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	KDHC Daegu Biomass Cogeneration Project
Scale of the project activity	☐ Large-scale ☒ Small-scale
Version number of the PDD	17.1
Completion date of the PDD	14/05/2021
Project participants	Korea District Heating Corporation(KDHC)
Host Party	Republic of Korea
Applied methodologies and standardized baselines	AMS I.C(Ver.18) : Thermal energy production with or without electricity
Sectoral scopes	1 : Energy industries(renewable-/non-renewable sources)
Estimated amount of annual average GHG emission reductions	20,855 tCO_2e

SECTION A. Description of project activity

A.1. Purpose and general description of project activity

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The purpose of this project is to install new co-generation power plant generating heat and electricity with the use of woody biomass as energy resources.
The generated electricity by cogeneration system is connected to the national grid. The generated heat by cogeneration system is connected to the district heating (DH) network and is supplied to customers. Since the biomass woodchip is used as a fuel in the project activity, it puts the low amount of CO_2 into the atmosphere compared to fossil fuel. However, CO_2 emission from biomass is regarded as carbon neutral under IPCC. Therefore, its use can contribute to preventing global warming.
It would lead to the diversification to energy utilization by using the waste wood. Also this project would make a significant contribution to minimize the environmental effect by using the forest waste. Therefore, it improves the forest environment.
The woodchip used in the project is divided into two types, i.e. forest waste and industrial & municipal waste. There is a sufficient surplus of the biomass for the project activity.

- Forest waste[1]: The forest waste consists of damaged wood (e.g., pine wood nematode[2]) and thinning out tree. The damaged wood is managed by the government to prevent spreading disease and decreasing carbon stock. The thinning out tree is from forest management for making good growth circumstance and increasing carbon stock.
- Industrial & municipal waste[3]: Through industrial waste from industrial activity at industrial settings to municipal waste, the woodchip is made.

The Pine wood nematode can be treated by incineration, fumigation or crushing but it is mainly treated by fumigation since incineration can cause the forest fires and it is difficult to move crushing facility into the forest. As a result, the fumigated wood was left behind only to be perished. This led to negative landscape view of the city and the roadside so Korea District Heating Corporation (KDHC) decided to positively use the fumigated wood for energy production.
Originally, the industrial use of nematode infected wood was prohibited due to the transportation ban laws to prevent the spread of infection. But recently under cooperation between KDHC and Korea Forest Service, a new guideline named “Administrative guideline for industrial utilization of pine wood nematode” was made for the commercial use of pine wood nematode. According to this law, the fumigated wood left over 6 months after fumigation and the infected wood can be used for industrial purpose.

The cogeneration system installed by the project activity consists of boiler and steam turbine. (Electrical Power Generation: 3MW, DH Capability: 14.5Gcal/h)

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[1] According to the definition of the renewable biomass (EB23, Annex 18 Definition of renewable biomass), the biomass is originating from land areas that are forests where: (a) The land area remains a forest; and (b) Sustainable management practices are undertaken on these areas to ensure, in particular, that the level of carbon stocks on these land areas does not systematically decrease over time (carbon stocks may temporarily decrease due to harvesting); and (c) Any national or regional forestry and nature conservation regulations are complied with. The pine wood nematode disease is highly infective that fumigation and incineration process for infected ones is performed in order to prevent carbon stock reduction. The Korea Forest Service make reforestation program in the infected area to prevent decreasing carbon stock. Therefore, it is in accordance with the definition of the renewable biomass.

[2] According to the "Administrative guideline for industrial utilization of pine wood nematode” (2006.06), the pine wood nematode is possible to use as the industrial application.

[3] According to the Enforcement regulation Decree of the Wastes Control Act, Waste wood consists of forest waste, municipal waste and industrial waste. These are possible to recycle as a fuel of cogeneration.

To control the woodchip and ash, the woodchip handling system and ash handling system will be arranged. These all facilities will be installed in Daegu branch of KDHC.

The estimates of annual average and total GHG emission reductions for the chosen crediting period are shown in the table below:

Years	Estimation of annual reduction in tonnes of CO_2
2011.09~2012.08	20,885
2012.09~2013.08	20,885
2013.09~2014.08	20,885
2014.09~2015.08	20,885
2015.09~2016.08	20,885
2016.09~2017.08	20,885
2017.09~2018.08	20,885
2018.09~2019.08	20,885
2019.09~2020.08	20,885
2020.09~2021.08	20,885
Total estimated reductions (tonnes of CO_2)	208,850
Total number of crediting years	10
Annual average of the estimated Reductions over the crediting period(tCO_2)	20,885

Contribution to sustainable development
This project contributes to sustainable development for several reasons.

- The woody biomass used as a energy source can improve the forest environment in Korea and meet the national energy policy
- As the woody biomass is used for producing electricity and heat, it contributes to diversification of fuels.
- The cogeneration system to produce electricity and heat simultaneously allows reducing the GHG emissions by increasing energy efficiency and it contributes to the mitigation of global warming.
- The use of the woody biomass will reduce the emission of the polluting substances such as sulphur oxides, dust, and so on, thus it contributes to the clean environment.
- Agricultural district's manpower is utilized due to collecting waste wood, installing and managing the woody biomass cogeneration system. KDHC contributes to creating new jobs in a rural district through this work.

A.2. Location of project activity

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The project site largely consists of woodchip biomass cogeneration facility and biomass storage facility. The woodchip biomass cogeneration facility is inside the Daegu branch of KDHC, which is located in 895, Daecheon-dong, Dalseo-gu, Daegu, Korea. It is included in Seongseo industrial complex. It is 3km west from Dalseogu office and Guma highway is east

from the Daegu branch of KDHC. GPS coordinates of the woodchip biomass cogeneration facility are latitude 35.8311°, longitude 128.4896°.

<KDHC Woodchip biomass facility>

A.3. Technologies/measures

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Main equipments and auxiliary facilities of cogeneration system will consist of Boiler, Steam Turbine, Woodchip Handling System, Ash Handling System and DH System, etc.
More details are as follows:

1. Boiler

Type	Stoker Boiler
Capacity (Steam Flow)	27.63ton/hr
Pressure	36 bar(kg/cm^2g)
Temperature	388℃ (output temperature of a super heater)
Fuel	woody biomass (Start-up fuel: LNG)
Plant Load Factor (PLF)	54.8% (Boiler is operating 200 days a year)

According to paragraph 3 in EB48 Annex11, KDHC chooses the PLF (option (a)) provided to the government when requesting approval for the modification of district heating and cooling energy system business in Daegu.
* Because of the characteristics of demands of heat for district heating and cooling (much in winter season, little in summer season), the Boiler stops operating from the middle of April to September when demands of heat is little.

2. Steam Turbine

Type	Back Pressure Type
Capacity	Electricity Power Generation: 3MW

3. DH System

Type	Shell & Tube Heat Exchanger
Capacity	DH Heat Exchanger(DHE): 13.517Gcal/hr Turbine Bypass Heat Exchanger(THE): 17.383Gcal/hr Grand Steam Condenser(GSC): 0.243Gcal/hr

DH System maintains the temperature of closed-loop water for district heat between 60℃ and 100℃ by using the steam of back pressure turbine.
*Normal Operation: 14.5Gcal/hr (DHE 12.638Gcal/hr + THE 1.577Gcal/hr + GSC 0.243Gcal/hr = 14.458Gcal/hr)

4. Woodchip Handling System

Type	Belt Conveyor + Magnetic Separator + Fuel feeder
Capacity	15.3ton/hr

Woodchip Handling System conveys woodchip from the CHIP Bunker into the furnace of boiler.

5. Ash Handling System

Bottom Ash	Submerged Chain Conveyor + Belt Conveyor + Silo 0.51ton/hr
Fly ash	Flow conveyor + Silo 0.19 ton/hr

Ash Handling System conveys the bottom ash from boiler and the fly ash from dust collector into Ash Silo.

6. Air Pollution Control System
KDHC introduces the Air Pollution Control System to reduce the dust, NOx, SOx, etc. according to the standards of Clean Air Conservation Act.

- SNCR (Selective Non-Catalytic Reduction)

Type	Dual Flow Fixed type
Efficiency	49.6%

- Muti-Cyclone

Type	Dry type
Efficiency	50%

- Electrostatic Precipitator

Type	Dry type
Efficiency	95%

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)	Korea District Heating Corporation	No

A.5. Public funding of project activity

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The project involves no public funding or ODA. The investment of this project is completely offered from the KDHC.

A.6. History of project activity

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The CDM project(Ref.5153) was registered in 18 Sep 2014 and is now on Post Registration Change.

	(a)	(b)

1.Confirmation	The proposed CDM project activity is neither registered as a CDM project activity nor include as a component project activity(CPA) in a registered CDM programme of activities (PoA);	The proposed CDM project activity is not a project activity that has been deregistered.
	The CDM project(Ref.5153)registered in 18 Sep 2014. The CDM project is not linked to other CDM project.	
2.Declaration	The proposed CDM project activity is not a project activity that has been deregistered.	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.
	The CDM project(Ref.5153)registered in 18 Sep 2014. The CDM project is not linked to other CDM project.	

A.7. Debundling

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Based on the information provided in Appendix C of the Simplified Modalities and Procedures for small-scale CDM project, a small-scale project is considered as a de-bundled component of a large project activity if there is a registered small-scale activity or a possibility to register another small-scale activity:

- With the same project participants;
- In the same project category and technology/measure;
- Registered within the previous 2 years; and
- Whose project boundary is within 1km of the project boundary of the proposed small-scale activity.

KDHC is promoting two CDM projects in Daegu district office within 1km of the project boundary of the proposed small-scale activity. This biomass project activity is one case and the other is the fuel switch from fossil fuel to renewable energy (Project title: Fuel switch from fossil fuel to renewable energy for thermal energy in Korea District Heating Corp.). The summary of the project are as below.

Project title	KDHC Daegu biomass cogeneration project	Fuel switch from fossil fuel to renewable energy for thermal energy in Korea District Heating Corp.
Project participant	Korea District Heating Corporation	Korea District Heating Corporation
Project category and technology / measure	Cogenerating power plant using biomass Methodology used: AMS-I.C	Heat generation with heat only boiler using LFG from the local landfill site Methodology used: AMS-I.C
Registered within the previous 2 years	Nothing was registered nor in the registration process.	
Project boundary is within 1km of the project boundary	Both projects are located in the same boundary, i.e. This project boundary is overlapped within 1km with the other project boundary.	

As above mentioned, both project activities apply a little bit different technology/measure. One is the cogeneration system using biomass and the other is only heat generation with Heat only boiler using landfill gas from the local landfill site. Moreover both projects are not registered nor in the registration process. Therefore, this project is not debundled project.

However, according to the paragraph 4 (b), Annex 27 EB36, PP confirms that once this project is registered, the other project will not request for registration with SSC CDM project activity.

SECTION B. Application of methodologies and standardized baselines

B.1. References to methodologies and standardized baselines

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[Baseline methodology]
Methodology title: AMS I.C Thermal energy production with or without electricity
Version: 18.0

B.2. Applicability of methodologies and standardized baselines

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The project activity satisfies applicability condition of AMS I.C (ver.18) as followings:

1. This category comprises renewable energy technologies that supply users with thermal energy that displaces fossil fuel use. These units include technologies such as solar thermal water heaters and dryers, solar cookers, energy derived from renewable biomass and other technologies that provide thermal energy that displaces fossil fuel.

   ⇒ The project activity is 3MW woodchip cogeneration system that produces heat and electricity. As the project activity avoids fossil fuel consumption in the producing electricity and heat, it is included in the category.

2. Biomass-based cogeneration systems consisting of steam generator(s) and steam turbine(s) are included in this category. For the purpose of this methodology cogeneration shall mean the simultaneous generation of thermal energy and electrical energy in one process. Project activities that produce heat and power in separate element processes (for example, heat from a boiler and electricity from biogas engine) do not fit under the definition of cogeneration project.

   ⇒ The project activity is a woodchip-based cogeneration system which generates heat and electricity at the same time.

3. Emission reductions from a biomass cogeneration system can accrue from one of the following activities:

   (a) Electricity supply to a grid;

   (b) Electricity and/or thermal energy (steam or heat) production for on-site consumption or for consumption by other facilities;

   (c) Combination of (a) and (b).

   ⇒ Emission reductions from the project are accrue from (c) activity since produced electricity is supplied to the grid and produced heat is provided to the project customer in the project.

4. The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45MW thermal.

   ⇒ The total thermal generation capacity is 25.864 MW_{th} as follows.

[Thermal generation capacity]

$$= \frac{14.5Gcal}{h} \times \frac{4.1868GJ}{1Gcal} \times \frac{10^3 MJ}{1GJ} \times \frac{1h}{3600s}$$
$$= 16.864MJ / s$$
$$= 16.864MW_{th}$$

[Converting electrical energy to thermal energy]
= 3MW_e X 3 (conversion factor)
= 9MW_{th}

➔ Total capacity = 16.864MW_{th} + 9MW_{th} = 25.864 MW_{th}

Therefore, the project activity does not exceed 45MW_{th}, which is type I according to the capacity standard as specified in the category.

5. For co-fired systems, the total installed thermal energy generation capacity of the project equipment, when using both fossil and renewable fuel shall not exceed 45MW thermal.

⇒ The project activity don't use co-fired system, especially which uses fossil fuel.

6. The following capacity limits apply for biomass cogeneration units:
   (a) If the project activity includes emission reductions from both the thermal and electrical energy components, the total installed energy generation capacity(thermal and electrical) of the project equipment shall not exceed 45MW thermal. For the purpose of calculating this capacity limit the conversion factor of 1:3 shall be used for converting electrical energy to thermal energy(i.e., for renewable project activities, the maximal limit of 15MW(e) is equivalent to 45MW thermal output of the equipment or the plant);
   (b) If the emission reductions of the cogeneration project activity are solely on account of thermal energy production(i.e., no emission reductions accrue from electricity component), the total installed thermal energy production capacity of the project equipment of the cogeneration unit shall not exceed 45MW thermal;
   (c) If the emission reductions of the cogeneration project activity are solely on account of electrical energy production (i.e., no emission reductions accrue from thermal energy component), the total installed electrical energy generation capacity of the project equipment of the cogeneration unit shall not exceed 15MW.

[Thermal generation capacity]

$$= \frac{14.5Gcal}{h} \times \frac{4.1868GJ}{1Gcal} \times \frac{10^3 MJ}{1GJ} \times \frac{1h}{3600s}$$
$$= 16.864MJ / s$$
$$= 16.864MW_{th}$$

[Converting electrical energy to thermal energy]
= 3MW_e X 3 (conversion factor)
= 9MW_{th}

➔ Total capacity = 16.864MW_{th} + 9MW_{th} = 25.864 MW_{th}

7. In case electricity and/or steam/heat produced by the project activity is delivered to another facility or facilities within the project boundary, a contract between the supplier and consumer(s) of the energy will have to be entered into specifying that only the facility generating the energy can claim emission reductions from the energy displaced.

⇒ This project provides the electricity to the national electricity grid and heat to the district heating grid which is a system to supply heat to each individual home (end-user, around 100,000 homes). The quantity and price for electricity and heat used by an individual home are determined by the used amount by each home and the national guidelines, Community Energy Supply Business law (Partly revised on 2010) and Ministerial Order of the District Heat Tariff Cap by Ministry of Knowledge Economy (2006). Since the heat and electricity generated are supplied to the end-users through the electricity and district heating grid system, there is no contract between the supplier and consumer(s) for this project.

8. Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category.

⇒ Since the project activity is to introduce the new equipment, it is not included in this category.

9. The capacity limits specified in the above paragraphs apply to both new facilities and retrofit projects. In the case of project activities that involve the addition of renewable energy units at an existing renewable energy facility, the total capacity of the units added by the project should comply with capacity limits in paragraphs 3 to 5 and should be physically distinct4 from the existing units.

⇒ Since the project activity is to introduce the new equipment, it is not included in this category.

10. Charcoal based biomass energy generation project activities are eligible to apply the methodology only if the charcoal is produced from renewable biomass sources provided:

    (a) Charcoal is produced in kilns equipped with methane recovery and destruction facility; or

    (b) If charcoal is produced in kilns not equipped with a methane recovery and destruction facility, methane emissions from the production of charcoal shall be considered. These emissions shall be calculated as per the procedures defined in the approved methodology AMS-III.K. Alternatively, conservative emission factor values from peer reviewed literature or from a registered CDM project activity can be used, provided that it can be demonstrated that the parameters from these are comparable e.g., source of biomass, characteristics of biomass such as moisture, carbon content, type of kiln, operating conditions such as ambient temperature.

⇒ The project activity don’t use charcoal based biomass.

11. If solid biomass fuel (e.g. briquette) is used, it shall be demonstrated that it has been produced using solely renewable biomass and all project or leakage emissions associated with its production shall be taken into account in emissions reduction calculation

⇒ The woodchip used in this project is made of pinewood nematode and industrial/municipal waste wood which has no fossilized component. That is, the woodchip meets the definition of renewable biomass from UNFCCC. Because the use of solid fuel which is GHG emission intensive was prohibited in Daegu city where the project is implemented, PP got approval for use of woodchip which is solid but environmentally friendly under the condition that only non-fossilized wood is used. Regarding woodchip production, leakage emission (emission from processing of biomass) is already considered in emission reduction calculation

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

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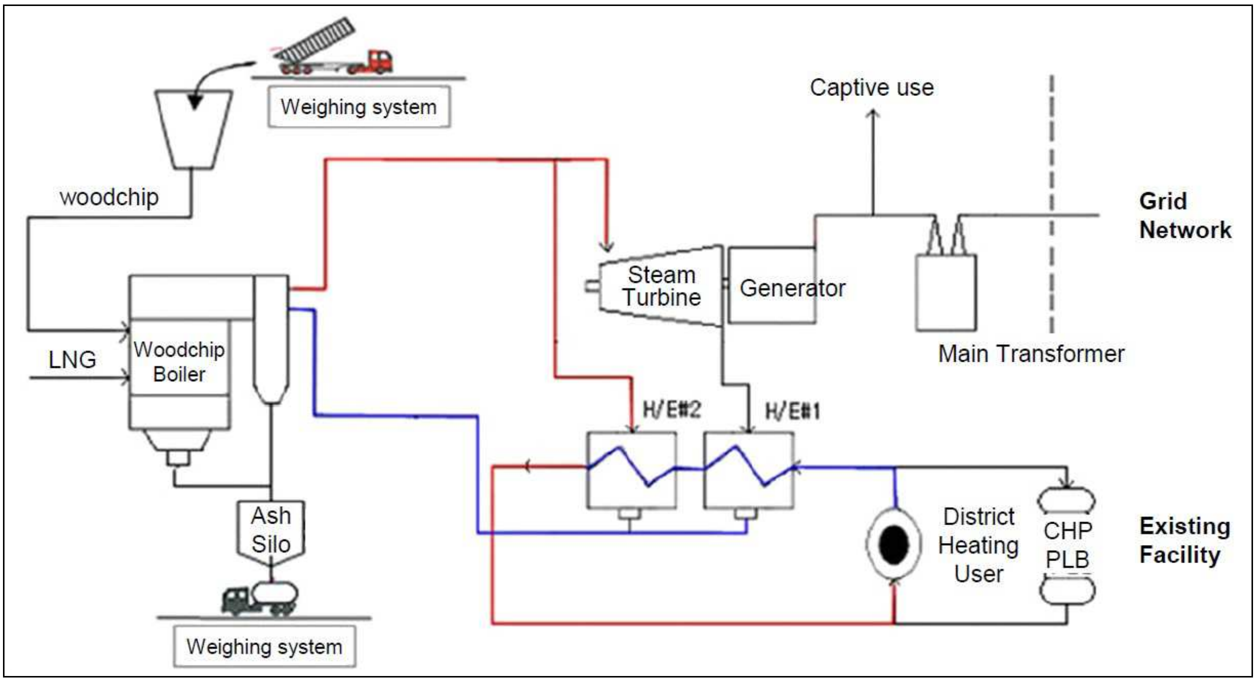
According to AMS I.C, project boundary includes the physical, geographical site of the renewable energy generation delineates the project boundary.

