



**Project design document form
(Version 11.0)**

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

BASIC INFORMATION

Title of the project activity	Daegu Bangcheon-Ri Landfill Gas CDM Project
Scale of the project activity	<input checked="" type="checkbox"/> Large-scale <input type="checkbox"/> Small-scale
Version number of the PDD	Version 18.0
Completion date of the PDD	23/04/2021
Project participants	Daegu Metropolitan City Daesung Eco-energy Co., Ltd. Korea District Heating Corporation Ecoeye Co., Ltd.
Host Party	Republic of Korea
Applied methodologies and standardized baselines	Methodology: ACM0001 Flaring or use of landfill gas (version 19.0) Standardized baselines: No standardized baselines applicable.
Sectoral scopes	Sectoral Scope 1: Energy industries Sectoral Scope 13 : Waste Handling and Disposal
Estimated amount of annual average GHG emission reductions	233,150 tCO ₂ e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

>>

Daegu Bangcheon-Ri Landfill Gas CDM Project is located in 820, Dasa-Ro¹, Dasa-Eup, Dalsung-Gun, Daegu Metropolitan City, Korea. The total project area is 1,373,732 m². The landfill site is 1,053,732 m² including area of waste disposal, LFG utilization facility, road, afforestation and others. The area of the waste disposal is 853,400 m²², which was initially expanded from 585,334 m², after legal approval of the local environmental authorities. Daegu Metropolitan City have a plan that the landfill will be operated until 2050.

The expected amount of MSW³ till 2028 is as follows;

The expected amount of MWS at the landfill			
Year	Amount of MSW (ton/year)	Year	Amount of MSW (ton/year)
2014	466,987	2022	478,771
2015	494,887	2023	482,530
2016	357,522	2024	486,253
2017	282,633	2025	489,976
2018	301,056	2026	493,736
2019	322,242	2027	497,459
2020	347,796	2028	501,218
2021	475,011	Total	6,478,075 ton

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

Following are the purpose of the project activity;

Daegu Bangcheon-Ri Landfill Gas CDM Project:

- *changes the way of LFG treatment from simple incineration into improvement of capture efficiency and reuse as alternative energy;*
- *reduces adverse environmental impacts such as odour emission;*
- *prevents global warming by controlling methane emission to the atmosphere;*
- *reduces CO₂ emissions by altering usage of fossil fuel;*
- *creates financial benefit from CERs.*

¹ Road name address was enacted on October 4, 2006 and is based on the road name address law that began to be enforced on April 5, 2007. The business, which assigns road names and building numbers, was started 1996 and completed in September 2010. Starting in 2014, only road name address will be used as legal addresses.

² The expansion of Daegu Bangcheon-Ri landfill was approved by Daegu environmental office in November 2006, which was prior the registration of the project as CDM.

³ The source of the information is the feasibility study published by Daegu Metropolitan City in February 2006, Status of bringing in wastes provided by Daegu Metropolitan City in 2014~2020.

The project activity contributes to sustainable development by following ways:

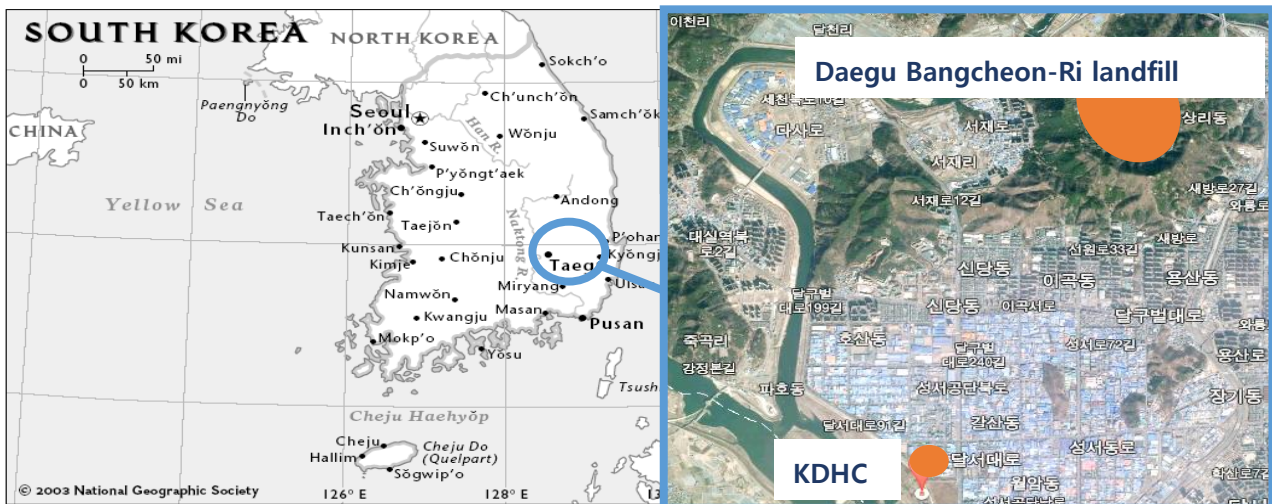
- To protect the environment, the project:
 - traps major landfill gas, CH₄ and mitigation of climate change;
 - solves environmental problems in the vicinity of landfill site by reducing odor and danger of explosion;
 - reduces non-methane organic compound.
- To replace fossil fuels, this project:
 - transfers landfill gas into alternative energy;
 - activates economy/raise competitiveness for local development;
 - manages landfill gas and promotes initial settlement of the gas.
- Socio-economic effect, this project:
 - creates economic efficiency in the local area by selling medium quality gas;
 - brings positive reputation for Daegu Metropolitan City.

A.2. Location of project activity

>>

- Republic of Korea
- Daegu Metropolitan City
- Bangcheon-Ri, Dasa-Eup, Dalsung-Gun

Daegu Bangcheon-Ri Landfill site is located at 820, Dasa-Ro Dasa-Eup, Dalsung-Gun, Daegu Metropolitan City, Korea. Daegu Metropolitan City is located in the centre of Gyeongsangbuk-Do province located in the south-eastern part of Korea. The project site is located on the east longitude 128.5096, the north latitude 35.8814 and surrounded by mountains except the north site. 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 A-1> Location of Daegu Bangcheon-Ri Landfill site and KDHC

KDHC is about 8 km away from the Landfill, which is advantageous to utilize LFG geographically. For the project site location, refer to <Figure A-1> and <Figure A-2>.



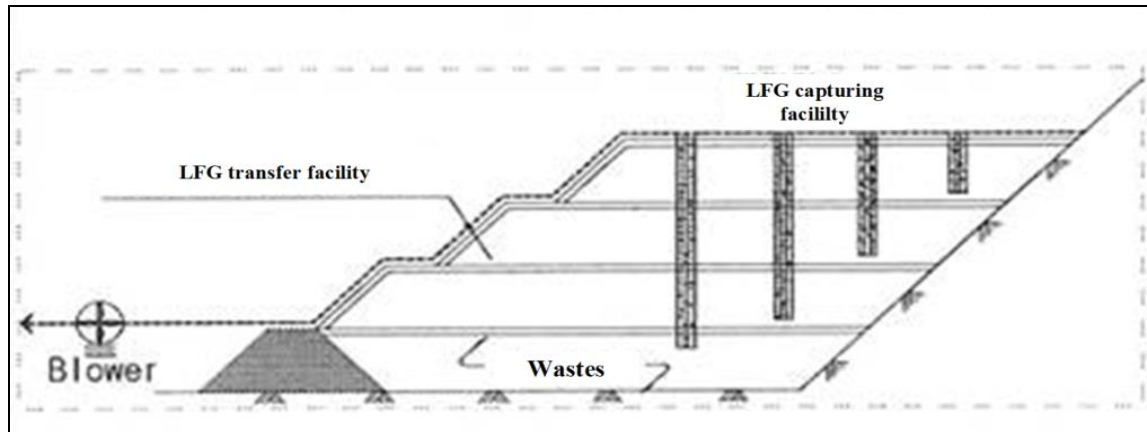
<Figure A-2> Bird's-eye-view of Daegu Bangcheon-Ri Landfill site

A.3. Technologies/measures

>>

- LFG capturing system

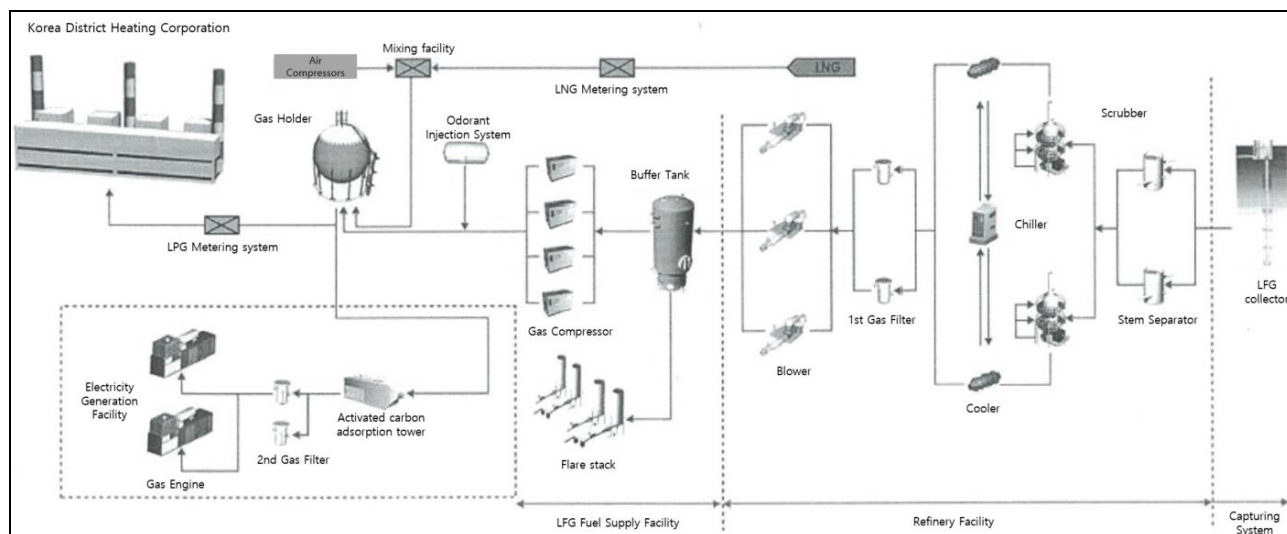
In order to capture LFG, vertical capturing pipes are installed for the project. The type of LFG capturing system is expected to enhance maintenance and LFG capturing efficiency because vertical capturing system has higher capturing efficiency and is easier to maintain and repair system compared to the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



<Figure A-3> Vertical LFG capturing equipment installation concept

- LFG utilization system

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



<Figure A-4> LFG utilization system flow chart

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

► 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.

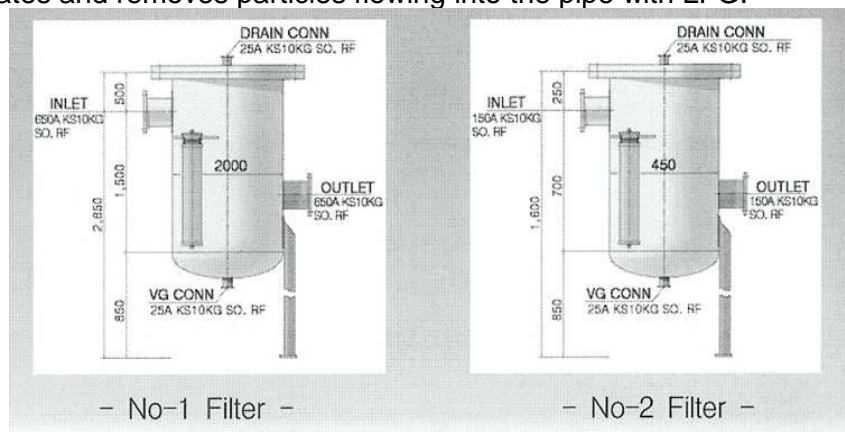


<Figure A-5> Blower

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

► Filter

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



<Figure A-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

► Scrubber

Scrubber removes acid gas (H₂S, NH₃ etc.) from LFG using solubility, so that the problem of erosion of the facility and pollutant emissions can be reduced.

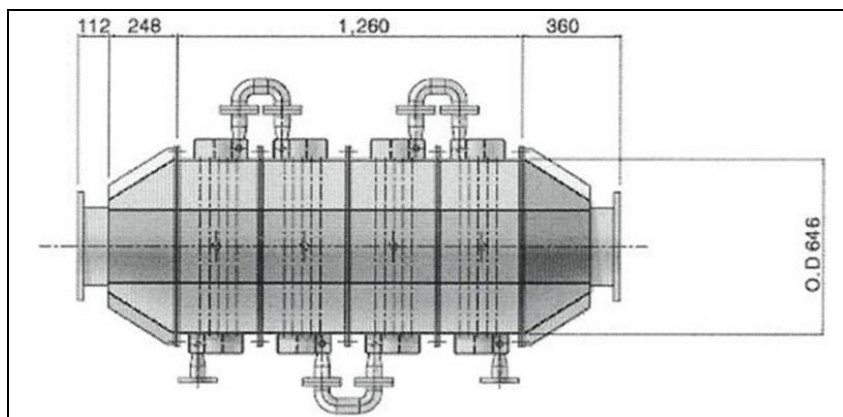


<Figure A-7> Scrubber

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

► Cooler

Cooler removes moisture in LFG, so that caloric value of the gas rises and trouble cause for the facility can be removed.



<Figure A-8> Cooler

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

► Chiller

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



<Figure A-9> Chiller

Equipment	CHILLER
No. of Equipment	CH-1-04 (1unit)
Type	Water-cooled, Screw type(Compact)
Capacity	147 RT

► Gas Engine

Gas Engine generates electricity which used for the internal use.



<Figure A-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)

► Flare Stack

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



<Figure A-11> Flare Stack

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

► 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 A-12> Gas storage tank

Equipment	Gas storageTANK
No. of Equipment	T-3-05 (1unit)
Type	Spherical Type
Capacity	3,000m ³

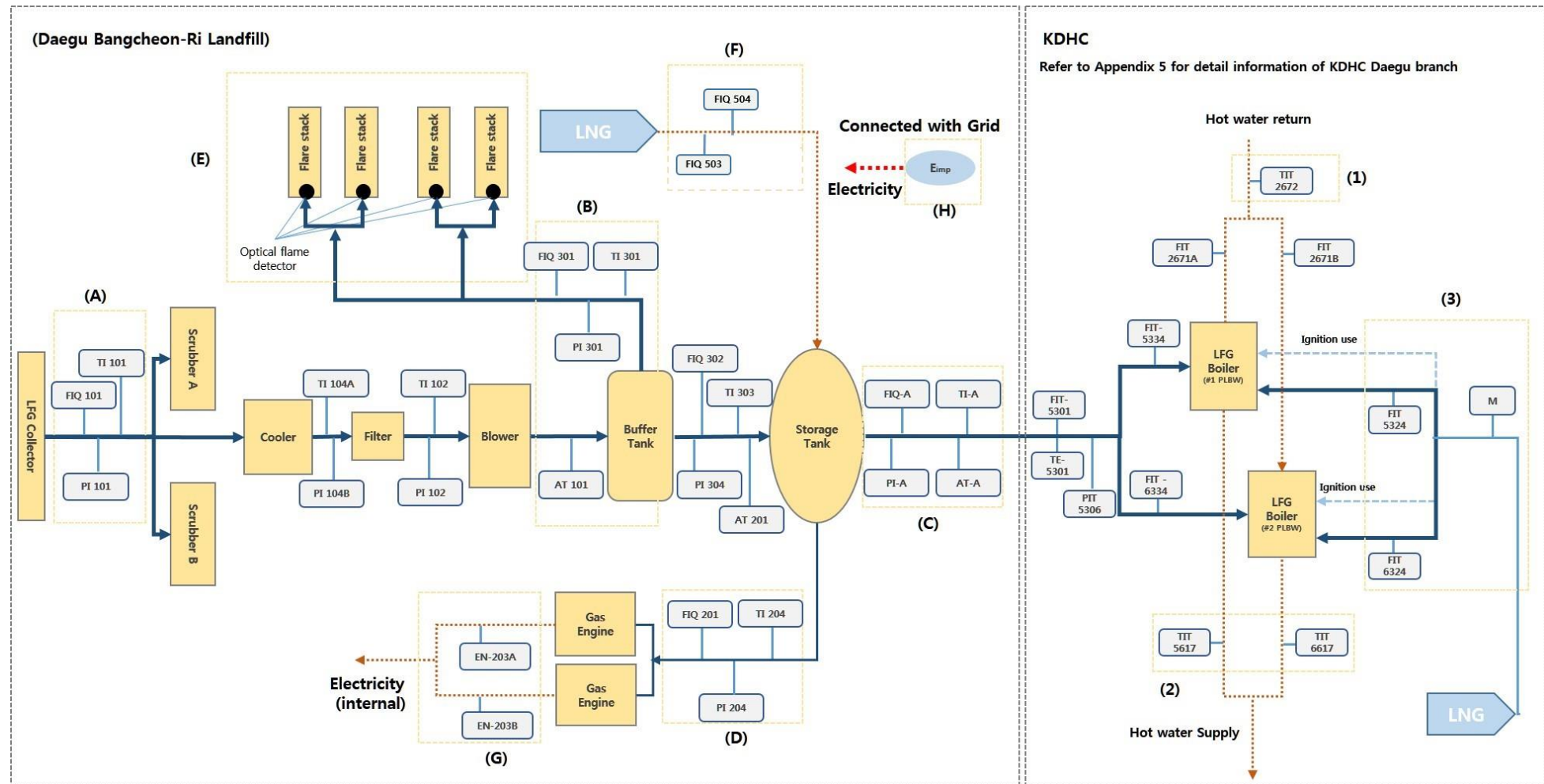
► LFG boilers

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

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

- Location of monitoring equipment

Monitoring equipment is composed of Flow meters, Manometer, thermometers, etc. Location of monitoring equipment is presented as follows.



<Figure A-13> Diagram of monitoring points

Landfill	(A)	FIQ-101	Flow meter	Flow meter - Type : Vortex or Turbine, Rotary flow meter - Accuracy : ±1.0%(Vortex), ±0.5%(Turbine, Rotary)												
		TI-101	Thermometer													
		PI-101	Manometer													
	(B)	FIQ-301	Flow meter	Manometer (pressure, transmitter) - Type : Diaphragm, Volume corrector - Accuracy : ±0.075%, ±0.25%												
		AT-101	Gas analyzer													
		TI-301	Thermometer													
		PI-301	Manometer													
	(C)	FIQ-A	Flow meter	Thermometer - Type : Thermocouple, RTD, Volume corrector - Accuracy : ±0.2%, ±0.305 t , ±0.25%												
		TI-A	Temperature													
		PI-A	Manometer													
		AT-A	Gas analyzer													
	(D)	FIQ-201	Flow meter	Optical flame detector (Type : UV-IR) - FD -101,102 (Accuracy: ±0.5mA) - FD -103,104 Operating Temperature Rating: -18℃ ~ 102℃ Maximum Pressure Rating : 5 psi (34.5kPa)												
		TI-204	Thermometer													
		PI-204	Manometer													
	(E)	FD-101	Optical flame detector	Gas Analyzer - Repeatability : ± 0.5 % - Linearity : 1% - Measurable Range												
		FD-102	Optical flame detector													
		FD-103	Optical flame detector													
		FD-104	Optical flame detector													
	(F)	FIQ-503	LNG flow meter	<table><tr><th>Gas</th><th>Minimum range</th><th>Maximum range</th></tr><tr><td>CH₄</td><td>0~1000 ppm</td><td>0 ~ 100 vol%</td></tr><tr><td>CO₂</td><td>0~500 ppm</td><td>0 ~ 100 vol%</td></tr><tr><td>O₂(Built-in paramagnet)</td><td>0~ 5 vol%</td><td>0 ~ 100 vol%</td></tr></table>	Gas	Minimum range	Maximum range	CH ₄	0~1000 ppm	0 ~ 100 vol%	CO ₂	0~500 ppm	0 ~ 100 vol%	O ₂ (Built-in paramagnet)	0~ 5 vol%	0 ~ 100 vol%
		Gas	Minimum range		Maximum range											
CH ₄	0~1000 ppm	0 ~ 100 vol%														
CO ₂	0~500 ppm	0 ~ 100 vol%														
O ₂ (Built-in paramagnet)	0~ 5 vol%	0 ~ 100 vol%														
FIQ-504	LNG flow meter															
(G)	EN-203A	Generated electricity indicator	Generated electricity Indicator on gas engines													
	EN-203B															
(H)	E _{imp}	Electricity meter (incoming)	- Three-phase four-wire system - 110/190 V 5(2.5)A 60 Hz 0.5 Rank													
(1)	TIT-2672	Thermometer	- Accuracy : ±0.25%													
(2)	TIT-5617	Thermometer	- Accuracy : ±0.25%													
	TIT-6617	Thermometer	- Accuracy : ±0.25%													
(3)	M	LNG flow meter	- Type : Turbine - Accuracy : Qt ~ Qmax : ±1% Qmin ~ Qt : ±2%													
	FIT-5324	LNG flow meter	- Type : Vortex - Accuracy : ±1%													
	FIT-6324	LNG flow meter	※ Reading Volumes in normalized cubic meters													

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

- ① Behind of the buffer tank (for reference, AT-201)
- ② In front of the buffer tank: The data measured by this gas analyser will be used to calculate flaring. (AT-101)
- ③ Behind the gas storage tank (right before supplying gas to user): The data measured by this gas analyser will be used to calculate heat and electricity generation. (AT-A)

Daegu Bangcheon-Ri landfill is only a landfill in Daegu Metropolitan which has an area of 883.48 Km² and 2.5 million people live in. The project is one of the best examples for green gas reduction in Republic of Korea. The project will contribute to enhance the knowledge and spread technology of waste utilization. These knowledge and experience will be an asset for the local area.

A.4. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of Korea (host Party)	<ul style="list-style-type: none"> • Public Entity: Daegu Metropolitan City (Project developer) • Public Entity: Korea District Heating Corporation (Project executor) • Private Entity: Daesung Eco-energy Co., Ltd. (Project executor) • Private Entity: Ecoeye Co., Ltd. (Project consultant) 	No

A.5. Public funding of project activity

>>

This CDM project has not been funded by official development assistance or other sources counted towards the financial obligations of Parties included in Annex I.

A.6. History of project activity

>>

The CDM project(Ref.0851) was registered in 19 Aug 2007 and the second crediting period which approved in 17 Sep 2016 was 19 Aug 2014~18 Aug 2021. It is now on 3rd renewal crediting period.

	(a)	(b)
1. Confirmation	<p>The proposed CDM project activity is neither registered as a CDM project activity <i>nor included</i> as a component project activity (CPA) in a registered CDM programme of activities (PoA);</p> <p>The CDM project(Ref. 0851) registered in 19 Aug 2007 is now on 3rd crediting period. The CDM project is not linked to other CDM project.</p>	<p>The proposed CDM project activity is not a project activity that has been deregistered.</p>
2. Declaration	<p>The proposed CDM project activity is not a project activity that has been deregistered.</p> <p>The CDM project(Ref. 0851) registered in 19 Aug 2007 is now on 3rd crediting period. The third crediting period is from 19 Aug 2021 to 18 Aug 2028. The CDM project is not linked to other CDM project.</p>	<p>A registered CDM project activity or a CPA under a registered CDM PoA whose crediting period has or has not expired (hereinafter referred to as former project) exists in the same geographical location as the proposed CDM project activity.</p>

A.7. Debundling

>>

Not applicable

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

>>

ACM0001 version 19.0 "Flaring or use of landfill gas", has been applied to this project.

The other methodological tools applied along with the methodology are:

- TOOL02-"Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0)
- TOOL03-"Tool to calculate project or leakage CO2 emissions from fossil fuel combustion"(version 03.0)
- TOOL04-"Emission from solid waste disposal sites" (version 08.0)
- TOOL05-"Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0)
- TOOL06-"Project emissions from flaring" (version 03.0)
- TOOL07-"Tool to calculate the emission factor for an electricity system" (version 07.0)
- TOOL08-"Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03.0)
- TOOL09-"Determining the baseline efficiency of thermal or electric energy generation systems" (version 03.0)
- TOOL15-"Upstream leakage emissions associated with fossil fuel use" (version 02.0)

For more information on applied methodology and applicable tools please refer to the following link. (<https://cdm.unfccc.int/methodologies/DB/JPYB4DYQUXQPZLBDVPHA87479EMY9M>)

B.2. Applicability of methodologies and standardized baselines

>>

There are some updates on ACM0001 methodology. The project was originally registered under methodology ACM0001(version 05.0) "*Consolidated baseline methodology for landfill gas project activities*". After that the approved version of the 2nd crediting period for this CDM-PDD was ACM0001(version 15.0) "*Flaring or use of landfill gas*". The latest approved version of the baseline and monitoring methodology applied in this CDM-PDD is ACM0001(version 19.0) "*Flaring or use of landfill gas*".

The project activity meets following applicability conditions of the latest version methodology;

Methodological requirements		Justification
This methodology is applicable to the project activities which		
A	Install a new LFG capture system in an existing or new SWDS where no LFG capture system was or would have been installed prior to the implementation of the project activity; or	LFG was treated by simple flaring system prior to the implementation of the project activity. The simple flaring system prevented odor and safety for resident. Therefore A is not applicable.

