B
(3)
FIT-5334
LFG Boiler (#1 PLBW)
Ignition use
FIT-5301
TE-5301
PIT 5306
FIT -6334
LFG Boiler (#2 PLBW)
Ignition use
FIT 5324
M
FIT 6324
TIT 5617
TIT 6617
(2)
Hot water Supply
LNG

<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="20">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 : ±0.5mA

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="5">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

Captured LFG is monitored by FIQ-101 and combusted LFG is monitored by FIQ-201, FIQ-301 and FIQ-A. These flow meter 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.

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 CH4 fraction fed to flare is AT-101 and the analyser which is monitoring CH4 fraction fed to boiler and gas generator 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 boiler as fuel to satisfy the operation condition of the boiler which is in KDHC. The amount of supplied LNG is continuously measured by flow meter (F) 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 generator. 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

LFG which is measured at FIQ-A is fed to LFG boiler, which is in KDHC site. To check whether boiler is operating or not, temperature measure equipment (called thermometer, TIT-2672, TIT-5617 and TIT-6617) 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) The change of temperature was used to check operating as a result of using LFG in this project. However, it is not determinated that how much temperature is changing in registered PDD. So, PP developed that at least 50℃ is changed and the heating production is higher 100℃.

- **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 monitored variables are controlled by an electrical control system. This control system is provided with a PLC (Programmable Logic Controller). All the measured process signals are processed by the PLC. With this system it is possible to control and monitor the installation at a distance, including through the internet. The main functions of PLC are indicated 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.

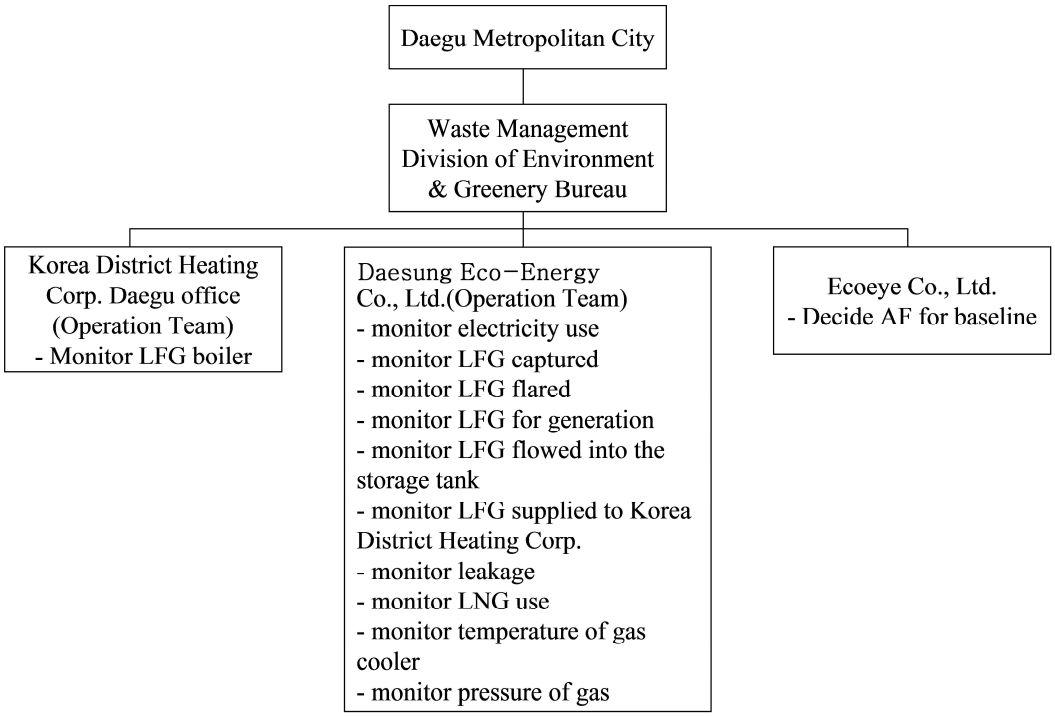
4) Down Loading Function
Saved data is able to download by excel file for monitoring.