The project boundary includes the biomass cogeneration system, measuring instrument, electricity grid and district heating network. CO_2 is the only GHG included in the Project boundary. The project boundary is illustrated in the following diagram:



H/E: Heat Exchanger, **CHP**: Combined Hea tand Power Plant, **PLB**: Peak Load Boiler

Project boundary at Daegu branch biomass CHP project

	Source	GHG	Included?	Justification/Explanation
Baseline	Emission from electricity generation	CO_2	Yes	There is a major emission source.
		CH_4	No	CH_4 emission is very small compared to CO_2 emission. Exclusion of this is conservative.
		N_2O	No	N_2O emission is very small compared to CO_2 emission. Exclusion of this is conservative.
	Emission from heat generation	CO_2	Yes	There is a major emission source.
		CH_4	No	CH_4 emission is very small compared to CO_2 emission. Exclusion of this is conservative.
		N_2O	No	N_2O emission is very small compared to CO_2 emission. Exclusion of this is conservative.
	Emission from fossil	CO_2	Yes	It is an important emission source.

	fuel consumption due to the project activity	CH_4	No	Excluded for simplification. This is an emission source assumed to be very small.
		N_2O	No	Excluded for simplification. This is an emission source assumed to be very small.
	Emission from electricity use 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_2O	No	Excluded for simplification. This is an emission source assumed to be very small.
Leakage	Emission from biomass processing fuel consumption	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_2O	No	Excluded for simplification. This is an emission source assumed to be very small.
	Emission from fuel consumption for woodchip transportation	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_2O	No	Excluded for simplification. This is an emission source assumed to be very small.
	Emission from fuel consumption for ash transportation	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_2O	No	Excluded for simplification. This is an emission source assumed to be very small.

B.4. Establishment and description of baseline scenario

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Since the project activity is to install new co-generation power plant and the existing facilities in the district heating system are not displaced by the project activity, paragraph 14 of the methodology AMS I.C should not be applicable to the project activity. According to AMS I.C paragraph 15, cogeneration projects shall use one of the eight following options for a baseline scenario emission calculation depending on the technology that would have been used to produce the thermal energy and electricity in the absence of the project activity:

No.	Alternative baseline scenario	Description
1	Electricity is imported from the grid and thermal energy(steam/heat) is produced using fossil fuel	This scenario is the most general practice in Republic of Korea and can be a credible baseline scenario. Electricity: Most residential and commercial facilities are supplied with electricity through the national grid. Heat: Most residential and commercial facilities are supplied with heat through the fossil fuel (B-C oil, LNG) boiler in the district heating system in the absence of project activity. Conservatively LNG boiler is applied in this scenario.
2	Electricity is produced in an on-site captive power plant using fossil (with a possibility of export to the grid) and thermal energy(steam/heat) is produced using fossil fuel	This scenario can be a credible baseline scenario, but it is excluded due to the following reasons: As an onsite captive power plant to generate the electricity in Korea, it can be a fossil fuel power plant (coal, B-C oil, LNG) or a renewable power plant (wind, solar, water, etc). Among them, LNG

		power plant is the most practical alternative. However since the cost of the electricity generated through LNG power plant is not cheaper than the buying price of electricity supplied from the national grid, this scenario is less economically attractive than the scenario 1.
3	A combination of (a) and (b)	This scenario can be a credible baseline scenario, but it is not to be considered for the baseline scenario as the same reason above scenario 2.
4	Electricity and thermal energy(steam/heat) are produced in a cogeneration unit using fossil fuel (with a possibility of export of electricity to the grid/other facilities and/or thermal energy to other facilities)	This scenario can be a credible baseline scenario but it is excluded due to the following reasons: According to “The Public Notice on the Use of a Clean Fuel (Law No.2007-180)”, the new cogeneration facility, which supplies heat and electricity to the city, must use LNG as a fuel. LNG is the most expensive among fossil fuels and LNG cogeneration facility is less economically attractive than the scenario 1. And now LNG cogeneration facility as a Community Energy System in Korea is not a common practice to generate electricity and heat.
5	Electricity is imported from the grid and/or produced in an on-site captive power plant using fossil fuels (with a possibility of export to the grid); steam/heat is produced from biomass	This scenario can be a credible baseline scenario but it is excluded due to the following reasons: As a biomass for supplying heat, it can be a LFG (Landfill Gas) or woodchip. However, with the limitation of resource and location, just 3 heating facilities using LFG as a fuel are operating and only one woodchip cogeneration facility is operating. Therefore, this scenario is not the common practice in Korea.
6	Electricity is produced in an on-site captive power plant using biomass (with possibility of export to a grid) and/or imported from the grid; steam/heat is produced using fossil fuel	This scenario can be a credible baseline scenario, but it is excluded due to the following reasons: As a biomass for electricity generation, it can be a LFG or woodchip. However, only one woodchip cogeneration facility is operating for electricity generation in Korea. Since the cost of the electricity generated through biomass power plant is not cheaper than the buying price of electricity supplied from the national grid, this scenario is less economically attractive than the scenario 1.
7	Electricity and thermal energy (steam/heat) are produced in a biomass fired cogeneration unit (without a possibility of export of electricity either to the grid or to other facilities and without a possibility of export of thermal energy to other facilities)	This scenario cannot be a credible baseline scenario due to the following reasons: Because the project activity is to supply electricity generated to the grid and heat generated to residential facilities for heating, this scenario is not applicable.
8	Electricity and/or thermal energy produced in a co-fired system.	This scenario cannot be a credible baseline scenario due to the following reasons: As a fuel for co-fired system, it can be LFG + LNG or woodchip + LNG according to “The Public Notice on the Use of a Clean Fuel (Law No.2007-180).” As above scenario 2, LNG co-fired system

		is not economically attractive than scenario 1. Since the generation facility with LFG has to be located near the landfill, LFG co-fired system is not the common practice in Korea.

When considering above eight options on the heat production and electricity generation, the alternative baseline scenario #1 is the most plausible scenario. Therefore, "Electricity is imported from the grid and steam/heat is produced using fossil fuel" was selected as the baseline scenario.

B.5. Demonstration of additionality

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The project activity is not in force by compulsion and is on its own initiative for reduction GHG simultaneously sustainable development. There are many barriers for operating. However there are possibilities for financing the project in view of the CERs benefit, it would help overcome these barriers.

This project is a small-scale CDM project. According to "Attachment A to Appendix B of the Simplified Modalities and Procedures for small-scale CDM project activities" and "Non-binding best practice examples to demonstrate additionality for SSC project activities", the project developer must provide that the project have at least one additionality among the following factors: (a) Investment barrier (b) Access-to-finance barrier (c) Technological barrier (d) Barrier due to prevailing practice (e) Other barriers

(a) Investment barrier
The renewable energy projects require high capital investments but the expectation of return is very low. Due to these reasons the renewable energy is not a very attractive option for power and heat generation. According to study of Korea Energy Economics Institute (KEEI)[4] "A Study on the Energy Utilization of Ligneous Biomass – Focusing on Energy Production Facility Fuel by Woodchip", using woodchip biomass for fuel is economically unattractive for highly costing transportation, production and loss of woodchip and the range of fluctuation in price is wide.

The scenario is classified according to the ratio of woodchip. The result of every scenario is as followings:

- Optimistic view : residual products for forest management 40% + Industrial waste 30% + waste wood 30%
- Neutrality view : (trees for) species regeneration 50% + Industrial waste 20% + waste wood 30%
- Pessimistic view : residual products for forest management 20% + (trees for) species regeneration 50% + waste wood 30%

Scenario	Cost of Woodchip (Won/m^3)	NPV (million Won)	IRR (%)	Appropriate price of system marginal price (Won/kWh)
Optimistic view	30,565	-562	-0.37	72.92
Neutrality view	38,190	-1,761	-1.22	81.65
Pessimistic view	56,124	-4,633	-3.37	102.30

Source: "A study on the Energy Utilization of Ligneous Biomass", KEEI

[4] KEEI was established as a government-affiliated research institute in order to contribute to the national energy policy-making by collecting, analyzing, and disseminating energy information and issues

According to above results of the study, all of the three views are not economically attractive. Even though the electricity selling cost to grid is more expensive than the actual electricity selling cost to grid, 68.99Won/kWh, it is unattractive.

Therefore, the benefit of transaction CERs is important for promoting the project

For demonstrating additionality, we calculated financial indicator of woody biomass cogeneration facility i.e., Net present Value (NPV) and Internal Rate of Return (IRR) taking into account expected benefits from electricity, heat, CERs sales and costs from investment requirements and operation for facility.

Major assumptions are as followings:

[Major assumptions]

(a) Net electricity generation: 14,400MWh/year, Renewable energy business implementation (2006.4)
(b) Net heat generation: 57,600Gcal/year, Renewable energy business implementation (2006.4)
(c) Total investment requirements: 14,500,000,000 Won, Renewable energy business implementation (2006.4)
(d) Cost of fuel: 1,458,000,000Won/year, Renewable energy business implementation (2006.4)
(e) Discount rate: 6%, KDHC, Analytical criterion for validation of district heating project (2002.1) WACC+ α (risk cost, the opportunity cost of the risk compensation)
(f) The period of expected operation of the project activity: 20years, Korean Tax law enforcement, Standard of depreciation for heat facility
(g) Expected electricity selling cost to grid: 68.99Won/KWh, FIT(Feed In Tariff), Ministry of Knowledge Economy (2006.8)
(h) Expected sale price for heat: 49,264Won/Gcal, The management statistic of KDHC (2005)
(i) Cost of major maintenance and/or rehabilitation, cost of labour, paying for insurance and overhead expense etc.: KDHC, Analytical criterion for project validation (2006.4)
(j) Depreciation: 5%, KDHC, Analytical criterion for project validation" (2006.4), residual value of the new equipment is zero.

The estimated NPV and IRR are as follows:

	Value (excluding CERs benefit)	Value (including CERs benefit)
IRR	4.81%	6.39%
NPV	-1.44billion Won	0.47billion Won

In order to prove the investment barrier of the project, the benchmark analysis was chosen for the tool of additionality demonstration.

As shown in the above table, IRR of the project excluding CERs benefit is lower than the discount rate (6%) provided by KDHC, so this project without CDM is not economically attractive. Thus, Promoting CDM project is a critical factor for investment decision and this project has investment additionality.
KDHC's biomass project is the sole case in Korea for introducing district heating to provide heat to local households. Since there's no similar projects in Korea the benchmark (discount rate) of this project is compared to similar projects with similar risks, developed by the same company according to the 'Guidance on the Assessment of Investment Analysis' (Annex58, EB51). According to KDHC community energy supply (CES) business plan in Goyang (2008.8), the discount rate of 7% was applied in analyzing economic feasibility of that project. The discount rate of Bangcheon-Ri Landfill gas CDM Project KDHC participated in is 7.0%. The discount rates of other renewable energy CDM projects are 7.0% of Hangyeong second phase SS-wind power and 7.0% of Sudokwon Landfill Gas Electricity Generation Project.

The discount rate of this project is 6% that is 5% (WACC) + 1% (risk premium). Therefore discount rate of this project is conservative in comparison with that of other projects.
KDHC' business is a public investment projects accompanied by High Upfront Investment and applied by standard of SOC (Social Overhead Capital) Investment. In case of SOC Investment the long-term premium (about 1%) is applied. (1.1%, the average value for previous 20-year US Credit Spread which is US government bond yield spread.)
Risk premium (1.1%) is much lower than other projects that it is very conservative value.

During project progress, the boiler capacity changed from 27ton/hr to 27.63ton/hr which changed the values of some input parameters such as net electricity generation, net heat generation, woodchip consumption(fuel cost). Therefore in order to defend the above investment analysis, we performed the additional investment analysis with the following changed values of input parameters.

(a) Net electricity generation: 11,942MWh/year (see (1) Electricity in page 28)
(b) Net heat generation: 66,058Gcal/year (see (2) Heat in page 29)
(c) Cost of fuel: 1,674,720,000Won/year, Price comparison of woodchip suppliers (2008.8), Boiler performance data by DAELIM Boiler co., Ltd (2008.8)

The estimated IRR and NPV are as follow:

	Value (excluding CER benefits)
IRR	5.00%
NPV	-1.22billion Won

The result of additional investment analysis, IRR 5.00%, does not cross the benchmark value of 6%, which reveals that this project is not economically attractive.

[Sensitivity analysis]
The key factors which affect investment analysis are a unit price of selling electricity, a unit price of selling heat, a unit cost of woodchip, net electricity generation, net heat generation, investment cost, O&M cost. Thus, we perform the sensitivity analysis in assuming that the variables range from +10% to -10%.

The result of sensitivity analysis is as followings:

	Scenario	IRR	
		IRR(excluding CERs benefit)	IRR(including CERs benefit)
Price of selling electricity	+10%	5.43%	6.99%
	-10%	4.18%	5.78%
Price of selling heat	+10%	6.52%	8.04%
	-10%	2.93%	4.57%
Unit cost of woodchip	+10%	3.87%	5.48%
	-10%	5.71%	7.26%
Net electricity generation	+10%	5.43%	6.99%
	-10%	4.18%	5.78%
Net heat generation	+10%	6.52%	8.04%
	-10%	2.93%	4.57%
Investment cost	+10%	3.84%	5.31%
	-10%	5.93%	7.64%
O&M cost	+10%	4.17%	5.77%
	-10%	5.44%	7.00%

According to above sensitivity analysis, the following two scenarios cross the benchmark value of 6%.

No.	Parameter	Scenario	IRR	Scenario to meet benchmark*	Improbable reason
1	Price of selling heat	+10%	6.52%	+6.84%	Combination pricing policy by government
2	Net heat generation	+10%	6.52%	+6.84%	Must-run heat sources

*Scenario where IRR is equal to the benchmark value (6%)

① Heat price 10% up

Since the policy regulates the heat price in connection with fuel (woodchip) cost, the heat price can be increased when the fuel cost increase and vice versa. That is, if the heat price would increase by 10%, we can assume that the fuel cost would have increased by the similar rate to 10% at the same or a little bit earlier moment. For reference, if the heat price and fuel cost increase by 10% respectively, IRR of this scenario is 5.66%. That is, those IRRs would not cross the benchmark value of 6%. Furthermore, since the heat price is closely checked and controlled by government according to Clause 10 of Article 17 in Community Energy Business Law (2010) and Clause 2 of Article 4 in Ministerial Order of District Heat Tariff Cap by Ministry of Knowledge Economy (2006), the sharp increase of heat price seems to be unreasonable and unrealistic.

② Net heat generation 10% up

The Daegu branch of KDHC has several heat sources for district heating such as LFG, incineration heat, heat generated from woodchip CHP and so on. Since the unit cost of heat generated by LFG or incineration heat is cheaper than that of heat generated from woodchip CHP, LFG and incineration heat are utilized as must-run heat sources all the year round in accordance with the contract between KDHC and LFG/incineration heat suppliers.

According to KDHC heat generation plan, since the heat is generated by LFG and incineration heat enough to meet the heat demand from May to October (6 months), woodchip CHP does not operate during that period and can only operate during the other 6 months (from November to April, about 180 days at maximum). That is, woodchip CHP cannot generate more than the amount of heat based on 200 operating days. So, it is not practical that net heat generation can increase by over 6.84%.

Therefore, sensitivity analysis reveals that this project is not economically attractive.

(b) Other barriers

According to Renewable Energy RD&D Strategy 2030 by Korea Energy Management Corporation (KEMCO, 2007.11), Korea's only biomass cogeneration system under progress is Seo-Daegu biomass cogeneration system and it is also progressing as a CDM project, but in this case the facility is providing heat to nearby industrial complex. Therefore this project is the sole case in Korea for introducing district heating to provide heat to local households.

In addition, there is no legislation present to properly support the operation of biomass cogeneration system. The use of renewable energy in the world's primary energy marks 16.7% of total, whereas 54% for biomass energy and 3.6% for woody biomass. In contrast, the use of biomass in primary energy is only 0.14% because of lack of support from the Korean government. (Renewable Energy Statistics by KEMCO, 2008)

< CDM Consideration before the construction of the project and implementation timeline of the CDM project activity >

a) In the project decision

KDHC are performing many kind of CDM project and registered CDM project activity: On 9th May 2006, KDHC considered to start Biomass cogeneration system at board meeting. On the meeting, directors decided promoting biomass cogeneration system for preventing the Climate Change, although the project is not economically attractive and has many problems.

b) In the project processing

- The executive board of KDHC decided to promote woodchip cogeneration system on 9th .May.2006.
- The Korea Forest Service and KDHC make an agreement on the use of damaged pine wood nematode on 25th.May.2006.
- On 25th.Jan.2007, KDHC receives an approval for use of solid fuels from Daegu metropolitan.
- After KDHC performed a feasibility study on biomass, KDHC started CDM procedure with Eco-Frontier, a consulting firm which made a contract with KDHC on 18.Jun.2008.