B	<p>Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:</p> <p>i) The captured LFG was vented or flared and not used prior to the implementation of the project activity; and</p> <p>ii) In the case of an existing active LFG capture system for which the amount of LFG cannot be collected separately from the project system after the implementation of the project activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available.</p>	<p>This project introduces the efficient LFG capture system instead of existing LFG capture system. An existing capture part(i.e. LFG collection well) is reused for enhancing LFG capture efficiency.</p> <p>i) A significant amount of LFG from the landfill was released to atmosphere and not used even though the LFG is captured partially and combusted the simple flaring system.</p> <p>ii) Existing simple flaring system was one of the passive capture system.</p> <p>Therefore B is applicable.</p>
C	<p>Flare the LFG and/ or use the captured LFG in any (combination) of the following ways:</p> <p>i) Generation electricity;</p> <p>ii) Generating heat in a boiler, air heater or kiln (brick fire only) or glass melting furnace; and/or</p> <p>(iii) Supplying the LFG to consumers through a natural gas distribution network;</p> <p>(iv) Supplying compressed/liquefied LFG to consumers using trucks;</p> <p>(v) Supplying the LFG to consumers through a dedicated pipeline;</p>	<p>The captured LFG will be flared and be used for;</p> <p>i) Electricity generation;</p> <p>ii) Producing heat by using LFG at boilers and supplying thermal energy to end users.</p> <p>(v) Providing the amount of LFG to consumers via dedicated pipeline.</p> <p>Hence this version of the methodology is applicable.</p> <p>However, these emission reduction aren't claimed for 3rd crediting period.</p>
D	<p>Do not reduce the amount of organic waste that would be recycled in an absence of the project activity.</p>	<p>The project activity does not imply any change in the waste received at the landfill.</p> <p>Therefore D is satisfied.</p>
<p>The methodology is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is:</p>		
A	<p>Atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons; and</p>	<p>The most plausible baseline scenario is the atmospheric release of the significant LFG even though simple flaring system was installed for safety and odour problem as complied with environment regulation.</p> <p>Hence, it is applicable.</p>

B	<p>In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln;</p> <p>i) For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plant and/or</p> <p>ii) For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary.</p>	<p>The LFG will be used for;</p> <p>i) Electricity is supplied from the grid for internal use.</p> <p>ii) Oil boiler works and produces the heat using Residual fuel(i.e. B-C oil).</p> <p>Accordingly, the methodology is applicable.</p> <p>However, these emission reduction aren't claimed for 3rd crediting period.</p> <p>There is no change on baseline scenario between the 2nd and the 3rd crediting period.</p>
C	<p>In the case of LFG supplied to the end-user(s) through natural gas distribution network, trucks or the dedicated pipeline, the baseline scenario is assumed to be displacement of natural gas.</p>	<p>In the project, the LFG is transferred to the end-user through the dedicated pipeline, which is calculated as a project emission factor.</p> <p>However, it is not included in the baseline emissions in order to conservative calculation.</p> <p>Thus, C is not applicable.</p>
D	<p>In the case of LFG from a Greenfield SWDS, the identified baseline scenario is atmospheric release of the LFG or capture of LFG in a managed SWDS and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.</p>	<p>This project activity is not the case of LFG from a Greenfield SWDS.</p> <p>Therefore, D is not applicable.</p>
This methodology is not applicable in the following:		
A	<p>In combination with other approved methodologies. For instance, ACM0001 cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln or glass melting furnace, where the purpose of the CDM project activity is to implement energy efficiency measures at a kiln or glass melting furnace;</p>	<p>No other approved methodology is applied.</p>
B	<p>If the management of the SWDS in the project activity is deliberately changed during the crediting in order to increase methane generation compared to the situation prior to the implementation of the project activity.</p>	<p>The project implementers have no intention to change the management of the SWDS in the project activity to increase the methane generation over the project life cycle.</p>

TOOL04-“Emissions from solid waste disposal sites”(version 08.0)

Applicability conditions	Justification
<p>The Tool can be used to determine emission for the following types of application:</p> <p>(a) Application A: The CDM project activity mitigates methane emissions from a specific existing SWDS. Methane emissions are mitigated by capturing and flaring or combusting the methane (e.g. “ACM0001: Flaring or use of landfill gas”). The methane is generated from waste disposed in the past, including prior to the start of the CDM project activity. In these cases, the tool is only applied for and ex ante estimation of emissions in the project design document (CDM-PDD). The emissions will then be monitored during the crediting period using the applicable approaches in the relevant methodologies(e.g. measuring the amount of methane captured from the SWDS);</p> <p>(b) Application B: The CDM project activity avoids or involves the disposal of waste at a SWDS. An example of this application of the tool is ACM0022, in which municipal solid waste (MSW) is treated with an alternative option, such as composting or anaerobic digestion, and is then prevented from being disposed of in a SWDS. The methane is generated from waste disposed or avoided from disposal during the crediting period. In these cases, the tool can be applied for both ex ante and ex post estimation of emissions. These project activities may apply the simplified approach detailed in 0 when calculating baseline emissions.</p>	<p>This project reduces the amount of methane emitted by capturing and flaring from an existing SWDS.</p> <p>The tool is only used for the calculation of an ex ante estimation.</p> <p>Therefore (a) Application A is applicable.</p>
<p>In the case that: (a) different types of residual waste are disposed or prevented from disposal; or that (b) both MSW and residual waste(s) are prevented from disposal, then the tool should be applied separately to each residual waste and to the MSW.</p>	<p>The condition is not applicable. This project activity treats only MSW, not residual.</p>

TOOL05-“Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation(version 03.0)”

Applicability conditions	Justification
<p>If emissions are calculated for electricity consumption, the tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption:</p> <ul style="list-style-type: none"> (a) Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either no captive power plant(s) is/are installed at the site of electricity consumption or, if any captive power plant exists on site, it is either not operating or it is not physically able to provide electricity to the electricity consumer; (b) Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid; or (c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power plant(s) and the grid. 	<p>In this project, there are gas engine generators, but it is not operating. Therefore, electricity consumption is not consumed from the captive power plant, but only from the grid.</p> <p>In other words, the project corresponds to (a) Scenario A.</p>
<p>This tool can be referred to in methodologies to provide procedures to monitor amount of electricity generated in the project scenario, only if on out of the following three project scenarios applies to the recipient of the electricity generated:</p> <ul style="list-style-type: none"> (a) Scenario I: Electricity is supplied to the grid; (b) Scenario II: Electricity is supplied to consumers/electricity consuming facilities; or (c) Scenario III: Electricity is supplied to the 	<p>After the implementation of project activity, gas engine generators have been installed at the site, but they are not actually operating. The result is that the amount of the electricity generation is not supplied to the grid and consumers.</p> <p>Thus this condition is not relevant to this project.</p>

grid and consumers/electricity consuming facilities.	
This tool is not applicable in cases where captive renewable power generation technologies are installed to provide electricity in the project activity, in the baseline scenario or to sources of leakage. The tool only accounts for CO ₂ emissions.	In the project activity, in the baseline scenario or to sources of leakage, electricity is provided from grid, not captive renewable power generation.

TOOL06-“Project emissions from flaring”(version 03.0)

Applicability conditions	Justification
<p>This tool is applicable to the flaring of flammable greenhouse gases where:</p> <p>(a) Methane is the component with the highest concentration in the flammable residual gas; and</p> <p>(b) The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g. biogas, landfill gas or wastewater treatment gas).</p>	<p>In this project, LFG is used and flared by capture system in an existing landfill.</p> <p>Therefore, this condition is applicable.</p>
<p>The tool is not applicable to the use of auxiliary fuels and therefore the residual gas must have sufficient flammable gas present to sustain combustion. For the case of an enclosed flare, there shall be operating specifications provided by the manufacturer of the flare.</p>	<p>The project is not applicable to the use of auxiliary fuels and is capable of supplying combustible gases sufficient to sustain combustion.</p> <p>There are two enclosed flares in Daegu Bangcheon-Ri landfill. It is managed operated in accordance with the flare manufacturer's manual.</p> <p>Thus, this tool is applicable in the PDD.</p>

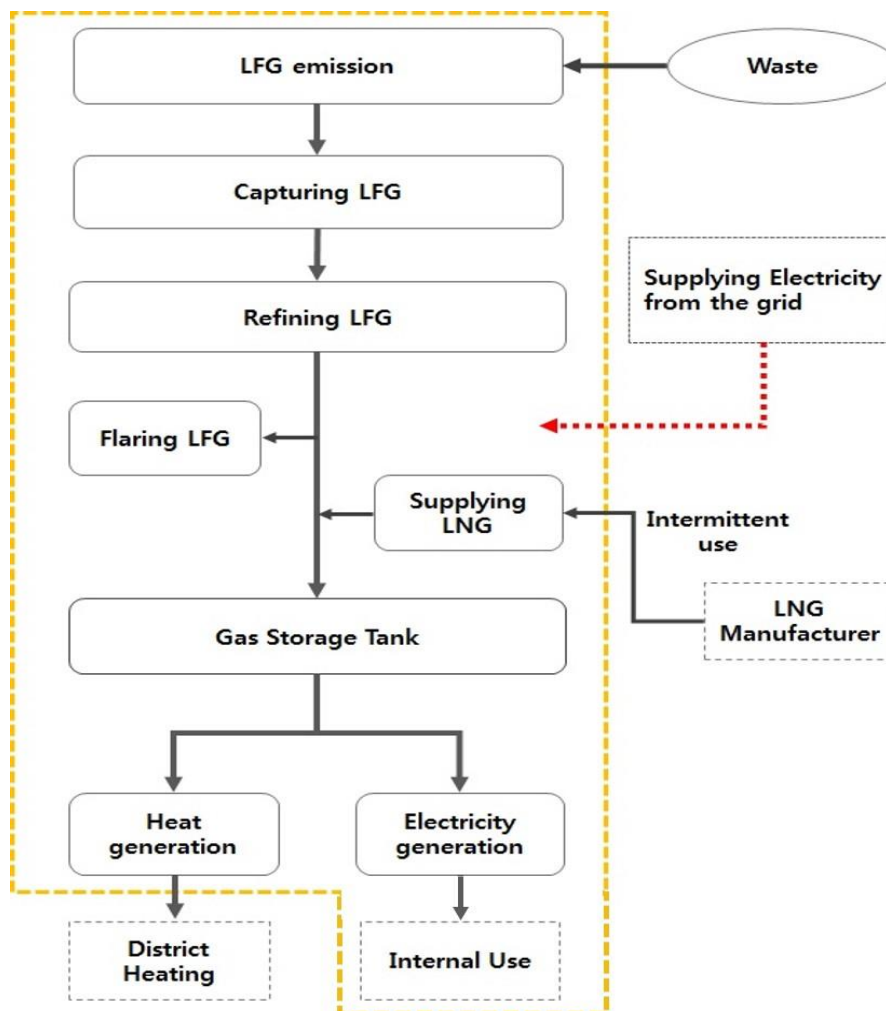
TOOL07-“Tool to calculate the emission factor for an electricity system” (version 07.0)

Applicability conditions	Justification
<p>This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid(e.g. demand-side energy efficiency projects).</p>	<p>The project activity will generate electricity for internal use by using the LFG.</p> <p>Hence, This condition is applicable.</p>
<p>In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country.</p>	<p>This project is located in Republic of Korea which in non-Annex I country.</p> <p>Therefore, this condition is not relevant for the project.</p>

B.3. Project boundary, sources and greenhouse gases (GHGs)

>>

The project boundary includes capturing, flaring LFG and utilizing captured LFG to generate electricity for in-house consumption and to produce thermal energy. Methane(CH_4) in LFG is destroyed by flaring at the incinerator, generating electricity at the gas engine and producing heat at the boilers.



<Figure B- 1> Boundary of the Project

Source		GHG	Included	Justification/Explanation
Baseline	Emissions from decomposition of waste at the SWDS site	CO ₂	No	CO ₂ emissions from the decomposition of organic waste are not accounted, even though CO ₂ is also released under the project activity.
		CH ₄	Yes	Methane is the major source of the emissions in the baseline.
		N ₂ O	No	N ₂ O emissions are small compared to CH ₄ emissions from landfills. Exclusion of this gas is conservative
	Emissions from electricity generation	CO ₂	No	There is a major emission source. Its emission reductions caused by displacing energy from other sources are not claimed.
		CH ₄	No	There is a minor emission source. Its emission reductions caused by displacing energy from other sources are not claimed.
		N ₂ O	No	There is a minor emission source. Its emission reductions caused by displacing energy from other sources are not claimed.
	Emissions from heat generation	CO ₂	No	There is a major emission source. Its emission reductions caused by displacing energy from other source are not claimed.
		CH ₄	No	There is a minor emission source. Its emission reductions caused by displacing energy from other sources are not claimed.
		N ₂ O	No	There is a minor emission source. Its emission reductions caused by displacing energy from other sources are not claimed.
	Emissions from the use of natural gas	CO ₂	No	Not applicable as there is no use of natural gas
		CH ₄	No	Not applicable as there is no use of natural gas
		N ₂ O	No	Not applicable as there is no use of natural gas
Project activity	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO ₂	Yes	It is an important emission source.
		CH ₄	No	Excluded for simplification. This is an emission source assumed to be very small.
		N ₂ O	No	Excluded for simplification. This is an emission source assumed to be very small.
	Emissions from electricity consumption due to the project activity	CO ₂	Yes	In case there is a shortage of electricity in the project for operation, electricity from the grid will be used and CO ₂ emission from the grid will be accounted as the project emissions.
		CH ₄	No	Excluded for simplification. This is an emission source assumed to be very small.
		N ₂ O	No	Excluded for simplification. This is an emission source assumed to be very small.
	Emissions from flaring	CO ₂	No	Emissions are considered negligible.
		CH ₄	Yes	It is a major emission source due to an incomplete combustion at the open type flaring system.
		N ₂ O	No	Emissions are considered negligible.
	Emissions from distribution of LFG using trucks and dedicated pipelines	CO ₂	Yes	The main emission sources caused by supplying of LFGs through dedicated pipelines.
		CH ₄	Yes	The main emission sources caused by supplying of LFGs through dedicated pipelines.
		N ₂ O	No	Emissions are considered negligible.

B.4. Establishment and description of baseline scenario

>>

The baseline scenario of the first crediting period is that LFG was treated by a simple flaring system prior to the project activity. Although some of the LFG were treated by the flaring system, the significant amount of LFG is released into the atmosphere.

According to "CDM project standard for project activities" (version 02.0), the project for renewal of the crediting period requires validation whether the original project baseline is still valid or has been updated taking into account the new data.

The validity of the original baseline is assessed as the tool "Assessment of the validity of the original/current baseline and update the baseline at the renewal of a crediting period" (version 03.0.1).

First up, an assessment of the impact of new relevant national and/or sectoral policies and circumstances on the baseline is carried out at the time of requesting a renewal of crediting period. When the current baseline is needed to update, the current baseline is updated and new parameters are added.

The validity of the current baseline of the registered CDM project activity is assessed using the following Steps:

Step 1: Assess the validity of the current baseline for the next crediting period***Step 1.1: Assess compliance of the current baseline with relevant mandatory national and/or sectoral policies***

In order to determine whether or not this baseline scenario still complies with all relevant mandatory national and/or sectoral policies, which has come into effect since validation, an examination must be conducted in order to determine whether or not any current regulations require the landfill to capture and destroy more amount of LFG or any additional mitigation activities.

The baseline scenario is that a significant amount of LFG generated at the Daegu Bancheon-Ri landfill was released to atmosphere even though the LFG is captured partially and combusted by the simple flaring system.

According to the article 7 on "Enforcement decree of the wastes control Act⁴", a landfill has facilities for gas incineration (such as simple burning system) or power generation and fuel-making are required in order to prevent surrounding environment problem (e.g. air pollution, odour, etc.). However, the regulation does not specify the amount of the LFG flared and captured, efficiency and specification of relevant equipment.

Current baseline complies with the all the relevant mandatory national policy because there is no regulatory changes regarding the relevant LFG treatment after CDM registration. Therefore, current baseline complies with all relevant mandatory national policies.

Step 1.2 Assess the impact of circumstances

There are some changes on ACM0001 methodology. According to the original PDD, project activity is captured LFG, generates electricity and produces heat by using LFG, but emission reduction for electricity and heat generation was not claimed due to an application limitation of ACM0001 methodology(version 05.0).

⁴ The relevant regulation can refer to

https://elaw.klri.re.kr/eng_mobile/viewer.do?hseq=51207&type=sogan&key=16

Although the latest ACM0001 methodology (version 19.0) applied on the renewal PDD could cover emission reduction of heat and electricity generation, baseline scenario of heat and electricity generation for the 3rd crediting period will not be considered consistently like the 1st and the 2nd crediting period.

As “Assessment of the validity of the original/current baseline and update the baseline at the renewal of a crediting period(version 03.0.1)”, it required an assessment of the impact of existing circumstances for renewal of the crediting period on the current baseline emissions without reassessing the baseline scenario.

Consequently, the original baseline scenario for the 1st and the 2nd crediting period is not reassessed, the original baseline scenario is still valid for the 3rd crediting period.

Step 1.3: Assess whether the continuation of use of current baseline equipment(s) or an investment is the most likely scenario for the crediting period for which is requested.

All equipment for the project activity were installed newly and will be kept for the renewal crediting period. Remaining technical lifetime of all equipment still cover for third crediting period.

Step 1.4: Assessment for the validity of the data and parameters

There are differences of methodological approaches, which are applicable. It should be considered as ex-ante determined parameter, other default values and assumptions between ACM0001 version 5 and 19.0.

For this reason, updated data and ex-ante determined parameters, updated default values are applied for estimation of baseline emissions during the 3rd crediting period. Thus, some of data and parameters are displaced and newly added.

The baseline emission, ex-ante determined parameter and monitored parameters for the 3rd crediting period are presented and justified in the following Step 2.

Step 2: Updates the current baseline and the data and parameters

Step 2.1: Update the current baseline

There are no updates on current baseline because the original baseline scenario is still valid for the 3rd crediting period.

As for a post registration changes during the 2nd crediting period which is an addition of component or extension of technology (i.e. adding two flare stacks), there is no effect on current baseline.

Step 2.2: Update the data and parameters

There are some changes in default value of some parameters and some new parameters are added due to the emission reduction calculation procedures and used algorithms. According to the temporary measures⁵ as a result of the EB 108th meeting, the lowest of the value of global warming potential of Methane (GWP_{CH4}) from the second, fourth and fifth IPCC assessment reports is applied for the 3rd crediting period until CMP 16 guidance is released. CO₂ emissions intensity of the electricity imported (currently known as grid emission factor) will be calculated based on the historical data available. New values based on the recent version of applicable tools and methodology will be added and the same values will be used for this crediting period.

For the purpose of the ex-ante emission reductions calculation, in the original registered PDD, a modified version of the US EPA First Order of Decay Model was used to calculate the methane destruction by the project. However, in the revised PDD for the 2nd crediting period, as per

⁵ For details of the temporary measures, see EB108 meeting report, paragraphs 7-8

https://cdm.unfccc.int/Reference/CDM_note.html

ACM0001(version 15.0), the methane generation from the landfill in the absence of the project activity ($BE_{CH_4, SWDS,y}$) is calculated as instructed in the "*Emissions from solid waste disposal sites (version 06.0.1)*". Baseline emission from the flaring of LFG is calculated in accordance with the methodological tool "*Project emissions from flaring*".

As the latest ACM0001 Version 19.0 and related methodological tool is applied for the 3rd crediting period, all applicable parameter (including the PRC which adding two flare stacks) are presented in Section B.6.1., B.6.2. and B.7.1.

B.5. Demonstration of additionality

>>

According to the CDM Project standard for project activities(version 02.0), the demonstration of additionality is not required for the renewal of the crediting period of a registered CDM project activity. Therefore, the part of the demonstration of additionality is the same as that during the second crediting period and the same applies to the third crediting period.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the project activity:

The following alternative scenarios are assessed to determine which of the scenarios is plausible to occur in the absence of the project (baseline scenario).

Scenario 1: Maintain the status quo. The previous status has been continued when this project was not existed. Prior to this project, LFG was flared by simple burning system.

Scenario 2: This project not undertaken as a CDM project activity. LFG is captured compulsory and flared through vertical captured pipe and horizontal captured pipe. Additionally, thermal energy is produced from LFG and produced thermal energy is provided to users.

Scenario 3: The project activity that deliver outputs and on services with comparable quality. This project treats LFG and reduces greenhouse gas emission. From the point of treating LFG, LFG incinerator can be considered as alternative which provides similar service, treating LFG. The activity which captures LFG and incinerates it using an incinerator also reduces CH₄ emission. However, it does not give positive influence to the environment more than reducing CH₄ emission. Also, the project participant can not make profit under this alternative.

Considering one of the policies of Daegu Metropolitan City, 'making green city', and other advantages, the project participant chose this project which reduces greenhouse gas emission and also influences the reduction of fossil fuel use by utilizing LFG as energy rather than other alternatives.

Sub-step 1b: Enforcement of applicable laws and regulations:

Each of the above three scenarios complies with Korean laws and regulatory requirements.

Step 2. Investment Analysis

GHG emission activity occurs in Daegu Bangcheon-Ri landfill site and Korea District Heating Corp. by capturing LFG, utilizing LFG and producing thermal energy using LFG. However, emission reductions caused by displacing energy from other sources are not claimed in this project.

Therefore, the boundary of investment analysis for this project is Daegu Bangcheon-Ri landfill site and income from sale of the refined LFG to Korea District Heating Corporation is included. In the post registration change, there is no revenue for this change, construction cost for installation of the two type flare stacks and O&M cost were only reflected on original economic analysis data.

Sub-step 2a. Determine appropriate analysis method

The CDM project contains income (from sale of the refined LFG) other than CERs. Therefore, Option I (Apply simple cost analysis) can not be selected, so it is necessary to choose from either Option II (Apply Investment comparison analysis) or Option III (Apply benchmark analysis). According to the methodology for determination of additionality, if the alternative to the CDM project activity does not include investments of comparable scale to the project, then Option III must be used. Option III will be applied for this project.

Sub-step 2b.-Option III. Apply benchmarking Analysis

IRR (Internal Rate of Return) is selected for the economic analysis indicator. IRR is the discount rate which makes that present value of income and present value of outcome are same. IRR can be compared to government bond rates increased by risk premium, required rate of return (RRR) on equity etc. to evaluate financial attractiveness of the project.

In this project, calculated IRR of the project is compared to 3 year term government bond rates increased by risk premium. Considering that the project executor (Daesung Eco-Energy Co., Ltd.) and the project developer (Daegu Metropolitan city) concluded an revised agreement for details of the project in 2005, applied government bond rate for investment analysis of the project was the average 3 year term government bond rate in 2004~2005 and the value is 4.2%.

Additionally, risk premium was substantiated by an accountant, independent financial expert. Considering the level of rate of return by SOC(Social Overhead Capital) project in Korea, the level of rate of return by environment related projects and the level of rate of return of the similar project to Daegu Bangcheon-Ri landfill gas utilization project, substantiated risk premium is 2.8%~3.8%.

Therefore, in this project, benchmark can be 7.0% which is the sum of average 3 year term government bond rate in 2004~2005 and the minimum value of risk premium, 2.8%, as conservative manner and IRR is compared to 7.0% benchmark.

Sub-step 2c. Calculation and comparison of financial indicator

-Calculation: The process for calculating IRR(Internal Rate of Return) is followed.

<Table B-1> Process for economic analysis

Table 2-12-1 Values for economic analysis

Used values for economic analysis												
Content	Value						Remarks					
Analysis period (years)	23						Construction period and expected project activity period					
Construction period	2005.5~2006.10 2009.7~2009.9											
Unit cost of LFG purchase(won/m3)	Depends on each year						Source : Unit cost of LFG purchase applied to financial analysis for the project					
Details of economic analysis implementation												
Year Content	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Construction cost (million Won)	-	15,145	2,602	-	-	2,226	-	-	-	-	-	-
New installation for LFG flaring stock (million Won)	-	-	-	-	-	-	-	-	-	-	-	-
Other investment cost (except construction cost) (million Won)	231	200	-	-	-	55	-	-	-	-	-	-
Operation & Maintenance cost (million Won)	-	-	480	1,270	1,272	1,620	1,360	1,927	1,539	2,507	1,834	1,868
Other expenses (million Won)	60	997	660	417	401	501	370	356	344	330	317	305
Corporation tax (million Won)	-	-	-	739	740	8	754	599	704	430	611	597
Amount of sold LFG (10 ³ m3)	-	-	12,982	50,691	50,886	52,010	52,855	53,070	53,239	53,093	53,093	53,093
Income of LFG purchase (million Won)	-	-	1,128	4,376	4,363	4,429	4,471	4,459	4,443	4,401	4,372	4,343

Year Content	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Construction cost (million Won)	-	-	-	-	-	-	-	-	-	-	-
New installation for LFG flaring stock (million Won)	-	-	566	-	-	-	-	-	-	-	-
Other investment cost (except construction cost) (million Won)	-	-	-	-	-	-	-	-	-	-	-
Operation & Maintenance cost (million Won)	2,624	1,273	1,454	1,641	1,276	1,725	1,97	1,548	1,540	1,274	1,758
Other expenses(million Won)	294	285	274	264	254	245	240	231	222	214	155
Corporation tax(million Won)	387	750	539	639	737	605	662	642	642	707	303
Amount of sold LFG (10 ³ m3)	53,239	53,093	53,093	53,093	53,239	53,093	53,093	53,093	53,239	53,093	39,711
Income of LFG purchase (million Won)	4,325	4,285	4,255	4,227	4,210	4,170	4,142	4,115	4,098	4,060	3,016
Outcome											
Content	Value			Remarks							
Cash outflow (Current value)	43,058,226,959			Accumulated from 2004 to 2026							
Cash inflow (Current value)	38,947,294,252			Accumulated from 2004 to 2026							
IRR (%)	4.579%										

*Economic analysis detail calculation contents will be submitted to DOE as an excel file

*Construction period above means the construction period of LFG utilization facility

-comparison of indicator: Result of comparing benchmark 7.0% is followed.

<Table B-2> Result of economic analysis

	IRR of the Project excluding CER income	Benchmark
Result (%)	4.579	7.0

Based on result of analysis, IRR of the Project is 4.579% which is lower than benchmark value 7.0%. Therefore, this project cannot be considered financially attractive.

Sub-step 2d. Sensitivity Analysis

Sensitivity analysis is performed as followed parameter variables

- +5%; Growth of benefit (Increasing unit cost of thermal energy purchase)
- -5%; Decrease total cost of construction
- -5%; Decrease O&M cost

Above parameters choose high variable values and chosen parameters analyse the result which is IRR with increased or decreased value.

<Table B-3> Result of sensitivity analysis

Scenario	IRR (%)
Standard	4.579
+5%; Growth of benefit (Increasing unit cost of LFG purchase)	5.631
-5%; Decrease total cost of construction	5.116
-5%; Decrease O&M cost	4.898

As a result of analysing, the result is lower than benchmark (7.0%). Therefore, this project is not available for commercial purpose. The purpose of this project is only for CDM which prevent global warming.

Step 3. Barrier analysis

Step 3 is skipped.