Every five minutes, PLC reads data from the server and the data can 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 boiler) :
Korea District Heating Corp. Daegu office (Operation Team)

- AF for the baseline calculating:
Ecoeye. Co., Ltd.

SECTION D. Data and parameters

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

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	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	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	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	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	-
Monitoring equipment	N/A
Measuring/reading/recording frequency:	Recording annually
Calculation method (if applicable):	N/A
QA/QC procedures:	N/A
Purpose of data:	N/A
Additional comments:	N/A

Data/parameter:	$Op_{j,h}$
Unit	-
Description	Operation of the equipment that consumes the LFG
Measured/calculated/default	Measured
Source of data	PLC data (Temeprature – TIT-2672, TIT-6617, TIT-6612) (Flame Detector – FD-101, FD-102)
Value(s) of monitored parameter	N/A

<table>
<tr><td>Monitoring equipment</td><td>
$F_{CH4,HG}$ (Boiler)
<table>
<tr><td>Tag</td><td>TIT-2672</td></tr>
<tr><td>Type</td><td>Temperature transmitter</td></tr>
<tr><td>Accuracy class</td><td>± 0.25%</td></tr>
<tr><td>Serial number</td><td>TIT-2672</td></tr>
<tr><td>Past Calibration Date</td><td>28/08/2012</td></tr>
<tr><td>Calibration frequency</td><td>3 years</td></tr>
<tr><td>Date of last calibration</td><td>09/09/2015</td></tr>
<tr><td>Validity</td><td>28/08/2012~27/08/2015
09/09/2015~08/09/2018</td></tr>
<tr><td>Delayed date</td><td>28/08/2015~08/09/2015</td></tr>
</table>
<table>
<tr><td>Tag</td><td>TIT-5617</td></tr>
<tr><td>Type</td><td>Temperature transmitter</td></tr>
<tr><td>Accuracy class</td><td>± 0.25%</td></tr>
<tr><td>Serial number</td><td>TIT-5617</td></tr>
<tr><td>Past Calibration Date</td><td>28/08/2012</td></tr>
<tr><td>Calibration frequency</td><td>3 years</td></tr>
<tr><td>Date of last calibration</td><td>02/09/2015</td></tr>
<tr><td>Validity</td><td>28/08/2012~27/08/2015
02/09/2015~01/09/2018</td></tr>
<tr><td>Delayed date</td><td>28/08/2015~01/09/2015</td></tr>
</table>
<table>
<tr><td>Tag</td><td>TIT-6617</td></tr>
<tr><td>Type</td><td>Temperature transmitter</td></tr>
<tr><td>Accuracy class</td><td>± 0.25%</td></tr>
<tr><td>Serial number</td><td>TIT-6617</td></tr>
<tr><td>Past Calibration Date</td><td>11/09/2012</td></tr>
<tr><td>Calibration frequency</td><td>3 years</td></tr>
<tr><td>Date of last calibration</td><td>02/09/2015</td></tr>
<tr><td>Validity</td><td>11/09/2012~10/09/2015
02/09/2015~01/09/2018</td></tr>
</table>
$F_{CH4,flared}$ (Flare stack)
<table>
<tr><td>Tag</td><td>FD-101</td></tr>
<tr><td>Type</td><td>UV-IR</td></tr>
<tr><td>Accuracy class</td><td>± 0.5mA</td></tr>
<tr><td>Serial number</td><td>53131</td></tr>
<tr><td>Calibration frequency</td><td>3 years</td></tr>
<tr><td>Date of last calibration</td><td>14/12/2015</td></tr>
<tr><td>Validity</td><td>14/12/2015~13/12/2018</td></tr>
</table>
<table>
<tr><td>Tag</td><td>FD-102</td></tr>
<tr><td>Type</td><td>UV-IR</td></tr>
<tr><td>Accuracy class</td><td>± 0.5mA</td></tr>
<tr><td>Serial number</td><td>53067</td></tr>
<tr><td>Calibration frequency</td><td>3 years</td></tr>
<tr><td>Date of last calibration</td><td>14/12/2015</td></tr>
<tr><td>Validity</td><td>14/12/2015~13/12/2018</td></tr>
</table>
</td></tr>
<tr><td>Measuring/reading/recording frequency:</td><td>Recording hourly (TIT-2672, TIT-5617, TIT-6617)
Measuring minutely (FD-101, FD-102)</td></tr>
<tr><td>Calculation method (if applicable):</td><td>N/A</td></tr>
<tr><td>QA/QC procedures:</td><td>Temperature transmitter and UV-IR(Flame Detector) 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>Regarding Op of flaring, it is not determined that how much temperature is changing in registered PDD. So, PP developed that at least 50℃ is changed and the temperature of heating production is higher 100℃.</td></tr>
</table>