The project owner started preparation of the project activity in line with the time schedule below:

Date	Event	
’06. Apr	Agenda for 3rd board meeting: Implementation of renewable energy project utilizing pine wood nematode	Business Headquarter provides business plan
’06. May	Decision to promote renewable energy project utilizing pine wood nematode	2006 third board meeting
’06. May	Contract agreement about use of damaged pine wood nematode	Korea Forest Service ↔ KDHC
’06. Jun	Guideline for stimulating commercial use of damaged pine wood nematode (’06.6.1)	Conventional fumigation method →Establishment of guidelines for use of fumigated and lumbered wood
’06. Nov	Report on basic design and important measures for the Daegu woodchip renewable energy project (Report from the head of construction department, ‘06.11.17)	-
’07. Jan	Approval for use of solid fuels for Daegu woodchip cogeneration (Daegu metropolitan, ’07.1.25)	-
’07. Jul	Basic design for the Daegu woodchip facility completed	-
’07. Sep	Construction contract signed for Daegu woodchip project(‘07.9.28)	Contract party: Kenertec Co.(’07.9.20~’09.5.29)
’08. Apr	Plan to proceed Daegu biomass CDM project (’08.4.17)	Proposals from CDM consulting firms
’08. Jun	CDM UN registration and CERs issuance consulting contract for Daegu biomass project signed (’08.6.18)	Contract party: Eco-Frontier (’08.6.18~ ’10.3.31)
’08. Oct	CDM validation contract signed	DOE: TÜV-SÜD

B.6. Estimation of emission reductions

B.6.1. Explanation of methodological choices

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Difference between the baseline emissions and project emission is emission reduction. And then, Reductions in GHG emissions shall be adjusted for leakage. According to AMS I.C and I.D, the emission reduction is calculated.

$$ER_y = BE_y - PE_y - LE_y$$

Where:

Parameter	Description
ER_y	Emissions reduction in the year y (tCO_2)
BE_y	Baseline emission in the year y (tCO_2)
PE_y	Project emission in the year y (tCO_2)
LE_y	Leakage emission in the year y (tCO_2)

[Project emission]

Woody biomass has peculiarity that is carbon neutral, therefore project emission for combustion of woody biomass does not considered.

The project emission includes emission through combustion of fossil fuel and emission through electricity consumption in the year y (tCO_2), as follow:

$$PE_y = PE_{y,comb} + PE_{y,power}$$

Parameter	Unit	Description
$PE_{y,}$	tCO_2/year	Project Emission in the year y
$PE_{y,comb}$	tCO_2/year	Emission through combustion of fossil fuel in the year y
$PE_{y,power}$	tCO_2/year	Emission through electricity consumption in the year y

(1) Emission through combustion of fossil fuel in the year y
In case of the combustion of woodchip, the reaction time for combusting wood chip is so long that the fuel for the starting operation has to be LNG. Therefore the emission from the consumption of fossil fuel has to be considered.

$$PE_{y,comb} = FF_{start-up,y,k} \times NCV_k \times EF_k$$

Parameter	Unit	Description
$FF_{start-up,y,k}$	m^3 or kℓ	Quantity of start-up fossil fuel k used in the year y
NCV_k	*Kcal/* m^3 or kℓ	Net calorific value for fossil fuel k
EF_k	tCO_2/TJ	CO_2 emission factor per unit of energy of the fuel k that would have been used in the baseline plant, obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used

(2) Emission through electricity consumption in the year y
The emission through electricity consumption in the project boundary shall be considered.

In case of that the auxiliary electricity in cogeneration facility is used to generate itself, emission from electricity consumption need not to be considered, because the baseline emission for electricity shall apply net generation excluding auxiliary use. In case of the auxiliary electricity use of electricity in cogeneration facility is from grid, emission through electricity shall be calculated according to “Tool to calculate baseline, project and/or leakage emissions from electricity consumption.”

• In case of the auxiliary electricity use supplied from public supply

$$PE_{y,power} = EG_{captive,y} \times EF_{grid,CM,y} \times (1 + TDL_y)$$

Parameter	Unit	Description
$EG_{captive,y}$	MWh	The electricity imported from the grid in the year y
$EF_{grid,CM,y}$	tCO_2/MWh	CO_2 emission factor for electricity form public supply in the year y
TDL_y	%	Average technical transmission and distribution losses in the year y

$EF_{grid,CM,y}$ is calculated following “Tool to calculate the emission factor for an electricity system (version 02)”.

[Baseline emission]

Baseline emission calculations for AMS I.C

In absence of the project activity, baseline scenario is that heat is produced using fossil fuel and electricity is imported from the grid. Therefore, baseline emission for heat and electricity is calculated separately.

(1) Electricity

According to AMS I.C, baseline emissions for electricity imported from the grid shall be calculated as the amount of electricity produced with the renewable energy technology (GWh) multiplied by the CO_2 emission factor of the grid. The emission factor for grid electricity shall be calculated as the procedures detailed in AMS I.D. According to AMS I.D, a combined margin(CM), consisting of the combination of operating margin(OM) and build margin(BM) according to the procedures prescribed in the “Tool to calculate the emission factor for an electricity system”.

$$BE_{electricity,y} = EG_y \times EF_{grid,CM,y}$$

Parameter	Unit	Description
$BE_{electricity,y}$	tCO_2/year	Baseline emission for electricity in the year y
EG_y	MWh/year	Quantity of net electricity supplied to the grid in the year y
$EF_{grid,CM,y}$	tCO_2/MWh	CO_2 emission factor for grid electricity in the year y

(2) Heat

According to AMS I.C, for heat produced using fossil fuels the baseline emissions are calculated as follows:

$$BE_{thermal,y} = \frac{EG_{thermal,y} \times (1 - HL_y)}{\eta_{BL,thermal}} \times EF_k$$

Parameter	Unit	Description
$BE_{thermal,y}$	tCO_2/year	Baseline emissions from heat displaced by the project activity during the year y
$EG_{thermal,y}$	TJ/year	Total quantity of heat generated by the project activity during the year y
EF_k	tCO_2/TJ	CO_2 emission factor per unit of energy of the fuel k that would have been used in the baseline plant; tCO_2/TJ, obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used
$\eta_{BL,thermal}$	%	Efficiency of the plant using fossil fuel that would have been used in the absence of the project activity
HL_y	%	Technical transmission and distribution heat losses for providing heat to users in the year y

[Leakage emission]
According to AMS I.C paragraph 28 & 29, if the energy generating equipment is transferred from outside the boundary to the project activity or if collection / processing / transportation of biomass residues is outside the project boundary, leakage is to be considered.

As a source for woodchip production, forest waste and industrial & municipal waste are used in this project. In the absence of the project activity, forest waste was collected and treated for preventing pine wilt disease from spreading according to the Administrative guideline for industrial utilization of pine wood nematode, and industrial & municipal waste was collected and disposed according to the Waste Control Act. Therefore, CO_2 emission from collection of biomass residues is not considered as a leakage.

Leakage emission (LE_y) is estimated as sum of leakage emissions from process of biomass and transportation of biomass and ash. Details of estimation procedure are as follows:

$$LE_y = LE_{PB,y} + LE_{TB,y} + LE_{TA,y}$$

Parameter	Unit	Description
LE_y	tCO_2/year	Emission from processing / transportation of biomass or ash in the year y
$LE_{PB,y}$	tCO_2/year	Emission from processing of biomass in the year y
$LE_{TB,y}$	tCO_2/year	Emission from transportation of biomass in the year y
$LE_{TA,y}$	tCO_2/year	Emission from transportation of ash in the year y

(1) Emission from Processing of Biomass ($LE_{PB,y}$)

$$LE_{PB,y} = Q_{woodchip,y} \times FC_{woodchip,facility} \times NCV_{diesel} \times EF_{diesel} \times CF_{thermal}$$

Parameter	Unit	Description
$Q_{woodchip,y}$	ton/year	Total biomass quantity required in the year y
$FC_{woodchip,facility}$	ℓ/ton	Consumption of diesel per processing of biomass
NCV_{diesel}	kcal/ℓ	Net calorific value of Diesel
EF_{diesel}	tCO_2/TJ	The CO_2 emission factor for Diesel

$CF_{thermal}$	TJ/kcal	Unit conversion factor
$LE_{PB,y}$	tCO_2/year	Emission from chipping process of biomass in the year y

(2) Emission from Transportation of Biomass ($LE_{TB,y}$)

$$LE_{TB,y} = \frac{Q_{woodchip,y}}{TL_{woodchip,y}} \times MAD_{woodchip} \times \frac{NCV_{diesel} \times EF_{diesel}}{FE_{woodchip,truck}} \times CF_{thermal}$$

Parameter	Unit	Description
$Q_{woodchip,y}$	ton/year	Total biomass quantity required in the year y
$TL_{woodchip,y}$	ton/unit	Average biomass load of trucks
$MAD_{woodchip}$	km	Max. round-trip distance between project site and biomass supply site
$FE_{woodchip,truck}$	km/ℓ	Fuel(Diesel) efficiency of truck for transportation of biomass
NCV_{diesel}	kcal/ℓ	Net calorific value of Diesel
EF_{diesel}	tCO_2/TJ	The CO_2 emission factor for Diesel
$CF_{thermal}$	TJ/kcal	Unit conversion factor
$LE_{TB,y}$	tCO_2/yea r	Emission from transportation of biomass in the year y

(3) Emission from Transportation of Ash ($LE_{TA,y}$)

$$LE_{TA,y} = \frac{Q_{ash,y}}{TL_{ash,y}} \times MAD_{ash} \times \frac{NCV_{diesel} \times EF_{diesel}}{FE_{ash,truck}} \times CF_{thermal}$$

Parameter	Unit	Description
$Q_{ash,y}$	ton/year	Total ash quantity generated in the year y
$TL_{ash,y}$	ton/unit	Average ash load of trucks
MAD_{ash}	km	Max. round-trip distance between project site and landfill
$FE_{ash,truck}$	km/ℓ	Fuel(Diesel) efficiency of truck for transportation of ash
NCV_{diesel}	kcal/ℓ	Net calorific value of Diesel
CEF_{diesel}	tCO_2/TJ	CO_2 emission factor of Diesel
$CF_{thermal}$	TJ/kcal	Unit conversion factor
$LE_{TA,y}$	tCO_2/year	Emission from transportation of ash in the year y

B.6.2. Data and parameters fixed ex ante

(Copy this table for each piece of data or parameter.)

Data/Parameter	$EF_{grid,CM,y}$
Data unit	tCO_2/MWh
Description	CO_2 emission factor for grid connected power generation
Source of data	Statistics of electric power in Korea, Korea electric power corporation
Value(s) applied	0.5215
Choice of data or measurement methods and procedures	According to “Tool to calculate emission factor for an electricity system (version 02)”, CO_2 emission factor is determined.
Purpose of data	To determine the baseline emission
Additional comment	Refer Appendix 4

Data/Parameter	$\eta_{BL,thermal}$
Data unit	%
Description	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity
Source of data	Manufacture company (Hankook boiler, Ilsung)
Value(s) applied	95.0 (NCV)
Choice of data or measurement methods and procedures	We collect the plant efficiency values from four companies that produce plant using LNG. And then, the highest value applies for baseline emission.
Purpose of data	To determine the baseline emission
Additional comment	-

Data/Parameter	TDL_y
Data unit	%
Description	Average technical transmission and distribution losses in the year y
Source of data	UNFCCC
Value(s) applied	20
Choice of data or measurement methods and procedures	According to “Tool to calculate baseline, project and/or leakage emissions from electricity consumption,” since this project purchases electricity from the grid only (scenario A) the default value of 20% is applied.
Purpose of data	To determine the project emission($PE_{y,power}$)
Additional comment	-

Data/Parameter	***$FE_{woodchip,truck}$***
Data unit	km/ℓ
Description	Fuel(Diesel) efficiency of truck for transportation of biomass
Source of data	Certificate of Truck Registration
Value(s) applied	3.5
Choice of data or measurement methods and procedures	The average fuel(diesel) efficiency is 4km/ℓ from newspaper and the fuel(diesel) efficiencies collected from two certificates of truck registration are 3.5km/ℓ and 3.9km/ℓ respectively. For conservativeness, the lowest value (3.5km/ℓ) among them is applied.
Purpose of data	To determine the leakage emission($LE_{TB,y}$)
Additional comment	-

Data/Parameter	***$FE_{ash,truck}$***
Data unit	km/ℓ
Description	Fuel(Diesel) efficiency of truck for transportation of ash
Source of data	Truck Manufacture Company
Value(s) applied	3.5
Choice of data or measurement methods and procedures	The average fuel(diesel) efficiency is 4km/ℓ from newspaper and the fuel(diesel) efficiencies collected from two certificates of truck registration are 3.5km/ℓ and 3.9km/ℓ respectively. For conservativeness, the lowest value (3.5km/ℓ) among them is applied.
Purpose of data	To determine the leakage emission($LE_{TA,y}$)
Additional comment	-

B.6.3. Ex ante calculation of emission reductions

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[Ex-ante baseline emission]

•Estimated heat and electricity

Year	Net electricity generation (MWh)	Net heat generation (Gcal)
2011	11,942	66,058
2012	11,942	66,058
2013	11,942	66,058
2014	11,942	66,058
2015	11,942	66,058
2016	11,942	66,058
2017	11,942	66,058
2018	11,942	66,058
2019	11,942	66,058
2020	11,942	66,058
Average	11,942	66,058

(1) Electricity

$$BE_{electricity,y} = EG_y \times EF_{grid,CM,y}$$

Parameter	Description	Unit	Value
$BE_{electricity,y}$	Baseline emission for electricity during the year y	tCO_2/year	6,228.0

EG_y	Quantity of net electricity supplied to the grid in the year y	MWh/year	11,942
$EF_{grid,CM,y}$	CO_2 emission factor for grid electricity during the year y	tCO_2/MWh	0.5215

• Quantity of net electricity supplied to the grid:
During operation of cogeneration system, some electricity generated is used for on-site cogeneration equipments. According to the final specification of equipments, the electricity capacity required in on-site cogeneration equipments is 512kW.

$$EG_y = (3MW - 0.512MW) \times \frac{200day}{year} \times \frac{24hour}{day} = 11,942MWh / year$$

$$BE_{electricity,y} = EG_y \times EF_{grid,CM,y} = \frac{11,942MWh}{year} \times \frac{0.5215tCO_2}{MWh} = 6,228.0tCO_2 / year$$

• Baseline emission for electricity: 6,228.0tCO_2/year

(2) Heat

$$BE_{thermal,y} = \frac{EG_{thermal,y} \times (1 - HL_y)}{\eta_{BL,thermal}} \times EF_{LNG}$$

Parameter	Description	Unit	Value
$BE_{thermal,y}$	The baseline emissions from heat displaced by the project activity during the year *y*	tCO_2/year	16,332.3
$EG_{thermal,y}$	Total quantity of heat generated by the project activity during the year *y*	TJ/year	291.4
EF_{LNG}	The CO_2 emission factor per unit of energy of the fuel (LNG) that would have been used in the baseline plant; obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used	tCO_2/TJ	56.1
$\eta_{BL,thermal}$	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity	%	95.0
HL_y	Technical transmission and distribution heat losses for providing heat to users in the year y	%	5.089

• Total quantity of heat generated by the project activity:

$$EG_{thermal,y} = \frac{14.5Gcal}{hour} \times \frac{4.1868GJ}{Gcal} \times \frac{1TJ}{10^3 GJ} \times \frac{200day}{year} \times \frac{24hour}{day} = 291.4TJ / year(69,600Gcal / year)$$

• Heat losses(HL_y): 5.089%
According to balance sheet of KDHC, the annual heat losses for past 5 years are as follows.

Year	2005	2006	2007	2008	2009
Heat losses	4.451%	5.707%	5.325%	5.436%	4.525

Therefore, the average heat losses from 2005 to 2009 are 5.089%.

• Net quantity of heat generated by the project activity:

$$EG_{thermal,y} \times (1-HL_y) = \frac{291.4TJ}{year} \times (1-0.05089) = 276.6TJ/year(66,058Gcal/year)$$

$$BE_{thermal,y} = \frac{EG_{thermal,y} \times (1-HL_y)}{\eta_{BL,thermal}} \times EF_{LNG}$$
$$= \frac{291.4TJ}{year} \times (1-0.05089) \times \frac{1}{0.95} \times \frac{56.1tCO_2}{TJ} = 16,332.3tCO_2/year$$

• The baseline emission form heat displaced by the project activity: 16,332.3tCO_2

$$BE_y = BE_{electricity,y} + BE_{thermal,y}$$
$$= 6,228.0tCO_2/year + 16,332.3tCO_2/year = 22,560.3tCO_2/year$$

Therefore, baseline emission is 22,560tCO_2 /year.

※ According to AMS I.C, efficiency of the baseline units shall be determined by adopting one of the following criteria:

(a) Highest measured efficiency of a unit with similar specifications
(b) Highest of the efficiency values provided by two or more manufacturers for units with similar specifications
(c) Maximum efficiency of 100%

For determining boiler efficiency, we collect the efficiency of district heating boiler that uses LNG. The highest efficiency of district heating boiler among four companies is 86%. The value is based on Gross Calorific Value (GCV). 95% is applied to this project that is recalculated by Net Calorific Value (NCV).

$$BoilerEfficiency_{LNG,NCV} = BoilerEfficiency_{LNG,GCV} \times \frac{GCV_{LNG}}{NCV_{LNG}}$$

$$= 86\% \times \frac{10,550Kcal}{9,550Kcal} = 95\%$$

[Ex-ante project emission]

Woody biomass has peculiarity that is carbon neutral, therefore project emission for combustion of woody biomass does not considered.

Ex-ante project emission (PE_y) is expressed as following:

$$PE_y = PE_{y,comb} + PE_{y,power}$$

(1) Emission through combustion of fossil fuel in the year "y"

$$PE_{y,comb} = FF_{start-up,y,LNG} \times NCV_{LNG} \times EF_{LNG}$$

Parameter	Description	Unit	Value
$PE_{y,comb}$	Emission through combustion of fossil fuel in the year y	tCO_2/year	2.92

$FF_{start\text{-}up,y,LNG}$	Quantity of start-up fossil fuel LNG used in the year y	Nm^3/year	1,300
NCV_{LNG}	Net calorific value for fossil fuel LNG	kcal/Nm^3	9,550
EF_{LNG}	The CO_2 emission factor per unit of energy of the fuel (LNG) that would have been used in the baseline plant, obtained from reliable local or national data if available, otherwise, IPCC default emission factors are used	tCO_2/TJ	56.1

In case of the start-up of wood chip combustion, the fossil fuel, LNG will be used for starting boiler operation. As the reaction time for combusting wood chip takes some time, the emission from the combustion of fossil fuel, LNG for start-up has to be considered in project boundary.