Step 4. Common practice analysis

Sub-step 4a. Analyse other activities similar to the proposed activity

Total number of landfill site is 238 all over the country in Korea. Because of high investment cost, only 7 sites utilize LFG for generating electricity or producing thermal energy (Source: Ministry of Environment of Korea 2004). 6 of those 7 sites generate electricity utilizing LFG and 1 site, Ulsan Seongam landfill site, utilizes LFG for producing thermal energy for internal use or selling Medium Energy Content Gas from refined LFG like Daegu Bangcheon-Ri landfill site which utilizes LFG for producing thermal energy. Also, considering that only 7 sites out of 238 landfill sites (about 3%) utilize LFG for generating and that 7 sites which utilize LFG developed the project through CDM project, it can be known that LFG utilization project including this project is not common in Korea.

<Table B-4> Landfill gas utilizing status in 2004

Landfill name	Province	Capacity (m ³)	Total size of landfill (m ²)
Sudokwon	Gyeyang-gu, Incheon	240,000,000	19,582,000
Busan, Sanggok	Busan	24,493,000	758,342
Unjeong-dong	Buk-gu, Gwang ju	4,369,000	261,898
Ulsan, Seongam	Nam-gu, Ulsan	4,255,000	142,663
Gunsan	Jeonbuk	2,562,000	278,000

Daejeon Keumgo-dong	Daejeon	8,762,000	602,429
Hwoicheon	Jeju	2,404,000	203,320
Daegu Bangcheon-Ri	Dalsung-gun, Daegu	9,224,941	585,334

(Source: National landfill statistic in 2004, Ministry of Environment)

Sub-step 4b: Discuss any similar options that are occurring

Most of Korean landfill is currently just flaring LFG. Only a few landfills utilize LFG because of high cost. Even though Daegu city prefer utilizing LFG to using other fossil fuel, it is not compulsory. Therefore, without generating CERs, utilizing LFG and producing thermal energy hardly occur in Daegu Bangcheon-Ri landfill site. Just flaring LFG does not violate Korean law.

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

>>

ACM0001(version 19.0) and applicable tools are used to calculated the emission reductions. The captured LFG will be used to generate energy (heat and electricity) in replacement of fossil fuel.

Baseline emissions

Baseline emissions are determined according to equation (1) and comprised the following sources:

- (a) Methane emissions from the SWDS in the absence of the project activity;
- (b) Electricity generation using fossil fuels or supplied by the grid in the absence of the project activity;
- (c) Heat generation using fossil fuels in the absence of the project activity; and
- (d) Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = BE_{CH_4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \text{Equation (1)}$$

Where:

- BE_y = Baseline emissions in year y (tCO₂e/yr)
- $BE_{CH_4,y}$ = Baseline emissions of methane from the SWDS in year y (tCO₂e/yr)
- $BE_{EC,y}$ = Baseline emissions associated with electricity generation in year y (tCO₂/yr)
- $BE_{HG,y}$ = Baseline emissions associated with heat generation in year y (tCO₂/yr)
- $BE_{NG,y}$ = Baseline emissions associated with natural gas use in year y (tCO₂/yr)

The project activity produces heat energy and electricity by using LFG. The captured LFG is sent to KDHC(Korea District Heating Corporation), which is located in the project boundary, for heat generation. However, baseline scenario for the project activity do not include its heat and power generation so that $BE_{EC,y}$ and $BE_{HG,y} = 0$.

As the project does not send LFG to the natural gas distribution network, $BE_{NG,y} = 0$. In such condition Equation (1) could be simplified in the following form.

$$BE_y = BE_{CH_4,y} \quad \text{Equation (2)}$$

Step (A): Baseline emissions of methane from the SWDS ($BE_{CH_4,y}$)

Baseline emissions of methane from the SWDS are determined as follows, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account:

$$BE_{CH_4,y} = ((1 - OX_{top_layer}) \times F_{CH_4,PJ,y} - F_{CH_4,BL,y}) \times GWP_{CH_4} \quad \text{Equation (3)}$$

Where:

- $BE_{CH_4,y}$ = Baseline emissions of methane from the SWDS in year y (tCO₂e/yr)
- OX_{top_layer} = Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
- $F_{CH_4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in the project activity in year y (tCH₄/yr)
- $F_{CH_4,BL,y}$ = Amount of methane in the LFG that would be flared in the baseline in year y (tCH₄/yr)
- GWP_{CH_4} = Global warming potential of CH₄ (tCO₂e / tCH₄)

Step (A.1): Ex post determination of $F_{CH_4,PJ,y}$

During the crediting period, $F_{CH_4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s), boiler(s), air heater(s), glass melting furnace(s), kiln(s) and natural gas distribution, as follow:

$$F_{CH_4,PJ,y} = F_{CH_4,flared,y} + F_{CH_4,EL,y} + F_{CH_4,HG,y} + F_{CH_4,NG,y} \quad \text{Equation (4)}$$

Where:

- $F_{CH_4,PJ,y}$ = Amount of methane in the LFG which is flared and/or used in year y (tCH₄/yr)
- $F_{CH_4,flared,y}$ = Amount of methane in the LFG which is destroyed by flaring in year y (tCH₄/yr)
- $F_{CH_4,EL,y}$ = Amount of methane in the LFG which is used for electricity generation in year y (tCH₄/yr)
- $F_{CH_4,HG,y}$ = Amount of methane in the LFG which is used for heat generation in year y (tCH₄/yr)
- $F_{CH_4,NG,y}$ = Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year y (tCH₄/yr)

As the proposed Project Activity has not involved in natural gas generation, $F_{CH_4,NG,y} = 0$. The Equation (4) could be simplified as Equation(5) below;

$$F_{CH_4,PJ,y} = F_{CH_4,flared,y} + F_{CH_4,EL,y} + F_{CH_4,HG,y} \quad \text{Equation (5)}$$

The operation of the power plant, boiler and the flare should be monitored and no emission reduction should be claimed for methane destruction during non-working hours. This is taken into account by monitoring the hours that the equipment utilizing the LFG is operating in the year y ($OP_{j,h,y}$).

Amount of methane destroyed by power plant and boiler ($F_{CH_4,EL,y}$, $F_{CH_4,HG,y}$)

$F_{CH_4,EL,y}$ and $F_{CH_4,HG,y}$ are determined using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream (Version 03.0)”.

<Table B- 5> Measurement options

Option	Flow of gaseous stream	Volumetric fraction
A	Volume flow – dry basis	dry or wet basis
B	Volume flow – wet basis	dry basis
C	Volume flow – wet basis	wet basis
D	Mass flow – dry basis	dry or wet basis
E	Mass flow – wet basis	dry basis
F	Mass flow – wet basis	wet basis

Option A from Table B-5(measurement options) of the above tool is applied, that is, the volume flow is on a dry basis, and volumetric fraction is on a wet/dry basis. Absolute humidity is not calculated, as the gaseous stream is considered dry, which will be demonstrated by a gas temperature of less than 60°C (333.15 K) at the flow measurement point⁶.

As per Option A, the mass flow of greenhouse gas *i* (methane) is determined as follows:

$$F_{CH_4,t} = V_{t,db} \times v_{CH_4,t,db} \times \rho_{CH_4,t} \quad \text{Equation (6)}$$

Where:

- $F_{CH_4,t}$ = Mass flow of CH₄ in the LFG in the gaseous stream (here used for electricity & heat generation) in time interval *t* (t CH₄/h)
- $V_{t,db}$ = Volumetric flow of the LFG (used for electricity and heat generation) in time interval *t* on a dry basis (m³ dry LFG/h)
- $v_{CH_4,t,db}$ = Volumetric fraction of CH₄ in the LFG in time interval *t* on a dry basis (m³ CH₄/m³ dry LFG)
- $\rho_{CH_4,t}$ = Density of CH₄ in time interval *t* (tCH₄/m³ CH₄)

Equation (6) will be separately used to calculate mass flow of CH₄ in the LFG stream for electricity generation and heat generation and they are then summed up. The mass flow calculated for hour *h* is 0 if the equipment is not working in hour *h* (Op_{*j,h*} = not working), the hourly values are then summed to a yearly unit basis (Op_{*j,h,y*})

According to the tool, density of greenhouse gas *i* (here methane) in the gaseous stream in time interval *t* can be calculated using following formula.

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \quad \text{Equation (7)}$$

Where:

- $\rho_{i,t}$ = Density of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas *i* / m³ gas *i*)
- P_t = Absolute pressure of the gaseous stream in time interval *t* (Pa)
- MM_i = Molecular mass of greenhouse gas *i* (kg/kmol)
- R_u = Universal ideal gases constant (Pa.m³/kmol.K)
- T_t = Temperature of the gaseous stream in time interval *t* (K)

⁶ Option A of “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”(Version 03.0)

Flow measurement on dry basis is not doable for a wet gaseous stream. If the moisture content of the gaseous stream (C_{H₂O,t,db,n}) is less than or equal to 0.05kgH₂O/m³ dry gas or the temperature of the gaseous stream (T_{*t*}) is less than 60°C(333.15 K) which is demonstrated that the gaseous stream is dry.

Because of gas volumes in normalized cubic meter, gas volumes and density of methane in normal condition are applied directly for this project.

Amount of methane destroyed by flaring ($F_{CH_4,flared,y}$)

$F_{CH_4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare and any methane emissions from the flare, as follows:

$$F_{CH_4,flared,y} = F_{CH_4,sent_flare,y} - \frac{PE_{flare,y}}{GWP_{CH_4}} \quad \text{Equation (8)}$$

Where:

$F_{CH_4,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year y (tCH ₄ /yr)
$F_{CH_4,sent_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year y (tCH ₄ /yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year y (tCO ₂ e/yr)
GWP_{CH_4}	=	Global warming potential of CH ₄ (tCO ₂ e/tCH ₄)

(1) $F_{CH_4,sent,flare,y}$

$F_{CH_4,sent,flare,y}$ is determined directly using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream(version 03.0)”.

As per Option A, the mass flow of greenhouse gas i (methane) is determined as follows:

$$F_{CH_4,t} = V_{t,db} \times v_{CH_4,t,db} \times \rho_{CH_4,t} \quad \text{Equation (9)}$$

Where:

$F_{CH_4,t}$	=	Mass flow of CH ₄ in the LFG in the gaseous stream (here used for electricity & heat generation) in time interval t (t CH ₄ /h)
$V_{t,db}$	=	Volumetric flow of the LFG (used for electricity and heat generation) in time interval t on a dry basis (m ³ dry LFG/h)
$v_{CH_4,t,db}$	=	Volumetric fraction of CH ₄ in the LFG in time interval t on a dry basis (m ³ CH ₄ /m ³ dry LFG)
$\rho_{CH_4,t}$	=	Density of CH ₄ in time interval t (tCH ₄ /m ³ CH ₄)

Because of gas volumes in normalized cubic meter, gas volumes and density of methane in normal condition are applied for this project.

(2) $PE_{flare,y}$

This project operates two enclosed flaring stacks installed in 2018 and two existing open flaring stacks. These flare stacks have handled with the captured LFG when heat demands are low in summer season. Project emissions from flaring of the residual gas stream in year y ($PE_{flare,y}$) is calculated as follow;

$PE_{flare,y}$ is determined using the methodological tool “Project emissions from flaring (version 03.0)” and is the sum of the emissions for each flare determined separately.

According to the above tool, $PE_{\text{flare},y}$ are calculated based on the flare efficiency ($\eta_{\text{flare},m}$) and the mass flow of methane to the flare ($F_{\text{CH}_4,\text{RG},m}$). The flare efficiency is determined for each minute m of year y based either on monitored data or default values.

Two type flare stacks(open and enclosed type) for the project satisfy applicability of Methodological tool “*Project emissions from flaring(version 03.0)*”.

- *Methane is the component with the highest concentration in the flammable residual gas (landfill gas); and*
- *The source of the residual gas is a gas from a biogenic source (landfill gas).*

The project emissions calculation procedure is given in the following steps:

- *Step 1: Determination of methane mass flow of the residual gas;*
- *Step 2: Determination of the flare efficiency;*
- *Step 3: Calculation of project emissions from flaring.*

Step 1: Determination of the methane mass flow of the residual gas;

$F_{\text{CH}_4,m}$ which is mass flow of methane in the residual gaseous stream in the minute m is determined as “*Tool to determine the mass flow of a greenhouse gas in a gaseous stream*”.

This project satisfy the following requirements on tool “*Project emission from flaring (version 03.0)*”.

- *The gaseous stream tool shall be applied to the residual gas;*
- *The flow of the gaseous stream shall be measured continuously;*
- *CH_4 is the greenhouse gas i for which the mass flow should be determined;*
- *The simplification offered for calculating the molecular mass of the gaseous stream is valid;*
- *The time interval t for which mass flow should be calculated is every minute m .*

$F_{\text{CH}_4,m}$ which is measured as the mass flow during minute m , shall then be used to determine the mass of methane in kilograms fed to the flare in minute m ($F_{\text{CH}_4,\text{RG},m}$), i.e. ($F_{\text{CH}_4,m} = F_{\text{CH}_4,\text{RG},m}$). $F_{\text{CH}_4,m}$ shall be determined on a dry basis.

Step 2: Determination of the flare efficiency;

The flare efficiency depends on the efficiency of combustion in the flare and the time that the flare is operating. There are four flare stacks onsite including two flare stacks of enclosed type and two flare stack of open type. Although the different type of flare stacks will run onsite, as a conservative approach, a default value($\eta_{\text{flare},m}$: 50%), which is an open type flare efficiency, is applied to all of the flare stacks of the project. The time is determined by monitoring the flame detectors.

The flare efficiency in the minute m ($\eta_{\text{flare},m}$) is 50% when each flame is detected in the minute m (Flame_m), otherwise $\eta_{\text{flare},m}$ is 0%.

There are one LFG flow meter and four flame detectors on the flaring system. Each flare stack will be controlled by each valve. Monitoring results from valves condition(Open or Close condition) and operation of the flame detectors will be reflected in determination of the time that the flare is operating.

In exceptional case, when flare stacks have breakdowns or regular inspections, these documentary evidences for the exceptional case will be provided to DOE during the verification.

Step 3: Calculation of project emissions from flaring

The project emission from flaring are calculated as the sum of emissions for each minute m in year

y, based on the methane mass flow in the residual gas ($F_{CH4, RG, m}$) and the flare efficiency ($\eta_{flare, m}$), as follows:

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

Where:

$PE_{flare, y}$	=	Project emissions from flaring of the residual gas stream in year y (tCO ₂ e)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO ₂ e/tCH ₄)
$F_{CH4, RG, m}$	=	Mass flow of methane in the residual gas in the minute m (kg)
$\eta_{flare, m}$	=	Flare efficiency in minute m

Step (A.1.1): Ex ante estimation of $F_{CH4, PJ, y}$

An *ex ante* estimation of $F_{CH4, PJ, y}$ is required to estimate baseline emission of methane from the SWDS in order to estimate the emission reductions during the 3rd crediting period. It is determined as follows:

$$F_{CH4, PJ, y} = \eta_{PJ} \times BE_{CH4, SWDS, y} / GWP_{CH4, t} \quad \text{Equation (11)}$$

Where:

$F_{CH4, PJ, y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH ₄ /yr)
$BE_{CH4, SWDS, y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year y (t CO ₂ e/yr)
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH4}	=	Global warming potential of CH ₄ (t CO ₂ e/t CH ₄)

$BE_{CH4, SWDS, y}$ is determined using the methodological tool “Emissions from solid waste disposal sites(version 08.0)”.

According to the above tool, the amount of methane generated from disposal of waste at the SWDS is calculated on a first order decay (FOD) model. The model differentiates between the different types of waste j with respective constant decay rates (k_j) and fractions of degradable organic carbon (DOC_j). The model calculates the methane generation occurring in year y (a period of 12 consecutive months) or month m based on the waste streams of waste types j ($W_{j, x}$ or $W_{j, i}$) disposed in the SWDS over a specified time period (years or months). The amount of methane generated from disposal of waste at the SWDS is calculated for year y by equation below:

$$BE_{CH4, SWDS, y} = \phi_y \times (1 - f_y) \times GWP_{CH4} \times (1 - OX) \times \frac{16}{12} \times F \times DOC_{t, y} \times MCF_y \times \sum_{x=1}^y \sum_j (W_{j, x} \times DOC_j \times e^{-k_j \times (y-x)} \times (1 - e^{-k_j})) \quad \text{Equation (12)}$$

Where:

$BE_{CH4, SWDS, y}$	=	Baseline methane emissions occurring in year y generated from waste disposal at a SWDS during a time period ending in year y (tCO ₂ e/yr)
x	=	Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (x=1) to year y (x=y)

y	=	Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)
$DOC_{f,y}$	=	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction)
$W_{j,x}$	=	Amount of solid waste type j disposed or prevented from disposal in the SWDS in the year x (t)
ϕ_y	=	Model correction factor to account for model uncertainties for year y
f_y	=	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
GWP_{CH_4}	=	Global Warming Potential of methane
OX	=	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	=	Fraction of methane in the SWDS gas (volume fraction)
MCF_y	=	Methane correction factor for year y
DOC_j	=	Fraction of degradable organic carbon in the waste type j (weight fraction)
k_j	=	Decay rate for the waste type j (1 / yr)
j	=	Type of residual waste or types of waste in the MSW

Application (A) specified in the “Emissions from solid waste disposal sites(version 08.0)” is selected to determine the parameters required above, that is, default values are adopted.

Step (A.2): Determination of $F_{CH_4,BL,y}$

This step provides a procedure to determine the amount of methane that would have been captured and destroyed (by flaring) in the baseline due to regulatory or contractual requirements, to address safety and odor concerns (collectively referred to as requirement in this step). The four cases in Table B-6 are distinguished as per ACM0001 version 19.0. The appropriate case should be identified and the corresponding instructions followed.

<Table B-6> Cases for determining methane captured and destroyed in the baseline

Situation at the start of the project activity:	Requirement to destroy methane	Existing LFG capture and destruction system
Case 1	No	No
Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

Daegu Bangcheon-Ri landfill had installed simple flaring system for destruction methane as “Wastes Control Act”. In this situation, the project activity satisfies the case 4(Requirement to destroy methane exists and LFG capture system exists):

$$F_{CH_4,BL,y} = \max\{F_{CH_4,BL,R,y}; F_{CH_4,BL,sys,y}\} \quad \text{Equation (13)}$$

$F_{CH_4,BL,R,y}$ = Amount of methane in the LFG which is flared in the baseline due to a requirement in year y (t CH₄/yr).

$F_{CH_4,BL,sys,y}$ = Amount of methane in the LFG that would be flared in the baseline in year y for the case of an existing LFG capture system (t CH₄/yr)

The regulatory requirement does not specify the amount or percentage of LFG that should be destroyed, and only requires the installation of LFG capture and treatment systems. For this reason, there is no historical or monitored data on amount of methane that was captured prior to the implementation of the project activity. Considering above situation, $F_{CH_4,BL,y}$ will be calculated as follow:

$$F_{CH_4,BL,y} = F_{CH_4,BL,sys,y} = 0.2 \times F_{CH_4,PJ,y} \quad \text{Equation (14)}$$

Where:

$F_{CH_4,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year y (t CH ₄ /yr).
$F_{CH_4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year y (t CH ₄ /yr)

Project emissions

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} + PE_{SP,y} \quad \text{Equation (15)}$$

Where

PE_y	=	Project emissions in year y (tCO ₂ /yr)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year y (tCO ₂ /yr)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year y (tCO ₂ /yr)
$PE_{DT,y}$	=	Emissions from the distribution of compressed/liquefied LFG using trucks, in year y (tCO ₂ /yr)
$PE_{SP,y}$	=	Emissions from the supply of LFG to consumers through a dedicated pipeline, in year y (tCO ₂ /yr)

$PE_{EC,y}$

The project emissions from consumption of electricity by the project activity ($PE_{EC,y}$) shall be calculated using the “*Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation*”. When applying the tool:

- $EC_{PJ,k,y}$ in the tool is equivalent to the amount of electricity consumed by the project activity in year y ($EC_{PJ,k,y}$);

Electricity consumption from grid is used for LFG treatment facility of Daegu Bangcheon-Ri landfill (i.e. refinery facilities, LFG fuel supply facilities, etc).

According to the “*Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation(version 03.0)*”, $PE_{EC,grid,y}$ is determined as follows:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y}) \quad \text{Equation (16)}$$

Where:

$PE_{EC,y}$	=	Project emissions from electricity consumption in year y (tCO ₂ /yr)
$EC_{PJ,j,y}$	=	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr) ($EC_{EL,grid,y}$ in this project)
$EF_{EF,j,y}$	=	Emission factor for electricity generation for source j in year y (tCO ₂ /MWh) ($EF_{grid,CM,y}$ in this project)
$TDL_{j,y}$	=	Average technical transmission and distribution losses for providing to source j in year y ($TDL_{grid,y}$ in this project)

The combined margin emission factor is calculated for the emission factor for electricity generation ($EF_{EL,grid,y}$) as the option A1 mentioned in the “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation(version 03.0)”.

- Option A1: Calculate the combined margin emission factor of the applicable electricity system, using the procedures in the latest approved version of the “Tool to calculate the emission factor for an electricity system(version 07.0)” ($EF_{EL,j,y} = EF_{grid,CM,y}$)

Determination of CO₂ $EF_{grid,CM,y}$

Recent version(version 07.0) of “Tool to calculate the emission factor for an electricity system” is used for calculating $EF_{grid,CM,y}$. The tool is used for calculating the following parameters:

<Table B-7> Parameters determined by “to calculate the emission factor for an electricity system”

Parameter	SI Unit	Description
$EF_{grid,CM,y}$	tCO ₂ /MWh	Combined margin CO ₂ emission factor for the project electricity system in year y
$EF_{grid,BM,y}$	tCO ₂ /MWh	Build margin CO ₂ emission factor for the project electricity system in year y
$EF_{grid,OM,y}$	tCO ₂ /MWh	Operating margin CO ₂ emission factor for the project electricity system in year y

The combined margin CO₂ emission factors ($EF_{grid,CM,y}$) consists of operating margin CO₂ emission factors ($EF_{grid,OM,y}$) and build margin CO₂ emission factors ($EF_{grid,BM,y}$). $EF_{grid,CM,y}$, which is $EF_{j,y}$ in equation(16), is calculated using “Tool to calculate the emission factor for an electricity system(version 07.0)” and the six steps including one optional step in it are as follows:

- STEP 1. Identify the relevant electricity systems;
- STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional);
- STEP 3. Select a method to determine the operating margin (OM);
- STEP 4. Calculate the operating margin emission factor according to the selected method;
- STEP 5. Calculate the build margin (BM) emission factor;
- STEP 6. Calculate the combined margin (CM) emissions factor.

<Table B-8> Major parameter of emission factor

Parameter	Value	Source
FC _{i, m, y} is the amount of fuel <i>j</i> (in a mass or volume unit) consumed by a relevant power source <i>m</i> in year(s) <i>y</i> , which supplies electricity to the grid, not including low-operating cost and must-run power plants.	Refer to <Table Appendix 4-1>	Statistics of Electric Power in KOREA 2017-2019 (Source: KEPCO 2017-2019)
Net Calorific Values by Power Plant		Caloric value sourced from Statistics of Electric Power in 2017-2019 (Source: KEPCO 2017-2019) (Net Caloric Value = Caloric value × caloric value conversion factor)
EG _{m, y} (MWh) is the electricity delivered to the grid by source <i>m</i>		Statistics of Electric Power in KOREA 2010-2012, 2017-2019 (Source: KEPCO 2011-2013, 2017-2019)
Net Caloric Values Conversion Factor	Solid/Liquid fossil fuel : 0.95 Gaseous fuel : 0.90	2006 IPCC Guidelines for National Greenhouse Gas Inventories

Operating Margin Emissions Factor ($EF_{grid,OM,y}$) (ton CO ₂ /MWh)	0.5995	Calculated
Build Margin Emissions Factor ($EF_{grid,BM,y}$) (ton CO ₂ /MWh)	0.5027	Calculated for the 2 nd crediting period
Baseline Emissions Factor ($EF_{grid,CM,y}$) (ton CO ₂ /MWh) for the third crediting period	0.5269	Calculated

STEP 1. Identify the relevant electricity systems

According to “Tool to calculate the emission factor for an electricity system(version 07.0)”, there are three options to delineate the project electricity system:

- Option1: A delineation of the project electricity system by the DNA or the group of the DNAs of the host country(ies).
- Option2: A delineation of the project electricity system defined by the dispatch area and dispatching electricity generated by the project activity.
- Option3: A delineation of the project electricity system defined by more than one independent dispatch areas. (e.g. multi-nation power pools.)

The project choose Option2. A delineation of the project electricity system defined by the dispatch area and dispatching electricity generated by the project activity.



<Figure B- 2> National Power grid map of Korea (source: Korea Electric Power Corporation)

STEP 2. Choose whether to include off-grid power plants in the project electricity system (optional)

According to “Tool to calculate the emission factor for an electricity system (version 07.0)”, there

are two options to calculate the operating margin and build margin emission factor:

- *Option I:* Only grid power plants are included in the calculation.
- *Option II:* Both grid power plants and off-grid power plants are included in the calculation.

This project chooses **Option 1**. Only grid power plants are including in the calculation.

STEP 3. Select a method to determine the operating margin (OM)

Operating Margin emission factor ($EF_{\text{grid,OM,simple,y}}$) shall be calculated basis on one of the four following methods:

- *Option (a) Simple OM*
- *Option (b) Simple adjusted OM*
- *Option (c) Dispatch Data Analysis OM*
- *Option (d) Average OM*

If low-cost/must-run resources constitute less than 50% of total grid generation in average of the five most recent years, **Option (a) simple OM** can be chosen.

As described in “Tool to calculate the emission factor for an electricity system(version 07.0)”, the OM emission factor is calculated as the generation-weighted emissions per electricity unit of all generating units serving the system, excluding low-operating cost and must-run power plants. Low-cost/must-run resources include hydro, nuclear, low cost biomass, geothermal and solar generation. Furthermore, group energy is also defined as low-cost/must-run in the project. This is because as stated in “Electric Utility Act” Article 31(4)⁷, group energy is specified as one of the electric power that may be purchased preferentially by an electricity sales business entity in Republic of Korea.