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/14 ~ 31/Dec/14 : 2,585MWh 01/Jan/15 ~ 31/Dec/15 : 7,358 MWh 01/Jan/16 ~ 18/Aug/16 : 4,874 MWh This value is in $EC_{PJ,grid}$ sheet in the Daegu 5th 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:	Recording hourly
Calculation method (if applicable):	N/A
QA/QC procedures:	Electricity meter is calibrated every 7years. 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:	-

Data/parameter:	$Flame_m$
Unit	-
Description	Flame detection of flare 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: ± 0.5mA 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: ± 0.5mA 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** 19/08/2014~31/12/2014 : 0 Nm^3 01/01/2015~31/12/2015 : 0 Nm^3 01/01/2016~18/08/2016 : 0 Nm^3 **FIQ-301** 19/08/2014~31/12/2014 : 318,024 Nm^3 01/01/2015~31/12/2015 : 2,371,153 Nm^3 01/01/2016~18/08/2016 : 3,672,918 Nm^3 **FIQ-A** 19/08/2014~31/12/2014 : 16,412,848 Nm^3 01/01/2015~31/12/2015 : 45,103,360 Nm^3 01/01/2016~18/08/2016 : 29,132,968 Nm^3
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 8years.
Purpose of data:	Calculation of baseline emissions
Additional comments:	N/A

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** 19/08/2014~31/12/2014 : 48.45 % 01/01/2015~31/12/2015 : 44.90 % 01/01/2016~18/08/2016 : 44.62 % **AT-A** 19/08/2014~31/12/2014 : 48.50 % 01/01/2015~31/12/2015 : 45.16 % 01/01/2016~18/08/2016 : 44.10 %
Monitoring equipment	

Tag	AT-101
Type	Infrared analyzer
Serial number	A1E5039T
Past calibration date	16/05/2011
Calibration frequency	5years
Date of last calibration	03/05/2016
Validity	16/05/2011~15/05/2016 03/05/2016~02/05/2021

Tag	AT-A (A)
Type	Infrared analyzer
Serial number	A6C0597T
Calibration frequency	5years
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	5years
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:	N/A

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	21.52kg/h (average value of data during the 4th monitoring period) This value is in MD_{flared} sheet in the ER sheet.

Monitoring equipment	

Tag	PI-204
Type	Diaphragm
Accuracy	± 0.075%
Serial number	91F625744
Past calibration date	12/08/2014, 24/06/2016
Calibration frequency	1 month
Date of last calibration	22/07/2016
Validity	12/08/2014~11/07/2014 24/06/2016~23/07/2016 22/07/2016~21/08/2016
Delayed date	12/07/2014~23/06/2016

Tag	PI-301
Type	Diaphragm
Accuracy	± 0.075%
Serial number	91F347307
Past calibration date	12/08/2014, 24/06/2016
Calibration frequency	1 month
Date of last calibration	22/07/2016
Validity	12/08/2014~11/09/2014 24/06/2016~23/07/2016 22/07/2016~21/08/2016
Delayed date	12/07/2014~23/06/2016

Tag	PI-A (A)
Type	Diaphragm
Accuracy	± 0.25%
Serial number	09507363
Calibration frequency	1 month
Date of last calibration	05/08/2014
Validity	05/08/2014~04/09/2014

Tag	PI-A (B)
Type	Diaphragm
Accuracy	± 0.25%
Serial number	08506921
Past calibration date	23/06/2016, 22/07/2016
Calibration frequency	1 month
Date of last calibration	20/08/2016
Validity	23/06/2016~22/07/2016 22/07/2016~21/08/2016