- Expected natural gas consumption: 1,300 Nm^3/year (2 start-up planned per year. 1 start-up needs 1 hour operation with LNG and the consumption of LNG per hour is 650Nm^3)

$$PE_{y,comb} = FF_{start-up,y,LNG} \times NCV_{LNG} \times EF_{LNG}$$

$$= \frac{1,300Nm^3}{year} \times \frac{9,550kcal}{Nm^3} \times \frac{56.1tCO_2}{TJ} \times \frac{4.1868kJ}{kcal} \times \frac{1TJ}{10^9 kJ} = 2.92tCO_2 / year$$

- CO_2 emissions due to combusting fossil fuel: 2.92tCO_2/year

(2) Emission through electricity consumption in the year "y"

$$PE_{y,power} = EG_{captive,y} \times EF_{grid,CM,y} \times (1 + TDL_y)$$

Parameter	Description	Unit	Value
$PE_{y,power}$	Emission through electricity consumption in the year y	tCO_2/year	6.4082
$EG_{captive,y}$	The electricity imported from the grid to cogeneration facility in the year y	MWh/year	10.24
$EF_{grid,CM,y}$	CO_2 emission factor for electricity form public supply	tCO_2/MWh	0.5215
TDL_y	Average technical transmission and distribution losses in the year y	%	20

The electricity used in cogeneration facility is from national grid when the facility operates at first during 10 hours(twice a year). After then the electricity generated from the biomass CHP is used for on-site cogeneration facility. The electricity capacity required in on-site cogeneration facility is 512kW.

$$PE_{y,power} = EG_{captive,y} \times EF_{grid,CM,y} \times (1 + TDL_y)$$

$$= 512kW \times \frac{10h}{time} \times \frac{2time}{year} \times \frac{0.5215tCO_2}{MWh} \times \frac{1MWh}{1,000kWh} \times (1 + 0.2) = 6.4082tCO_2/year$$

• CO_2 emissions due to electricity consumption: 6.4082tCO_2/year

$$PE_y = PE_{y,comb} \times PE_{y,power} = 2.92 + 6.4082 = 9.3282 tCO_2/year$$

Therefore, project emission is 10tCO_2/year.

[Leakage emission]
Since the energy generating equipments of this project is not transferred from outside the boundary to the project but since collection / processing / transportation of biomass residues is outside the project boundary, CO_2 emissions from collection / processing / transportation of biomass residues should be considered as a leakage.

Since regardless of the project activity, biomass residues would have been collected, CO_2 from collection of biomass residues is not considered as a leakage.

Therefore, leakage emission (LE_y) is estimated as follows:

$$LE_y = LE_{PB,y} + LE_{TB,y} + LE_{TA,y}$$

Parameter	Description	Unit	Value
LE_y	Emission from processing / transportation of biomass or ash in the year y	tCO_2/year	1,695
$LE_{PB,y}$	Emission from processing of biomass in the year y	tCO_2/year	1,273.3
$LE_{TB,y}$	Emission from transportation of biomass in the year y	tCO_2/year	414.0
$LE_{TA,y}$	Emission from transportation of ash in the year y	tCO_2/year	7.2

The biomass collected can be processed and transported in two ways;

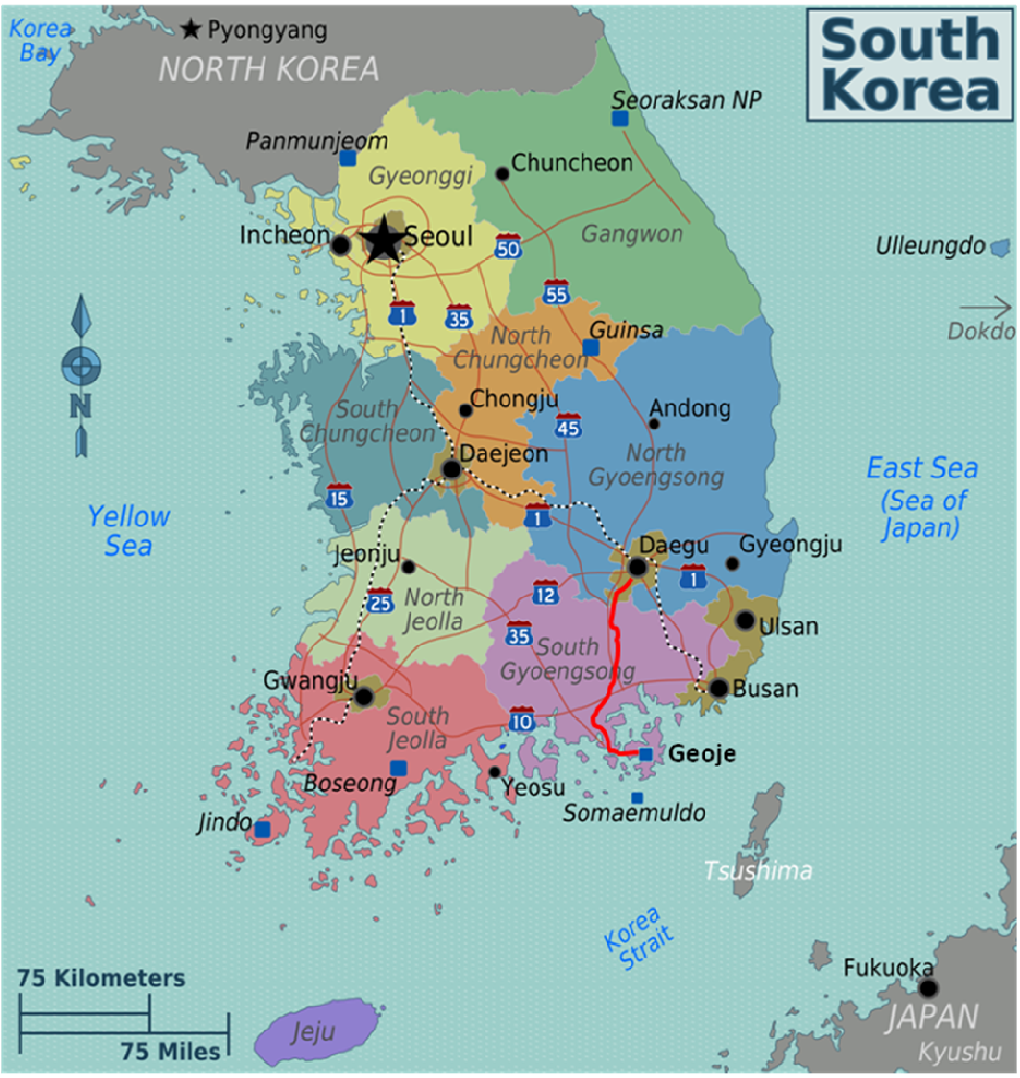
(a) The biomass is processed in the same place where biomass is collected, and it is transported to the generation facility or

(b) The biomass collected is transported to a specific place where it will be processed, and then it is transported to the generation facility

For conservativeness, we assume that the biomass used in project activity is processed and transported in case (b) way.

The woodchip used is transported from Gimhae, Sachun and so on. Either forest waste or wood waste is supplied within Gyongbuk and Gyougnam. Because of the transport charge of woodchip, the woodchip which is located outside Gyongbuk and Gyougnam is not economically attractive. The ash from the project activity is disposed to a nearby landfill.

Since the biomass and woodchip used in project activity is from mainly Gyeongbuk and Gyeongnam, the maximum distance for transportation of woodchip is 165km (Daegu-Goeje, Geoje is located in the southernmost of Gyoungnam.). In general, the distance for transportation from collection site to generation facility is closer than the maximum distance for transportation (165Km). Therefore, for conservativeness, the maximum distance for transportation with round-trip is applied. If the average distance for transportation from collection site to generation facility is farther than the maximum distance for transportation, the average distance with round-trip would be applied.
In general, since the biomass is transported over a distance of less than 200km, the leakage emission from transportation can be neglected but for conservativeness project participant shall consider it.



(1) Emission from Processing of Biomass ($LE_{PB,y}$)

Generally, fuel is consumed in facility processing of biomass.

$$LE_{PB,y} = Q_{woodchip,y} \times FC_{woodchip,facility} \times NCV_{diesel} \times EF_{diesel} \times CF_{thermal}$$

Parameter	Description	Unit	Value
$Q_{woodchip,y}$	Total biomass quantity required	ton/year	33,494
$FC_{woodchip,facility}$	Consumption of Diesel per processing of biomass	ℓ/ton	14.5
	Total Diesel consumption	ℓ/year	485,663
NCV_{diesel}	Net calorific value of Diesel	kcal/ℓ	8,450
$CF_{thermal}$	Unit conversion factor	TJ/kcal	4.1868×10^{-9}
EF_{diesel}	The CO_2 emission factor for Diesel	tCO_2/TJ	74.1
$LE_{PB,y}$	Emission from chipping process of biomass	tCO_2/year	1,273.3

Since the amount of woodchip required is 6,978kg per hour and the biomass cogeneration facility is operating for 200days in the year, the total amount of woodchip required in the year is 33,494ton.

$$Q_{woodchip,y} = 6{,}978kg/hr \times 24hr/day \times 200day/year = 33{,}494ton/year$$

(2) Emission from Transportation of Biomass ($LE_{TB,y}$)

Generally, fuel is consumed in transportation of biomass.

$$LE_{TB,y} = \frac{Q_{woodchip,y}}{TL_{woodchip,y}} \times MAD_{woodchip} \times \frac{NCV_{diesel} \times EF_{diesel}}{FE_{woodchip,truck}} \times CF_{thermal}$$

Parameter	Description	Unit	Value
$Q_{woodchip,y}$	Total biomass quantity required	ton/year	33,494
$TL_{woodchip,y}$	Average biomass load of trucks	ton	20
	Total # of trips	unit/year	1,675
MAD_{QW}	Max. round-trip distance between project site and biomass supply site (Daegu - Geoje)	km	330
	Total distance of conveying biomass	km/year	552,750
$FE_{woodchip,truck}$	Fuel(Diesel) efficiency of truck for transportation of biomass	km/ℓ	3.5
	Total diesel consumption	ℓ/year	157,929
NCV_{diesel}	Net calorific value of Diesel	kcal/ℓ	8,450
$CF_{thermal}$	Unit conversion factor	TJ/kcal	4.1868×10^{-9}
EF_{diesel}	The CO_2 emission factor for Diesel	tCO_2/TJ	74.1
$LE_{TB,y}$	Emission from transportation of biomass	tCO_2/year	414.0

(3) Emission from Transportation of Ash ($LE_{TA,y}$)

In Korea, there is no law or rule for an ash disposal. The ash from the project activity is disposed in the nearby landfill.

$$LE_{TA,y} = \frac{Q_{ash,y}}{TL_{ash,y}} \times MAD_{ash} \times \frac{NCV_{diesel} \times EF_{diesel}}{FE_{ash,truck}} \times CF_{thermal}$$

Parameter	Description	Unit	Value
$Q_{ash,y}$	Total ash quantity generated	ton/year	670
$TL_{ash,y}$	Average ash load of trucks	ton	20
	Total # of trips	unit/year	34
MAD_{ash}	Max. round-trip distance between project site and landfill (Daegu - landfill in Ulsan)	km	280
	Total distance of conveying ash	km/year	9,520
$FE_{ash,truck}$	Fuel(Diesel) efficiency of truck for transportation of ash	km/ℓ	3.5
	Total Diesel consumption	ℓ/year	2,720
NCV_{diesel}	Net calorific value of Diesel	kcal/ℓ	8,450
$CF_{thermal}$	Unit conversion factor	TJ/kcal	4.1868×10^{-9}
EF_{diesel}	CO_2 emission factor of Diesel	tCO_2/TJ	74.1
$LE_{TA,y}$	Emission for conveying ash	tCO_2/year	7.2

Since the amount of ash generated is 139.57kg per hour and the biomass cogeneration facility is operating for 200days in the year, the total amount of ash generated in the year is 670ton.

$$Q_{woodchip,y} = 139.57 kg/hr \times 24 hr/day \times 200 day/year = 670 ton/year$$

According to AMS-I.C footnote 12, if biomass residues are transported over a distance of less than 200km, the leakage by transportation can be neglected. That is, CO_2 emission from transportation of biomass and ash can be neglected. However, for conservativeness, this leakage shall be considered in this project with the maximum distance. Therefore, leakage emission (LE_y) is 1,720 tCO_2/year.

Emission reductions are calculated as follows.

$$ER_y = BE_y - PE_y - LE_y$$
= 22,560 – 10 – 1,695 = 20,885tCO_2/year

For reference, leakage emission (LE_y), CO_2 emission from processing / transportation, is 8.3% of emission reduction (ER_y) (< 10%) which is not potentially significant. And according to the official reports which are 'A study on the energy utilization of ligneous biomass', 'Report on basic design and important measures for the Daegu woodchip renewable energy project' and 'Statistics on New and Renewable Energy in 2007', the quantity of available woodchip biomass in the region is around 361,205 ton/year which is far bigger than the regional demand, 64,944 ton/year including the demand of the project activity. This figure satisfies the criteria of 25% larger than the quantity of biomass that is utilized including the project activity.

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

Year	Baseline emissions ($t CO_2e$)	Project emissions ($t CO_2e$)	Leakage ($t CO_2e$)	Emission reductions ($t CO_2e$)
2011.09~2012.08	22,560	10	1,695	20,885
2012.09~2013.08	22,560	10	1,695	20,885
2013.09~2014.08	22,560	10	1,695	20,885
2014.09~2015.08	22,560	10	1,695	20,885
2015.09~2016.08	22,560	10	1,695	20,885
2016.09~2017.08	22.560	10	1,695	20,885
2017.09~2018.08	22,560	10	1,695	20,885
2018.09~2019.08	22,560	10	1,695	20,885
2019.09~2020.08	22,560	10	1,695	20,885
2020.09~2021.08	22,560	10	1,695	20,885
Total	225,600	100	16,950	20,885
Total number of crediting years	10 years			
Annual average over the crediting period	22,560	10	1,695	20,885

B.7. Monitoring plan

B.7.1. Data and parameters to be monitored

Data/Parameter	***EG_y***
Data unit	MWh/year
Description	Electricity generated by the project activity and supplied to the grid in the year y
Source of data	Watt-hour meter (Korea Power Exchange, hereinafter KPX)
Value(s) applied	11,942

Measurement methods and procedures	The electricity produced by the project is supplied not to other facilities but to the national grid. Therefore, the measurement at recipient's end is not necessary. It is continuously monitored, integrated hourly and at least monthly recorded by the watt-hour meter and managed by KDHC power management system. The result will be cross checked with the confirmation of KPX who is the electricity buyer.
Monitoring frequency	Continuously monitored, integrated hourly and at least monthly recorded
QA/QC procedures	The watt-hour meter will be calibrated once every 3 years by the authorized institution.
Purpose of data	To determine the baseline emission
Additional comment	Accuracy ± 0.5%

Data/Parameter	$EG_{captive,y}$
Data unit	MWh/year
Description	Electricity used by the project cogeneration facility from the national grid
Source of data	Watt-hour meter (Korea Electric Power Corporation, hereinafter KEPCO)
Value(s) applied	10.24
Measurement methods and procedures	The electricity used in the cogeneration facility is supplied from the national grid when the facility operates at first. It is measured by the watt-hour meter which is established by KEPCO. KDHC manages the data after recording the result of measurement on log sheet at every 24 hour. The result will be cross-checked with invoices for sale.
Monitoring frequency	Continuously monitored, integrated daily
QA/QC procedures	The watt-hour meter will be calibrated once every 7 years by the authorized institution or the watt-hour meter manufacturer.
Purpose of data	To determine the project emission
Additional comment	Accuracy ± 1%

Data/Parameter	$EG_{thermal,y}$
Data unit	TJ/year (Gcal/year)
Description	Total quantity of heat generated by the project activity
Source of data	Calorimeter (KDHC)
Value(s) applied	291.4 (69,600)

Measurement methods and procedures	The flow of district heating water is continuously monitored and measured by flow meter and the front and rear temperatures of heat exchanger are measured by temperature meter. And then the calorimeter calculates and displays the heat generation. The heat generation is determined as the difference of the enthalpy of hot water supplied to the plant and the enthalpy of returned water by the plant therefore it is evaluated by multiplying the flow of district heating water by the difference between the front and the rear temperature of heat exchanger. The result of measurement is recorded to Centre control Room's Distributed control system and log sheet. When accuracy of the installed flow meter does not meet the ±0.25% accuracy requirement, this parameter is conservatively calculated for a given monitoring period by employing the below formula. Adjusted value = measured value – measured value*0.5% (0.5% is the accuracy value of the actual installed flow meter)
Monitoring frequency	Continuously
QA/QC procedures	The flow meter and temperature meter will be calibrated once every 3 years by the authorized institution.
Purpose of data	To determine the baseline emission
Additional comment	Accuracy ± 0.5%(temperature meter) / Accuracy ± 0.25%(flow meter)

Data/Parameter	EF_{LNG}
Data unit	tCO_2/TJ
Description	The CO_2 emission factor per unit of energy of the fuel LNG
Source of data	IPCC
Value(s) applied	56.1
Measurement methods and procedures	IPCC value will be used since there is no reference for CO_2 emissions factor in Korea. EF_{LNG} is obtained from the " 2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 2 – Energy, Table 2.2 Default emission factors for stationary combustion in the energy industries" When the value of the IPCC Guidelines is revised, the updated value should be applied.
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	To determine the baseline emission($BE_{thermal,y}$)
Additional comment	-

Data/Parameter	NCV_{LNG}
Data unit	$Kcal/Nm^3$
Description	Net calorific value for fossil fuel LNG
Source of data	Ministry of Knowledge Economy
Value(s) applied	9,550

Measurement methods and procedures	The value is applied by “Energy Statistics Yearbook” and “Energy Policy Act” which published by Korea Ministry of knowledge Economy. The appropriateness of the value should be reviewed annually and when the valued is revised, the updated valued should be applied.
Monitoring frequency	-
QA/QC procedures	The value should be verified if it is within the uncertainty range of the IPCC default value as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.
Purpose of data	To determine project emission($PE_{y,comb}$)
Additional comment	-

Data/Parameter	***EF_{diesel}***
Data unit	tCO_2/TJ
Description	The CO_2 emission factor per unit of energy of the fuel Diesel
Source of data	IPCC
Value(s) applied	74.1
Measurement methods and procedures	IPCC value will be used since there is no reference for CO_2 emissions factor in Korea. EF_{diesel} is obtained from the “ 2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 2 – Energy, Table 2.2 Default emission factors for stationary combustion in the energy industries” The appropriateness of the value should be reviewed annually and when the valued is revised, the updated valued should be applied.
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	To determine project emission($PE_{y,comb}$)
Additional comment	-