<Table B-9> Gross electricity generation in the Republic of Korea during past 5 years (MWh)

Source: 2015~2019 Statistics of Electric Power in Korea

Item		Year				
		2015	2016	2017	2018	2019
Low cost/must run	Hydro	5,759,133	6,377,606	6,948,836	7,217,387	6,201,683
	Nuclear	157,161,254	154,195,147	141,278,284	127,077,899	138,679,204
	*Alternative	17,286,242	18,833,841	23,679,934	26,596,918	29,950,859
	**Group Energy	21,940,106	32,462,140	36,111,536	46,877,856	45,916,881
Sub Total		202,146,735	211,868,734	208,018,590	207,770,060	220,748,627
***Total		503,505,376	518,478,254	531,305,955	548,218,865	540,057,486
Off-grid	Private Power generation	576,355	220,419	304,506	798,850	1,146,405
	Internal combustion	227,179	237,297	212,507	257,264	263,647
Ratio of LCMR		40.15%	40.86%	39.15%	37.90%	40.88%
ShareLCMR		39.79%				
LCMR share <50% in recent 5 years → Simple OM						

*Alternative: New & Renewable

**Group Energy is Low cost/must run resources in Korea. According to “Electric utility act” article 31(4), an electric sales business entity may preferentially purchase the electricity produced by an integrated energy (group energy).

***Excluding Off-grid electricity generation

The table illustrates the gross electricity generation rate by energy sources of the host country (Republic of Korea), the rate of low cost/must run power generation does not exceed 50% of the total grid. In detail, the most recent 5-year (2015~2019) average data shows that the rate of low cost/must run is 39.79%. (Source: 2015~2019 Statistics of Electric Power in Korea)

⁷https://elaw.klri.re.kr/kor_service/lawView.do?hseq=48707&lang=ENG

Therefore, for this project case, “**Option (a) Simple OM**” is available.

For the simple OM, the emissions factor can be calculated using either of the two following data vintages:

- **Ex ante option:** If the ex ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation. For off-grid power plants, use a single calendar year within the 5 most recent calendar years prior to the time of submission of the CDM-PDD for validation.
- **Ex post option:** If the ex post option is chosen, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required calculating the emission factor for year y is usually only available later than six months after the end of year y , alternatively the emission factor of the previous year $y-1$ may be used. If the data is usually only available 18 months after the end of year y , the emission factor of the year proceeding the previous year $y-2$ may be used. The same data vintage (y , $y-1$ or $y-2$) should be used throughout all crediting periods.

For this project, **Ex-ante option** is chosen.

Step 4. Calculate the operating margin emission factor according to the selected method

(a) **Simple OM option** is chosen for the project as described in STEP 3 above.

The simple OM emission factor is calculated as the generation-weighted average CO₂ emissions per unit net electricity generation (tCO₂/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units.

The simple OM may be calculated using one of the following options;

Option A: Based on the net electricity generation and a CO₂ emission factor of each power unit;
or

Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.

For this project, **Option A** is chosen to calculate the simple OM.

Where Option A is used, the simple OM emission factor is calculated as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \text{Equation (17)}$$

Where:

- $EF_{grid,OMsimple,y}$ = Simple operating margin CO₂ emission factor in year y (tCO₂/MWh)
 $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
 $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
 m = All power units serving the grid in year y except low-cost / must-run power units
 y = The relevant year as per the data vintage chosen in Step 3

Determination of $EF_{EL,m,y}$

Depending on power unit m data, Option A1 Option A2 are chosen as follows to calculating $EF_{EL,m,y}$:

Option A1 If for a power unit m data on fuel consumption and electricity generation is available, the emission factor ($EF_{EL,m,y}$) should be determined as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

- $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
 $FC_{i,m,y}$ = Amount of fuel type i consumed by power unit m in year y (Mass or volume unit)
 $NCV_{i,y}$ = Net calorific value (energy content) of fuel type i in year y (GJ/mass or volume unit)
 $EF_{CO2,i,y}$ = CO₂ emission factor of fuel type i in year y (tCO₂/GJ)
 $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
 m = All power units serving the grid in year y except low-cost/must-run power units
 i = All fuel types combusted in power unit m in year y
 y = The relevant year as per the data vintage chosen in Step 3

Option A2 If for a power unit m only data on electricity generation and the fuel types used is available, the emission factor should be determined based on the CO₂ emission factor of the fuel type used and the efficiency of the power unit, as follows:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}} \quad \text{Equation (19)}$$

Where:

- $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
 $EF_{CO2,i,y}$ = Average CO₂ emission factor of fuel type i used in power unit m in year y (tCO₂/GJ)
 $\eta_{m,y}$ = Average net energy conversion efficiency of power unit m in year y (ratio)
 m = All power units serving the grid in year y except low-cost/must-run power units
 y = The relevant year as per the data vintage chosen in Step 3
 3.6 = Conversion factor (GJ/MWh)

In the case of this project, the applied data of $EF_{CO2,i,y}$ is according to the IPCC default values at the lower limit of the uncertainty at a 95 per cent confidence interval of the 2006 IPCC Guidelines on National GHG Inventories. Net calorific value (NCV) is based on calorific values provided by KEPCO(2017~2019 Statistics of Electric Power in Korea) which is indicated as country-specific data of gross calorific value(GCV) and conversion factor suggested in the 2006 IPCC Guidelines. The detailed information used in the calculation is presented at tables in Appendix 4. Furthermore, the data of $\eta_{m,y}$ is applied as a default value of constant efficiency⁸ in accordance with “*Determining the baseline efficiency of thermal or electric energy generation systems (version 03.0)*”.

Determination of $EG_{m,y}$

- For grid power plants, $EG_{m,y}$ should be determined as per the provisions in the monitoring tables.
- Off-grid power plants are not considered in determination of $EG_{m,y}$.

As a result, the OM emission factor ($EF_{grid,OM,simple,y}$) is 0.5995 (tCO₂/MWh).

STEP 5. Calculate the build margin (BM) emission factor

According to “*Tool to calculate the emission factor for an electricity system (version 07.0)*”, there are two options to choose in order to calculate the BM.

- **Option 1.** For the first crediting period, calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information

⁸ Main sources for values are IEA Energy technology perspective publication 2010 to 2017, IEA, Projected costs of generating electricity, 2015 and IEA, World Energy Outlook, 2018

available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

- **Option 2.** For the first crediting period, the build Margin emission factor shall be updated annually, ex-post, including those unit built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex ant, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

For this project case, **Option 1** is chosen to calculate the BM emission factor.

The build margin factor calculated for the second crediting period is used for the third crediting period, and the values for the second crediting period are as follows.

The sample group of power units m used to calculate the build margin should be determined as per the following procedure as described in the methodology, consistent with the data vintage selected in the steps above:

- Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5-units}$) and determine their annual electricity generation ($AEG_{SET-5-units}$, in MWh);
- Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total} , in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET-\geq 20\%}$, in MWh);
- From $SET_{5-units}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample}); Identify the date when the power units in SET_{sample} started to supply electricity to the grid.

If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. Ignore steps (d), (e) and (f).

Following the guidance above, the sample group of power unit m is established to calculate the build margin.

- Calculation of the Build Margin (BM) emission factor (Refer to <Table Appendix 4-2>)

	Result										
Step (a)	<p>- Five power units that started to supply electricity to the grid most recently (SET_{5-units}):</p> <table border="1"> <tr><td>1. Namjeju solar</td><td>2012.10</td></tr> <tr><td>2. Yeonggwang solar (#3)</td><td>2012.10</td></tr> <tr><td>3. Yeonggwang-wind</td><td>2012.10</td></tr> <tr><td>4. Busan solar</td><td>2012.10</td></tr> <tr><td>5. Juam</td><td>2012.10</td></tr> </table> <p>- Total electricity generation in 2012: 1,358 MWh</p>	1. Namjeju solar	2012.10	2. Yeonggwang solar (#3)	2012.10	3. Yeonggwang-wind	2012.10	4. Busan solar	2012.10	5. Juam	2012.10
1. Namjeju solar	2012.10										
2. Yeonggwang solar (#3)	2012.10										
3. Yeonggwang-wind	2012.10										
4. Busan solar	2012.10										
5. Juam	2012.10										
Step (b)	<p>- AEG_{total}: 488,046,169 MWh</p> <p>- The set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total}: Refer to the Appendix 4</p> <p>- AEG_{SET-≥20%}: 101,644,356 MWh (20.83 % of AEG_{total})</p>										
Step (c)	<p>- SET_{sample}: SET_{≥20%} because it is larger than SET_{5-units}.</p> <p>- Because none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, steps (d), (e) and (f) are ignored.</p>										
Step (d)~(f)	Skipped (Not applicable)										

The build margin emissions factor is the generation-weighted average emission factor (tCO₂/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \text{Equation (20)}$$

Where;

- $EF_{grid,BM,y}$ = Build margin CO₂ emission factor in year y (tCO₂/MWh)
 $EG_{m,y}$ = Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
 $EF_{EL,m,y}$ = CO₂ emission factor of power unit m in year y (tCO₂/MWh)
 m = Power units included in the build margin
 y = Most recent historical year for which electricity generation data is available

According to the BM calculation formula and variables of above tables, $EF_{BM,y}$ is 0.5027 (tCO₂/MWh).

STEP 6. Calculate the combined margin emissions factor

The calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

- (a) Weighted average CM; or
 (b) Simplified CM.

The weighted average CM method (Option a) is used for this project.

(a) Weighted average CM

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \quad \text{Equation (21)}$$

Where,

$EF_{grid,CM,y}$	= Combined margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EF_{grid,OM,y}$	= Operating margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EF_{grid,BM,y}$	= Build margin CO ₂ emission factor in year y (tCO ₂ /MWh)
W_{OM}	= Weighting of operating margin emissions factor (%)
W_{BM}	= Weighting of build margin emissions factor (%)

2nd and 3rd crediting period:

According to “Tool to calculate the emission factor for an electricity system (version 07.0)”, the project activities are $w_{OM}=0.5$ and $w_{BM}=0.5$ (owing to intermittent and non-dispatchable nature) for the first crediting period. However, for the third crediting periods, the values of w_{OM} and w_{BM} should be 0.25 and 0.75 respectively.

And $EF_{grid,OM,y}$, $EF_{grid,BM,y}$ are calculated as described in Steps 4 and 5 above and are expressed in tCO₂/MWh. Therefore baseline emission factor ($EF_{grid,CM,y}$) for this project is 0.5269(tCO₂/MWh) as follows:

$$\begin{aligned}
 EF_{grid,CM,y} &= EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \\
 &= 0.25 \times 0.5995 \text{ tCO}_2/\text{MWh} + 0.75 \times 0.5027 \text{ tCO}_2/\text{MWh} \\
 &= 0.5269 \text{ tCO}_2/\text{MWh}
 \end{aligned}$$

$PE_{FC,y}$

The amount of methane collection in the landfill fluctuate seasonally as the character of the project activity. For this reason, supplement of LNG(Liquefied Natural Gas) on LFG is important for continuous and efficient operating the LFG boilers which is a base-load units of KDHC. Other LNG use is to start up LFG boilers as ignition. As per ACM0001(version 19.0), project emissions from fossil fuel consumption(i.e. LNG) will be calculated using the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion(version 03.0)”, when applying the tool:

- Process j in the tool correspond to the sources of fossil fuel consumption due to the project activity other than for electricity generation or and any on-site transportation by trucks or cars;

The tool is applicable, because fossil fuel consumption is related with project activity.

As per “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion(version 03.0)”, determination of $PE_{FC,y}$ is followed;

$$PE_{FC,j,y} = \sum_j FC_{LNG,j,y} \times COEF_{LNG,y} \quad \text{Equation (22)}$$

Where:

$PE_{FC,j,y}$	=	The CO ₂ emissions from fossil fuel combustion in process j during the year y (tCO ₂ /yr)
$FC_{LNG,j,y}$	=	Quantity of LNG combusted in process j during the year y (Nm ³ /yr)
$COEF_{LNG,y}$	=	CO ₂ emission coefficient of LNG in year y (tCO ₂ /Nm ³)

Option B is selected as “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion(Version 03.0)”.

$$COEF_{LNG,y} = NCV_{LNG,y} \times EF_{CO2,LNG,y} \quad \text{Equation (23)}$$

Where:

$COEF_{LNG,y}$	=	CO ₂ emission coefficient of LNG in year y (tCO ₂ /Nm ³)
$NCV_{LNG,y}$	=	Net calorific value of the LNG in year y (GJ/Nm ³)
$EF_{CO2,LNG,y}$	=	CO ₂ emission factor of LNG in year y (tCO ₂ /GJ)

$PE_{DT,y}$

The project emissions from the distribution of compressed/liquefied LFG using trucks ($PE_{DT,y}$) is determined by the sum of emissions arising from the transportation of LFG using trucks and possible leaks during the transportation, as follows:

$$PE_{DT,y} = PE_{TR,y} + PE_{Leaks,y} \quad \text{Equation (24)}$$

Where:

$PE_{DT,y}$	=	Project emissions from the distribution of compressed/liquefied LFG using trucks, in year y (tCO ₂ /yr)
$PE_{TR,y}$	=	Emissions from the transportation of compressed/liquefied LFG using trucks, in year y (tCO ₂ /yr)
$PE_{Leaks,y}$	=	Emissions from CH ₄ leaks during the transportation of compressed/liquefied LFG in year y (tCO ₂ /yr)

Daegu Bangcheon-Ri landfill is connected with the KDHC through the dedicated pipeline. There are no trucks for transportation of LFG. Therefore, the project is not considered $PE_{DT,y}$ ($FC_{TR,y}$ and $PE_{Leaks,y}$).

$$PE_{DT,y} = 0$$

 $PE_{SP,y}$

The project emissions from the supply of LFG through a dedicated pipeline ($PE_{SP,y}$) shall be determined as follows:

$$PE_{SP,y} = 0.0504 \times DEFT_{SP,y} \times F_{CH4,NG,y} \quad \text{Equation (25)}$$

Where:

$PE_{SP,y}$	=	Project emissions from the supply of LFG to consumers due to physical leakage from the dedicated pipeline, in year y (tCO ₂ /yr)
$DEFT_{SP,y}$	=	Default emission factor for the supply of LFG to consumers due to physical leakage through the dedicated pipeline (tCO _{2e} /TJ) ⁹
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the consumer through a dedicated in year y (tCH ₄ /yr)

B.6.2. Data and parameters fixed ex ante

Data/Parameter	OX_{top_layer}
Data 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 08.0)
Value(s) applied	0.1
Choice of data or measurement methods and procedures	-
Purpose of data	To determine the baseline emission
Additional comment	-

⁹ This default value (2.2 tCO_{2e}/TJ) is based on Tool 15-Upstream leakage emissions associated with fossil fuel use, version2, Appendix, Table 1, page 19 (Natural gas distribution).

Data/Parameter	GWP_{CH_4}
Data unit	tCO ₂ e/tCH ₄
Description	Global warming potential (GWP) of methane
Source of data	The IPCC second assessment report (AR2)
Value(s) applied	21 (It will be updated according to decision by the CMP 16.)
Choice of data or measurement methods and procedures	-
Purpose of data	To determine the baseline emission
Additional comment	Regarding applicable value, the lowest of the GWP values from the second, fourth and fifth IPCC Assessment reports 100 year shall be applied according to CDM-EB 108th meeting report. The project and PDD should be updated to satisfy the corresponding guideline When the CMP 16 guidance is finalized.

Data/Parameter	η_{PJ}
Data unit	Dimensionless
Description	Efficiency of the LFG capture system that will be installed in the project activity
Source of data	Final report for LFG generation improving way for Daegu Bangcheon-ri landfill (2013, Daesung Eco Energy Co.,Ltd.)
Value(s) applied	89.1%
Choice of data or measurement methods and procedures	-
Purpose of data	To determine the $F_{CH_4,PJ,y}$ for ex-ante estimation
Additional comment	Technical specifications of the LFG capture system

Data/Parameter	NCV_{CH_4}
Data unit	TJ/tCH ₄
Description	Net calorific value of methane at reference conditions
Source of data	Technical literature in accordance with ACM0001(version 19.0)
Value(s) applied	0.0504
Choice of data or measurement methods and procedures	-
Purpose of data	-
Additional comment	-

Data and parameters required for the “*Project emissions from flaring (version 03.0)*”

Data/Parameter	ρ_{CH_4}
Data unit	kg/m ³
Description	Density of methane gas at reference conditions
Source of data	“Project emissions from flaring” (version 03.0)
Value(s) applied	0.716
Choice of data or measurement methods and procedures	-
Purpose of data	-
Additional comment	-

Data and parameters required for the “*Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)*”

Data/Parameter	R_u
Data unit	Pa.m ³ /kmol.K
Description	Universal ideal gases constant
Source of data	“Tool to determine the mass flow of a greenhouse gas in gaseous stream” (version 03.0)
Value(s) applied	8,314
Choice of data or measurement methods and procedures	-
Purpose of data	-
Additional comment	-

Data/Parameter	MM _i (MM _{CH₄})		
Data unit	Kg/kmol		
Description	Molecular mass of greenhouse gas <i>i</i> (CH ₄)		
Source of data	“Tool to determine the mass flow of a greenhouse gas in gaseous stream” (version 03.0)		
Value(s) applied	The CH ₄ values of molecular mass is 16.04		
	Compound	Structure	Molecular mass(kg/kmol)
	Methane	CH ₄	16.04
Choice of data or measurement methods and procedures	-		
Purpose of data	-		
Additional comment	-		

Data and parameters required for the “Emissions from solid waste disposal sites (version 08.0)”

Data and parameters required for the “Emissions from solid waste disposal sites (version 08.0)”											
Data/Parameter	ϕ _{default}										
Data unit	-										
Description	Default value for the model correction factor to account for model uncertainties										
Source of data	“Emissions from solid waste disposal site(version 08.0)”										
Value(s) applied	<p>According to the above tool, one between the following Application A and B is chosen for calculating baseline emissions.</p> <p>For baseline emissions: refer to the following table to identify the appropriate factor based on the application of the tool(A or B) and the climate where the SWDS is located.</p> <p>Default values for the model correction factor</p> <table><tr><td></td><td>Humid/wet conditions</td><td>Dry conditions</td></tr><tr><td>Application A</td><td>0.75</td><td>0.75</td></tr><tr><td>Application B</td><td>0.85</td><td>0.80</td></tr></table> <p>As the project activity falls under Application A of the tool, 0.75 is the appropriate default value for ϕ_{default}</p>			Humid/wet conditions	Dry conditions	Application A	0.75	0.75	Application B	0.85	0.80
	Humid/wet conditions	Dry conditions									
Application A	0.75	0.75									
Application B	0.85	0.80									
Choice of data or measurement methods and procedures	-										
Purpose of data	To determine the F _{CH₄,PJ,y} for ex-ante estimation										
Additional comment	-										

Data/Parameter	W_j														
Data unit	-														
Description	Fraction of the waste type j(weight fraction)														
Source of data	Fraction of each waste type is based on ‘Status of waste generation and disposal nationwide (2019)’ which published by Ministry of Environment.														
Value(s) applied	<p>The following value s for the different waste types j should be applied</p> <p>Values for W_j</p> <table> <tr> <th>Waste type j</th><th>Value</th></tr> <tr> <td>Wood and wood product</td><td>1.7%</td></tr> <tr> <td>Pulp, paper and cardboard (other than sludge)</td><td>21.2%</td></tr> <tr> <td>Food, food waste, beverages and tobacco (other than sludge)</td><td>5.6%</td></tr> <tr> <td>Textiles</td><td>4.0%</td></tr> <tr> <td>Garden, yard and park waste</td><td>38.6%</td></tr> <tr> <td>Glass, plastic, metal, other inert waste</td><td>28.9%</td></tr> </table>	Waste type j	Value	Wood and wood product	1.7%	Pulp, paper and cardboard (other than sludge)	21.2%	Food, food waste, beverages and tobacco (other than sludge)	5.6%	Textiles	4.0%	Garden, yard and park waste	38.6%	Glass, plastic, metal, other inert waste	28.9%
Waste type j	Value														
Wood and wood product	1.7%														
Pulp, paper and cardboard (other than sludge)	21.2%														
Food, food waste, beverages and tobacco (other than sludge)	5.6%														
Textiles	4.0%														
Garden, yard and park waste	38.6%														
Glass, plastic, metal, other inert waste	28.9%														
Choice of data or measurement methods and procedures	-														
Purpose of data	To determine the $F_{\text{CH}_4, \text{PJ}, y}$ for ex-ante estimation														
Additional comment	-														

Data/Parameter	OX
Data unit	-
Description	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data	Based on an extensive review of published literature on this subject, including the IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.1
Choice of data or measurement methods and procedures	-
Purpose of data	To determine the $F_{CH_4,PJ,y}$ for ex-ante estimation
Additional comment	-

Data/Parameter	F
Data unit	-
Description	Fraction of methane in the SWDS gas (volume fraction)
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	-
Purpose of data	To determine the $F_{CH_4,PJ,y}$ for ex-ante estimation
Additional comment	Upon biodegradation, organic material is converted to a mixture of methane and carbon dioxide

Data/Parameter	$DOC_{f,default}$
Data unit	Weight fraction
Description	Default value for the fraction of degradable organic carbon (DOC) in MSW that can decompose in the SWDS
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	0.5
Choice of data or measurement methods and procedures	-
Purpose of data	To determine the $F_{CH_4,PJ,y}$ for ex-ante estimation
Additional comment	As per "Emissions from solid waste disposal sites(version 08.0)", the default value shall be applied to application A.

Data/Parameter	MCF_{default}
Data unit	-
Description	Methane correction factor
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value(s) applied	The appropriate default value for MCF _y is 1.0.
Choice of data or measurement methods and procedures	-
Purpose of data	To determine the F _{CH4,PJ,y} for ex-ante estimation
Additional comment	As per the tool, for Application A : MCF _y = MCF _{default} The project is an anaerobic managed solid waste disposal site, due to the fact that the landfill had controlled placement of waste, and included (i)cover materials; (ii)mechanical compacting; or (iii) levelling of the waste.

Data/Parameter	DOC_j														
Data unit	%														
Description	Fraction of degradable organic carbon in the waste type j (weight fraction)														
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories(adapted from Volume 5, Tables 2.4 and 2.5)														
Value(s) applied	<p>For MSW, the following values for the different waste types j should be applied</p> <p>Default values for DOC_j</p> <table border="1"> <thead> <tr> <th>Waste type j</th><th>DOC_j (% wet waste)</th></tr> </thead> <tbody> <tr> <td>Wood and wood product</td><td>43</td></tr> <tr> <td>Pulp, paper and cardboard (other than sludge)</td><td>40</td></tr> <tr> <td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td></tr> <tr> <td>Textiles</td><td>24</td></tr> <tr> <td>Garden, yard and park waste</td><td>20</td></tr> <tr> <td>Glass, plastic, metal, other inert waste</td><td>0</td></tr> </tbody> </table>	Waste type j	DOC _j (% wet waste)	Wood and wood product	43	Pulp, paper and cardboard (other than sludge)	40	Food, food waste, beverages and tobacco (other than sludge)	15	Textiles	24	Garden, yard and park waste	20	Glass, plastic, metal, other inert waste	0
Waste type j	DOC _j (% wet waste)														
Wood and wood product	43														
Pulp, paper and cardboard (other than sludge)	40														
Food, food waste, beverages and tobacco (other than sludge)	15														
Textiles	24														
Garden, yard and park waste	20														
Glass, plastic, metal, other inert waste	0														
Choice of data or measurement methods and procedures	-														
Purpose of data	To determine the F _{CH4,PJ,y} for ex-ante estimation														
Additional comment	-														

Data/Parameter	k_j																					
Data unit	1/yr																					
Description	Decay rate for the waste type j																					
Source of data	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 3.3)																					
Value(s) applied	<p>Apply the following default values for the different waste types j Default values for the decay rate(k_j)</p> <table border="1"> <thead> <tr> <th colspan="2" rowspan="2">Waste type j</th><th colspan="2">Boreal and Temperate (MAT)</th></tr> <tr> <th>Dry (MAP/PET<1)</th><th>Wet (MAP/PET>1)</th></tr> </thead> <tbody> <tr> <td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard(other than sludge), textiles</td><td>0.04</td><td>0.06</td></tr> <tr> <td>Wood, wood products and straw</td><td>0.02</td><td>0.03</td></tr> <tr> <td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td><td>0.1</td></tr> <tr> <td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.06</td><td>0.185</td></tr> </tbody> </table> <p>The region which the landfill is located in is summarized, as follows:</p> <ul style="list-style-type: none"> • Mean annual temperature(MAT): 13.2 °C • Mean Annual precipitation(MAP): 1,224.8 mm • Potential evapotranspiration(PET) : 1,069 mm <p>(Source: 'Climate change report of Daegu & Gyeong Sang Buk-do' published by Korea Meteorological administration)</p> <p>The climate in the area of the project site is both Boreal & Temperate and Wet. Therefore, values provided by "Emissions from solid waste disposal site"(version 08.0) for Boreal and Temperate, wet climate were applied.</p>	Waste type j		Boreal and Temperate (MAT)		Dry (MAP/PET<1)	Wet (MAP/PET>1)	Slowly degrading	Pulp, paper, cardboard(other than sludge), textiles	0.04	0.06	Wood, wood products and straw	0.02	0.03	Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.1	Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185
Waste type j				Boreal and Temperate (MAT)																		
		Dry (MAP/PET<1)	Wet (MAP/PET>1)																			
Slowly degrading	Pulp, paper, cardboard(other than sludge), textiles	0.04	0.06																			
	Wood, wood products and straw	0.02	0.03																			
Moderately degrading	Other (non-food) organic putrescible garden and park waste	0.05	0.1																			
Rapidly degrading	Food, food waste, sewage sludge, beverages and tobacco	0.06	0.185																			
Choice of data or measurement methods and procedures	-																					
Purpose of data	To determine the $F_{CH_4,PJ,y}$ for ex-ante estimation																					
Additional comment	-																					

Data and parameters required for the “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation(version 03.0)”.

Data/Parameter	$EF_{grid,CM,y}$
Data unit	tCO _{2e} /MWh
Description	Combined margin CO ₂ emission factor in year y
Source of data	Calculated
Value(s) applied	0.5269
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 07.0). The applied value was derived from “2017~2019 Statistics of Electric Power in Korea” (KEPCO) and “2019 Status of Generation facility (published in 2020” (Korea Power Exchange).
Purpose of data	To determine the $F_{CH4,PJ,y}$ for ex-ante estimation
Additional comment	-

Data and parameters required for the “Upstream leakage emissions associated with fossil fuel use(version 02.0)”.