Measuring/reading/recording frequency:	Houly
Calculation method (if applicable):	$=FV_{RG,h}*fv_{CH4,RG,h}*\rho_{CH4,n,h}$
QA/QC procedures:	N/A
Purpose of data:	Calculation of project emissions
Additional comments:	N/A

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	$MD_{thermal}$, $MD_{electricity}$(AT-A)

	Average : 48.99% MD_{flared}(AT-101) Average : 45.75% Refer the $MD_{thermal}$, $MD_{electricity}$ and MD_{flared} sheet in the ER sheet.
Monitoring equipment	

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	11/08/2014~10/08/2016 22/07/2016~21/07/2018

Tag	TI-301
Type	RTD
Accuracy	± 0.305|t|
Serial number	08506921
Past calibration date	08/08/2014
Calibration frequency	2 years
Date of last calibration	22/07/2016
Validity	08/08/2014~07/08/2016 22/07/2016~21/07/2018

Tag	TI-A (A)
Type	RTD
Accuracy	±0.25%
Serial number	09507363
Calibration frequency	2 years
Date of last calibration	07/08/2014
Validity	07/08/2014~06/08/2016

Tag	TI-A (B)
Type	RTD
Accuracy	±0.25%
Serial number	08506921
Calibration frequency	2 years
Date of last calibration	25/07/2016
Validity	25/07/2016~24/07/2018

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:	Calculation of baseline emissions
Additional comments:	N/A

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

<table>
<tr><td>Source of data</td><td>PLC data(F) and KEPCO data (Electricity bill)</td></tr>
<tr><td>Value(s) of monitored parameter</td><td>N/A</td></tr>
<tr><td>Monitoring equipment</td><td>
<table>
<tr><td>Tag</td><td>F (FIQ-503) (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>20505437</td></tr>
<tr><td>Calibration frequency</td><td>8 years</td></tr>
<tr><td>Date of last calibration</td><td>18/08/2008</td></tr>
<tr><td>Validity</td><td>18/08/2008~17/08/2016</td></tr>
</table>
<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>20505438</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>20505433</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>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>
<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 project emissions</td></tr>
</table>

Additional comments:	N/A

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	19/08/2014~31/12/2014 : 0.04313 01/01/2015~31/12/2015 : 0.04314 01/01/2016~18/08/2016 : 0.04288
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	19/08/2014~31/12/2014 : 3.69 01/01/2015~31/12/2015 : 3.60 01/01/2016~18/08/2016 : 3.59 Average : 3.62%

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:	N/A

D.3. Implementation of sampling plan

>>

N/A

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

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

>>

- **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)

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

$F_{CH4,sent\_flare,t}$	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)

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)

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)

The detail information related with BE is described below.

►$BE=BE_{CH4}$

Period	BE	=	BE_{CH4}
Unit	tCO_2eq		tCO_2eq
2014-08-19 ~ 2014-12-31	95,812	=	95,812
2015	247,649	=	247,649
2016-01-01 ~ 2016-08-18	168,235	=	168,235
Total	511,696		

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

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
2014-08-19 ~ 2014-12-31	95,812	0.1	5,475	1,095	25
2015	247,649	0.1	14,151	2,830	25
2016-01-01 ~ 2016-08-18	168,235	0.1	9,613	1,923	25
Total	514,795				

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

Period	$F_{CH4,BL}$	$F_{CH4,PJ}$
Unit	tCH_4	tCH_4
2014-08-19 ~ 2014-12-31	1,095	5,475
2015	2,830	14,151
2016-01-01 ~ 2016-08-18	1,923	9,613
Total	5,848	

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
2014-08-19 ~ 2014-12-31	5,475	0	0	5,475
2015	14,151	0	0	14,151
2016-01-01 ~ 2016-08-18	9,613	679	0	8,934
Total	29,239			

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
2014-08-19 ~ 2014-12-31	0	0	0	25
2015	0	0	0	25
2016-01-01 ~ 2016-08-18	679	1,358	16,979	25
Total	679			