Data/Parameter	***NCV_{diesel}***
Data unit	Kcal/ℓ
Description	Net calorific value for fossil fuel Diesel
Source of data	Ministry of Knowledge Economy
Value(s) applied	8,450
Measurement methods and procedures	The value is applied by “Energy Statistics Yearbook” and “Energy Policy Act” which published by Korea Ministry of knowledge Economy. When the value of the IPCC Guidelines is revised, the updated value should be applied.
Monitoring frequency	-
QA/QC procedures	The value should be verified if it is within the uncertainty range of the IPCC default value as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines.
Purpose of data	To determine project emission($PE_{y,comb}$)
Additional comment	-

Data/Parameter	***HL_y***
Data unit	%

Description	Technical transmission and distribution heat losses for providing heat to users in the year y
Source of data	KDHC balance sheet
Value(s) applied	5.089 (average of historical heat losses for 5 years)
Measurement methods and procedures	Based on balance sheet of KDHC, the annual heat losses for providing heat to users in the year y are calculated with heat generated and heat supplied. The heat generated($EG_{thermal,y}$)is measured by Calorimeter at KDHC and the heat supplied is measured by Calorimeter at end-user side.
Monitoring frequency	-
QA/QC procedures	If the heat losses for the monitoring period are available in balance sheet of KDHC, it will be applied but if not available, for conservativeness, the highest value among heat losses from 2005 to the year y available in balance sheet will be applied.
Purpose of data	To determine the baseline emission($BE_{thermal,y}$)
Additional comment	-

Data/Parameter	$FF_{start\text{-}up,y,LNG}$
Data unit	Nm^3/year
Description	Quantity of start-up fossil fuel, LNG used
Source of data	Gas flow meter (KDHC)
Value(s) applied	1,300
Measurement methods and procedures	The natural gas consumption is measured by the gas flow meter which is installed in front of biomass CHP. It is recorded on log sheet at every 24 hour and can be cross checked with the bill from the gas supplier.
Monitoring frequency	Daily
QA/QC procedures	The Gas flow meter will be calibrated once every 8 years by the authorized institution.
Purpose of data	To determine project emission($PE_{y,comb}$)
Additional comment	Accuracy ±1%

Data/Parameter	$Q_{woodchip,i,y}$
Data unit	ton/year
Description	Total woodchip/biomass i quantity consumed
Source of data	Weighing system (KDHC)
Value(s) applied	33,494
Measurement methods and procedures	The woodchip/biomass, i is managed by the weighing system in Daegu branch of KDHC. The weighing system measures the loaded and unloaded truck and evaluates the difference between them. The woodchip/biomass, i is classified as forest waste or industrial & municipal waste and the information on source, delivery, weight of woodchip are recorded by the weighing management system.
Monitoring frequency	Every time woodchip arrives
QA/QC procedures	The weighing system will be calibrated once every 3 years by authorized institution.
Purpose of data	To determine leakage emission($LE_{PB,y}$, $LE_{TB,y}$)

Additional comment	This is used in calculating leakage emission from project activity.

Data/Parameter	$Q_{ash,y}$
Data unit	ton/year
Description	Total ash quantity generated
Source of data	Weighing system (KDHC)
Value(s) applied	670
Measurement methods and procedures	The ash is managed by the weighing system in Daegu branch of KDHC. The weighing system measures the loaded and unloaded truck and evaluates the difference between them. The information on source, delivery, weight of ash are recorded by the weighing management system.
Monitoring frequency	Every time ash carries out
QA/QC procedures	The weighing system will be calibrated once every 3 years by authorized institution.
Purpose of data	To determine leakage emission($LE_{TA,y}$)
Additional comment	This is used in calculating leakage emission from project activity.

Data/Parameter	$BU_{woodchip,y}$
Data unit	ton/year
Description	The quantity of biomass utilized in the region
Source of data	KDHC
Value(s) applied	64,944
Measurement methods and procedures	The quantity of woodchip biomass utilized in the region is applied by KDHC($Q_{woodchip,i,y}$) and “Statistics on New and Renewable energy” issued by Korea Energy Management Corporation.
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	-
Additional comment	-

Data/Parameter	$BA_{woodchip,y}$
Data unit	ton/year
Description	The quantity of biomass available in the region
Source of data	KDHC
Value(s) applied	361,205
Measurement methods and procedures	The quantity of available woodchip biomass is applied by “A Study on the Energy Utilization of Ligneous Biomass” issued by The Ministry of Commerce, Industry. At the beginning of crediting period, the biomass availability will be calculated by using the quantity of available woodchip biomass and the quantity of woodchip utilized($BU_{woodchip,y}$) which will be collected from the recent national reports mentioned above.
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	-

Additional comment	The quantity of available woodchip biomass in the region should be at least 25% larger than the quantity of woodchip biomass utilized including project activity.

Data/Parameter	$FC_{woodchip,facility}$
Data unit	ℓ/ton
Description	Fuel(Diesel) consumption per unit production of woodchip
Source of data	Chipper Manufacture Company, Korean Construction Estimating Standards
Value(s) applied	14.5
Measurement methods and procedures	Basically the fuel consumption efficiency is calculated based on facility specification or national standard. The fuel(Diesel) consumption efficiency is separately monitored as follows. **i)** For woodchip **directly supplied** from chipping companies, the chipping facility specification is collected directly from chipping companies under KDHC management and the fuel consumption efficiency is calculated based on it. **ii)** For woodchip **purchased from market**, the information on fuel consumption efficiency is collected from Korean Standard for Estimating Construction Cost, which is published by Korea Institute of Civil Engineering and Building Technology and the fuel consumption efficiency is calculated based on it. For conservativeness, the highest value is applied among fuel consumption efficiencies from default value(14.5L/ton), i) and ii).
Monitoring frequency	-
QA/QC procedures	-
Purpose of data	To determine leakage emission($LE_{PB,y}$)
Additional comment	-

Data/Parameter	$TL_{woodchip,y}$
Data unit	ton
Description	Average biomass load of trucks
Source of data	On-site measurements
Value(s) applied	20
Measurement methods and procedures	Determined by averaging the weights of biomass each truck carries to project site.
Monitoring frequency	Measured continuously and aggregated annually
QA/QC procedures	-
Purpose of data	To determine leakage emission($LE_{TB,y}$)
Additional comment	$TL_{woodchip,y}$ can be calculated at the CHP site. This is used in calculating leakage emission from project activity.

Data/Parameter	$TL_{ash,y}$
Data unit	ton
Description	Average ash load of trucks
Source of data	On-site measurements

Value(s) applied	20
Measurement methods and procedures	Determined by averaging the weights of ash each truck carries to landfill
Monitoring frequency	Measured continuously and aggregated annually
QA/QC procedures	-
Purpose of data	To determine leakage emission($LE_{TA,y}$)
Additional comment	This is used in calculating leakage emission from project activity.

Data/Parameter	***$MAD_{woodchip}$***
Data unit	km
Description	Maximum round-trip distance between project site and biomass supply site
Source of data	Maps and records by project participants on the origin of the biomass
Value(s) applied	330(=165×2)
Measurement methods and procedures	Since Geoje is the fathrest from project site(165km). For data credibility, KDHC checks whether transportation distance of biomass is closer than 165km through maps or GPS or transportation records of biomass. If the average distance between project site and biomass supply site is farther than 165Km, the average distance would be applied.
Monitoring frequency	-
QA/QC procedures	The transportation data will be checked with the documents such as waybills or invoices from truckers.
Purpose of data	To determine leakage emission($LE_{TB,y}$)
Additional comment	This is used in calculating leakage emission from project activity.

Data/Parameter	***MAD_{ash}***
Data unit	km
Description	Maximum round-trip distance between project site and landfill
Source of data	Maps and records by project participants on the disposal site of the ash
Value(s) applied	280(=140×2)
Measurement methods and procedures	Since Ulsan landfill is the farthest from project site, the distance between project site and Ulsan landfill (140km) is applied. For data credibility, KDHC checks whether transportation distance of ash is closer than 140km through maps or GPS or transportation records of ash. If the average distance between project site and ash disposal site is farther than 140Km, the average distance would be applied.
Monitoring frequency	-
QA/QC procedures	The transportation data will be checked with the documents such as waybills or invoices from truckers.
Purpose of data	To determine leakage emission($LE_{TA,y}$)
Additional comment	This is used in calculating leakage emission from project activity.

B.7.2. Sampling plan

>>
No sampling is required for this project activity.

B.7.3. Other elements of monitoring plan

>>
According to AMS I.C, this project selects the option (b) in paragraph 31 that is metering the thermal and electrical energy generated for co-generation projects.

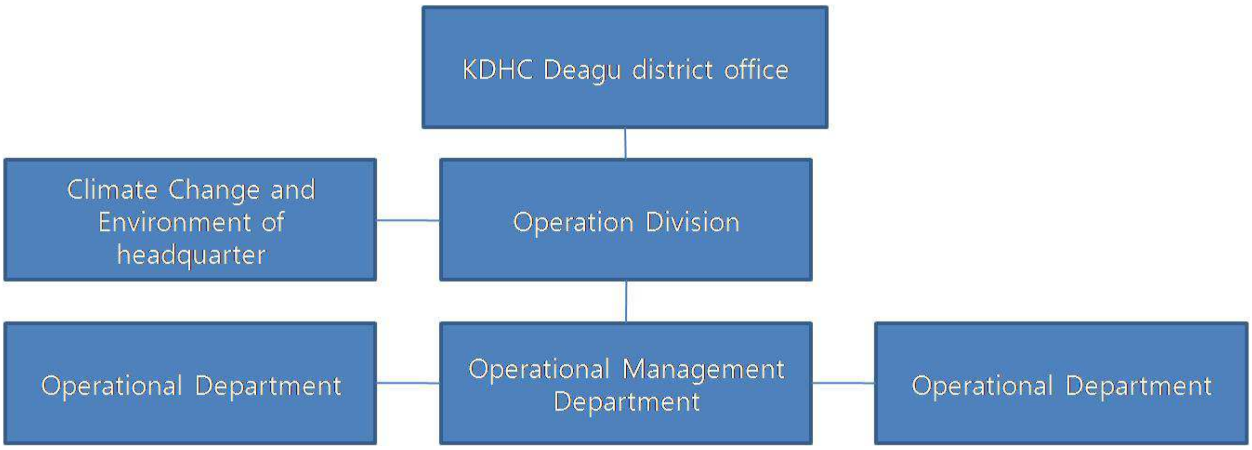
<Description of the monitoring plan>

KDHC Daegu district office Centre Control Room controls cogeneration facility by Distributed Control System. The monitored data and parameters are recorded in the computer system and/or the log sheet.

<Operational and management structure>

The proposed project will be operated and managed by climate change and environment team of headquarter and operation division of Daegu district office.
The rule of each team related this project activity is as follows:

- Climate change and environment team of headquarter: in charge of planning this project and supporting operation division
- Operation division of Daegu district office: in charge of implementing this project
  - Operation department: in charge of operating facility and data monitoring
  - Operational Management department: in charge of demand and supply of woodchip, analysis and verification of monitoring data
  - Environment department: in charge of managing CDM project and monitoring data



<Training>

KDHC Daegu district office operation department will be trained from each equipment suppliers
After the completion of construction, Operating team will be trained for operation management education twice annually for operating project facility stably.

<Responsibilities for and institutional arrangements for data collection and archiving>

The operation division of Daegu district office is in charge of data collection and the headquarters is in charge of its storage.

- Data collection and storage method
  The electricity supplied to the grid is collected through the adjustment data of KPX exchange system and the adjustment data is stored every day as back-up file in power management system of KDHC.
  The heat generation is stored in DCS server and backed up every month.
  The woodchip and ash is stored in management computer server of weighing system and backed up every day in management computer of weighing system.
  The Electricity used in cogeneration facility from national grid which is not possible to record at computer system and consumption of LNG for start-up are measured by on-site meters and the data is recorded on log sheet every day. The log sheet data are confirmed by checking the bills from KEPCO and city gas supplier and kept in document keeping room of Daegu district office during the project lifetime.
- Data modification method
  If recorded data are different from monitored data, the manager of operational management team will call an urgent-meeting and discuss those problems with the operation manager, data recording manager and data monitoring manager. All records related to the meeting will be stored during the project lifetime in Daegu branch data storage room.

<Quality Assurance and Quality Control>

KDHC obtained ISO14001 certification in 1997. According to environmental management system, KDHC prepares CDM monitoring procedure. The purpose of the system sets up a monitoring procedure about collecting and managing data for increasing reliability. Monitoring plan of the proposed project activity will be managed in integration and continuation with Environmental management procedure.

SECTION C. Start date, crediting period type and duration

C.1. Start date of project activity

>>
28/09/2007 (contract date of construction and the earliest date on which the project owner committed himself to financial expenditures as per EB47, Annex 71)

C.2. Expected operational lifetime of project activity

>>
20 years

C.3. Crediting period of project activity

C.3.1. Type of crediting period

>>
Fixed crediting period

C.3.2. Start date of crediting period

>>
01/09/2011 or registration date, which ever is later

C.3.3. Duration of crediting period

>>
10 years

SECTION D. Environmental impacts

D.1. Analysis of environmental impacts

>>
The project activity is allowed by Ministry of Knowledge Economy. According to the Act on Assessment of Impacts of Work on Environment, Traffic, Disasters, and etc., the Republic of Korea does not require an EIA (Environmental Impact Assessment) for the project activity as regard District heating. Although the government doesn't require an EIA, KDHC considered environmental impact for the project activity-Air quality, water quality etc. and environmental impact for using biomass in the designing stage. A waste water treatment system is located in project boundary. The waste water is going to be cleanly disposed.
Since at first KDHC intended to introduce the heavy oil cogeneration facility but changed the plan with introducing biomass cogeneration one, the environmental impacts of the project activity would be compared with heavy oil cogeneration. The results are as follows:

<Analysis of environmental effect>

		Biomass cogeneration	Heavy oil cogeneration
Energy generation		81,984 Gcal/year	81,984 Gcal/year
Fuel consumption		33,494 Woodchip: ton/year	B-C(1%-S): 9,859 kℓ/year
Pollution control facility		• SOx: - • NOx: denitrification facility(49.6%) • Dust: cyclones(50%) Electrostatic precipitators (95%)	• SOx: desulfurization facility(90%) • NOx: Low NOx burner(20%) • Dust: electrostatic precipitators(90%)
Emission calculation		Fuel consumption × emission factor × efficiency control facility	Fuel consumption × emission factor × efficiency control facility
Emissions	SOx	0	14.1
	NOx	21.2	52.4
	Dust	1.6	1.5
	total	22.8	67.9

Total amount of gross energy generation in the cogeneration facility (1MWh = 0.86Gcal)
= 69,600Gcal/year + 14,400MWh/year = 69,600Gcal/year + 12,384Gcal/year = 81,984Gcal/year

D.2. Environmental impact assessment

>>

Some of the biomass for the project is from pine wood nematode that is disposed of fumigation and incineration before. According to “Administrative guideline for industrial utilization of pine wood nematode”, the Woodchip used in the cogeneration facility is crushed on the spot and it is as less than 1.5cm, then it is transported by covered vehicle and stored at bunker within the building. Therefore it is the best way to prevent fine wilt disease according to research result of Korea Forest Service and related to university (Gangwon univ. and Gyongsan univ.).

SECTION E. Local stakeholder consultation

E.1. Modalities for local stakeholder consultation

>>

Stakeholders’ comments of the project activity were carried out in two methods: 1) survey for stakeholder related to this project activity (government institute, research institute, local community and university, etc.) 2) collect comments from KDHC website (09/10/2008~28/10/2008).

The details are as follows:

[Survey]

- Stakeholders

	Participants
Authorities related to the project	Gyeongsan city hall
	Daegu Metropolitan City (ministry of environment)
	Korean Forest Research Institute
	Korea Forest Service
Other staker	Gyeongbuk University
	Local residents (4 people)
	Industrial Technology Service (Public Opinion)
	The mail Newspaper (Public opinion)
	Korea Power exchange

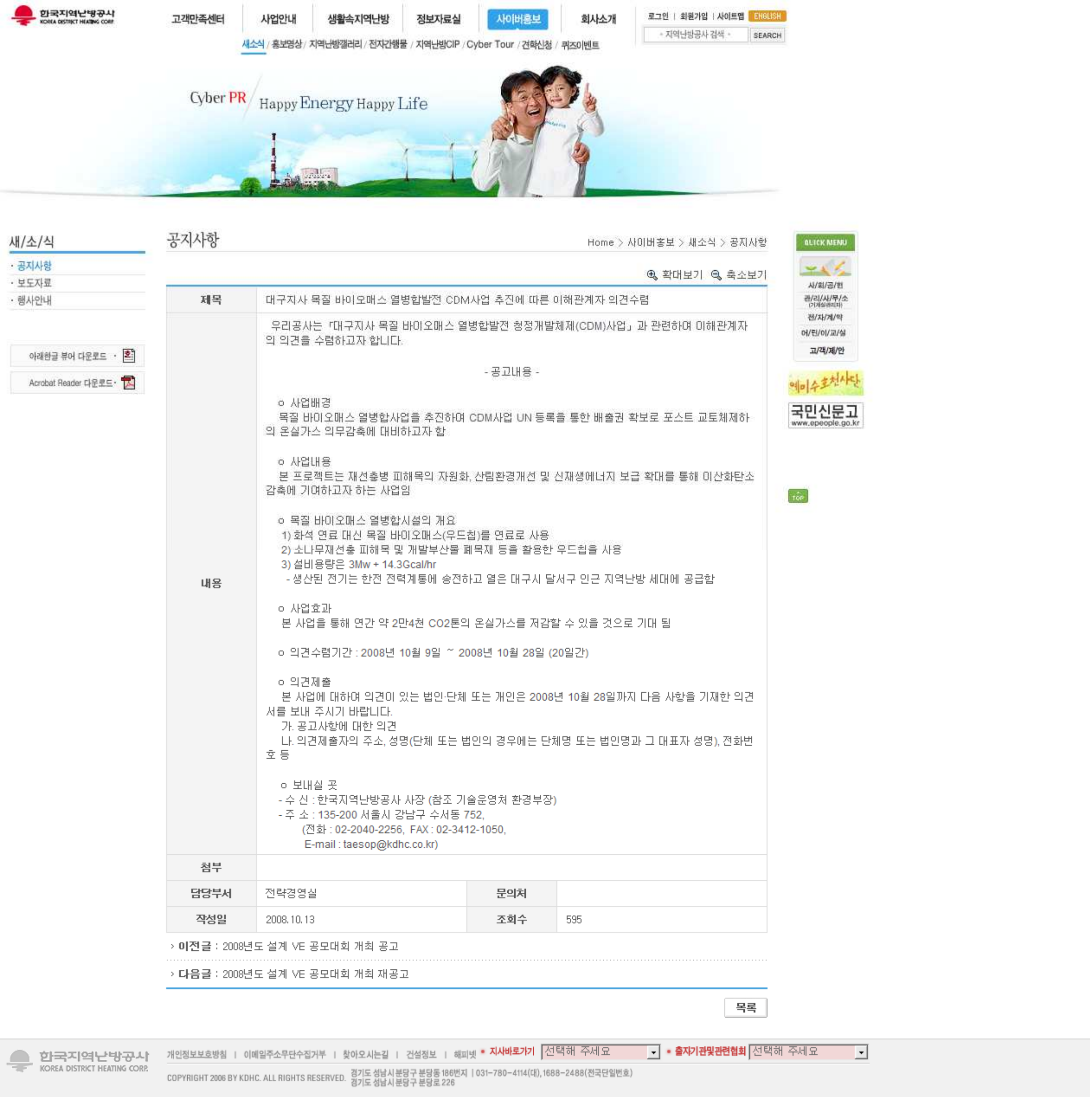
- Survey process

  KDHC performs a survey of stakeholders. The purpose of the survey is assessment of understanding of climate change and the collect for this project. KDHC wrote the question of survey and performed at Electric Industry Forum that held at Daegu-Gyeongbuk region. The participants were public officials, professors, journalists and people who work in the fields of electric industry, etc. and they answered the questions by direct. Also, the survey is performed by the people who work in the fields of the forest (government and public research centre) by e-mail.