Data/Parameter	$DEFT_{SP,y}$
Data unit	tCO _{2e} /TJ
Description	Default value for the supply of LFG to consumers due to physical leakage through the dedicated pipeline
Source of data	Upstream leakage emissions associated with fossil fuel use(Version 02.0) (Natural gas distribution)
Value(s) applied	2.2
Choice of data or measurement methods and procedures	-
Purpose of data	To determine the $PE_{SP,y}$ for ex-ante estimation
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

>>

The actual emission reductions of the project activity will be calculated and claimed as the ex-post monitoring parameters during the 3rd crediting period. Ex-ante estimation of emission reductions is calculated according to ACM0001 (version 19.0). Every methodological tools and formula mentioned in above sections of the PDD are applied for the ex-ante estimation of emission reduction.

1. Baseline emission (ex-ante emission)

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

<Table B-10> Calculation of BE_y

Year	$BE_{CH4,y}$	$BE_{EC,y}$	$BE_{HG,y}$	$BE_y(tCO_2e)$
2021.8.19 ~ 2022.8.18	235,036	0	0	235,036
2022.8.19 ~ 2023.8.18	237,222	0	0	237,222
2023.8.19 ~ 2024.8.18	239,372	0	0	239,372
2024.8.19 ~ 2025.8.18	241,504	0	0	241,504

2025.8.19 ~ 2026.8.18	243,579	0	0	243,579
2026.8.19 ~ 2027.8.18	245,674	0	0	245,674
2027.8.19 ~ 2028.8.18	247,732	0	0	247,732

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

<Table B-11> Calculation of $BE_{CH_4,y}$

Year	$(1 - OX_{top_layer})$	$F_{CH_4,PJ,y}$	$F_{CH_4,BL,y}$	GWP_{CH_4}	$BE_{CH_4,y}(tCO_2e)$
2021.8.19 ~ 2022.8.18	0.9	15,988	3,197	21	235,036
2022.8.19 ~ 2023.8.18	0.9	16,137	3,227	21	237,222
2023.8.19 ~ 2024.8.18	0.9	16,283	3,256	21	239,372
2024.8.19 ~ 2025.8.18	0.9	16,428	3,285	21	241,504
2025.8.19 ~ 2026.8.18	0.9	16,570	3,314	21	243,579
2026.8.19 ~ 2027.8.18	0.9	16,712	3,342	21	245,674
2027.8.19 ~ 2028.8.18	0.9	16,852	3,370	21	247,732

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

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

$$BE_{CH_4,SWDS,y} = \varphi_y \cdot (1 - f_y) \cdot GWP_{CH_4} \cdot (1 - OX) \cdot 16/12 \cdot F \cdot DOC_{f,y} \cdot MCF_y \cdot \sum_{x=1}^y \sum_j W_{j,x} \cdot DOC_j \cdot e^{-k(t-t_0)} \cdot (1 - e^{-k})$$

Parameters for 2019 Statistics of Electric Power $BE_{CH_4,SWDS,y}$ are showed as follows;

<Table B-12> Parameters from “Emissions from solid waste disposal sites(version 08.0)”

Parameter		Value
Model correction factor	φ_y	0.75
Global Warming Potential of Methane	GWP_{CH_4}	21
Oxidation factor	OX	0.1
Fraction of methane in the SWDS gas	F	0.5
Fraction of degradable organic carbon (DOC) that can decompose	$DOC_{f,y}$	0.5
Methane correction factor	MCF_y	1
Fraction of methane captured at the SWDS and flared, combusted or used in another manner	f_y	0

Detail information for calculating $BE_{CH_4,SWDS,y}$ is included in the separate calculation sheet.

Amount of methane in LFG which is flared and/or used in the project activity $F_{CH_4,PJ,y}$ is calculated by using the equation (11).

<Table B-13> Calculation of $F_{CH_4,PJ,y}$

Year	$BE_{CH_4,SWDS,y}$	η_{PJ}	GWP_{CH_4}	$F_{CH_4,PJ,y}(t CO_2e)$
2021.8.19 ~ 2022.8.18	376,829	89.1%	21	15,988
2022.8.19 ~ 2023.8.18	380,340	89.1%	21	16,137
2023.8.19 ~ 2024.8.18	383,793	89.1%	21	16,283
2024.8.19 ~ 2025.8.18	387,195	89.1%	21	16,428
2025.8.19 ~ 2026.8.18	390,556	89.1%	21	16,570
2026.8.19 ~ 2027.8.18	393,887	89.1%	21	16,712
2027.8.19 ~ 2028.8.18	397,191	89.1%	21	16,852

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

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

Year	$F_{CH4,PJ,y}$	20%	$F_{CH4,BL,y}(t CO_2e)$
2021.8.19 ~ 2022.8.18	15,988	20%	3,197
2022.8.19 ~ 2023.8.18	16,137	20%	3,227
2023.8.19 ~ 2024.8.18	16,283	20%	3,256
2024.8.19 ~ 2025.8.18	16,428	20%	3,285
2025.8.19 ~ 2026.8.18	16,570	20%	3,314
2026.8.19 ~ 2027.8.18	16,712	20%	3,342
2027.8.19 ~ 2028.8.18	16,852	20%	3,370

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

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

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

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

2. Project emission

Main source of project emission in the project activity are the consumption of electricity and LNG. The electricity is used for the operation of LFG collection and refine facilities. LNG is supplementary to LFG which have uneven quality of methane seasonally. It assures quality of LFG as a fuel for energy generation. Amounts of electricity and LNG for the project activity will be recorded and used for ex-post calculation.

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

<Table B-15> Calculation of PE_y

Year	$PE_{EC,y}$	$PE_{FC,y}$	$PE_{SP,y}$	$PE_y(t CO_2e)$
2021.8.19 ~ 2022.8.18	4,214	512	3,570	8,296
2022.8.19 ~ 2023.8.18	4,214	512	3,570	8,296
2023.8.19 ~ 2024.8.18	4,214	512	3,570	8,296
2024.8.19 ~ 2025.8.18	4,214	512	3,570	8,296
2025.8.19 ~ 2026.8.18	4,214	512	3,570	8,296
2026.8.19 ~ 2027.8.18	4,214	512	3,570	8,296
2027.8.19 ~ 2028.8.18	4,214	512	3,570	8,296

$$a) PE_{EC,y}$$

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

Year	$EC_{PJ,grid,y}$	$EF_{grid,CM,y}$	$(1 + TDL_{grid,y})$	$PE_{EC,y}$
2021.8.19 ~ 2022.8.18	7,722	0.5269	1.0359	4,214
2022.8.19 ~ 2023.8.18	7,722	0.5269	1.0359	4,214
2023.8.19 ~ 2024.8.18	7,722	0.5269	1.0359	4,214
2024.8.19 ~ 2025.8.18	7,722	0.5269	1.0359	4,214
2025.8.19 ~ 2026.8.18	7,722	0.5269	1.0359	4,214
2026.8.19 ~ 2027.8.18	7,722	0.5269	1.0359	4,214
2027.8.19 ~ 2028.8.18	7,722	0.5269	1.0359	4,214

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

Year	$FC_{LNG,y}$	NCV_{LNG}	$EF_{CO2,LNG,y}$	$PE_{FC,y}$
2021.8.19~ 2022.8.18	205,700	0.04276	0.05830	512
2022.8.19~ 2023.8.18	205,700	0.04276	0.05830	512
2023.8.19~ 2024.8.18	205,700	0.04276	0.05830	512
2024.8.19~ 2025.8.18	205,700	0.04276	0.05830	512
2025.8.19~ 2026.8.18	205,700	0.04276	0.05830	512
2026.8.19~ 2027.8.18	205,700	0.04276	0.05830	512
2027.8.19~ 2028.8.18	205,700	0.04276	0.05830	512

c) $PE_{SP,y}$ <Table B-18> Calculation of $PE_{SP,y}$

Year	NCV_{NG}	$DEFT_{SP,y}$	ρ_{CH4} (tCH_4/Nm_3CH_4)	$F_{CH4,NG,y}$	$PE_{SP,y}$
2021.8.19~ 2022.8.18	0.0504	2.2	0.000716	44,970,068	3,570
2022.8.19~ 2023.8.18	0.0504	2.2	0.000716	44,970,068	3,570
2023.8.19~ 2024.8.18	0.0504	2.2	0.000716	44,970,068	3,570
2024.8.19~ 2025.8.18	0.0504	2.2	0.000716	44,970,068	3,570
2025.8.19~ 2026.8.18	0.0504	2.2	0.000716	44,970,068	3,570
2026.8.19~ 2027.8.18	0.0504	2.2	0.000716	44,970,068	3,570
2027.8.19~ 2028.8.18	0.0504	2.2	0.000716	44,970,068	3,570

3. Leakage

No leakage effects need to be accounted under ACM0001 (version 19.0).

4. Emission Reduction

Applying the ACM0001 Version 19.0, and applicable methodical tools, ex-ante calculation of necessary parameters has been made above and emission reduction for the 3rd crediting period is presented in the following table.

B.6.4. Summary of ex ante estimates of emission reductions

Year	Baseline emissions (t CO ₂ e)	Project emissions (t CO ₂ e)	Leakage (t CO ₂ e)	Emission reductions (t CO ₂ e)
2021.8.19~ 2022.8.18	235,036	8,296	0	226,740
2022.8.19~ 2023.8.18	237,222	8,296	0	228,926
2023.8.19~ 2024.8.18	239,372	8,296	0	231,076
2024.8.19~ 2025.8.18	241,504	8,296	0	233,208
2025.8.19~ 2026.8.18	243,579	8,296	0	235,283
2026.8.19~ 2027.8.18	245,674	8,296	0	237,378
2027.8.19~ 2028.8.18	247,732	8,296	0	239,436
Total	1,690,119	58,072	0	1,632,047
Total number of crediting years	7 Years			
Annual average over the crediting period	241,446	8,296	0	233,150

B.7. Monitoring plan**B.7.1. Data and parameters to be monitored**

Data/Parameter	Management of SWDS
Data unit	-
Description	Management of SWDS
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) applied	-
Measurement methods and procedures	Project participants should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity. Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications.
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	To determine the baseline emission
Additional comment	-

Data/Parameter	$Op_{j,h}$
Data unit	-
Description	Operation of the equipment that consumes the LFG
Source of data	Project participants
Value(s) applied	For each equipment unit j using the LFG monitor that the plant is operating in hour h by the monitoring any one or more of the following three as described in ACM0001 methodology (version 19.0). (a) Temperature; (b) Flame; (c) Products generated. $Op_{j,h} = 0$ when: (a) One of the more temperature measurements are missing or below minimum threshold in hour h (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour h (Instantaneous measurements are made at least every minute); (c) No Products are generated in the hour h Otherwise , $Op_{j,h} = 1$
Measurement methods and procedures	Hourly
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	To determine the baseline emission
Additional comment	-

Data/Parameter	$EG_{EC,y}$
Data unit	MWh

Description	Amount of electricity consumed by the activity in year y
Source of data	Electricity meter
Value(s) applied	-
Measurement methods and procedures	Source of consumption shall include, where applicable, electricity consumed for the operation of the LFG capture system, for any processing and upgrading of the LFG, for transportation of the LFG to the flare or other applications.
Monitoring frequency	Continuous
QA/QC procedures	Electricity meter is subject to regular (in accordance with stipulation of KEPCO) maintenance and testing to ensure accuracy. Electricity meter is calibrated every 7 years in accordance with "Enforcement Decree of Measures ACT". The value will be cross-checked with the invoice from KEPCO.
Purpose of data	To determine the project emission
Additional comment	This parameter is required for calculating project emissions from electricity consumption as the "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation(version 03.0)"

Data/Parameter	F_{CH4,BL,R,y}
Data unit	tCH ₄ /yr
Description	Amount of methane in the LFG which is flared due to a requirement in year y
Source of data	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns.
Value(s) applied	-
Measurement methods and procedures	-
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	To determine the baseline emission
Additional comment	-

Data/Parameter	p_{reg,y}
Data unit	-
Description	Fraction of LFG that is required to be flared due to a requirement in year y
Source of data	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns
Value(s) applied	0.2
Measurement methods and procedures	-
Monitoring frequency	Annually
QA/QC procedures	-
Purpose of data	To determine the baseline emission

Additional comment	<p>There are no the regulatory requirement specifying any amount or percentage of LFG to be destroyed and monitored or historic data on the amount of methane to be captured in the year.</p> <p>So, the default value of 20% is selected according to the ACM 0001(version 19.0)</p>
--------------------	---

Data and parameters required for the “*Project emission from flaring*” (version 03.0):

Data/Parameter	Flame_m
Data unit	Flame on or flame off
Description	Flame detection of flare in the minute <i>m</i>
Source of data	Project participants
Value(s) applied	-
Measurement methods and procedures	Measure using a fixed installation optical flame detector: Ultra Violet detector or Infra Red or both
Monitoring frequency	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off
QA/QC procedures	<p>Each flame detector is installed at each flare stacks. Equipment(i.g. flame detector) shall be maintained or calibrated in accordance with manufacturer’s recommendations or local regulation.</p> <p>According to the manufacturer’s specification, the below information was included. FD-103, 104 : (Durability) 40,000 hour</p>
Purpose of data	To determine the baseline emission
Additional comment	-

Data and parameters required for the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (Version 03.0):

Data/Parameter	V_{t,db}
Data unit	Nm ³ dry gas/h
Description	Volumetric flow of the gaseous stream in a time interval <i>t</i> on a dry basis
Source of data	Monitored data from on-site measurement
Value(s) applied	-
Measurement methods and procedures	Volumetric flow measurement should always refer to the pressure and temperature of normal condition.
Monitoring frequency	Continuous
QA/QC procedures	<p>Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Frequency of calibration is every 8 years in accordance with the “Enforcement Decree of Measures ACT”.</p> <p>*Gas flow meter which the maximum flow is below 10m³/h is calibrated every 5 years or the others are calibrated every 8 years.</p>
Purpose of data	To determine the baseline emission
Additional comment	There are no changes for the volumetric flow meters during the 2 nd and the 3 rd crediting period.

Data/Parameter	V_{CH4,t,db}
Data unit	Nm ³ CH ₄ /Nm ³ dry gas (or %)
Description	Volumetric fraction of CH ₄ in a time interval <i>t</i> on a dry basis

Source of data	Monitored data from on-site measurement
Value(s) applied	-
Measurement methods and procedures	Continuous gas analyzer operating in dry-basis. Volumetric flow measurement should always refer to the pressure and temperature of normal condition.
Monitoring frequency	Continuous
QA/QC procedures	<p>Calibration should include zero verification with an inert gas (e.g. N₂) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas).</p> <p>All calibration gases must have a certificate provided by the manufacturer and the must be under their validity period.</p> <p>Gas analyzers will be calibrated every 5 years by an independent accredited laboratory as the 1st crediting period.</p>
Purpose of data	To determine the baseline emission
Additional comment	<p>There are 3 gas analysers as below</p> <p>① Behind of the buffer tank (for reference)</p> <p>② In front of the buffer tank: The data measured by this gas analyser will be used to calculate flaring.</p> <p>③ Behind the gas storage tank (right before supplying gas to user): The data measured by this gas analyser will be used to calculate heat and electricity generation.</p>

Data/Parameter	P_t
Data unit	Pa
Description	Pressure of the gaseous stream in time interval <i>t</i>
Source of data	Monitored data from on-site measurement
Value(s) applied	-
Measurement methods and procedures	Instruments with recordable electronic signal(analogical or digital) are required.
Monitoring frequency	Continuous
QA/QC procedures	<p>Periodic calibration against a primary device must be performed periodically and records of calibration procedures must be kept available as well as the primary device and its calibration certificate.</p> <p>Pressure are regularly calibrated by an independent accredited laboratory in accordance with local regulation. Pressure transducers (either capacitive or resistive) will be calibrated monthly.</p>
Purpose of data	To determine the baseline emission
Additional comment	This parameters is used for conversion of the normal condition during the monitoring process.

Data/Parameter	T_t
Data unit	°C or K
Description	The temperature of the gaseous stream (LFG) in time interval <i>t</i> .
Source of data	Monitored data from on-site measurement
Value(s) applied	-

Measurement methods and procedures	Instruments with recordable electronic signal(analogical or digital) are required.
Monitoring frequency	Continuous
QA/QC procedures	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration for measuring equipment are complied with local regulation.
Purpose of data	To determine the baseline emission
Additional comment	The temperature is used for conversion of the normal condition and is also monitored continuously because the applicability condition related to the gaseous stream flow temperature being below 60 °C is adopted.

Data/Parameter	F_{CH4,NG,y}
Data unit	tCH ₄ /yr
Description	Amount of methane in the LFG which is sent to dedicated pipeline in year y
Source of data	Monitored data from onsite measurements or calculation
Value(s) applied	-
Measurement methods and procedures	The amount of LFG provided to consumption(KDHC) through the dedicated pipeline is measurable by flow meters installed at the project site and the quantity is automatically converted into normal condition(Nm ³).
Monitoring frequency	Continuously
QA/QC procedures	According to the “Enforcement Decree of Measures ACT”, the main flow meters of LFG boilers(FIQ-A) is regularly calibrated every 8 years by an independent accredited laboratory.
Purpose of data	To determine the project emission
Additional comment	-

Data and parameters required for the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion” (Version 03.0):

Data/Parameter	FC_{LNG,j,y}
Data unit	Nm ³ /yr
Description	Quantity of LNG combusted in process j during the year y
Source of data	Monitored data from onsite measurements or calculation
Value(s) applied	-
Measurement methods and procedures	LNG is supplied from local supplier. The amount of LNG consumption is measurable by flow meters installed at the project site and LNG consumption is automatically converted into normal condition(Nm ³).
Monitoring frequency	Continuously
QA/QC procedures	<ul style="list-style-type: none"> - According to the “Enforcement Decree of Measures ACT”, the main flow meters of LNG supplier are regularly calibrated every 8 years by an independent accredited laboratory. - The total amount of LNG consumption will be cross-checked with the invoice. - Sub flow meters of LFG boilers are especially calibrated in accordance with local regulation. Especially, amount of LNG consumption for ignition is calculated as deducting quantity of sub flow meters from quantity of main LNG flow meter.
Purpose of data	To determine the project emission

Additional comment	In case of LFG boilers, detail information of measurement at KDHC site is described in Appendix 5 of this PDD.
--------------------	--

Data/Parameter	NCV _{LNG,y}											
Data unit	GJ/Nm ³											
Description	Weighted average net calorific value of LNG in year y											
Source of data	<div>The following data sources may be used if the relevant conditions apply:<table><tr><th>Data source</th><th>Conditions for using the data source</th></tr><tr><td>a) Values proved by the fuel supplier in invoices</td><td>This is the preferred source if the carbon fraction of the fuel is not provided (Option A).</td></tr><tr><td>b) Measurements by the project participants</td><td>If a) is not available</td></tr><tr><td>c) Regional or national default values</td><td>If a) is not available These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)</td></tr><tr><td>d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr></table> <i>a) is preferred. c) or d) are also applicable for the project activity, if a) is not available.</i></div>		Data source	Conditions for using the data source	a) Values proved by the fuel supplier in invoices	This is the preferred source if the carbon fraction of the fuel is not provided (Option A).	b) Measurements by the project participants	If a) is not available	c) Regional or national default values	If a) is not available These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)	d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If a) is not available
Data source	Conditions for using the data source											
a) Values proved by the fuel supplier in invoices	This is the preferred source if the carbon fraction of the fuel is not provided (Option A).											
b) Measurements by the project participants	If a) is not available											
c) Regional or national default values	If a) is not available These sources can only be used for liquid fuels and should be based on well documented, reliable sources (such as national energy balances)											
d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol.2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If a) is not available											
Value(s) applied	-											
Measurement methods and procedures	For a): Measurements should be undertaken in line with national or international fuel standards.											
Monitoring frequency	For a): The NCV should be obtained for each fuel delivery, from which weighted average annual values should be calculated. For c): Review appropriateness of the values annually. For d): Any future revision of the IPCC Guidelines should be taken into account.											
QA/QC procedures	Verify if the values under a), c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol.2 of the 2006 IPCC Guidelines. If the values fall below this range collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), c) should have ISO17025 accreditation or justify that they can comply with similar quality standards.											
Purpose of data	To determine the project emission											
Additional comment	Regarding a), net calories values are monthly posted each fuel supplier on KOGAS website (www.kogas.or.kr).											

Data/Parameter	EF_{CO₂,LNG,y}										
Data unit	tCO ₂ /GJ										
Description	Weighted average CO ₂ emission factor of LNG in year y										
Source of data	<p>The following data sources may be used if the relevant conditions apply:</p> <table border="1"> <thead> <tr> <th>Data source</th><th>Conditions for using the data source</th></tr> </thead> <tbody> <tr> <td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr> <tr> <td>b) Measurements by the project participants</td><td>If a) is not available</td></tr> <tr> <td>c) Regional or national default values</td><td>If a) is not available These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr> <tr> <td>d) 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</td><td>If a) is not available</td></tr> </tbody> </table> <p><i>a) is preferred. c) or d) are applicable for the project activity, if a) is not available.</i></p> <p><i>In this project, d) may be applied to the weighted average CO₂ emission factor of LNG.</i></p>	Data source	Conditions for using the data source	a) Values provided by the fuel supplier in invoices	This is the preferred source	b) Measurements by the project participants	If a) is not available	c) Regional or national default values	If a) is not available These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)	d) 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	If a) is not available
Data source	Conditions for using the data source										
a) Values provided by the fuel supplier in invoices	This is the preferred source										
b) Measurements by the project participants	If a) is not available										
c) Regional or national default values	If a) is not available These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)										
d) 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	If a) is not available										
Value(s) applied	-										
Measurement methods and procedures	For a): Measurements should be undertaken in line with national or international fuel standards										
Monitoring frequency	<p>For a): The CO₂ emission factor should be obtained for each fuel delivery, from which weighted average annual values should be calculated.</p> <p>For c): Review appropriateness of the values annually.</p> <p>For d): Any future revision of the IPCC Guidelines should be taken into account.</p> <p>Any future revision of the IPCC Guidelines and national default values should be taken into account.</p>										
QA/QC procedures	-										
Purpose of data	-										
Additional comment	For a): If the fuel supplier does provide the NCV value and the CO ₂ emission factor on the invoice and these two values are based on measurements for this specific fuel, this CO ₂ factor should be used. If another source for the CO ₂ emission factor is used or no CO ₂ emission factor is provided, Options b), c) or d) should be used.										

Data and parameters required for the “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0):

Data/Parameter	TDL _{j,y}
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j in year y.
Source of data	“Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”(version 03.0)
Value(s) applied	-
Measurement methods and procedures	As per "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", “KEPCO in Brief” which is accurate and reliable data in Republic of Korea is selected.
Monitoring frequency	Annually, In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years.
QA/QC procedures	-
Purpose of data	To determine the project emission
Additional comment	-

B.7.2. Sampling plan

>>

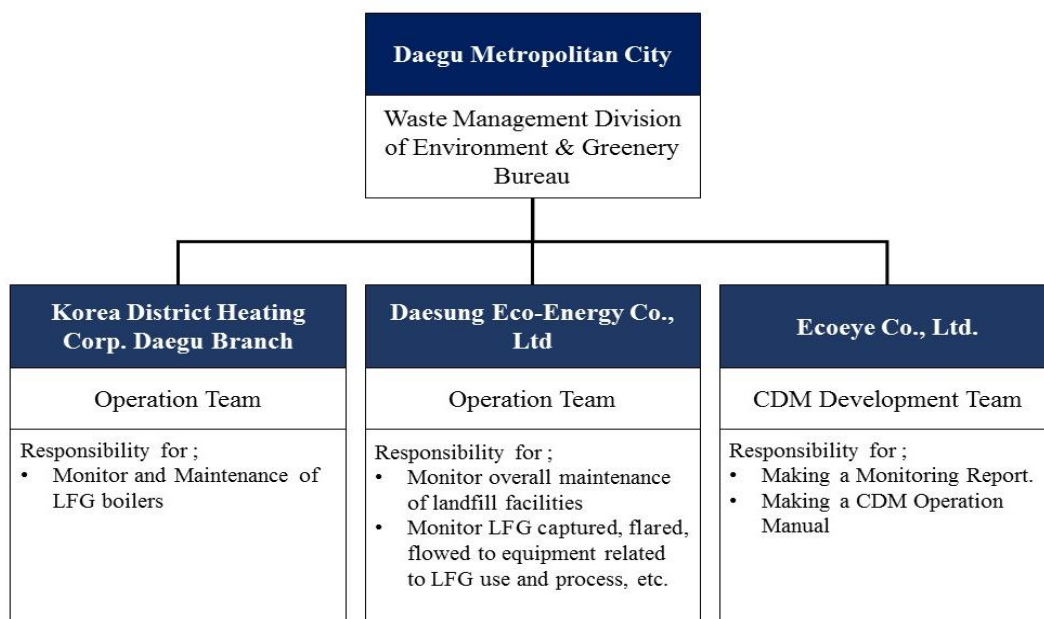
No sampling is required for this project activity.

B.7.3. Other elements of monitoring plan

>>

Data and parameter presented in section B.7.1 will be monitoring method for each data or parameter can be referred to section B.7.1 as well.

The following figure describes the operational and management structure that will operate project activity and monitor monitoring instruments/equipment.



<Figure B- 4> Monitoring structure

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

In order to ensure the implementation of monitoring plan, QA/QC measures are carried out as the following procedures;

Monitoring equipment and calibration

Monitoring instruments/equipment will be set up and managed transparently for calculation of emission reduction as per applicable methodologies.

Calibration frequency of monitoring instruments/equipment will be determined and periodically performed in accordance with manufacturer's specifications and/or appropriate national/international standards and/or local regulation. If any monitoring equipment is performed abnormally (i.e. failure or malfunction), an immediate corrective actions and applicable repair or replacement will be carried out.

Data collection and management

The monitored data will be remained in electronic or hard copy format. All monitoring records will be kept for 2 years after the end of the crediting period.