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

※ The detail calculation is in Daegu 5th 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 5th 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 5th 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 5th ER sheet ($F_{CH4,HG,h}$ Sheet)

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

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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
2014-08-19 ~ 2014-12-31	1,455	1,454	1
2015	4,869	4,133	736
2016-01-01 ~ 2016-08-18	3,494	2,737	757
Total	9,706		

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	%
2014-08-19 ~ 2014-12-31	1,454	2,585	0.5421	1	3.69%
2015	4,133	7,358	0.5421	1	3.60%
2016-01-01 ~ 2016-08-18	2,737	4,874	0.5421	1	3.59%
Total	8,324				

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

Period	PE_{FC}	FC_{LNG}	$COEF_{LNG}$
Unit	tCO_2eq	Nm^3	tCO_2/Nm^3
2014-08-19 ~ 2014-12-31	1	70	0.002514
2015	736	292,577	0.002515
2016-01-01 ~ 2016-08-18	757	302,538	0.002500
Total	1,494		

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
2014-08-19 ~ 2014-12-31	0.002514	0.04313	0.0583
2015	0.002515	0.04314	0.0583
2016-01-01 ~ 2016-08-18	0.002500	0.04289	0.0583

E.3. Calculation of leakage

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・ Calculations for all formulae used and calculation of leakage

N/A

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

Item	Baseline emissions or baseline net GHG removals by sinks ($t CO_2e$)	Project emissions or actual net GHG removals by sinks ($t CO_2e$)	Leakage ($t CO_2e$)	GHG emission reductions or net GHG removals by sinks ($t CO_2e$) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total	511,696	9,818	0	0	501,878	501,878

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

Item	Values estimated in ex ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks ($t CO_2e$)	355,383 tCO2e 2014.8.19 – 2015.8.18 : 177,823 tCO2e 2015.8.19 – 2016.8.18 : 177,560 tCO2e (Estimated Emission Reduction, which is described in PDD page 50)	501,878 tCO_2e

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

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The amount of estimated emission reductions which is calculated in registered PDD is 355,383 tCO_2e and actual emission reductions is 501,878 tCO_2e. The amount of difference between estimated and actual is 146,495 tCO_2e. The proportion of issuance is 141.18%.

The reason why the actual emission reduction is higher than estimated emission reduction calculated in 2nd crediting period (i.e in the registered PDD) is that the calculating method is changed. EPA Landfill Air Emission Medel(ver.2.01) was used to calculate estimated emission reduction for the 1st crediting period. It is because there is no calculation tool and guideline in the "ACM0001 methodology ver05". For the 2nd crediting period, as renewal of crediting period, "Emissions from solid waste disposal sites Ver.06.0.1" tool was used to calculate estimated emission reduction. However, the estimated emission reduction which is calculated by using the "Emissions from solid waste disposal site" tool was underestimated. PP concluded there are 3 evidence to support this insistence.

First, the actual emission reduction was not changed significantly.

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Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	☒ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
Organization name	Daegu Metropolitan City
Street/P.O. Box	88, Gongpeongno, Jung-Gu
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Contact person	
Title	Action officer
Salutation	Mr.
Last name	Kim
Middle name	
First name	Donggyeom
Department	
Mobile	
Direct fax	
Direct tel.	+82-53-803-4262
Personal e-mail	

Project participant and/or responsible person/ entity	☒ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
Organization name	Daesung Eco-Energy Co., Ltd.
Street/P.O. Box	449, Bangcheon-Ri, Dasa-Eup, Dalsung-Gun
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Fax	+82-53-593-2121
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Website	http://www.deeco.com
Contact person	
Title	President & CEO
Salutation	Dr

Last name	Lee
Middle name	
First name	Suk-hyung
Department	
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Personal e-mail	

Project participant and/or responsible person/ entity	☒ Project participant ☐ Person/entity responsible for completing the CDM-MR-FORM
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Middle name	
First name	Tae-Sop
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Project participant and/or responsible person/ entity	☒ Project participant ☒ Person/entity responsible for completing the CDM-MR-FORM
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