[Collect comments from KDHC website]

KDHC informed the public of the CDM project and collected opinions from the stakeholders through the KDHC website. (www.kdhc.co.kr, 09/10/2008~28/10/2008)

The website picture during the collecting opinion is as follow:



E.2. Summary of comments received

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1. Collect comments from KDHC website:

Some people wondered about the environment effect about operating biomass cogeneration facility and risk about spreading pine wilt disease by using it as a fuel.

2. Collect the survey from the stakeholder related to this project:

Q. How much do you know about UNFCCC, Kyoto Protocol and CDM?

A. Most of the stakeholders know the UNFCCC, Kyoto protocol and CDM.

Q. How the local people be affected by the CDM project?

A. It is contributed to the environmental improvement especially for air and water. It's because the waste wood originally fumigated and incinerated is reused as a fuel for the energy.

Q. Do you think that this project is contributed to the sustainable development of the country or the local community?

A. As this project activity is making a positive effect to the creation of employment, the raise of public awareness, regional economy development, it is expected to contribute to the sustainable development.

In general, government institute, local residents and research institute welcomes the project activity as a result of survey and collected opinion from KDHC website.
They expected that the project activity would reduce greenhouse gases as well as forest conservation, etc. They expected on expansion of utilization for pine wood nematode, as it is the best way prevent of pine wood wilt disease prevent.

E.3. Consideration of comments received

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Most comments which have been received to this date were very positive for project activity implementation.
KDHC received the comment about the project activity from questioner and answered it. The environmental effect from the project activity is positive. Air pollutant from the biomass cogeneration emit less than other fossil fuel cogeneration. As operating biomass cogeneration facility, actually hours of operation of the Bunker-C oil cogeneration in Daegu district office fall. Thus, the environment effect is positive compare to without the project activity. Also, it is impossible to spread pine wood nematode using it. According to the law, woodchip have to be made by introducing the shredding machine for forest waste within the administrative district.
KDHC made the woodchip following step: 1) the pine wood nematode will be crush under 1.5cm in administrative district. 2) the woodchip transports by covered vehicle. 3) the woodchip stores within the building 4) the woodchip combusts .
According to the above steps, it is not possible to spread pine wood nematode by forest specialist.

SECTION F. Approval and authorization

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PP has received Ministry of Knowledge Economy in Korea, on August 19, 2009(Certificate No. 2009-13).

Appendix 1. Contact information of project participants

Organization name	Korea District Heating Corporation
Country	Republic of Korea
Address	186 Bundang-dong, Bundang-gu, Seongnam-si
Telephone	+82-31-780-4440
Fax	+82-31-702-5084
E-mail	cdm@kdhc.co.kr
Website	http://www.kdhc.co.kr/eng
Contact person	Won-Seok, Kang

Appendix 2. Affirmation regarding public funding

There is no public funding for the project.

Appendix 3. Applicability of methodologies and standardized baselines

Mentioned in the involved section of the PDD.

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

According to the tool to calculate the emission factor for an electricity system (version 02), operational margin and build margin can be calculated as below:

The baseline is the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in kg CO_2equ/kWh) calculated in a transparent and conservative manner as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) according to the procedures prescribed in the approved methodology tool to calculate the emission factor for an electricity system. Any of the four procedures to calculate the operating margin can be chosen, but the restrictions to use the Simple OM and the Average OM calculations must be considered.

1. Operational Margin emission factor

According to Tool to calculate the emission factor for an electricity system, dispatch data analysis should be the first methodological choice for OM emission factor. But, in Korea, dispatch data of the grid is not available. Thus this dispatch data analysis is not selected as an emission factor. Here, Simple OM method is selected for calculating emission factor. As indicated in Tool to calculate the emission factor for an electricity system, the Simple OM method can only be used where low-cost/must run resources 5 constitute less than 50% of total grid generation in: 1) average of the five most recent years, or 2) based on long-term normal for hydroelectricity production.

The ratio must run/low cost resources constitute of total grid

	2003	2004	2005	2006	2007
Total net generation(MWh)	308,225,887	326,879,672	348,187,780	365,368,969	386,510,193
Net generation of must run/low cost Resources	136,613,550	135,248,199	149,934,596	153,236,680	147,904,578
Anthracite generation(MWh)	6,236,623	5,130,890	5,117,963	5,466,561	5,501,255
Hydro generation(MWh)	6,820,709	5,796,720	5,135,032	5,144,992	4,973,993
Nuclear generation(MWh)	123,280,502	123,970,409	139,286,513	142,114,439	136,599,046
Renewable energy generation (MWh)	275,716	350,180	395,088	510,689	830,284
The ratio must run/low cost resources constitute of total grid(%)	44.32%	41.38%	43.06%	41.94%	38.27%

As above, in average of the five most recent years, low-cost/must run resources constitute less than 50% of total grid generation in Korea. Thus, Simple OM is appropriate method for OM emission factor.

2. Build Margin emission factor

According to Tool to calculate the emission factor for an electricity system, Build Margin emission factor $EF_{BM,y}$ can be calculated ex-ante based on the most recent information available on plants already built for sample group m at the time of PDD submission. The sample group m consists of either the five power plants that have been built most recently, or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) that have been built most recently. Project participants should use from these two options that sample group that comprises the larger annual generation.

	The power plant capacity additions in the electricity system that comprise 20% of the system generation	Capacity of five power plants that have been built most recently
Net generation (MWh)	74,382,528	33

In calculating the BM, emission factor of the power plant capacity additions in the electricity system that comprise 20% of the system generation is selected because the power plant capacity additions in the electricity system that comprise 20% of the system generation is larger than plant capacity five power plants that have been built most recently.

Key Parameter and data sources

No.	Key parameter	Data Source
1	Generation data for all plants for the year 2005-2007	KEPCO 2006, Statistics of Electric Power in 2005 KEPCO 2007, Statistics of Electric Power in 2006 KEPCO 2008, Statistics of Electric Power in 2007
2	fuel consumption data	KEPCO 2006, Statistics of Electric Power in 2005 KEPCO 2007, Statistics of Electric Power in 2006 KEPCO 2008, Statistics of Electric Power in 2007
3	Calorific value of fuel	KEPCO 2006, Statistics of Electric Power in 2005 KEPCO 2007, Statistics of Electric Power in 2006 KEPCO 2008, Statistics of Electric Power in 2007
4	Oxidation Factors	IPCC, Revised 2007 IPCC Guidelines for National Greenhouse Gas Inventories

5	Generation facility of Korea	KPX 2008, Statistics of Electricity Generation facility.

The below are results from calculation OM and BM using the statistics.

Operation Margin 2005

No	Plants	Type	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil consumption	LNG consumption	Coal caloric value	Heavy oil caloric value	Diesel oil caloric value	LNG caloric value	CO_2 Emission	Emission factor
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO_2	tCO_2/MWh
1	Honam #1	bituminous coal	1,787,715	870,214	961	278	0	5,122	9,343	8,369	0	1,768,603	0.9893
2	Honam #2	bituminous coal	1,875,790	912,497	338	185	0	5,107	9,361	8,364	0	1,846,745	0.9845
3	Samchonpo #1	bituminous coal	3,810,079	1,534,223	0	1,220	0	5,617	0	8,399	0	3,415,566	0.8965
4	Samchonpo #2	bituminous coal	4,323,618	1,731,265	0	626	0	5,628	0	8,439	0	3,859,447	0.8926
5	Samchonpo #3	bituminous coal	4,343,666	1,723,152	0	377	0	5,602	0	8,550	0	3,823,230	0.8802
6	Samchonpo #4	bituminous coal	4,112,297	1,632,334	0	1,029	0	5,603	0	8,496	0	3,624,106	0.8813
7	Samchonpo #5	bituminous coal	3,542,728	1,516,654	0	1,415	0	5,080	0	8,183	0	3,054,005	0.8620
8	Samchonpo #6	bituminous coal	3,643,969	1,546,663	0	1,001	0	5,107	0	8,550	0	3,130,296	0.8590
9	youngheung #1	bituminous coal	5,623,299	2,081,972	0	4,541	0	5,824	0	8,488	0	4,813,359	0.8560
10	youngheung #2	bituminous coal	4,658,862	1,761,395	0	2,903	0	5,750	0	8,500	0	4,018,070	0.8625
11	Boryeong #1	bituminous coal	3,547,140	1,440,343	0	761	0	5,539	0	8,496	0	3,160,619	0.8910
12	Boryeong #2	bituminous coal	3,433,608	1,388,532	0	551	0	5,525	0	8,496	0	3,039,134	0.8851
13	Boryeong #3	bituminous coal	4,124,745	1,589,150	0	90	0	5,588	0	8,303	0	3,516,257	0.8525
14	Boryeong #4	bituminous coal	3,698,705	1,421,343	0	603	0	5,596	0	8,311	0	3,150,580	0.8518
15	Boryeong #5	bituminous coal	4,121,314	1,587,999	0	156	0	5,588	0	8,312	0	3,513,881	0.8526
16	Boryeong #6	bituminous coal	3,283,477	1,260,305	0	627	0	5,606	0	8,312	0	2,799,073	0.8525
17	Taean #1	bituminous coal	3,992,112	1,508,570	0	621	0	5,700	0	8,257	0	3,406,290	0.8533
18	Taean #2	bituminous coal	3,484,251	1,323,078	0	395	0	5,709	0	8,250	0	2,991,552	0.8586
19	Taean #3	bituminous coal	3,957,054	1,494,175	0	650	0	5,707	0	8,242	0	3,377,807	0.8536
20	Taean #4	bituminous coal	3,653,534	1,383,297	0	365	0	5,699	0	8,270	0	3,122,386	0.8546
21	Taean #5	bituminous coal	3,744,413	1,411,398	0	742	0	5,730	0	8,242	0	3,204,277	0.8557
22	Taean #6	bituminous coal	3,999,847	1,504,962	0	417	0	5,716	0	8,256	0	3,407,248	0.8518
23	Hadong #1	bituminous coal	3,997,914	1,513,930	0	284	0	5,703	0	8,493	0	3,419,253	0.8553
24	Hadong #2	bituminous coal	3,732,583	1,410,099	0	792	0	5,697	0	8,482	0	3,182,952	0.8527
25	Hadong #3	bituminous coal	3,769,077	1,422,196	0	472	0	5,698	0	8,533	0	3,209,941	0.8517
26	Hadong #4	bituminous coal	3,989,315	1,511,054	0	567	0	5,699	0	8,491	0	3,411,231	0.8551
27	Hadong #5	bituminous coal	3,553,901	1,345,648	0	614	0	5,695	0	8,526	0	3,036,093	0.8543
28	Hadong #6	bituminous coal	4,037,763	1,520,774	0	331	0	5,695	0	8,482	0	3,430,253	0.8495
29	Dangjin #1	bituminous coal	3,797,307	1,438,702	0	637	0	5,664	0	8,392	0	3,228,108	0.8501
30	Dangjin #2	bituminous coal	3,798,078	1,437,473	0	632	0	5,664	0	8,469	0	3,225,354	0.8492
31	Dangjin #3	bituminous coal	4,081,017	1,549,041	0	141	0	5,638	0	8,402	0	3,458,533	0.8475
32	Dangjin #4	bituminous coal	4,079,557	1,544,010	0	134	0	5,644	0	8,387	0	3,450,767	0.8459
33	Dangjin #5	bituminous coal	1,318,670	499,714	0	5,701	0	5,809	0	8,459	0	1,164,380	0.8830
34	Dangjin #6	bituminous coal	96,365	38,671	0	1,779	0	5,910	0	10,540	0	96,307	0.9994
35	Ulsan #1	heavy oil	262,393	0	70,183	750	0	0	9,405	8,660	0	215,850	0.8226
36	Ulsan #2	heavy oil	255,812	0	67,296	585	0	0	9,408	8,657	0	206,672	0.8079
37	Ulsan #3	heavy oil	200,518	0	53,085	662	0	0	9,413	8,663	0	163,650	0.8161
38	Ulsan #4	heavy oil	1,549,091	0	375,417	1,971	0	0	9,501	8,666	0	1,160,796	0.7493
39	Ulsan #5	heavy oil	1,500,935	0	363,992	1,676	0	0	9,493	8,666	0	1,123,942	0.7488
40	Ulsan #6	heavy oil	1,454,644	0	352,776	1,708	0	0	9,480	8,662	0	1,088,011	0.7480
41	Youngnam #1	heavy oil	1,022,470	0	359,910	844	0	0	7,108	8,495	0	830,974	0.8127
42	Youngnam #2	heavy oil	531,006	0	190,085	584	0	0	7,343	8,496	0	453,689	0.8544
43	Yosu #1	heavy oil	430,310	0	106,919	434	0	0	9,462	8,443	0	328,874	0.7643
44	Yosu #2	heavy oil	904,597	0	218,356	346	0	0	9,447	8,442	0	669,155	0.7397
45	Pyongtaek #1	heavy oil	1,258,662	0	293,214	118	3,553	0	9,408	8,496	11,608	903,637	0.7179
46	Pyongtaek #2	heavy oil	1,376,342	0	321,188	140	2,641	0	9,410	8,513	11,585	986,651	0.7169
47	Pyongtaek #3	heavy oil	1,321,167	0	308,042	132	1,784	0	9,412	8,502	11,648	944,440	0.7149
48	Pyongtaek #4	heavy oil	1,338,204	0	311,245	138	2,047	0	9,414	8,502	11,604	955,111	0.7137
49	Namjeju #1	heavy oil	44,602	0	14,628	15	0	0	9,384	8,852	0	44,511	0.9980
50	Namjeju #2	heavy oil	44,654	0	15,031	12	0	0	9,385	8,842	0	45,733	1.0242
51	Jeju #1	heavy oil	36,266	0	12,564	12	0	0	9,435	8,441	0	38,435	1.0598
52	Jeju #2	heavy oil	532,700	0	129,516	0	0	0	9,433	0	0	395,768	0.7429
53	Jeju #3	heavy oil	502,189	0	122,866	48	0	0	9,429	8,491	0	375,423	0.7476
54	Seoul #4	LNG	207,498	0	0	0	49,143	0	0	0	11,702	135,028	0.6507
55	Seoul #5	LNG	444,324	0	0	1	108,761	0	0	8,617	11,707	298,979	0.6729
56	Incheon #1	LNG	16,450	0	0	0	4,365	0	0	0	11,729	12,021	0.7308
57	Incheon #2	LNG	37,727	0	0	0	8,505	0	0	0	11,723	23,410	0.6205
58	Incheon #3	LNG	29,202	0	0	400	6,620	0	0	8,506	11,723	19,278	0.6602
59	Namjeju D/P	Interanal Combusion	268,073	0	56,727	37	0	0	9,383	8,526	0	172,533	0.6436
60	Jeju G/T	Interanal Combusion	5,069	0	0	2,869	0	0	0	8,473	0	7,539	1.4874
61	Pyongtaek C/C	combined cycle	659,932	0	0	1	110,953	0	0	8,503	11,727	305,520	0.4630
62	Ilsan C/C	combined cycle	2,873,958	0	0	0	533,188	0	0	0	11,710	1,466,033	0.5101
63	Bundang C/C	combined cycle	3,742,073	0	0	0	671,944	0	0	0	11,723	1,849,539	0.4943
64	Ulsan C/C	combined cycle	3,131,075	0	0	0	470,131	0	0	0	11,475	1,266,723	0.4046
65	Seoincheon C/C	combined cycle	7,001,031	0	0	335	989,645	0	0	8,740	11,708	2,721,579	0.3887
66	Shinincheon C/C	combined cycle	10,543,280	0	0	0	1,458,763	0	0	0	11,712	4,011,575	0.3805
67	Boryeong C/C	combined cycle	8,221,926	0	0	0	1,161,510	0	0	0	11,727	3,198,307	0.3890
68	Incheon	combined cycle	2,055,016	0	0	0	281,813	0	0	0	11,711	774,922	0.3771
69	Busan C/C	combined cycle	9,076,327	0	0	0	1,211,144	0	0	0	11,700	3,327,299	0.3666

70	Hallim C/C	combined cycle	100,346	0	0	29,686	0	0	0	8,524	0	78,484	0.7821
71	Anyang C/C	combined cycle	1,433,978	0	0	0	261,202	0	0	0	11,723	718,964	0.5014
72	Bucheon C/C	combined cycle	1,404,160	0	0	0	261,705	0	0	0	11,703	719,131	0.5121
73	POSCO Power	combined cycle	2,571,095	0	0	0	445,253	0	0	0	11,722	1,225,474	0.4766
74	GS Bugog	combined cycle	2,189,808	0	0	0	297,976	0	0	0	12,380	866,216	0.3956
75	Yulchon	combined cycle	1,300,627	0	0	159	194,534	0	0	10,384	11,721	535,889	0.4120
total			194,893,307									141,021,467	0.7236