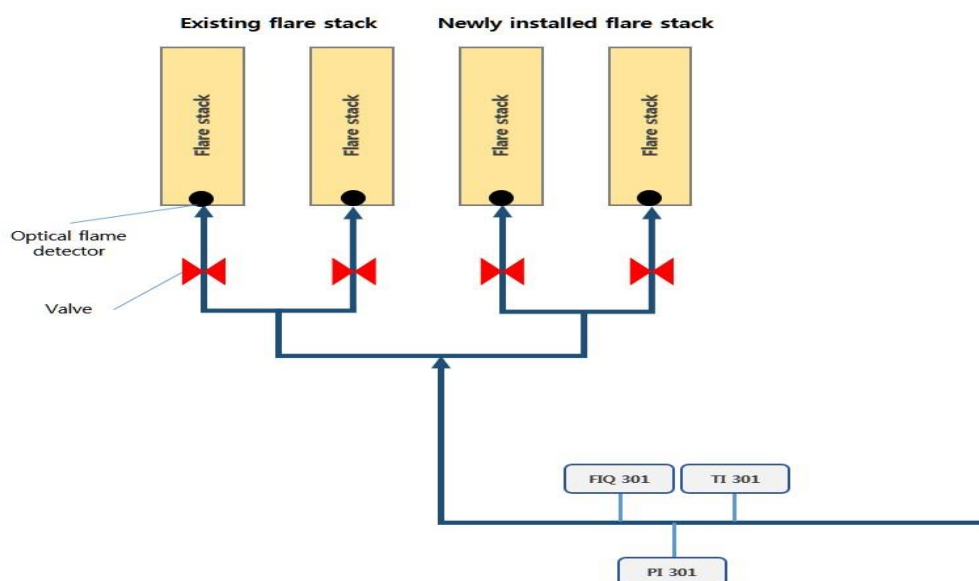
Training program

All employees directly involved in the monitoring process will be trained for appropriate monitoring and managing its data and equipment. The employees in charge of monitoring will enhance their comprehensive knowledge of CDM project and management for monitoring instruments/equipment. The CDM operation manual has included training program and its education.

New installation of enclosed flare stack.

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

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



<Figure B-5> Diagram of flare stacks monitoring

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

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>

01/05/2005

C.2. Expected operational lifetime of project activity

>>

According to an expected plan of Bangcheon-Ri landfill, disposal of waste at the landfill would be expected until 2050.

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>

Renewable crediting period (7years)

C.3.2. Start date of crediting period

>>

The 1st crediting period was started on 19/08/2007, after that the 2nd crediting period was started on 19/08/2014. The 3rd crediting period starts on 19/08/2021.

Start date	Details
19/08/2007	The 1 st crediting period
19/08/2014	The 2 nd crediting period
19/08/2021	The 3 rd crediting period

C.3.3. Duration of crediting period

>>

The length of the third crediting period is 7 years.

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>

The analysis of environmental impacts for the project activity was carried out prior the registration of project activity. Description and assessment about the environment impact of the project activity are presented in the latest version of PDD(15/05/2007) and Validation Report(25/05/2007) in detail.

D.2. Environmental impact assessment

>>

The analysis of environmental impacts for the project activity was carried out prior the registration of project activity. Description and assessment about the environment impact of the project activity are presented in PDD(15/05/2007) and Validation Report(25/05/2007) in detail.

SECTION E. Local stakeholder consultation**E.1. Modalities for local stakeholder consultation**

>>

Information on solicitation of comments from local stakeholders for the project activity are presented in PDD(15/05/2007) and Validation Report(25/05/2007) in detail.

E.2. Summary of comments received

>>

Summary on comment received from local stakeholders for the project activity are presented in PDD(15/05/2007) and Validation Report(25/05/2007) in detail.

E.3. Consideration of comments received

>>

Information on consideration of comments received from local stakeholders for the project activity are presented in PDD(15/05/2007) and Validation Report(25/05/2007) in detail.

SECTION F. Approval and authorization

>>

As per the CDM Cycle Procedures, new letter of approval from the host party DNA is not necessary for the renewal crediting period.

Appendix 1. Contact information of project participants

Organization name	Daegu Metropolitan City
Country	Republic of Korea
Address	88, Gongpyeong-ro, Jung-Gu, Daegu, Republic of Korea
Telephone	+82-53-803-3636
Fax	+82-53-803-3609
E-mail	ss3115@korae.kr
Website	http://www.daegu.go.kr
Contact person	Juhwan Seo

Organization name	Korea District Heating Corp.
Country	Republic of Korea
Address	368, Bundang-ro, Bundang-gu, Seongnam, Gyeonggi-Do
Telephone	+82-31-780-4114
Fax	-
E-mail	cdm@kdhc.co.kr
Website	http://www.kdhc.co.kr
Contact person	Tae-Sop Song

Organization name	Daesung Eco-Energy Co., Ltd.
Country	Republic of Korea
Address	822, Dasa-ro, Dasa-Eup, Dalseong-Gun, Daegu, Republic of Korea
Telephone	+82-53-593-1890
Fax	+82-53-593-2121
E-mail	ddeco@korea.com
Website	http://deeco.co.kr
Contact person	Suk-hyung Lee

Organization name	Ecoeye Co.,Ltd.
Country	Republic of Korea
Address	B dong, 70, Dusan-ro, Geumcheon-Gu, Seoul
Telephone	+82-2-6480-7346
Fax	+82-2-6480-7398
E-mail	sangsun_ha@ecoeye.com
Website	http://www.ecoeye.co.kr
Contact person	Sangsun Ha

Appendix 2. Affirmation regarding public funding

No public funding is involved in this project activity.

Appendix 3. Applicability of methodologies and standardized baselines

Mentioned in the involved section of PDD.

Appendix 4. Further background information on ex ante calculation of emission reductions

The baseline information used to calculate emission reductions of the proposed project is as follows:

- Determination of Emission Factor

[Appendix 4-1] Calculation of Operating Margin emission factor

<Table Appendix4-1-a> Data of simple OM in 2017

No.	Fuel Type	Plant		Amount of fossil fuel(FCi,m,y)				Net Caloric value(NCVi,y)				Caloric Consumption (106 kcal)				Net electricity generated (EGm,y) (MWh)	CO2 Emission by fuel					Results EF for each plant (tonCO2eq./MWh)
				Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)	Coal (kcal/kg)	Heavy oil (kcal/l)	Diesel oil (kcal/l)	L. N. G (kcal/kg)	Coal	Heavy oil	Diesel oil	L. N. G		Coal (tonCO2/y r)	Heavy oil (tonCO2/y r)	Diesel oil (tonCO2/y r)	L. N. G (tonCO2/y r)	Total (tonCO2/y r)	
1	Anthracite	Yeongdong	#2	372,854		1,669	-	5,445	0	8,265	-	2,136,992	-	14,523		739,840	804,081	-	4,194	-	808,274	1.0925
2		Donghae	#1	592,264		915	-	4,859	0	8,320	-	3,028,982	-	8,011		1,247,949	1,139,708	-	2,313	-	1,142,022	0.9151
3		Donghae	#2	497,546		616	-	4,812	0	8,310	-	2,520,000	-	5,388		1,038,740	948,195	-	1,556	-	949,751	0.9143
4		Seocheon	#1	208,957	15,099	-	-	5,431	9,398	-	-	1,194,501	149,362	-		490,608	425,222	44,853	-	-	470,075	0.9581
5		Seocheon	#2	219,533	14,546	-	-	5,401	9,392	-	-	1,248,057	143,802	-		501,773	469,604	43,183	-	-	512,787	1.0220
6	Bituminous coal	Dangjin	#1	1,585,298		502		5,313	-	8,333	-	8,866,621	-	4,399		3,715,995	3,156,363	-	1,270	-	3,157,634	0.8497
7		Dangjin	#2	1,311,799	341	940		5,292	-	8,391	-	7,308,078	-	8,299		3,063,079	2,601,549	-	2,397	-	2,603,946	0.8501
8		Dangjin	#3	1,047,890	109	989		5,287	-	8,330	-	5,832,008	-	8,675		2,410,510	2,076,094	-	2,505	-	2,078,599	0.8623
9		Dangjin	#4	965,085		1,165		5,299	-	8,299	-	5,382,731	-	10,181		2,274,240	1,916,159	-	2,940	-	1,919,099	0.8438
10		Dangjin	#5	1,084,705	31	741		5,257	-	8,306	-	6,002,279	-	6,480		2,543,293	2,136,707	-	1,871	-	2,138,578	0.8409
11		Dangjin	#6	1,023,355	88	1,120		5,243	-	8,323	-	5,647,975	-	9,813		2,429,487	2,010,581	-	2,834	-	2,013,415	0.8287
12		Dangjin	#7	1,146,298	85	839		5,246	-	8,338	-	6,329,720	-	7,367		2,663,703	2,253,271	-	2,127	-	2,255,398	0.8467
13		Dangjin	#8	1,220,053		373		5,247	-	8,301	-	6,738,739	-	3,258		2,875,461	2,398,874	-	941	-	2,399,815	0.8346

CDM-PDD-FORM

14	Dangjin	#9	2,444,331		926		5,247	-	8,284	-	13,501,648	-	8,078		6,152,494	4,806,353	-	2,333	-	4,808,686	0.7816
15	Dangjin	#10	2,104,127		2,834		5,262	-	8,298	-	11,655,733	-	24,753		5,248,772	4,149,239	-	7,148	-	4,156,387	0.7919
16	Boryeong	#1	1,496,051		-		5,392	-	-	-	8,491,928	-	-		3,472,194	3,022,979	-	-	-	3,022,979	0.8706
17	Boryeong	#2	1,391,754		-		5,343	-	-	-	7,827,471	-	-		3,155,453	2,786,444	-	-	-	2,786,444	0.8831
18	Boryeong	#3	1,536,383		-		5,401	-	-	-	8,733,935	-	-		3,743,486	3,109,130	-	-	-	3,109,130	0.8305
19	Boryeong	#4	1,464,074		-		5,391	-	-	-	8,308,569	-	-		3,555,622	2,957,707	-	-	-	2,957,707	0.8318
20	Boryeong	#5	1,456,859		-		5,402	-	-	-	8,283,753	-	-		3,575,516	2,948,873	-	-	-	2,948,873	0.8247
21	Boryeong	#6	1,398,349		-		5,417	-	-	-	7,973,212	-	-		3,460,331	2,838,325	-	-	-	2,838,325	0.8202
22	Boryeong	#7	1,410,211		-		5,375	-	-	-	7,978,277	-	-		3,505,437	2,840,128	-	-	-	2,840,128	0.8102
23	Boryeong	#8	1,547,655		-		5,390	-	-	-	8,781,062	-	-		3,904,445	3,125,906	-	-	-	3,125,906	0.8006
24	Samcheok Greenpower	#1	2,024,156		7,242		4,009	-	10,289	-	8,540,913	-	78,440		3,322,656	3,040,417	-	22,650	-	3,063,068	0.9219
25	Samcheok Greenpower	#2	1,572,432		855		3,976	-	10,380	-	6,581,099	-	9,340		3,188,621	2,342,757	-	2,697	-	2,345,454	0.7356
26	Samchonpo	#1	1,333,205		2,012		5,301	-	8,279	-	7,439,955	-	17,530		3,118,945	2,648,495	-	5,062	-	2,653,557	0.8508
27	Samchonpo	#2	1,562,154		1,953		5,289	-	8,293	-	8,697,094	-	17,048		3,627,441	3,096,015	-	4,923	-	3,100,938	0.8549
28	Samchonpo	#3	1,429,991		1,936		5,336	-	8,277	-	8,032,468	-	16,865		3,409,246	2,859,419	-	4,870	-	2,864,289	0.8402
29	Samchonpo	#4	1,769,296		825		5,306	-	8,313	-	9,882,777	-	7,218		4,235,875	3,518,098	-	2,084	-	3,520,182	0.8310
30	Samchonpo	#5	1,851,566		1,012		4,602	-	8,304	-	8,969,620	-	8,846		3,935,172	3,193,029	-	2,554	-	3,195,584	0.8121
31	Samchonpo	#6	1,554,991		2,362		4,589	-	8,291	-	7,511,780	-	20,612		3,305,075	2,674,064	-	5,952	-	2,680,015	0.8109
32	Sinboryeong	#1	2,080,951		4,965		4,861	-	8,290	-	10,648,367	-	43,323		5,779,858	3,790,634	-	12,510	-	3,803,144	0.6580
33	Sinboryeong	#2	1,517,218		11,223		6,066	-	8,285	-	9,687,376	-	97,879		4,367,686	3,448,538	-	28,264	-	3,476,802	0.7960
34	Yeosu	#1	1,268,346		1,911		4,095	-	8,290	-	5,466,699	-	16,678		2,101,908	1,946,050	-	4,816	-	1,950,866	0.9281
35	Yeosu	#2	1,072,573		1,106		4,377	-	8,255	-	4,942,220	-	9,612		1,963,827	1,759,345	-	2,775	-	1,762,120	0.8973
36	Yeongheung	#1	2,379,741		2,710		5,471	-	8,752	-	13,703,581	-	24,968		5,885,417	4,878,237	-	7,210	-	4,885,447	0.8301

CDM-PDD-FORM

37	Yeongheung	#2	2,257,078		6,079		5,483	-	8,752	-	13,026,483	-	56,005		5,561,119	4,637,202	-	16,172	-	4,653,374	0.8368
38	Yeongheung	#3	2,442,157		2,557		5,475	-	8,752	-	14,075,128	-	23,554		6,241,854	5,010,502	-	6,802	-	5,017,303	0.8038
39	Yeongheung	#4	2,703,559		4,297		5,474	-	8,223	-	15,579,432	-	37,198		6,786,133	5,546,008	-	10,741	-	5,556,749	0.8188
40	Yeongheung	#5	2,683,507		1,725		5,202	-	8,810	-	14,695,227	-	15,998		6,351,315	5,231,246	-	4,620	-	5,235,866	0.8244
41	Yeongheung	#6	2,703,786		1,419		5,228	-	8,768	-	14,879,666	-	13,097		6,487,489	5,296,903	-	3,782	-	5,300,685	0.8171
42	Taeon	#1	1,170,093		-		5,326	-	-	-	6,559,303	-	-		2,850,512	2,334,998	-	-	-	2,334,998	0.8192
43	Taeon	#2	1,343,636		-		5,321	-	-	-	7,525,547	-	-		3,313,914	2,678,964	-	-	-	2,678,964	0.8084
44	Taeon	#3	1,015,440		-		5,324	-	-	-	5,690,543	-	-		2,510,925	2,025,735	-	-	-	2,025,735	0.8068
45	Taeon	#4	1,359,189		-		5,322	-	-	-	7,614,395	-	-		3,319,418	2,710,593	-	-	-	2,710,593	0.8166
46	Taeon	#5	1,417,800		-		5,457	-	-	-	8,144,141	-	-		3,347,751	2,899,173	-	-	-	2,899,173	0.8660
47	Taeon	#6	1,218,714		-		5,460	-	-	-	7,003,814	-	-		2,986,062	2,493,237	-	-	-	2,493,237	0.8350
48	Taeon	#7	1,375,439		-		5,328	-	-	-	7,713,660	-	-		3,288,072	2,745,929	-	-	-	2,745,929	0.8351
49	Taeon	#8	1,353,242		-		5,325	-	-	-	7,584,918	-	-		3,280,465	2,700,099	-	-	-	2,700,099	0.8231
50	Taeon	#9	2,826,068		714		5,039	-	8,570	-	14,990,495	-	6,441		6,899,189	5,336,356	-	1,860	-	5,338,216	0.7737
51	Taeon	#10	1,796,181		581		4,892	-	12,237	-	9,249,780	-	7,480		5,072,719	3,292,761	-	2,160	-	3,294,921	0.6495
52	Hadong	#1	1,592,923		193		5,287	-	8,346	-	8,865,612	-	1,695		3,829,976	3,156,004	-	489	-	3,156,493	0.8242
53	Hadong	#2	1,417,181		204		5,284	-	8,432	-	7,883,256	-	1,814		3,348,011	2,806,302	-	524	-	2,806,826	0.8384
54	Hadong	#3	1,431,715		242		5,294	-	8,345	-	7,978,600	-	2,126		3,414,733	2,840,243	-	614	-	2,840,857	0.8319
55	Hadong	#4	1,627,856		160		5,288	-	8,341	-	9,060,896	-	1,409		3,884,999	3,225,522	-	407	-	3,225,929	0.8304
56	Hadong	#5	1,502,410		312		5,281	-	8,879	-	8,351,619	-	2,919		3,606,004	2,973,032	-	843	-	2,973,874	0.8247
57	Hadong	#6	1,567,058		462		5,285	-	8,614	-	8,717,008	-	4,192		3,809,100	3,103,104	-	1,211	-	3,104,314	0.8150
58	Hadong	#7	1,532,177		1		5,392	-	8,973	-	8,695,704	-	10		3,842,465	3,095,520	-	3	-	3,095,523	0.8056

CDM-PDD-FORM

59		Hadong	#8	1,457,792		1		5,390	-	8,327	-	8,271,547	-	12		3,689,607	2,944,527	-	4	-	2,944,531	0.7981
60		Honam	#1	791,772	412	112		5,254	10,118	8,323	-	4,379,169	4,390	982		1,569,678	1,558,908	1,318	284	-	1,560,510	0.9942
61		Honam	#2	767,332	707	146		5,241	10,118	8,324	-	4,233,172	7,528	1,279		1,548,142	1,506,936	2,261	369	-	1,509,566	0.9751
62		Bukpyeong	#1													2,931,168						0.6444
63		Bukpyeong	#2													1,768,922						0.6444
64		Heavy Oil	Namjeju	#1	-		128		-	0	8,260	-	-	-	1,112		585,931	-	-	321	-	321
65	Namjeju		#2	-	146,940	69		-	9,545	8,249	-	-	1,476,334	596		575,115	-	443,340	172	-	443,513	0.7712
66	Ulsan		#4	-	119,150	-		-	9,565	-	-	-	1,199,677	-	-	603,785	-	360,261	-	-	360,261	0.5967
67	Ulsan		#5	-	127,953	-		-	9,579	-	-	-	1,290,146	-	-	533,493	-	387,428	-	-	387,428	0.7262
68	Ulsan		#6	-	116,267	-		-	9,572	-	-	-	1,171,437	-	-	809,937	-	351,781	-	-	351,781	0.4343
69	Jeju		#2	-	30,566	32		-	9,332	-	-	-	300,265	-	-	396,012	-	90,169	-	-	90,169	0.2277
70	Jeju		#3	-	63,652	90		-	9,467	5,374	-	-	634,284	510	-	347,178	-	190,474	147	-	190,622	0.5491
71	Pyeongtaek		#1	-	48,820	49	3,112	-	9,444	9,055	11,755	-	485,304	468	40,640	206,317	-	145,736	135	8,315	154,186	0.7473
72	Pyeongtaek		#2	-	57,302	57	2,582	-	9,449	9,057	11,761	-	569,967	539	33,745	247,458	-	171,160	156	6,905	178,220	0.7202
73	Pyeongtaek		#3	-	54,956	68	2,062	-	9,463	9,055	11,758	-	547,436	652	26,944	232,769	-	164,394	188	5,513	170,095	0.7307
74	Pyeongtaek	#4	-	81,917	64	2,382	-	9,464	9,055	11,755	-	816,100	607	31,116	349,950	-	245,073	175	6,367	251,615	0.7190	
75	LNG	Seoul	#2	-	-	-	51,224	-	-	-	11,767	-	-	0	669,712	209,245	-	-	-	137,029	137,029	0.6549
76	Combi ned Cycle	Gunsan	C/C	-	-	171,917	-	-	-	11,795	-	-	-	2,253,026	1,109,949	-	-	-	460,989	460,989	0.4153	
77		Boryeong	C/C	-	-	114,348	-	-	-	11,803	-	-	-	1,499,585	722,011	-	-	-	306,828	306,828	0.4250	
78		Busan	C/C	-		65	725,084	-	-	8,301	11,782	-	-	569	9,491,837	5,239,811	-	-	164	1,942,114	1,942,279	0.3707
79		Bundang	C/C	-		-	390,249	-	-	-	11,777	-	-	-	5,106,741	2,230,974	-	-	-	1,044,885	1,044,885	0.4684
80		Seoincheon	C/C	-		3	368,803	-	-	10,450	11,789	-	-	34	4,830,724	2,508,877	-	-	10	988,409	988,419	0.3940

81	Shinincheon	C/C	-	-	472,310	-	-	-	11,769	-	-	-	6,176,134	3,239,046	-	-	-	1,263,692	1,263,692	0.3901
82	Andong	C/C	-	-	183,056	-	-	-	11,795	-	-	-	2,399,061	1,397,174	-	-	-	490,869	490,869	0.3513
83	Yeongwol	C/C	-	76	81,335	-	-	8,503	11,789	-	-	680	1,065,363	556,957	-	-	196	217,983	218,179	0.3917
84	Ulsan	C/C	-	-	863,230	-	-	-	7,254	-	-	-	6,957,870	6,299,890	-	-	-	1,423,642	1,423,642	0.2260
85	Incheon	C/C	-	-	846,783	-	-	-	13,466	-	-	-	12,669,625	5,855,008	-	-	-	2,592,318	2,592,318	0.4428
86	Ilsan	C/C	-	-	203,931	-	-	-	4,696	-	-	-	1,064,033	1,057,483	-	-	-	217,711	217,711	0.2059
87	Pyeongtaek	C/C	-	-	385,319	-	-	-	11,773	-	-	-	5,040,585	2,864,529	-	-	-	1,031,349	1,031,349	0.3600
88	Hanlim	C/C	-	28,433	-	-	-	8,367	-	-	-	250,417	-	100,042	-	-	72,311	-	72,311	0.7228
89	Kwangyang	C/C												6,806,932						0.3258
90	Dangjin	C/C	-	-	949,569	-	-	-	12,036	-	-	-	12,698,702	7,256,526	-	-	-	2,598,268	2,598,268	0.3581
91	Dongducheon	C/C												7,337,793						0.3153
92	Busanjeong-gwan energy	C/C												11,061						0.3153
93	Bucheon C/C	C/C	-	-	179,044	-	-	-	11,770	-	-	-	2,341,560	961,838	-	-	-	479,104	479,104	0.4981
94	Ansan C/C	C/C												4,452,409						0.3153
95	Anyang	C/C	-	-	253,770	-	-	-	11,775	-	-	-	3,320,023	1,441,875	-	-	-	679,306	679,306	0.4711
96	Yeongnam power	C/C												885,601						0.3153
97	Oseong	C/C												2,543,570						0.3153
98	Yulchon	C/C	-	-	253,122	-	-	-	10,393	-	-	-	2,923,098	6,060,540	-	-	-	598,092	598,092	0.0987
99	Pajumunsan	C/C												10,255,511						0.3153

CDM-PDD-FORM

100		POSCO energy	C/C	-	-	-	1,239,922	-	-	-	14,255	-	-	-	19,639,592	9,392,145	-	-	-	4,018,436	4,018,436	0.4279
101		Pocheon	C/C													4,138,764						0.3153
102		Pocheonche onyeon	C/C													3,680,760						0.3153
103		Daesan	C/C													1,222						0.4356
104		Jeju	G/T	-		1,019		-	-	7,389	-	-	-	7,928	-	2,359	-	-	2,289	0	2,289	0.9706
105		Jeju	D/P		48,946			-	9,426	-	-		485,642		-	229,627	-	145,837	-	-	145,837	0.6351
Total				90,296,155	927,885	103,100	7,743,153								323,287,366	176,266,394	2,787,270	267,945	20,518,124	199,839,733	0.6181	

<Table Appendix 4-1-b> Data of simple OM in 2018

No.	Fuel Type	Plant		Amount of fossil fuel(FCi,m,y)				Net Caloric value(NCvi,y)				Caloric Consumption (106 kcal)				Net electricity generated (EGm,y)	CO2 Emission by fuel					Results
				Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)	Coal (kcal/kg)	Heavy oil (kcal/l)	Diesel oil (kcal/l)	L. N. G (kcal/kg)	Coal	Heavy oil	Diesel oil	L. N. G	(MWh)	Coal (tonCO2/yr)	Heavy oil (tonCO2/yr)	Diesel oil (tonCO2/yr)	L. N. G (tonCO2/yr)	Total (tonCO2/yr)	EF for each plant (tonCO2eq/MWh)
1	Anthracite	Yeongdong	#2	212,365	-	2,502	-	5,564	0	8,265	-	1,243,733	-	21,764	-	449,372	467,977	-	6,285	-	474,261	1.0554
2		Donghae	#1	437,760	-	5	-	4,938	0	8,493	-	2,275,211	-	45	-	907,189	856,089	-	13	-	856,101	0.9437
3		Donghae	#2	516,675	-	458	-	4,889	0	8,493	-	2,659,237	-	4,092	-	1,066,749	1,000,585	-	1,182	-	1,001,767	0.9391
4	Bituminous coal	Dangjin	#1	1,363,644	207	207	-	5,201	8,499	8,499	-	7,465,567	1,853	1,853	-	3,167,255	2,657,612	556	535	-	2,658,704	0.8394
5		Dangjin	#2	1,595,364	-	-	-	5,185	0	0	-	8,706,916	-	-	-	3,796,796	3,099,511	-	-	-	3,099,511	0.8163
6		Dangjin	#3	1,050,695	-	-	-	5,160	0	0	-	5,706,398	-	-	-	2,436,624	2,031,379	-	-	-	2,031,379	0.8337
7		Dangjin	#4	1,215,388	142	142	-	5,140	8,499	8,499	-	6,575,340	1,269	1,269	-	2,862,811	2,340,707	381	367	-	2,341,455	0.8179
8		Dangjin	#5	1,357,697	-	-	-	5,254	0	0	-	7,509,419	-	-	-	3,238,050	2,673,223	-	-	-	2,673,223	0.8256
9		Dangjin	#6	1,331,982	90	90	-	5,257	8,499	8,499	-	7,370,624	807	807	-	3,214,242	2,623,815	242	233	-	2,624,290	0.8165
10		Dangjin	#7	1,199,919	1	1	-	5,263	8,500	8,500	-	6,647,703	7	7	-	2,840,048	2,366,467	2	2	-	2,366,471	0.8333
11		Dangjin	#8	1,169,412	-	-	-	5,259	0	0	-	6,473,702	-	-	-	2,810,776	2,304,526	-	-	-	2,304,526	0.8199
12		Dangjin	#9	1,935,484	7	7	-	5,199	8,493	8,493	-	10,593,053	62	62	-	4,751,747	3,770,943	19	18	-	3,770,980	0.7936
13		Dangjin	#10	2,078,439	12	12	-	5,184	8,493	8,493	-	11,340,741	106	106	-	5,262,547	4,037,107	32	31	-	4,037,170	0.7672
14		Boryeong	#1	1,056,00	-	-	-	5,421	0	0	-	6,025,31	-	-	-	2,515,422	2,144,908	-	-	-	2,144,908	0.8527

CDM-PDD-FORM

			0							7											
15	Boryeong	#2	1,058,010	-	-	-	5,423	0	0	-	6,039,887	-	-	-	2,533,851	2,150,095	-	-	-	2,150,095	0.8485
16	Boryeong	#3	1,059,353	-	-	-	5,385	0	0	-	6,004,326	-	-	-	2,561,265	2,137,436	-	-	-	2,137,436	0.8345
17	Boryeong	#4	1,260,997	-	-	-	5,371	0	0	-	7,129,532	-	-	-	3,055,577	2,537,990	-	-	-	2,537,990	0.8306
18	Boryeong	#5	1,332,954	-	-	-	5,257	0	0	-	7,375,523	-	-	-	3,274,184	2,625,558	-	-	-	2,625,558	0.8019
19	Boryeong	#6	1,501,100	-	-	-	5,376	0	0	-	8,494,922	-	-	-	3,722,344	3,024,045	-	-	-	3,024,045	0.8124
20	Boryeong	#7	1,405,616	-	-	-	5,381	0	0	-	7,961,744	-	-	-	3,536,871	2,834,243	-	-	-	2,834,243	0.8013
21	Boryeong	#8	1,199,326	-	-	-	5,378	0	0	-	6,789,550	-	-	-	3,038,389	2,416,962	-	-	-	2,416,962	0.7955
22	Samcheok Greenpower	#1	3,360,891	-	1,339	-	3,959	0	8,692	-	14,005,306	-	12,251	-	6,019,332	4,985,646	-	3,538	-	4,989,184	0.8289
23	Samcheok Greenpower	#2	2,612,700	-	182	-	3,949	0	8,695	-	10,861,842	-	1,665	-	4,546,890	3,866,628	-	481	-	3,867,108	0.8505
24	Samchonpo	#1	1,220,985	-	2,329	-	5,301	0	8,285	-	6,813,424	-	20,312	-	2,781,826	2,425,461	-	5,865	-	2,431,326	0.8740
25	Samchonpo	#2	1,239,354	-	1,273	-	5,289	0	8,278	-	6,899,781	-	11,091	-	2,858,397	2,456,202	-	3,203	-	2,459,405	0.8604
26	Samchonpo	#3	1,846,412	-	611	-	5,323	0	8,289	-	10,345,238	-	5,327	-	4,360,457	3,682,726	-	1,538	-	3,684,264	0.8449
27	Samchonpo	#4	1,443,900	-	1,106	-	5,336	0	8,278	-	8,110,443	-	9,640	-	3,445,910	2,887,177	-	2,784	-	2,889,961	0.8387
28	Samchonpo	#5	1,564,412	-	1,633	-	4,656	0	8,282	-	7,667,107	-	14,239	-	3,217,314	2,729,357	-	4,112	-	2,733,469	0.8496
29	Samchonpo	#6	1,753,626	-	1,480	-	4,672	0	8,285	-	8,623,745	-	12,906	-	3,665,360	3,069,904	-	3,727	-	3,073,631	0.8386
30	Sinboryeong	#1	2,389,481	-	758	-	4,680	0	8,341	-	11,771,749	-	6,659	-	5,664,470	4,190,539	-	1,923	-	4,192,462	0.7401
31	Sinboryeong	#2	2,258,712	-	431	-	4,548	0	8,342	-	10,812,172	-	3,788	-	4,991,289	3,848,946	-	1,094	-	3,850,040	0.7714

32	Yeosu	#1	1,195,147	-	1,786	-	4,007	0	8,434	-	5,040,731	-	15,858	-	1,958,836	1,794,413	-	4,579	-	1,798,992	0.9184
33	Yeosu	#2	1,180,744	-	529	-	4,356	0	8,336	-	5,413,597	-	4,638	-	2,149,645	1,927,147	-	1,339	-	1,928,486	0.8971
34	Yeongheung	#1	2,231,596	-	6,444	-	5,362	0	8,752	-	12,594,448	-	59,367	-	5,416,333	4,483,405	-	17,143	-	4,500,548	0.8309
35	Yeongheung	#2	2,455,515	-	4,428	-	5,360	0	8,752	-	13,853,780	-	40,792	-	5,903,862	4,931,706	-	11,779	-	4,943,485	0.8373
36	Yeongheung	#3	2,550,170	-	5,458	-	5,381	0	8,752	-	14,445,087	-	50,282	-	6,470,221	5,142,201	-	14,520	-	5,156,720	0.7970
37	Yeongheung	#4	2,371,633	-	6,829	-	5,367	0	8,752	-	13,399,600	-	62,916	-	5,773,022	4,770,025	-	18,168	-	4,788,193	0.8294
38	Yeongheung	#5	2,679,792	-	2,529	-	5,155	0	9,006	-	14,541,129	-	23,978	-	6,316,301	5,176,390	-	6,924	-	5,183,314	0.8206
39	Yeongheung	#6	2,670,529	-	4,845	-	5,150	0	8,946	-	14,478,262	-	45,626	-	6,332,152	5,154,010	-	13,175	-	5,167,185	0.8160
40	Taeon	#1	1,482,003	-	303	-	5,336	0	8,414	-	8,324,943	-	2,680	-	3,566,001	2,963,535	-	774	-	2,964,309	0.8313
41	Taeon	#2	820,690	-	147	-	5,336	0	8,418	-	4,609,713	-	1,302	-	2,002,903	1,640,978	-	376	-	1,641,354	0.8195
42	Taeon	#3	1,273,886	-	233	-	5,357	0	8,442	-	7,183,362	-	2,069	-	3,190,164	2,557,152	-	597	-	2,557,750	0.8018
43	Taeon	#4	1,128,377	-	919	-	5,342	0	8,345	-	6,344,878	-	8,070	-	2,761,345	2,258,667	-	2,330	-	2,260,997	0.8188
44	Taeon	#5	1,274,953	-	168	-	5,406	0	8,414	-	7,255,036	-	1,486	-	3,055,986	2,582,667	-	429	-	2,583,096	0.8453
45	Taeon	#6	1,496,284	-	180	-	5,416	0	8,413	-	8,529,618	-	1,595	-	3,633,202	3,036,396	-	460	-	3,036,857	0.8359
46	Taeon	#7	1,296,472	-	324	-	5,323	0	8,417	-	7,264,999	-	2,866	-	3,126,421	2,586,214	-	828	-	2,587,042	0.8275
47	Taeon	#8	1,470,385	-	106	-	5,319	0	8,417	-	8,233,197	-	939	-	3,635,091	2,930,875	-	271	-	2,931,147	0.8063
48	Taeon	#9	2,748,353	-	774	-	5,037	0	8,413	-	14,572,991	-	6,851	-	6,579,999	5,187,732	-	1,978	-	5,189,710	0.7887
49	Taeon	#10	2,234,727	-	1,373	-	5,008	0	8,413	-	11,779,401	-	12,160	-	5,379,232	4,193,263	-	3,511	-	4,196,774	0.7802

50		Hadong	#1	1,327,051	-	4	-	5,291	0	8,935	-	7,390,737	-	37	-	3,182,294	2,630,974	-	11	-	2,630,985	0.8268
51		Hadong	#2	1,631,984	-	184	-	5,283	0	8,653	-	9,076,097	-	1,679	-	3,927,563	3,230,933	-	485	-	3,231,418	0.8228
52		Hadong	#3	1,651,151	-	255	-	5,284	0	8,751	-	9,183,520	-	2,348	-	3,910,182	3,269,174	-	678	-	3,269,852	0.8362
53		Hadong	#4	1,348,530	-	30	-	5,270	0	8,788	-	7,480,396	-	274	-	3,202,453	2,662,891	-	79	-	2,662,971	0.8315
54		Hadong	#5	1,568,256	-	412	-	5,290	0	8,653	-	8,732,548	-	3,756	-	3,873,419	3,108,636	-	1,085	-	3,109,720	0.8028
55		Hadong	#6	1,279,830	-	113	-	5,294	0	8,658	-	7,131,718	-	1,034	-	3,108,722	2,538,768	-	298	-	2,539,066	0.8168
56		Hadong	#7	1,296,896	-	393	-	5,396	0	8,876	-	7,366,920	-	3,670	-	3,265,711	2,622,496	-	1,060	-	2,623,556	0.8034
57		Hadong	#8	1,563,750	-	206	-	5,402	0	8,826	-	8,891,822	-	1,912	-	3,951,981	3,165,334	-	552	-	3,165,887	0.8011
58		Honam	#1	483,346	821	171	-	5,164	10,119	8,272	-	2,627,598	8,744	1,486	-	954,987	935,379	2,626	429	-	938,434	0.9827
59		Honam	#2	800,177	631	159	-	5,170	10,119	8,268	-	4,354,955	6,722	1,385	-	1,602,336	1,550,288	2,019	400	-	1,552,707	0.9690
60		Bukpyeong	#1													4,433,017						0.6444
61		Bukpyeong	#2													4,402,412						0.6444
62		Heavy Oil	Namjeu	#1	-	4,896	190	-	-	9,335	8,259	-	-	48,105	1,651	-	620,088	-	14,446	477	-	14,922
63	Namjeu		#2	-	140,167	138	-	-	9,607	8,255	-	-	1,417,387	1,198	-	562,971	-	425,639	346	-	425,985	0.7567
64	Ulsan		#4	-	178,879	-	-	-	9,540	0	-	-	1,796,374	-	-	747,852	-	539,448	-	-	539,448	0.7213
65	Ulsan		#5	-	175,578	-	-	-	9,534	0	-	-	1,762,105	-	-	700,230	-	529,157	-	-	529,157	0.7557
66	Ulsan		#6	-	88,536	-	-	-	9,566	0	-	-	891,470	-	-	866,353	-	267,707	-	-	267,707	0.3090
67	Jeju		#2	-	67,874	86	-	-	9,415	8,496	-	-	672,678	766	-	361,185	-	202,004	221	-	202,225	0.5599
68	Jeju		#3	-	27,356	66	-	-	9,453	7,455	-	-	272,198	520	-	392,857	-	81,741	150	-	81,891	0.2084
69	Pyeongtaek	#1	-	42,520	15	2,335	-	9,541	9,001	11,656	-	427,038	139	30,237	186,176	-	128,239	40	6,187	134,465	0.7222	

70		Pyeongtaek	#2	-	79,950	28	4,034	-	9,551	8,987	11,720	-	803,816	268	52,531	354,334	-	241,384	77	10,748	252,210	0.7118
71		Pyeongtaek	#3	-	85,932	24	3,632	-	9,536	9,225	11,757	-	862,597	237	47,444	378,134	-	259,036	69	9,707	268,812	0.7109
72		Pyeongtaek	#4	-	69,615	90	1,490	-	9,529	9,328	11,744	-	698,279	884	19,437	300,237	-	209,692	255	3,977	213,924	0.7125
73	Combine d Cycle	Gunsan	C/ C	-	-	-	350,144	-	0	0	11,803	-	-	-	4,592,108	2,366,395	-	-	-	939,586	939,586	0.3971
74		Boryeong	C/ C	-	-	-	184,619	-	0	0	11,230	-	-	-	2,303,545	1,190,373	-	-	-	471,326	471,326	0.3959
75		Busan	C/ C	-	-	-	1,091,060	-	0	0	11,785	-	-	-	14,287,019	7,995,940	-	-	-	2,923,252	2,923,252	0.3656
76		Bundang	C/ C	-	-	-	358,926	-	0	0	11,779	-	-	-	4,697,484	2,050,719	-	-	-	961,147	961,147	0.4687
77		Seoincheon	C/ C	-	-	3	452,896	-	0	10,450	11,896	-	-	31	5,986,129	3,086,685	-	-	9	1,224,815	1,224,824	0.3968
78		Shinincheon	C/ C	-	-	-	510,529	-	0	0	11,779	-	-	-	6,681,657	3,515,425	-	-	-	1,367,127	1,367,127	0.3889
79		Andong	C/ C	-	-	-	291,686	-	0	0	11,798	-	-	-	3,823,682	2,279,064	-	-	-	782,359	782,359	0.3433
80		Yeongwol	C/ C	-	-	-	176,464	-	0	0	11,791	-	-	-	2,311,818	1,199,820	-	-	-	473,019	473,019	0.3942
81		Ulsan	C/ C	-	-	-	1,101,584	-	0	0	11,715	-	-	-	14,338,953	8,018,832	-	-	-	2,933,878	2,933,878	0.3659
82		Incheon	C/ C	-	-	-	692,478	-	0	0	11,777	-	-	-	9,061,485	4,709,989	-	-	-	1,854,061	1,854,061	0.3936
83		Ilsan	C/ C	-	-	-	235,665	-	0	0	11,777	-	-	-	3,083,837	1,213,654	-	-	-	630,981	630,981	0.5199
84		Pyeongtaek	C/ C	-	-	-	557,856	-	0	0	11,764	-	-	-	7,291,666	4,244,420	-	-	-	1,491,940	1,491,940	0.3515
85		Jeju LNG	C/ C	-	-	26,796	-	-	0	8,579	-	-	-	241,970	-	96,333	-	-	69,872	-	69,872	0.7253
86		Hanlim	C/ C	-	-	59,217	-	-	0	8,317	-	-	-	518,444	-	212,945	-	-	149,708	-	149,708	0.7030
87		Kwangyang	C/ C													7,874,591						0.3258
88		Dangjin	C/ C	-	-	-	946,084	-	0	0	12,086	-	-	-	12,705,199	7,137,463				2,599,597	2,599,597	0.3642
89		Dongducheon	C/ C													6,758,938						0.3153

CDM-PDD-FORM

90	Busanjeonggwan energy	C/C													1,607						0.3153
91	Bucheon	C/C													780,013						0.3258
92	Ansan	C/C													4,495,546						0.3153
93	Anyang	C/C													947,440						0.3258
94	Yeongnam power	C/C													3,220,393						0.3153
95	Oseong	C/C													3,105,147						0.3153
96	Yulchon	C/C	-	-	-	334,292	-	0	0	11,795	-	-	-	4,380,905	7,243,180				896,372	896,372	0.1238
97	Pajumunsan	C/C													12,022,120						0.3153
98	POSCO energy	C/C	-	-	-	1,428,867	-	0	0	11,777	-	-	-	18,697,772	10,963,546				3,825,731	3,825,731	0.3490
99	Pocheon	C/C													3,690,621						0.3153
100	Pocheoncheonyeon	C/C													4,655,850						0.3153
101	Daesan	C/C													800						0.4356
102	Jeju	G/T	-	-	2,311	-	-	0	8,507	-	-	-	20,692	-	4,397	-	-	5,975	0	5,975	1.3590
103	Jeju	D/P	-	50,016	-	-	-	10,078	0	-	-	530,588	-	-	236,991	-	159,335	-	-	159,335	0.6723
Total			90,540,880	1,013,229	142,829	8,724,642								340,448,804	173,275,414	3,063,704	368,386	23,405,809	200,113,313	0.5876	

<Table Appendix 4-1-c> Data of simple OM in 2019

No	Fuel Type	Plant		Amount of fossil fuel(FCi,m,y)				Net Caloric value(NCVi,y)				Caloric Consumption (106 kcal)				Net electricity generated (EGm,y)	CO2 Emission by fuel					Results
				Coal (t)	Heavy oil (kl)	Diesel oil (kl)	L. N. G (t)	Coal (kcal/kg)	Heavy oil (kcal/l)	Diesel oil (kcal/l)	L. N. G (kcal/kg)	Coal	Heavy oil	Diesel oil	L. N. G	(MWh)	Coal (tonCO2/yr)	Heavy oil (tonCO2/yr)	Diesel oil (tonCO2/yr)	L. N. G (tonCO2/yr)	Total (tonCO2/yr)	EF for each plant (tonCO2eq./MWh)
1	Anthracite	Yeongdong	#2	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0
2		Donghae	#1	586,966	-	393	-	4,951	-	8,325	-	3,059,181	-	3,444	-	1,228,915	1,151,071	-	994	-	1,152,066	0.9375
3		Donghae	#2	537,546	-	12	-	4,887	-	8,336	-	2,765,162	-	107	-	1,104,638	1,040,441	-	31	-	1,040,472	0.9419
4	Bituminous coal	Dangjin	#1	1,515,724	-	148	-	5,377	-	8,436	-	8,579,202	-	1,316	-	3,612,208	3,054,047	-	380	-	3,054,427	0.8456
5		Dangjin	#2	1,119,174	-	844	-	5,366	-	8,436	-	6,320,986	-	7,494	-	2,688,770	2,250,162	-	2,164	-	2,252,325	0.8377
6		Dangjin	#3	1,168,205	-	124	-	5,353	-	8,440	-	6,583,082	-	1,100	-	2,752,888	2,343,463	-	318	-	2,343,781	0.8514
7		Dangjin	#4	806,774	-	292	-	5,347	-	8,433	-	4,540,568	-	2,588	-	1,925,706	1,616,363	-	747	-	1,617,111	0.8397
8		Dangjin	#5	1,035,090	-	215	-	5,362	-	8,440	-	5,842,559	-	1,909	-	2,509,987	2,079,850	-	551	-	2,080,401	0.8288
9		Dangjin	#6	820,399	-	455	-	5,367	-	8,436	-	4,635,152	-	4,041	-	2,011,605	1,650,034	-	1,167	-	1,651,201	0.8208
10		Dangjin	#7	1,193,788	-	185	-	5,386	-	8,433	-	6,768,535	-	1,643	-	2,889,031	2,409,481	-	474	-	2,409,955	0.8342
11		Dangjin	#8	1,188,750	-	188	-	5,392	-	8,440	-	6,746,975	-	1,666	-	2,926,247	2,401,806	-	481	-	2,402,287	0.8209
12		Dangjin	#9	2,458,932	-	24	-	5,312	-	8,404	-	13,748,125	-	216	-	6,153,391	4,894,094	-	62	-	4,894,157	0.7954
13		Dangjin	#10	2,456,829	-	60	-	5,302	-	8,426	-	13,712,593	-	532	-	6,200,137	4,881,445	-	154	-	4,881,599	0.7873
14		Boryeong	#1	977,167	-	-	-	5,409	-	-	-	5,563,290	-	-	-	2,348,871	1,980,435	-	-	-	1,980,435	0.8431
15		Boryeong	#2	955,920	-	-	-	5,413	-	-	-	5,446,267	-	-	-	2,257,043	1,938,777	-	-	-	1,938,777	0.8590

CDM-PDD-FORM

16	Boryeong	#3	191,697	-	3,352	-	5,340	-	8,835	-	1,077,579	-	31,176	-	487,669	383,599	-	9,002	-	392,602	0.8051
17	Boryeong	#4	1,484,889	-	7	-	5,391	-	10,397	-	8,426,985	-	76	-	3,652,894	2,999,861	-	22	-	2,999,883	0.8212
18	Boryeong	#5	1,378,569	-	1,066	-	5,400	-	9,584	-	7,836,311	-	10,752	-	3,391,008	2,789,591	-	3,105	-	2,792,696	0.8236
19	Boryeong	#6	1,243,961	-	840	-	5,406	-	8,928	-	7,079,202	-	7,895	-	3,067,999	2,520,073	-	2,280	-	2,522,353	0.8221
20	Boryeong	#7	1,144,060	-	2	-	5,446	-	10,492	-	6,558,037	-	24	-	2,893,626	2,334,548	-	7	-	2,334,554	0.8068
21	Boryeong	#8	1,380,056	-	1,502	-	5,434	-	8,872	-	7,894,327	-	14,027	-	3,530,402	2,810,244	-	4,050	-	2,814,294	0.7972
22	Samcheok Greenpower	#1	2,825,985	-	-	-	4,218	-	-	-	12,548,467	-	-	-	5,320,857	4,467,037	-	-	-	4,467,037	0.8395
23	Samcheok Greenpower	#2	2,828,602	-	-	-	4,166	-	-	-	12,404,070	-	-	-	5,341,650	4,415,634	-	-	-	4,415,634	0.8266
24	Samchonpo	#1	1,706,061	-	2,434	-	5,441	-	8,314	-	9,770,609	-	21,298	-	4,003,856	3,478,167	-	6,150	-	3,484,317	0.8702
25	Samchonpo	#2	1,747,330	-	2,579	-	5,424	-	8,315	-	9,976,069	-	22,574	-	4,015,208	3,551,308	-	6,518	-	3,557,826	0.8861
26	Samchonpo	#3	1,283,696	-	1,648	-	5,449	-	8,286	-	7,362,878	-	14,379	-	3,049,978	2,621,057	-	4,152	-	2,625,209	0.8607
27	Samchonpo	#4	1,746,397	-	1,080	-	5,412	-	8,316	-	9,948,481	-	9,450	-	4,180,613	3,541,487	-	2,729	-	3,544,216	0.8478
28	Samchonpo	#5	778,586	-	578	-	4,779	-	8,334	-	3,916,388	-	5,072	-	1,612,675	1,394,166	-	1,465	-	1,395,631	0.8654
29	Samchonpo	#6	776,747	-	326	-	4,778	-	8,312	-	3,906,901	-	2,854	-	1,632,216	1,390,789	-	824	-	1,391,613	0.8526
30	Sinboryeong	#1	2,104,743	-	-	-	5,217	-	-	-	11,559,334	-	-	-	5,228,902	4,114,923	-	-	-	4,114,923	0.7870
31	Sinboryeong	#2	2,955,891	-	-	-	5,190	-	-	-	16,149,526	-	-	-	7,467,863	5,748,951	-	-	-	5,748,951	0.7698
32	Yeosu	#1	1,304,767	-	591	-	4,016	-	8,471	-	5,516,084	-	5,267	-	2,156,311	1,963,630	-	1,521	-	1,965,151	0.9113
33	Yeosu	#2	974,954	-	1,610	-	4,382	-	8,471	-	4,497,051	-	14,355	-	1,756,888	1,600,872	-	4,145	-	1,605,017	0.9136
34	Yeongheung	#1	2,367,501	-	2,252	-	5,513	-	8,752	-	13,738,590	-	20,744	-	5,808,741	4,890,700	-	5,990	-	4,896,690	0.8430

35	Yeongheung	#2	1,926,917	-	3,435	-	5,500	-	8,752	-	11,154,948	-	31,651	-	4,790,623	3,970,968	-	9,140	-	3,980,108	0.8308
36	Yeongheung	#3	2,145,387	-	983	-	5,501	-	8,752	-	12,423,385	-	9,056	-	5,488,642	4,422,510	-	2,615	-	4,425,125	0.8062
37	Yeongheung	#4	2,492,235	-	660	-	5,503	-	8,753	-	14,435,857	-	6,082	-	6,192,825	5,138,915	-	1,756	-	5,140,671	0.8301
38	Yeongheung	#5	2,464,922	-	810	-	5,166	-	9,025	-	13,405,106	-	7,699	-	5,784,636	4,771,986	-	2,223	-	4,774,209	0.8253
39	Yeongheung	#6	2,737,231	-	721	-	5,151	-	9,013	-	14,840,541	-	6,840	-	6,433,525	5,282,975	-	1,975	-	5,284,950	0.8215
40	Taeon	#1	1,208,776	-	1,860	-	5,405	-	8,219	-	6,877,497	-	16,088	-	2,917,594	2,448,270	-	4,646	-	2,452,915	0.8407
41	Taeon	#2	1,361,413	-	2,177	-	5,403	-	8,409	-	7,743,330	-	19,273	-	3,317,351	2,756,491	-	5,565	-	2,762,056	0.8326
42	Taeon	#3	1,198,823	-	995	-	5,400	-	8,416	-	6,814,694	-	8,811	-	2,985,914	2,425,913	-	2,544	-	2,428,457	0.8133
43	Taeon	#4	1,381,526	-	362	-	5,394	-	8,424	-	7,844,276	-	3,208	-	3,415,234	2,792,426	-	926	-	2,793,353	0.8179
44	Taeon	#5	1,221,526	-	756	-	5,461	-	8,411	-	7,021,572	-	6,691	-	2,996,261	2,499,558	-	1,932	-	2,501,490	0.8349
45	Taeon	#6	1,072,452	-	1,357	-	5,445	-	8,407	-	6,147,026	-	12,012	-	2,634,489	2,188,235	-	3,469	-	2,191,703	0.8319
46	Taeon	#7	1,421,277	-	1,081	-	5,532	-	8,411	-	8,276,459	-	9,566	-	3,444,360	2,946,276	-	2,762	-	2,949,038	0.8562
47	Taeon	#8	1,210,440	-	937	-	5,335	-	8,410	-	6,798,034	-	8,296	-	3,004,484	2,419,982	-	2,396	-	2,422,378	0.8063
48	Taeon	#9	1,750,731	-	961	-	5,049	-	8,406	-	9,304,055	-	8,504	-	4,224,775	3,312,082	-	2,456	-	3,314,538	0.7845
49	Taeon	#10	1,895,922	-	1,498	-	5,048	-	8,404	-	10,075,024	-	13,248	-	4,456,905	3,586,534	-	3,825	-	3,590,359	0.8056
50	Hadong	#1	1,333,825	-	147	-	5,348	-	8,326	-	7,508,220	-	1,292	-	3,321,584	2,672,796	-	373	-	2,673,169	0.8048
51	Hadong	#2	1,173,145	-	341	-	5,331	-	8,326	-	6,583,235	-	2,990	-	2,850,235	2,343,518	-	864	-	2,344,381	0.8225
52	Hadong	#3	1,260,737	-	219	-	5,324	-	8,303	-	7,066,025	-	1,915	-	3,002,798	2,515,382	-	553	-	2,515,935	0.8379