Operation Margin 2006

No	Plants	Type	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil consumption	LNG consumption	Coal caloric value	Heavy oil caloric value	Diesel oil caloric value	LNG caloric value	CO_2 Emission	Emission factor
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO_2	tCO_2/MWh
1	Honam #1	bituminous coal	1,622,639	781,139	1,113	279	0	5,164	9,318	8,472	0	1,601,224	0.9868
2	Honam #2	bituminous coal	1,782,016	859,736	1,251	359	0	5,137	9,332	8,426	0	1,753,422	0.9840
3	Samchonpo #1	bituminous coal	4,161,219	1,696,271	0	860	0	5,640	0	8,373	0	3,790,142	0.9108
4	Samchonpo #2	bituminous coal	3,703,880	1,508,082	0	1,362	0	5,645	0	8,373	0	3,374,481	0.9111
5	Samchonpo #3	bituminous coal	3,779,585	1,519,385	0	457	0	5,565	0	8,373	0	3,349,334	0.8862
6	Samchonpo #4	bituminous coal	3,816,997	1,521,263	0	1,818	0	5,568	0	8,363	0	3,358,739	0.8799
7	Samchonpo #5	bituminous coal	3,761,205	1,665,339	0	977	0	4,974	0	8,550	0	3,282,470	0.8727
8	Samchonpo #6	bituminous coal	4,065,091	1,770,348	0	428	0	4,993	0	8,550	0	3,500,782	0.8612
9	youngheung #1	bituminous coal	5,337,432	2,004,193	0	2,548	0	5,768	0	8,447	0	4,584,151	0.8589
10	youngheung #2	bituminous coal	5,727,937	2,129,118	0	2,545	0	5,782	0	8,454	0	4,880,975	0.8521
11	Boryeong #1	bituminous coal	3,988,848	1,638,140	0	306	0	5,479	0	8,412	0	3,554,788	0.8912
12	Boryeong #2	bituminous coal	3,423,101	1,389,425	0	1,137	0	5,478	0	8,496	0	3,016,695	0.8813
13	Boryeong #3	bituminous coal	3,409,486	1,323,779	0	514	0	5,552	0	8,496	0	2,911,590	0.8540
14	Boryeong #4	bituminous coal	4,133,946	1,610,928	0	82	0	5,533	0	8,496	0	3,529,307	0.8537
15	Boryeong #5	bituminous coal	3,364,148	1,296,455	0	541	0	5,552	0	8,312	0	2,851,592	0.8476
16	Boryeong #6	bituminous coal	3,987,488	1,553,273	0	518	0	5,542	0	8,312	0	3,409,690	0.8551
17	Taean #1	bituminous coal	3,556,797	1,354,832	0	514	0	5,683	0	8,312	0	3,050,123	0.8575
18	Taean #2	bituminous coal	4,035,753	1,532,209	0	162	0	5,679	0	7,952	0	3,445,908	0.8538
19	Taean #3	bituminous coal	3,528,613	1,338,967	0	575	0	5,684	0	8,216	0	3,014,739	0.8544
20	Taean #4	bituminous coal	4,069,820	1,548,909	0	133	0	5,680	0	8,232	0	3,483,895	0.8560
21	Taean #5	bituminous coal	4,013,235	1,542,775	0	544	0	5,638	0	8,232	0	3,445,244	0.8585
22	Taean #6	bituminous coal	3,381,867	1,294,577	0	1,113	0	5,662	0	8,232	0	2,905,314	0.8591
23	Taean #7	bituminous coal	159,677	61,910	0	4,799	0	5,667	0	8,130	0	151,011	0.9457
24	Hadong #1	bituminous coal	3,607,063	1,373,049	0	515	0	5,670	0	8,396	0	3,084,035	0.8550
25	Hadong #2	bituminous coal	4,068,036	1,543,074	0	293	0	5,662	0	8,482	0	3,459,824	0.8505
26	Hadong #3	bituminous coal	4,079,158	1,549,094	0	153	0	5,660	0	8,481	0	3,472,191	0.8512
27	Hadong #4	bituminous coal	3,631,374	1,376,612	0	796	0	5,671	0	8,384	0	3,092,975	0.8517
28	Hadong #5	bituminous coal	4,092,625	1,554,524	0	242	0	5,665	0	8,466	0	3,487,682	0.8522
29	Hadong #6	bituminous coal	3,610,222	1,371,801	0	690	0	5,669	0	8,456	0	3,080,952	0.8534
30	Dangjin #1	bituminous coal	3,598,820	1,380,527	0	966	0	5,588	0	8,526	0	3,057,197	0.8495
31	Dangjin #2	bituminous coal	4,115,891	1,570,077	0	161	0	5,611	0	8,529	0	3,488,527	0.8476
32	Dangjin #3	bituminous coal	3,666,490	1,402,916	0	433	0	5,592	0	8,556	0	3,107,169	0.8475
33	Dangjin #4	bituminous coal	3,610,984	1,386,317	0	1,549	0	5,581	0	8,564	0	3,067,760	0.8496
34	Dangjin #5	bituminous coal	3,946,931	1,456,458	0	745	0	5,743	0	8,507	0	3,314,126	0.8397
35	Dangjin #6	bituminous coal	3,392,395	1,216,582	0	3,051	0	5,814	0	8,450	0	2,808,422	0.8279
36	Dangjin #7	bituminous coal	1,474	1,008	0	505	0	5,527	0	8,535	0	3,543	2.4041
37	Ulsan #1	heavy oil	275,016	0	72,243	605	0	0	9,419	8,664	0	222,065	0.8075
38	Ulsan #2	heavy oil	306,668	0	80,187	469	0	0	9,427	8,664	0	246,136	0.8026
39	Ulsan #3	heavy oil	376,132	0	96,459	518	0	0	9,423	8,664	0	295,851	0.7866
40	Ulsan #4	heavy oil	1,511,557	0	360,919	3,729	0	0	9,529	8,664	0	1,124,146	0.7437
41	Ulsan #5	heavy oil	1,583,846	0	375,985	3,678	0	0	9,531	8,664	0	1,170,839	0.7392
42	Ulsan #6	heavy oil	1,589,838	0	378,331	3,694	0	0	9,533	8,664	0	1,178,317	0.7412
43	Youngnam #1	heavy oil	359,205	0	107,090	1,016	0	0	9,631	8,403	0	336,777	0.9376
44	Youngnam #2	heavy oil	323,595	0	95,127	1,494	0	0	9,605	8,419	0	299,883	0.9267
45	Yosu #1	heavy oil	403,547	0	99,129	281	0	0	9,465	8,358	0	304,679	0.7550
46	Yosu #2	heavy oil	906,849	0	215,957	291	0	0	9,456	8,356	0	662,302	0.7303
47	Pyongtaek #1	heavy oil	1,123,948	0	261,458	141	3,997	0	9,222	8,496	11,647	792,413	0.7050
48	Pyongtaek #2	heavy oil	1,198,620	0	277,025	166	5,687	0	9,233	8,496	11,647	844,631	0.7047
49	Pyongtaek #3	heavy oil	1,304,568	0	303,858	134	3,891	0	9,260	8,501	11,573	922,424	0.7071
50	Pyongtaek #4	heavy oil	1,052,228	0	245,602	103	3,473	0	9,208	8,501	11,667	742,448	0.7056
51	Namjeju #1	heavy oil	34,448	0	11,406	17	0	0	9,413	8,525	0	34,824	1.0109
52	Namjeju #2	heavy oil	28,686	0	9,772	14	0	0	9,412	8,504	0	29,833	1.0400
53	Namjeju #3	heavy oil	179,033	0	46,504	2,509	0	0	9,403	8,491	0	148,267	0.8282
54	Jeju #1	heavy oil	24,748	0	8,603	23	0	0	9,377	8,429	0	26,195	1.0585
55	Jeju #2	heavy oil	462,023	0	113,679	64	0	0	9,454	8,524	0	348,347	0.7540
56	Jeju #3	heavy oil	479,676	0	117,464	67	0	0	9,455	8,524	0	359,971	0.7504
57	Seoul #4	LNG	306,558	0	0	1	69,383	0	0	8,617	11,716	190,874	0.6226
58	Seoul #5	LNG	685,011	0	0	1	152,891	0	0	8,617	11,594	416,231	0.6076
59	Incheon #1	LNG	32,932	0	0	0	6,945	0	0	0	11,733	19,132	0.5810
60	Incheon #2	LNG	24,366	0	0	0	5,223	0	0	0	11,725	14,380	0.5902
61	Incheon #3	LNG	78,669	0	0	311	15,426	0	0	8,533	11,716	43,259	0.5499
62	Incheon #4	LNG	62,414	0	0	311	12,454	0	0	8,532	11,722	35,099	0.5624
63	Namjeju D/P	Interanal Combusion	239,690	0	51,347	111	0	0	9,734	8,462	0	162,201	0.6767
64	Jeju G/T	Interanal Combusion	15,986	0	0	8,264	0	0	0	8,352	0	21,405	1.3390
65	Jeju D/P	Interanal Combusion	252,764	0	52,907	0	0	0	9,136	0	0	156,594	0.6195
66	Pyongtaek C/C	combined cycle	497,441	0	0	45	84,054	0	0	8,503	11,727	231,558	0.4655
67	Ilsan C/C	combined cycle	3,038,165	0	0	1,384	556,504	0	0	8,540	11,715	1,534,480	0.5051
68	Bundang C/C	combined cycle	4,059,300	0	0	0	720,381	0	0	0	11,723	1,982,891	0.4885
69	Ulsan C/C	combined cycle	3,608,435	0	0	0	536,196	0	0	0	11,381	1,432,932	0.3971

70	Seoincheon C/C	combined cycle	8,726,521	0	0	1,066	1,199,196	0	0	8,740	11,723	3,303,795	0.3786
71	Shinincheon C/C	combined cycle	11,797,500	0	0	0	1,641,038	0	0	0	11,723	4,517,066	0.3829
72	Boryeong C/C	combined cycle	7,089,662	0	0	0	998,683	0	0	0	11,730	2,750,749	0.3880
73	Incheon	combined cycle	3,648,288	0	0	0	484,606	0	0	0	11,698	1,331,136	0.3649
74	Busan C/C	combined cycle	10,455,401	0	0	0	1,396,417	0	0	0	11,716	3,841,427	0.3674
75	Hallim C/C	combined cycle	175,356	0	0	48,475	0	0	0	8,506	0	127,879	0.7293
76	Anyang C/C	combined cycle	1,286,480	0	0	0	230,969	0	0	0	11,726	635,911	0.4943
77	Bucheon C/C	combined cycle	1,241,795	0	0	215	225,713	0	0	10,381	11,711	621,389	0.5004
78	POSCO Power	combined cycle	2,338,128	0	0	0	408,018	0	0	0	11,728	1,123,563	0.4805
79	GS Bugog	combined cycle	2,911,683	0	0	0	389,811	0	0	0	11,727	1,073,363	0.3686
80	Yulchon	combined cycle	2,276,276	0	0	0	315,132	0	0	0	12,039	890,794	0.3913
total			206,605,293									147,318,474	0.7130

Operation Margin 2007

No	Plants	Type	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil consumption	LNG consumption	Coal caloric value	Heavy oil caloric value	Diesel oil caloric value	LNG caloric value	CO_2 Emission	Emission factor
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO_2	tCO_2/MWh
1	Honam #1	bituminous coal	1,806,765	866,853	889	281	0	5,186	9,311	8,497	0	1,784,132	0.9875
2	Honam #2	bituminous coal	1,773,852	846,931	811	262	0	5,190	9,311	8,493	0	1,744,148	0.9833
3	Samchonpo #1	bituminous coal	3,903,591	1,631,706	0	296	0	5,545	0	8,373	0	3,584,260	0.9182
4	Samchonpo #2	bituminous coal	4,398,382	1,804,695	0	384	0	5,537	0	8,373	0	3,958,619	0.9000
5	Samchonpo #3	bituminous coal	4,311,704	1,755,374	0	434	0	5,525	0	8,349	0	3,842,516	0.8912
6	Samchonpo #4	bituminous coal	3,840,729	1,543,140	0	677	0	5,540	0	8,349	0	3,387,556	0.8820
7	Samchonpo #5	bituminous coal	4,074,103	1,850,764	0	315	0	4,865	0	8,550	0	3,567,364	0.8756
8	Samchonpo #6	bituminous coal	3,823,174	1,714,320	0	619	0	4,864	0	8,550	0	3,304,416	0.8643
9	youngheung #1	bituminous coal	5,020,901	1,902,557	0	3,320	0	5,745	0	8,391	0	4,337,794	0.8639
10	youngheung #2	bituminous coal	6,081,490	2,296,289	0	1,779	0	5,739	0	8,457	0	5,224,532	0.8591
11	youngheung #3	bituminous coal	320,502	119,883	0	3,964	0		0	7,878	0	9,687	
12	Boryeong #1	bituminous coal	3,604,642	1,466,761	0	811	0	5,519	0	8,496	0	3,208,345	0.8901
13	Boryeong #2	bituminous coal	4,120,511	1,655,488	0	169	0	5,515	0	8,496	0	3,616,289	0.8776
14	Boryeong #3	bituminous coal	4,214,892	1,648,008	0	187	0	5,518	0	8,655	0	3,602,531	0.8547
15	Boryeong #4	bituminous coal	3,438,773	1,347,303	0	646	0	5,513	0	8,944	0	2,943,874	0.8561
16	Boryeong #5	bituminous coal	4,162,530	1,629,904	0	195	0	5,520	0	8,655	0	3,564,171	0.8563
17	Boryeong #6	bituminous coal	3,817,024	1,490,809	0	387	0	5,518	0	8,655	0	3,258,983	0.8538
18	Taean #1	bituminous coal	4,055,394	1,524,391	0	410	0	5,733	0	8,174	0	3,462,731	0.8539
19	Taean #2	bituminous coal	3,796,670	1,434,221	0	374	0	5,733	0	8,387	0	3,257,755	0.8581
20	Taean #3	bituminous coal	4,039,811	1,521,349	0	350	0	5,734	0	8,388	0	3,456,114	0.8555
21	Taean #4	bituminous coal	3,504,214	1,320,380	0	422	0	5,727	0	7,963	0	2,995,962	0.8550
22	Taean #5	bituminous coal	3,523,988	1,342,358	0	676	0	5,686	0	8,361	0	3,024,835	0.8584
23	Taean #6	bituminous coal	4,036,733	1,535,931	0	491	0	5,695	0	8,347	0	3,465,981	0.8586
24	Taean #7	bituminous coal	3,868,817	1,430,171	0	2,321	0	5,717	0	8,044	0	3,244,196	0.8386
25	Taean #8	bituminous coal	2,528,587	919,055	0	3,636	0		0	7,256	0	8,186	
26	Hadong #1	bituminous coal	4,140,667	1,582,726	0	178	0	5,647	0	8,492	0	3,540,357	0.8550
27	Hadong #2	bituminous coal	3,681,670	1,396,830	0	637	0	5,645	0	8,456	0	3,124,626	0.8487
28	Hadong #3	bituminous coal	3,727,907	1,424,033	0	375	0	5,627	0	8,469	0	3,174,493	0.8515
29	Hadong #4	bituminous coal	4,115,014	1,572,409	0	292	0	5,639	0	8,519	0	3,512,359	0.8535
30	Hadong #5	bituminous coal	3,905,190	1,486,776	0	452	0	5,652	0	8,492	0	3,329,591	0.8526
31	Hadong #6	bituminous coal	4,158,792	1,585,307	0	109	0	5,640	0	8,495	0	3,541,736	0.8516
32	Dangjin #1	bituminous coal	3,968,103	1,512,904	0	269	0	5,660	0	8,610	0	3,392,182	0.8549
33	Dangjin #2	bituminous coal	3,595,927	1,358,316	0	543	0	5,663	0	8,606	0	3,047,907	0.8476
34	Dangjin #3	bituminous coal	4,010,715	1,516,065	0	119	0	5,657	0	8,617	0	3,397,177	0.8470
35	Dangjin #4	bituminous coal	4,009,178	1,519,231	0	342	0	5,659	0	8,635	0	3,405,854	0.8495
36	Dangjin #5	bituminous coal	3,443,482	1,279,796	0	1,038	0	5,713	0	8,620	0	2,898,801	0.8418
37	Dangjin #6	bituminous coal	3,497,359	1,281,318	0	878	0	5,737	0	8,613	0	2,913,774	0.8331
38	Dangjin #7	bituminous coal	2,904,680	1,059,612	0	6,681	0	5,725	0	8,621	0	2,420,607	0.8333
39	Dangjin #8	bituminous coal	1,297,925	467,807	0	4,873	0		0	8,596	0	12,994	
40	Ulsan #1	heavy oil	406,685	0	107,844	406	0	0	9,413	8,664	0	330,045	0.8116
41	Ulsan #2	heavy oil	407,321	0	108,381	483	0	0	9,420	8,664	0	332,152	0.8155
42	Ulsan #3	heavy oil	458,584	0	120,571	576	0	0	9,360	8,664	0	367,260	0.8009
43	Ulsan #4	heavy oil	1,418,034	0	341,170	3,525	0	0	9,508	8,664	0	1,060,664	0.7480
44	Ulsan #5	heavy oil	1,540,400	0	370,712	4,711	0	0	9,511	8,664	0	1,155,212	0.7499
45	Ulsan #6	heavy oil	899,604	0	216,409	3,021	0	0	9,502	8,664	0	674,480	0.7498
46	Youngnam #1	heavy oil	688,935	0	174,082	1,232	0	0	9,643	8,402	0	547,185	0.7942
47	Youngnam #2	heavy oil	474,475	0	122,249	796	0	0	9,643	8,403	0	384,083	0.8095
48	Yosu #1	heavy oil	497,053	0	121,572	332	0	0	9,464	8,368	0	373,705	0.7518
49	Yosu #2	heavy oil	1,071,405	0	257,420	367	0	0	9,462	8,370	0	790,238	0.7376
50	Pyongtaek #1	heavy oil	1,147,515	0	269,284	114	3,316	0	9,445	8,534	11,650	833,584	0.7264
51	Pyongtaek #2	heavy oil	1,553,162	0	359,870	140	6,339	0	9,448	8,530	11,653	1,119,577	0.7208
52	Pyongtaek #3	heavy oil	1,502,099	0	349,481	157	4,874	0	9,447	8,518	11,650	1,083,667	0.7214
53	Pyongtaek #4	heavy oil	1,095,986	0	255,443	117	4,047	0	9,460	8,517	11,651	794,454	0.7249
54	Namjeju #1	heavy oil	0	0	0	-	0	0	-	-	0	-	0.0000
55	Namjeju #2	heavy oil	-	0	0	-	0	0	-	-	0	-	0.0000
56	Namjeju #3	heavy oil	484,459	0	124,559	225	0	0	9,411	8,201	0	380,462	0.7853
57	Namjeju #4	heavy oil	500,222	0	127,900	341	0		-	8,515	0	900	
58	Jeju #1	heavy oil	3,019	0	1,049	4	0	0	9,412	8,458	0	3,212	1.0640
59	Jeju #2	heavy oil	280,454	0	70,122	112	0	0	9,420	7,906	0	214,335	0.7642
60	Jeju #3	heavy oil	396,186	0	98,846	34	0	0	9,419	8,490	0	301,788	0.7617
61	Seoul #4	LNG	357,572	0	0	1	75,080	0	0	7,411	11,727	206,811	0.5784
62	Seoul #5	LNG	962,861	0	0	1	206,908	0	0	8,617	11,727	569,902	0.5919
63	Incheon #1	LNG	148,821	0	0	0	30,402	0	0	0	11,727	83,741	0.5627
64	Incheon #2	LNG	157,042	0	0	0	31,528	0	0	0	11,730	86,864	0.5531
65	Incheon #3	LNG	205,530	0	0	354	41,270	0	0	8,514	11,730	114,642	0.5578
66	Incheon #4	LNG	95,143	0	0	201	18,892	0	0	8,483	11,730	52,581	0.5527
67	Namjeju D/P	Interanal Combusion	164,390	0	35,297	238	0	0	9,419	8,323	0	108,356	0.6591
68	Jeju G/T	Interanal Combusion	1,294	0	0	850	0	0	0	8,447	0	2,226	1.7212
69	Jeju D/P	Interanal Combusion	235,626	0	49,613	0	0	0	9,396	0	0	151,062	0.6411