53		Hadong	#4	1,495,062	-	132	-	5,343	-	8,416	-	8,408,251	-	1,173	-	3,617,811	2,993,192	-	339	-	2,993,530	0.8274
54		Hadong	#5	1,158,541	-	5	-	5,359	-	8,347	-	6,535,706	-	40	-	2,949,229	2,326,598	-	12	-	2,326,610	0.7889
55		Hadong	#6	1,466,459	-	202	-	5,347	-	8,346	-	8,253,490	-	1,776	-	3,645,774	2,938,099	-	513	-	2,938,612	0.8060
56		Hadong	#7	1,414,170	-	99	-	5,457	-	8,340	-	8,123,783	-	869	-	3,612,551	2,891,926	-	251	-	2,892,177	0.8006
57		Hadong	#8	1,073,045	-	2	-	5,478	-	8,390	-	6,187,625	-	16	-	2,786,913	2,202,687	-	5	-	2,202,692	0.7904
58		Honam	#1	739,533	1,035	158	-	5,068	10,119	8,435	-	3,945,212	11,028	1,407	-	1,431,841	1,404,427	3,312	406	-	1,408,145	0.9835
59		Honam	#2	836,340	379	94	-	5,066	10,119	8,450	-	4,460,232	4,033	839	-	1,635,692	1,587,765	1,211	242	-	1,589,219	0.9716
60		Bukpyeong	#1													3,652,413						0.6444
61		Bukpyeong	#2													3,637,945						0.6444
62		Heavy oil	Ulsan	#4	-	61,959	-	-	9,465	-	-	-	-	617,301	-	-	300,062	-	185,374	-	-	185,374
63	Ulsan		#5	-	68,423	-	-	9,471	-	-	-	-	682,164	-	-	307,548	-	204,853	-	-	204,853	0.6661
64	Ulsan		#6	-	53,706	-	-	9,447	-	-	-	-	534,085	-	-	554,746	-	160,385	-	-	160,385	0.2891
65	Pyeongtaek		#1	-	21,581	-	3,981	-	9,493	-	11,763	-	215,639	-	52,033	106,346	-	64,756	-	10,646	75,402	0.7090
66	Pyeongtaek		#2	-	25,463	-	3,942	-	9,470	-	11,768	-	253,820	-	51,540	121,757	-	76,222	-	10,546	86,767	0.7126
67	Pyeongtaek		#3	-	44,836	-	3,343	-	9,474	-	11,779	-	447,143	-	43,748	201,057	-	134,276	-	8,951	143,227	0.7124
68	Pyeongtaek		#4	-	30,654	-	3,041	-	9,487	-	11,770	-	306,116	-	39,767	142,286	-	91,926	-	8,137	100,063	0.7033
69	Combine d Cycle	Gunsan	C/C	-	-	-	325,309	-	-	-	11,810	-	-	-	4,268,708	2,185,489	-	-	-	873,416	873,416	0.3996
70		Boryeong	C/C	-	-	-	105,265	-	-	-	11,808	-	-	-	1,381,033	666,697	-	-	-	282,572	282,572	0.4238
71		Busan	C/	-	-	-	823,226	-	-	-	11,780	-	-	-	10,775,	5,915,190	-	-	-	2,204,71	2,204,719	0.3727

		C												285					9		
72	Bundang	C/ C	-	-	-	396,064	-	-	-	11,756	-	-	-	5,173,389	2,272,742	-	-	-	1,058,522	1,058,522	0.4657
73	Seoul	C/ C	-	-	-	207,302	-	-	-	12,534	-	-	-	2,886,961	1,231,260	-	-	-	590,698	590,698	0.4798
74	Seoincheon	C/ C	-	-	1	314,940	-	-	10,450	11,773	-	-	12	4,119,710	2,150,588	-	-	3	842,929	842,933	0.3920
75	Shinincheon	C/ C	-	-	-	402,031	-	-	-	11,760	-	-	-	5,253,070	2,747,219	-	-	-	1,074,825	1,074,825	0.3912
76	Andong	C/ C	-	-	-	235,717	-	-	-	11,799	-	-	-	3,090,323	1,820,971	-	-	-	632,308	632,308	0.3472
77	Yeongwol	C/ C	-	-	-	47,631	-	-	-	11,798	-	-	-	624,384	317,216	-	-	-	127,754	127,754	0.4027
78	Ulsan	C/ C	-	-	-	876,726	-	-	-	11,713	-	-	-	11,410,464	6,412,731	-	-	-	2,334,683	2,334,683	0.3641
79	Incheon	C/ C	-	-	-	464,547	-	-	-	11,774	-	-	-	6,077,273	3,017,374	-	-	-	1,243,464	1,243,464	0.4121
80	Ilsan	C/ C	-	-	-	237,301	-	-	-	11,777	-	-	-	3,105,192	1,242,266	-	-	-	635,350	635,350	0.5114
81	Jeju	C/ C	-	-	123,699	14,898	-	-	8,560	11,781	-	-	1,114,634	195,012	635,691	-	-	321,866	39,901	361,767	0.5691
82	Pyeongtaek	C/ C	-	-	-	641,591	-	-	-	11,782	-	-	-	8,398,866	4,883,609	-	-	-	1,718,483	1,718,483	0.3519
83	Hanlim	C/ C	-	-	78,360	5,875	-	-	8,297	11,757	-	-	684,361	76,746	300,407	-	-	197,619	15,703	213,322	0.7101
84	Kwangyang	C/ C													7,971,617						0.3258
85	Dangjin	C/ C	-	-	-	862,343	-	-	-	12,054	-	-	-	11,549,306	6,635,732	-	-	-	2,363,091	2,363,091	0.3561
86	Dongducheon	C/ C													5,621,357						0.3153
87	Busanjeonggwan energy	C/ C													626						0.3153
88	Sinpyeongtaek	C/ C													1,731,937						0.3153
89	Ansan	C/ C													4,807,063						0.3153

CDM-PDD-FORM

90	Yeongnam power	C/ C													2,936,899						0.3153
91	Oseong	C/ C													4,221,029						0.3153
92	Yulchon	C/ C	-	-	-	415,735	-	-	-	11,796	-	-	-	5,448,937	6,640,056	-	-	-	1,114,901	1,114,901	0.1679
93	Pajumunsan	C/ C													12,441,827						0.3153
94	POSCO energy	C/ C	-	-	-	1,625,976	-	-	-	10,971	-	-	-	19,820,420	12,849,745	-	-	-	4,055,435	4,055,435	0.3156
95	Pocheon	C/ C													2,722,223						0.3153
96	Pocheoncheonyeon	C/ C													4,099,184						0.3153
97	Daesan	C/ C													3,875						0.4356
98	Jeju	G/ T	-	-	4,001	-	-	-	8,522	-	-	-	35,891	-	7,411	-	-	10,364	-	10,364	1.3985
99	Jeju	D/ P	-	53,889	-	-	-	9,405	-	-	-	533,478	-	-	277,166	-	160,202	-	-	160,202	0.5780
Total			84,486,191	361,925	248,859	8,016,783								317,942,195	165,547,618	1,082,517	641,123	21,247,033	188,518,291	0.5929	

** Operating Margin emission factor

Year	Electricity generation by OM plants	CO ₂ emissions by OM plants
2017	323,287,366	199,839,733
2018	340,448,804	200,113,313
2019	317,942,195	188,518,291
Total	981,678,365	588,471,337

$$EF_{OM} = 0.5995 \text{ tonCO}_2/\text{MWh}$$

[Appendix 4-2] Sample group plants used in the Build Margin calculation and CO2 Emission Factor of the Build Margin

Year	3	Plant name		Technology	Type of Fossil Fuel	Year operation	Net electricity generated (EGM,y)	CO2 emission factor (tCO2/MWh)	EF for each plant (tCO2eq./MWh)
2012	1	Namjeju solar		Solar		2012.10	101		
	2	Sejong waste solar		Solar		2012.10			
	3	Yecheon solar	#1	Solar		2012.10			
	4	Yeonggwang solar	#3	Solar		2012.10	762		
	5	Yeonggwang-wind		wind		2012.10	435		
	6	Busan solar		Solar		2012.10	37		
	7	Juam		small hydro power		2012.10	23		
	8	Sinwolsong	#1	Nuclear		2012.08	4,964,709		
	9	Sinkori	#2	Nuclear		2012.07	5,400,279		
	10	BON solar		Solar		2012.06	-		
	11	Samcheonpo solar	#3	Solar		2012.06	328		
	12	Samcheonpo solar	#4	Solar		2012.06	1,335		
	13	Sejong solar	#1	Solar		2012.06			
	14	Sejong solar	#2	Solar		2012.06			
	15	Sejong solar	#3	Solar		2012.06			
	16	Water-quality restore center solar		Solar		2012.06			
	17	Yeongdong solar		Solar		2012.06	794		
	18	Jeju University solar		Solar		2012.06			
	19	Sangjubo		small hydro power		2012.06			
	20	Dalseongbo		small hydro power		2012.06			
	21	Nakdanbo		small hydro power		2012.06			
	22	Hapcheon,Changnyeongbo		small hydro power		2012.06			
	23	Chilgokbo		small hydro power		2012.06			
	24	Yeosu Expo		Solar		2012.04			
	25	Dangjin solar	#2	Solar		2012.03	1,387		

	26	Hadong solar	#4	Solar	2012.03	406		
	27	Hadong solar	#3	Solar	2012.03	76		
	28	Hadong solar	#2	Solar	2012.03	99		
	29	Hadong solar	#1	Solar	2012.03	52		
	30	Hamanbo		small hydro power	2012.03			
	31	Yeoju		small hydro power	2012.03			
	32	Sihwa lake tidal		tidal	2012.03	465,924		
	33	WP solar		Solar	2012.02	-		
2011	1	Kwangyanghang solar		Solar	2011.12	2,464		
	2	KC susan solar		Solar	2011.12	1,333		
	3	Seoul solar		Solar	2011.09			
	4	Hadong S/S solar		Solar	2011.09	63		
	5	Busan sinhang solar		Solar	2011.08	120		
	6	Ulsan solar		Solar	2011.08	625		
	7	Tangjeong solar		Solar	2011.08	1,434		
	8	Hoengseongdaem		small hydro power	2011			
	9	Kangjeong		small hydro power	2011			
	10	Kangcheonbo		small hydro power	2011			
	11	Kumibo		small hydro power	2011			
	12	Keumkangbo		small hydro power	2011	8,139		
	13	Keumnambo		small hydro power	2011	7,393		
	14	Baekjebo		small hydro power	2011			
	15	Seungchonbo		small hydro power	2011			
	16	Epobo		small hydro power	2011			
	17	Juksanbo		small hydro power	2011			
	18	Pankyo		small hydro power	2011	2,502		
	19	Yeoicheon pumping	#1	pumping	2011	788,997		

	20	Yeoicheon pumping	#2	pumping		2011			
2010	1	Haengwon solar park		solar		2010.11			
	2	Gunwi		small hydro power		2010.11	-		
	3	Dangjin solar park		solar		2010.10	1,226		
	4	Yeoicheon solar park		solar		2010.10	2,004		
	5	Yeongheung-wind power		wind		2010.10			
	6	Hangwon		small hydro power		2010.10	86		
	7	Seolibu		small hydro power		2010.08	-		
	8	Kyeongcheon	#2	small hydro power		2010.07	-		
	9	Gunsan		Combined		2010.06	5,504,259	0.3529	0.0191
	10	Tapjeong		small hydro power		2010.03	-		
	11	Sinkori	#1	nuclear		2010.02	7,091,408		
	12	Pangweo		small hydro power		2010	-		
	13	Yeongwol		Combined		2010	3,816,318	0.3700	0.0139
	14	Dangjin		small hydro power		2010			
	15	Rural community corp.		small hydro power		2010	-		
	16	New solar energy and others				2010			
2009	1	Gosan		small hydro power		2009.12			
	2	Ilsan fuel cell		fuel cell		2009.09	33,885		
	3	Gosado solar		solar		2009.07			
	4	Pyeongsado solar		solar		2009.07			
	5	Yukdo solar		solar		2009.07			
	6	Yuldo solar		solar		2009.07			
	7	Hadong	# 8	steam power	Bituminous coal	2009.06	4,077,193	0.7937	0.0318
	8	Daehanboryeong		small hydro power		2009.05	-		
	9	Hankukhaeyang		small hydro power		2009.05	-		
	10	Wooldolmok		small hydro power		2009.05	-		
	11	Dangsado solar		solar		2009.04			
	12	Hahwado solar		solar		2009.04			
	13	Hwangjedo solar		solar		2009.04			
	14	Seongsan-wind		wind		2009.04			

	15	Yeongwol solar		solar		2009.01	59		
	16	Boseong		small hydro power		2009	-		
	17	Seongju		small hydro power		2009	-		
	18	New solar energy and others				2009			
2008	1	Boryeong	#8	steam power	Bituminous coal	2008.12	3,836,658	0.7850	0.0296
	2	Hadong	#7	steam power	Bituminous coal	2008.12	3,695,547	0.7877	0.0286
	3	Yeongheung	#4	steam power	Bituminous coal	2008.12	6,892,623	0.7214	0.0489
	4	Kyeongcheon		small hydro power		2008.11	-		
	5	Seongnam 2		small hydro power		2008.10			
	6	Nulokdo solar		solar		2008.09			
	7	Jeju solar		solar		2008.09	37		
	8	Boryeong fuel cell		fuel cell		2008.09	1,885		
	9	Naeyeong solar		solar		2008.08			
	10	Yulhyeon		small hydro power		2008.07	-		
	11	Busan C/C solar		solar		2008.07			
	12	Hadong solar		solar		2008.07			
	13	Hongikdongjin		small hydro power		2008.06			
	14	Daecheongdaem		small hydro power		2008.06			
	15	Boryeong	#7	steam power	Bituminous coal	2008.06	4,302,263	0.7881	0.0334
	16	Yeongheung	#3	steam power	Bituminous coal	2008.06	6,013,822	0.8801	0.0521
	17	Kori-wind power		wind		2008.05			
	18	Samlangjin solar		solar		2008.04			
	19	Boryeong solar		solar		2008.04			
	20	Boryeong		small hydro power		2008.03			
	21	Yeongheung		small hydro power		2008.03			
	22	Yeonggwang solar park				2008.03			
	23	Boryeong 2		small hydro power		2008.03	-		
	24	POSCO fuel cell		fuel cell		2008.03			
	25	Gunjang heat & power		combined		2008.01			
	26	Seocheon solar		solar		2008.01			
	27	New solar energy and others		solar		2008			

2007	1	Taeon		small hydro power		2007			
	2	Hanbit Sungsan the second solar		solar		2007.12			
	3	Taein gangjin solar		solar		2007.12			
	4	Suni gangjin solar		solar		2007.12			
	5	Korea yeongcheon solar		solar		2007.12			
	6	Solar yungam solar		solar		2007.12			
	7	Changwhan yeongduk solar		solar		2007.12			
	8	Samsung jindo		solar		2007.12			
	9	Hwaseong heat & power		combined		2007.12			
	10	Dangjin	#8	steam power	Bituminous coal	2007.12	4,006,729	0.8055	0.0318
	11	SP solar yonggwang		solar		2007.11			
	12	Dongyang energy sinan		solar		2007.11			
	13	Ef yungam solar		solar		2007.11			
	14	Dongwon gangjin solar		solar		2007.11			
	15	Solec yonggwang solar		solar		2007.11			
	16	Solar jungeub solar		solar		2007.11			
	17	Sinbuk yungam solar		solar		2007.11			
	18	Hyein haenam solar		solar		2007.11			
	19	Samlangjin solar		solar		2007.11			
	20	Hyosung daegi-wind power		wind		2007.11			
	21	Nonhyun heat & power		combined		2007.10			
	22	Wuriyungam solar		solar		2007.08			
	23	Hwasung solar		solar		2007.08			
	24	Yeongju the first solar		solar		2007.08			
	25	Muan solar		solar		2007.08			
	26	Jangheung solar		solar		2007.08			
	27	Gomun		small hydro power		2007.08			
	28	Taeon	#8	steam power	Bituminous coal	2007.08	4,265,401	0.8040	0.0337
	29	Dangjin	#7	steam power	Bituminous coal	2007.06	3,776,402	0.8064	0.0300
	30	Munkyoung solar		solar		2007.06			
	31	Younggwang solar park		solar		2007.06			
	32	Yungam Solar		solar		2007.06			

	33	Wonjungsu		small hydro power		2007.05			
	34	Baekgok		small hydro power		2007.05	-		
	35	damyangho		small hydro power		2007.05	-		
	36	Juam		small hydro power		2007.05			
	37	Namjeju	#4	thermal	heavy oil	2007.03	601,048	0.7550	0.0045
	38	Eco energy		solar		2007.03			
	39	hapcheon		small hydro power		2007.02	7,633		
	40	Jeonju-resource recovery facility				2007.02			
	41	Seoul Marin(suncheon)		solar		2007.02			
	42	Mirae energy		solar		2007.02			
	43	samcheonpo		small hydro power		2007.02			
	44	dalbang		small hydro power		2007.02			
	45	Taeon	#7	steam power	Bituminous coal	2007.02	4,028,694	0.8059	0.0319
	46	Yeongju the second solar		solar		2007.01			
	47	Hyundaedaesan		combined		2007.01			
2 0 6	1	Cheongsong pumping	#2	pumping		2006.12	-		
	2	S&P Solar		solar		2006.10			
	3	Bundang fuel cell		fuel cell	LNG	2006.10	2,447		
	4	Namhae Solar		solar		2006.10			
	5	HanlaJeunggong Solar		solar		2006.10			
	6	Yungam Solar		solar		2006.09			
	7	Enepark		solar		2006.09			
	8	Yeongheung solar		solar		2006.09	1,167		
	9	Cheongsong pumping	#1	pumping		2006.09	559,191		
	10	Namjeju	#3	thermal	heavy oil	2006.09	609,639	0.7614	0.0046
	11	yangyang(pumping)	#4	pumping		2006.08	689,556		
	12	Donghae Solar		solar		2006.08			
	13	Kangwon-wind power		wind		2006.07			
	14	Woljeong-wind power		wind		2006.07			
	15	yangyang pump windpower		wind		2006.06			
	16	Hadongho		small hydro power		2006.06	-		
	17	yangyang (pumping)	#3	pumping		2006.06	-		

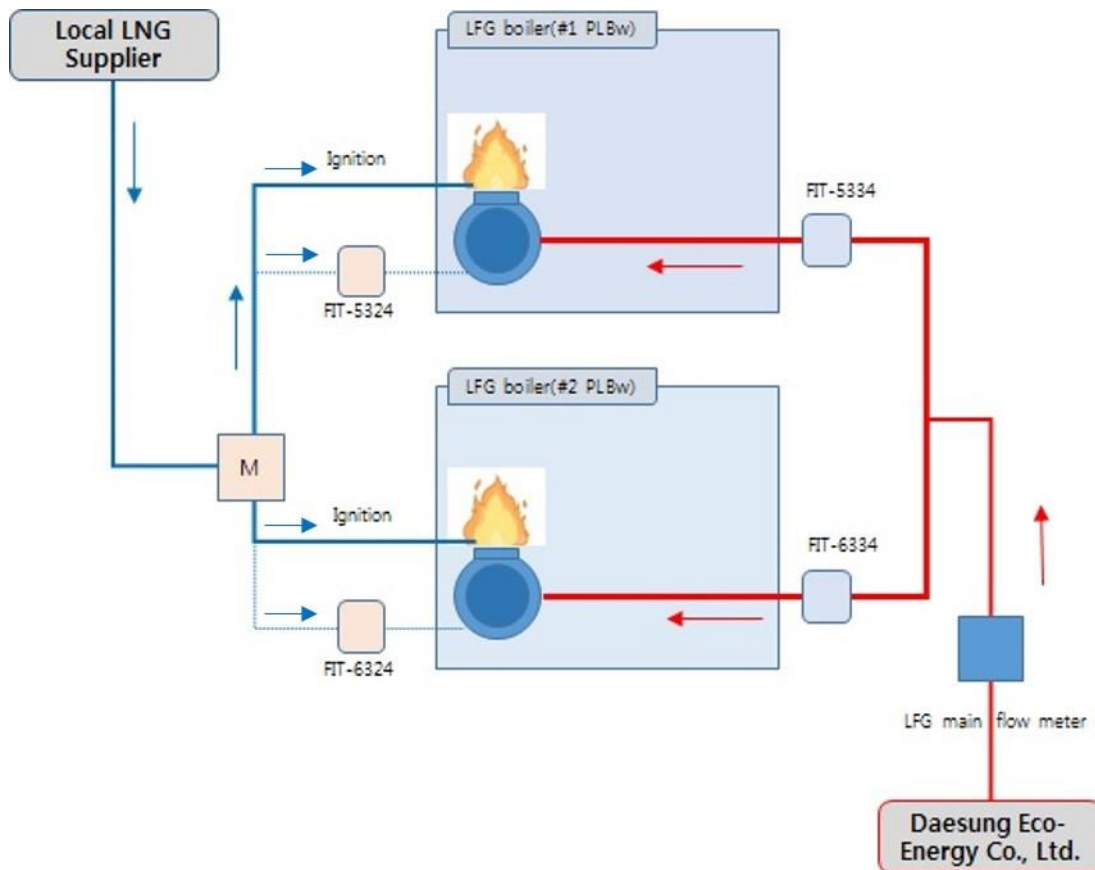
	18	Goheung Solar		solar		2006.06			
	19	Jangseong		small hydro power		2006.05	-		
	20	yangyang (pumping)	#2	pumping		2006.04	-		
	21	Dangjin	#6	thermal	Bituminous coal	2006.04	4,045,961	0.8015	0.0319
	22	Sinchang-wind power		wind		2006.03			
	23	yangyang (pumping)	#1	pumping		2006.02	-		
205	1	Janghengdam		small hydro power		2005.12			
	2	Suncheon Solar		solar		2005.12			
	3	Samcheonpo solar energy		solar		2005.12			
	4	Dangjin	#5	steam power	Bituminous coal	2005.10	4,051,030	0.8101	0.0323
	5	yangyang pump small hydro		small hydro power		2005.10			
	6	Taeon solar energy		solar		2005.10	130		
	7	Jeju DP		internal combustion	heavy oil	2005.07	448,535	0.6258	0.0028
	8	WunjeongLFG		internal combustion	LFG	2005.07			
	9	Yulchon		combined	LNG	2005.07	3,024,133	0.5911	0.0176
	10	Incheon		combined	LNG	2005.07	6,902,460	0.3578	0.0243
	11	Daegok		small hydro power		2005.07	1,965		
	12	Donghwa		small hydro power		2005.07	-		
	13	Ulchin	#6	nuclear		2005.04	7,703,145		
Total							101,644,356		0.5027

Appendix 5. Further background information on monitoring plan

This appendix describes monitoring plan of LFG boilers in detail. This part was newly added as project emissions for the 2nd crediting period and same applies to the 3rd crediting period. KDHC is charge of monitoring associated with LFG boilers and detail monitoring plan for KDHC is as follows;

Both LFG and LNG are available as the boiler's fuel for producing the heat generation. LNG is also used as ignition in order to start up LFG boilers. Its consumption for ignition use will be reflected as project emission.

There are three LNG meters on LFG boilers. One is a main LFG meter of LNG supplier(i.e. M) and others are LNG sub meters(i.e. FIT-5324, FIT-6324) of KDHC for measuring LNG fuel. LNG consumption for Ignition is an amount which sum of both sub flow meters is deducted from a value of LNG main flow meter.



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

Monitoring equipment and calibration

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

Appendix 6. Summary report of comments received from local stakeholders

Not received.

Appendix 7. Summary of post-registration changes

There are some correction of registered PDD in 1st crediting period. One is a technical specifications of installed equipment, the other is a gas analyser as monitoring point.

There are difference between specifications of basic design in the feasibility study and actual adjustment during installation. For measuring $MD_{\text{flared},y}$ under the actual operation, gas analyser AT-101 is appropriate as monitoring point in order to analyse methane density of FIQ-301 for flaring.

Detail information is as follows;

※ Corrections

- Correction of main equipment due to different between preparation specification(Preliminary design) and actual specification(Working design)

※ Corrections

- Gas analyser monitoring point was revised.
- (Behind the buffer tank : The data measured by this gas analyser will be used to calculate $MD_{\text{flared},y}$ → In front of the buffer tank : The data measured by this gas analyser will be used to calculate $MD_{\text{flared},y}$)

※ Corrections

- The company name was changed from Taegu Energy & Environment Co., Ltd. to Daesung Eco-Energy Co., Ltd.

※ Corrections

- The monitoring structure was changed as the company name is changed. And the name of person in charge was omitted because it is often changed.

The PRC is approved on 06 May 2016.

There is another post registration change in 2018, which is of the second crediting period. Two flare stack for the enclosed type were newly installed onsite due to a lots of complains for odor from landfill.

Item	Capacity	LFG supply pressure
Flare stack system (Enclosed type)	2,000 N ³ m/hr x 2 ea	1,000 mmAq

The project activity runs four flare stacks including two existing open type and two newly enclosed type in every summer season. The new flare stacks will be complement the existing flare stacks which is out of date.

Document information

<i>Version</i>	<i>Date</i>	<i>Description</i>
11.0	31 May 2019	Revision to: <ul style="list-style-type: none"> • Ensure consistency with version 02.0 of the “CDM project standard for project activities” (CDM-EB93-A04-STAN); • Make editorial improvements.
10.1	28 June 2017	Revision to make editorial improvement.
10.0	7 June 2017	Revision to: <ul style="list-style-type: none"> • Improve consistency with the “CDM project standard for project activities” and with the PoA-DD and CPA-DD forms; • Make editorial improvement.
09.0	24 May 2017	Revision to: <ul style="list-style-type: none"> • Ensure consistency with the “CDM project standard for project activities” (CDM-EB93-A04-STAN) (version 01.0); • Incorporate the “Project design document form for small-scale CDM project activities” (CDM-SSC-PDD-FORM); • Make editorial improvement.
08.0	22 July 2016	EB 90, Annex 1 Revision to include provisions related to automatically additional project activities.
07.0	15 April 2016	Revision to ensure consistency with the “Standard: Applicability of sectoral scopes” (CDM-EB88-A04-STAN) (version 01.0).
06.0	9 March 2015	Revision to: <ul style="list-style-type: none"> • Include provisions related to statement on erroneous inclusion of a CPA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Provisions related to the Host Party; • Make editorial improvement.
05.0	25 June 2014	Revision to: <ul style="list-style-type: none"> • Include the Attachment: Instructions for filling out the project design document form for CDM project activities (these instructions supersede the "Guidelines for completing the project design document form" (Version 01.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the project activity in B.7.4 and Appendix 1; • Change the reference number from F-CDM-PDD to CDM-PDD-FORM; • Make editorial improvement.
04.1	11 April 2012	Editorial revision to change version 02 line in history box from Annex 06 to Annex 06b.
04.0	13 March 2012	Revision required to ensure consistency with the “Guidelines for completing the project design document form for CDM project activities” (EB 66, Annex 8).

<i>Version</i>	<i>Date</i>	<i>Description</i>
03.0	26 July 2006	EB 25, Annex 15
02.0	14 June 2004	EB 14, Annex 06b
01.0	03 August 2002	EB 05, Paragraph 12 Initial adoption.
Decision Class: Regulatory Document Type: Form Business Function: Registration Keywords: project activities, project design document		