70	Pyongtaek C/C	combined cycle	909,449	0	0	67	151,414	0	0	8,503	11,739	417,670	0.4593
71	Ilsan C/C	combined cycle	3,506,350	0	0	-	635,260	0	0	-	11,725	1,749,553	0.4990
72	Bundang C/C	combined cycle	3,741,296	0	0	3	660,899	0	0	8716	11,728	1,820,511	0.4866
73	Ulsan C/C	combined cycle	4,383,453	0	0	0	649,494	0	0	0	11,610	1,771,074	0.4040
74	Seoincheon C/C	combined cycle	10,895,505	0	0	-	1,495,687	0	0	-	11,739	4,123,898	0.3785
75	Shinincheon C/C	combined cycle	12,533,994	0	0	0	1,761,001	0	0	0	11,735	4,853,776	0.3872
76	Boryeong C/C	combined cycle	7,839,371	0	0	0	1,121,251	0	0	0	11,735	3,090,504	0.3942
77	Incheon	combined cycle	3,696,784	0	0	0	494,690	0	0	0	11,726	1,362,529	0.3686
78	Busan C/C	combined cycle	11,616,221	0	0	0	1,552,997	0	0	0	11,727	4,277,635	0.3682
79	Hallim C/C	combined cycle	61,752	0	0	17,753	0	0	0	8,533	0	46,997	0.7611
80	Anyang C/C	combined cycle	1,615,090	0	0	0	289,384	0	0	0	11,741	798,066	0.4941
81	Bucheon C/C	combined cycle	1,523,068	0	0	-	269,651	0	0	-	11,898	753,572	0.4948
82	POSCO Power	combined cycle	3,788,598	0	0	0	660,445	0	0	0	11,756	1,823,696	0.4814
83	GS Bugog	combined cycle	2,767,811	0	0	0	371,586	0	0	0	11,734	1,024,143	0.3700
84	Yulchon	combined cycle	2,083,451	0	0	0	292,336	0	0	0	11,732	805,595	0.3867
total			230,640,453									160,409,844	0.6955

Build Margin

No	Plants	year	Net generation	Coal Consumption	Heavy oil Consumption	Diesel oil consumption	LNG consumption	Coal caloric value	Heavy oil caloric value	diesel oil caloric value	LNG caloric value	CO_2 Emission	Emission factor
			MWh	ton	kilo liter	kilo liter	ton	Kcal/kg	kcal/l	Kcal/l	kcal/kg	tCO_2	tCO_2/MWh
1	Hanbit Sungsan the second solar	2007.12	0	0	0	0	0	0	0	0	0	-	
2	Taein gangjin solar	2007.12	6									-	
3	Suni gangjin solar	2007.12	11									-	
4	Korea yeongcheon solar	2007.12	17									-	
5	Solar yungam solar	2007.12	0									-	
6	Changwhan yeongduk solar	2007.12	5									-	
7	Samsung jindo solar	2007.12	9									-	
8	Hyosung daegi-wind power	2007.12	42									-	
9	Hankyung-wind power	2007.12										-	
10	Dangjin	2007.12	1,297,925	467,807	0	4,873	0	5,742	0	8,596	0	1,076,478	
11	SP solar yongwang	2007.11	38									-	
12	Dongyang energy sinan	2007.11	268									-	
13	Ef yungam solar	2007.11	40									-	
14	Dongwon gangjin solar	2007.11	214									-	
15	Solec yonggwang solar	2007.11	120									-	
16	Solar jungeub solar	2007.11	92									-	
17	Sinbuk sungam solar	2007.11	178									-	
18	Hyein haenam solar	2007.11	364									-	
19	Samlangjin solar	2007.11	646									-	0.0000
20	Wuriyungam solar	2007.8	267									-	0.0000
21	Hwasung solar	2007.8	309									-	0.0000
22	Yeongju the first solar	2007.8	230									-	0.0000
23	Muan solar	2007.8	622									-	0.0000
24	Jangheung solar	2007.8	125									-	0.0000
25	Gomun	2007.8	2,996									-	0.0000
26	Taean #8	2007.8	2,528,587	919,055	0	3,636	0	5,722	0	7,256	0	2,090,263	0.8267
27	Dangjin #7	2007.6	2,904,680	1,059,612	0	6,681	0	5,725	0	8,621	0	2,419,855	0.8331
28	Munkyung solar	2007.6	2,563									-	0.0000
29	Yonnggwang solar park	2007.6	853									-	0.0000
30	Yungam Solar	2007.6	770									-	0.0000
31	Wonjungsu	2007.5	1,321									-	0.0000
32	Baekgok	2007.5	1,001									-	0.0000
33	Damyangho	2007.5	1,771									-	0.0000
34	Namjeju #4	2007.3	500,222	0	121,505	341	0	0	9,410	8,515	0	371,288	0.7422
35	Eco energy	2007.3	231,029									-	0.0000
36	Jeonju-resource recovery facility	2007.2	13,059									-	0.0000
37	Jeoul Marin(suncheon)	2007.2	1,223									-	0.0000
38	Mirae energy	2007.2	165									-	0.0000
39	Samcheonpo	2007.2	23,290									-	0.0000
40	Taean #7	2007.2	3,868,817	1,430,171	0	2,321	0	5,717	0	8,044	0	3,243,189	0.8383
41	cheongsong pumping #2	2006.12	28,619	0	0	0	0	0	0	0	0	-	0.0000
42	Bundang fuel cell	2006.10	1,959	0	0	0	0	0	0	0	0	-	0.0000
43	solar park(S&P Solar)	2006.10	995	0	0	0	0	0	0	0	0	-	0.0000
44	Namhae Solar	2006.10	1,462	0	0	0	0	0	0	0	0	-	0.0000
45	Hanla Jeunggong Solar	2006.10	1,292	0	0	0	0	0	0	0	0	-	0.0000
46	Enepark	2006.9	416	0	0	0	0	0	0	0	0	-	0.0000
47	Yongheng solar	2006.9	1,214	0	0	0	0	0	0	0	0	-	0.0000
48	Cheongsong pumping #1	2006.9	164,069	0	0	0	0	0	0	0	0	-	0.0000
49	Namjeju #3	2006.9	484,459	0	46,504	2,509	0	0	9,403	8,491	0	148,268	0.3060
50	Yangyang pumping #4	2006.8	91,270	0	0	0	0	0	0	0	0	-	0.0000
51	Hadongho	2006.6	1,832	0	0	0	0	0	0	0	0	-	0.0000
52	Hadongho	2006.6	56,495	0	0	0	0	0	0	0	0	-	0.0000
53	Goheung Solar	2006.6	1,233	0	0	0	0	0	0	0	0	-	0.0000
54	Jangseong	2006.5	648	0	0	0	0	0	0	0	0	-	0.0000
55	Maebongsan-wind power	2006.5 (2004.12)	11,058	0	0	0	0	0	0	0	0	-	0.0000
56	Yangyang pumping #2	2006.4	103,698	0	0	0	0	0	0	0	0	-	0.0000
57	Dangjin #6	2006.4	3,497,359	1,216,582	0	3,051	0	5,814	0	8,450	0	2,808,621	0.8031
58	Sinchang-Wind power	2006.3	3,572	0	0	0	0	0	0	0	0	-	0.0000
59	Yangyang pumping #1	2006.2	106,973	0	0	0	0	0	0	0	0	-	0.0000
60	Suncheon Solar	2005.12	1,259	0	0	0	0	0	0	0	0	-	0.0000
61	Samcheonpo solar	2005.12	131	0	0	0	0	0	0	0	0	-	0.0000
62	Dangjin #5	2005.10	3,443,482	1,456,458	0	745	0	5,743	0	8,507	0	3,314,126	0.9624
63	Taean solar	2005.10	118	0	0	0	0	0	0	0	0	-	0.0000
64	Wunjeong LFG	2005.10	11,415	0	0	0	0	0	0	0	0	-	0.0000
65	Yulchon C/C	2005.7	2,083,451	0	0	0	315,132	0	0	0	12,039	890,794	0.4276
66	Incheon C/C #1	2005.7	3,696,784	0	0	0	484,606	0	0	0	11,698	1,331,136	0.3601
67	Daegok	2005.7	1,278	0	0	0	0	0	0	0	0	-	0.0000
68	Donghwa	2005.7	2,481	0	0	0	0	0	0	0	0	-	0.0000
69	Ulchin #6	2005.4	7,911,305	0	0	0	0	0	0	0	0	-	0.0000

70	Hanrye LFG	2005.4	5,102	0	0	0	0	0	0	0	0	-	0.0000
71	Busan- Biogas #1,2	2005.3	1,551	0	0	0	0	0	0	0	0	-	0.0000
72	Daegwanryung-wind power	2004.12	4,288	0	0	0	0	0	0	0	0	-	0.0000
73	Yongheng #2	2004.11	6,081,490	2,129,118	0	2,545	0	5,782	0	8,454	0	4,880,975	0.8026
74	New solar energy	2004.11	216	0	0	0	0	0	0	0	0	-	0.0000
75	Ulchin #5	2004.7	8,025,928	0	0	0	0	0	0	0	0	-	0.0000
76	Yongheng #1	2004.7	5,020,901	2,004,193	0	2,548	0	5,768	0	8,447	0	4,584,151	0.9130
77	Busan C/C	2004.3	11,616,221	0	0	0	1,396,417	0	0	0	11,716	3,841,427	0.3307
78	Chunsang	2004.2	240	0	0	0	0	0	0	0	0	-	0.0000
79	Cheongju LFG	2004.2	5,808	0	0	0	0	0	0	0	0	-	0.0000
80	Gunsan-wind	2003.9 (2002.11)	7,958	0	0	0	0	0	0	0	0	-	0.0000
81	Daejon Geumgodong	2003.6	9,160	0	0	0	0	0	0	0	0	-	0.0000
82	Hoicheon ENC	2003.5	2,826										
83	Muju	2003.4	637	0	0	0	0	0	0	0	0	-	0.0000
84	Sangwon ENC	2003.3	2,752	0	0	0	0	0	0	0	0	-	0.0000
85	Yonggwang #6	2002.12	6,466,515	0	0	0	0	0	0	0	0	-	0.0000
86	Taean #6	2002.5	4,036,733	1,294,577	0	1112.575	0	5,662	0	8,232	0	2,905,314	0.7197
total			74,382,528									24,704,813	0.3321

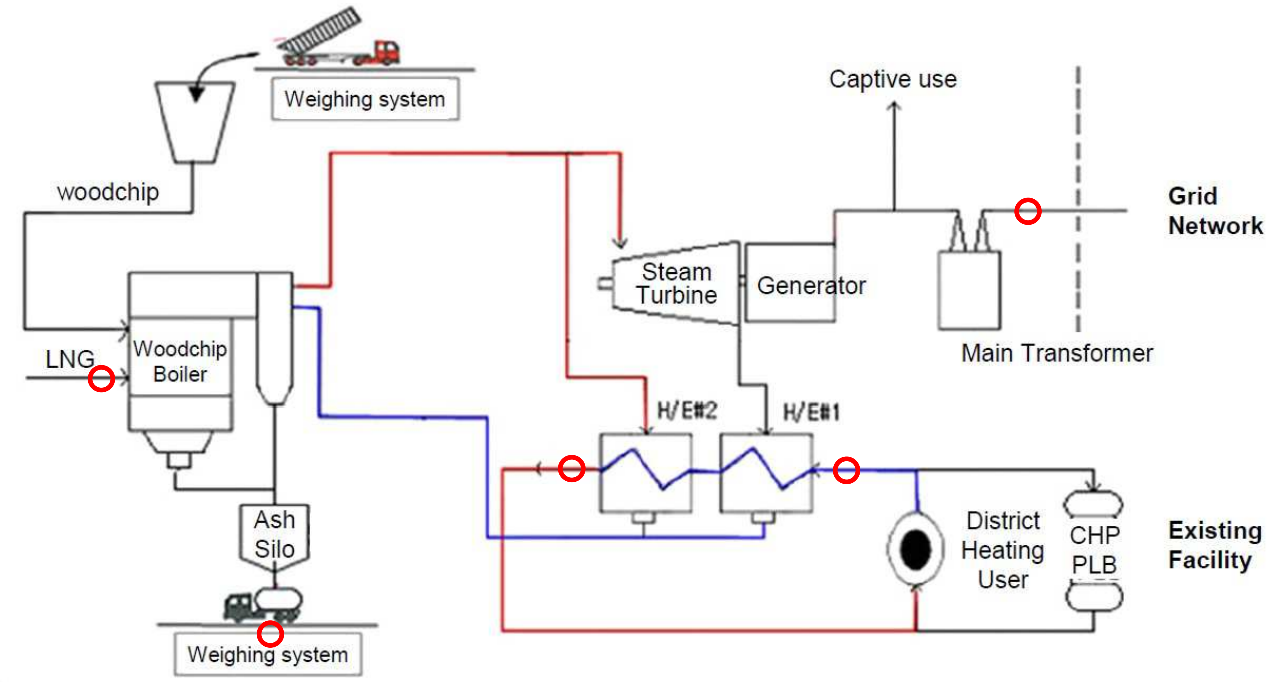
3. Combined margin emission factor

		tCO_2/MWh
		CM(1)=0.5*OM+0.5*BM
OM	2005	0.7238
	2006	0.7133
	2007	0.6955
	2005-2007	0.7109
BM	2007	0.3321
CM	2007	0.5215

Source: 2007 Statistics of Electric Power in Korea (2008.5, Korea electric power corporation)
http://cyber.kepco.co.kr/kepco_new/elec_info/info/statistical_kepco.jsp?div=3

Appendix 5. Further background information on monitoring plan

Measuring points for monitoring in project boundary are as follows.



Data monitored through physical monitoring equipment

EGy (MWh/year): Electricity produced and exported to the national grid

- Electricity is measured by watt-hour meter every hour and the measurement results are transferred to KPX exchange system.
- KDHC power management system backs up the data transferred to KPX.
- The watt-hour meter will be calibrated every 7 years.

EGcaptive,y (MWh/year): Electricity supplied from national grid for on-site consumption

- The measurement results are recorded in DATA log sheet of watt-hour meter every day.
- It can be cross-checked with KEPCO invoices for purchased electricity.
- The watt-hour meter will be calibrated every 3 years.

EGthermal,y (Gcal/year): Heat generation by project activity

- The flow of district heating water is measured by flow meter and the front and rear temperatures of heat exchanger are measured by temperature meter. And then the calorimeter calculates and displays the heat generation.
- The result of measurement is recorded to Centre control Room's Distributed control system and log sheet.
- The flow meter and temperature meter will be calibrated once every 3 years by the authorized institution.

FFstart-up,y,k (Nm3/year): LNG usage in project activity

- LNG consumption is recorded in DATA log sheet of LNG flow meter every day.
- It can be cross-checked with City Gas Supplier invoices for purchased LNG.
- The LNG flow meter will be calibrated every 8 years.

Qwoodchip,i,y (ton/year): Woodchip quantity consumed in project activity

- The measurement results by the weighing system and transportation information on woodchip are stored in the KDHC management server every time the woodchip is supplied.
- The stored data is backed up in the computer in central control room.
- The weighing system will be calibrated every 3 years.

Qash,y (ton/year): Ash quantity generated from project activity

- The measurement results by the weighing system and transportation information on ash are stored in the KDHC management server every time the ash is supplied
- The stored data is backed up in the computer in central control room.

- The weighing system will be calibrated every 3 years.

Appendix 6. Summary report of comments received from local stakeholders

Reference Section E.2.

Appendix 7. Summary of post-registration changes

The registered project activity does not include the woodchip storage site in the project boundary, since the woodchip storage site was considered a part of transportation route for woodchip during validation process. The woodchip storage site, which is a pre-treatment facility to receive high-quality woodchips stably, imports electricity from the national grid and consumes diesel for operating heavy equipment, so it can cause additional GHG emissions. Therefore, the woodchip storage site is additionally adopted and project boundary and monitoring plan has also changed.

Description	Date
Commission of the project activity	30/11/2010
Construction of the woodchip storage site	09/12/2011
CDM registration	14/09/2011
Approval of PDD revision	18/09/2014

There is second post registration change in 2018. Added a method to apply conservative estimation of the baseline emission parameter($EG_{thermal,y}$) when the flow meter(measuring the flow of district heating water) not meeting the accuracy requirement the ± 0.25% accuracy requirement was installed and used.

Third post registration change occurred in 2021. Since the woodchip storage site was closed on Aug 30 2017, Wood chips transported directly between project site and biomass supply site. GHG emissions from import electricity($EG_{storage,y}$) and consumed diesel($FF_{storage,y}$) for heavy equipment in the storage site were excluded from the calculation of emissions reduction. Therefore, The project boundary and monitoring plan has also changed.

There is no effect on additionality as all of the ‘CDM Project Standart for Programmes of Activities’ 242.

Document information

Version	Date	Description
11.0	31 May 2019	Revision to: • 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: • 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: • 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: • 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: • 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).

Version	*Date*	*Description*
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.

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Keywords: project activities, project design document