Monitoring report form (Version 03.1)

Monitoring report

Title of the project activity	KDHC Daegu Biomass Cogeneration Project
Reference number of the project activity	5153
Version number of the monitoring report	Ver. 1
Completion date of the monitoring report	
Registration date of the project activity	14/09/2011
Monitoring period number and duration of this monitoring period	1st monitoring period (14/09/2011 – 31/12 /2012)
Project participant(s)	Korea District Heating Corporation
Host Party(ies)	Republic of Korea
Sectoral scope(s) and applied methodology(ies)	Sectoral Scope 1: Energy Industry Applied Methodology: AMS-I.C. Ver. 18
Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD	20,606 tCO_2
Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period	23,755tCO_2

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 a new co-generation power plant, which generating heat and electricity with the use of woody biomass as energy source.

The generated electricity by the cogeneration system is connected to national grid. Generated heat by cogeneration system is connected to the district heating (hereinafter DH) network and is supplied to customers. The cogeneration facility is additional to existing DH system which utilizes multiple energy sources (heat from waste incineration, LNG, B-C oil, etc.) Since the biomass woodchip is used as a fuel in the project activity, it emits the lower amount of CO2 into the atmosphere compared to the case using fossil fuel. Moreover, CO2 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: The forest waste consists of damaged wood (e.g. pine wood nematode), 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: 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 spread of infection. However, 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 recently. According to the guideline, the woody biomass left over 6monthes after fumigation 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)

A.2. Location of project activity

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895, Daecheon-dong, Dalseo-gu, Daegu Metropolitan city, Gyeongsang-buk province, Republic of Korea
GPS coordination: Latitude 35.8311°, longitude 128.4896°.

<KDHC Woodchip biomass facility>

A.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
The Republic of Korea (host)	Korea District Heating Corporation (KDHC)	No

A.4. Reference of applied methodology

>> AMS I.C. Ver. 18

A.5. Crediting period of project activity

>> From 14/09/2011 to 13/09/2021

SECTION B. Implementation of project activity

B.1. Description of implemented registered project activity

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As per planned in PDD, 9 technologies are installed in the CHP site. Detail information of technologies is as follows:

Technology	Type	Capacity	Starting date of operation
Boiler	Stoker Boiler	27.63 ton/hr	30/11/2010
Steam Turbine	Back Pressure Type	3MW	30/11/2010
DH system	Shell & Tube Heat Exchanger	DH Heat Exchanger(DHE): 13.517Gcal/hr Turbine Bypass Heat	30/11/2010

		Exchanger(THE): 17.383Gcal.hr Grand Steam Condenser(GSC): 0.243Gcal/hr	
Woodchip Handling System	Belt Conveyor, Magnetic Separator, Fuel feeder	15.3ton/hr	30/11/2010
Ash Handling System (Bottom Ash)	Submerged Chain Conveyor, Belt Conveyor, Silo	0.51ton/hr	30/11/2010
Ash Handling System (Fly Ash)	Flow Conveyor, Silo	0.19 ton/hr	30/11/2010
Air Pollution Control System (SNCR: Selective Non-Catalytic Reduction)	Dual Flow Fixed Type	49.6% efficiency	30/11/2010
Air Pollution Control System (Multi-Cyclone)	Dry Type	50% efficiency	30/11/2010
Air Pollution Control System (Electrostatic Precipitator)	Dry Type	95% efficiency	30/11/2010

As described in the table above, the project CHP site began its operation on 30/11/2010. However, crediting period starts from 14/09/2011, about 10 months after operation start, because of delay of validation process from multiple revisions of applied CDM methodology and other issues.

Since the beginning of CHP site operation, daily operation halted several times. The operation holding events include both planned and unexpected. The planned events include regular maintenance, seasonal suspension (since the main service provided by the CHP facility is district heating. PP should hold operation of the technologies during summer season because of low demands on heat and high price for electricity generation.), and temporary operation hold for waiting feedstock supply. The unexpected events are of minor troubles of technologies installed in the facility. Those unexpected events are not considered as special operation events because those troubles are considered as parts of facility operation and usually last only short period(less than a day usually). Unusual operational events are as follows:

Event Period	Event Description	Notice
07/11/2011~22/11/2011	Temporary operation stop from feedstock supply halt because of woodchip storage site construction	Storage site completed on 08/12/2011
05/12/2011~08/12/2011	Temporary operation stop from feedstock supply halt because of woodchip storage site construction	Storage site completed on 08/12/2011
05/06/2012~12/08/2012	CHP operation stop for low heat demand	Event from seasonality
02/07/2012~20/07/2012	Regular facility maintenance	Performed between operation holding period
01/09/2012~13/09/2012	Operation hold for woodchip reclaimer maintenance	

B.2. Post registration changes

B.2.1. Temporary deviations from registered monitoring plan or applied methodology

>>N/A

B.2.2. Corrections

>>N/A

B.2.3. Permanent changes from registered monitoring plan or applied methodology

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The registered monitoring plan is originally built without woodchip storage site. Therefore, it does not include monitoring plan for the activities in the storage site. Changes of monitoring plan cover addition of monitoring parameters and update of existing monitoring parameters. Details of changes in monitoring plan are as follows:

Related parameter	Change detail	Description
$Q_{woodchip,j,y}$	Monitoring equipment change	Monitoring equipment changed from the weigh bridge installed on the CHP site to the weigh bridge installed on the storage site
$EG_{storage,y}$	Monitoring parameter added	In the storage site, extra electricity is consumed for operating equipments for pre-processing biomass and site operation. For monitoring the emissions from the electricity consumption, a monitoring parameter is added
$FF_{storage,diesel}$	Monitoring parameter added	In the storage site, extra fossil fuel (diesel) is consumed for operating heavy equipments for pre-processing and transfer of biomass. For monitoring the emissions from the fossil fuel consumption, a monitoring parameter is added
$MAD_{woodchip}$	Monitoring parameter value updated	Value of the parameter $MAD_{woodchip}$ is determined by comparing 330(km; derived from the longest transportation route planned before project start: Geoje-Daegu) and average round trip distance of woodchip transportation routes; the larger value is chosen as a value of $MAD_{woodchip}$. Construction of the woodchip storage sites expanded the distance of woodchip transportation route (every transportation vehicles must go by way of the storage site). Hence, the comparing standard is increased from 330 to 350(Geoje-storage site-Daegu).

For conservative supply of woodchips, an extra storage site is constructed on 837-9, Nae-ri, Guji-myun, Dalseong-gun, Daegu. Because of unique features of biomass woodchip as fuel (natural decay, degradation, and risk of spontaneous combustion), and better operation of CHP facilities, extra process is required in the storage site. For the processes, multiple equipments are operated in the storage site:

Technology	Electric capacity	Starting date of operation
Belt Apron Conveyor	15kW	09/12/2011
Disk Screen	7.5kW	09/12/2011
Over Size Conveyor	2.2kW	09/12/2011
Diamind Screen	5.5kW	09/12/2011
Triple Screw #1~3	22.5kW	09/12/2011

Under Size Conveyor	3.7kW	09/12/2011
Woodchip Belt Conveyor	5.5kW	09/12/2011
Magnet Separator	1.5kW	09/12/2011
Rotary Valve	2.2kW	09/12/2011
Turbo Fan	19kW	09/12/2011
Wind Shifter	76kW	09/12/2011

As described, total electric capacity of installed heavy equipments are 160kW. In addition to the heavy equipments above, general utility equipments, such as lighting equipments are also installed in the storage site. Total electric capacity of utility is 135kW.

B.2.4. Changes to project design of registered project activity

>> N/A

B.2.5. Changes to start date of crediting period

>>N/A

B.2.6. Types of changes specific to afforestation or reforestation project activity

>> N/A

SECTION C. Description of monitoring system

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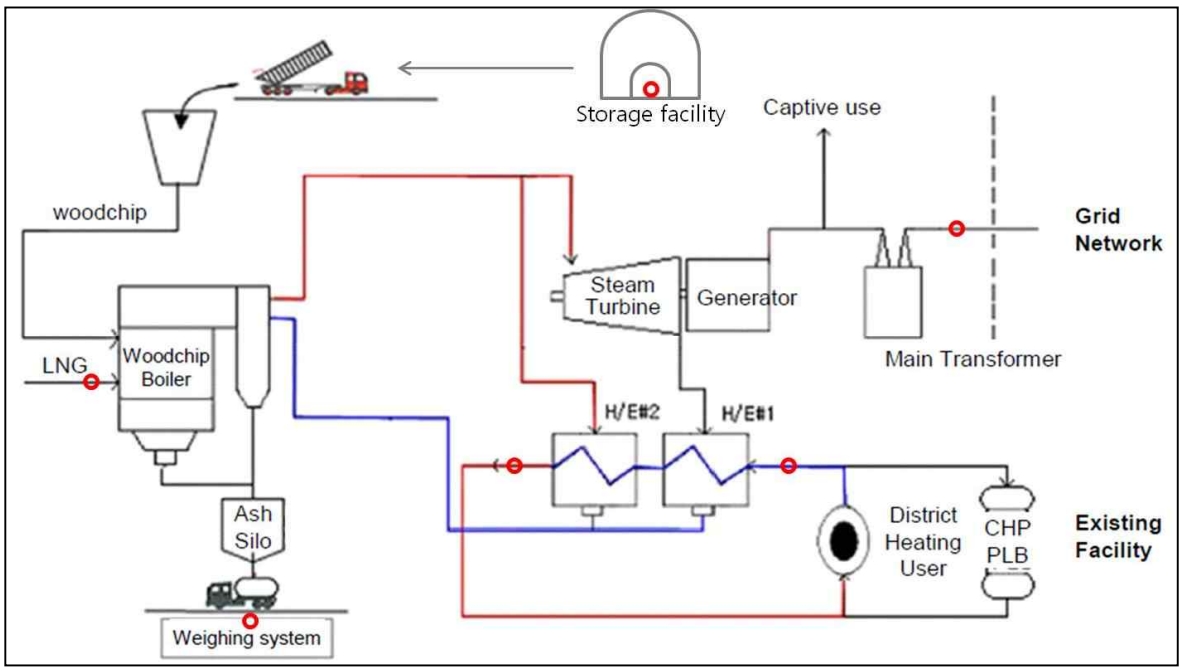
<Location of monitoring equipments>



<List of monitoring equipments>

There are 7 monitoring equipments installed in the KDHC CHP facility currently for measuring 6 parameters. In addition, there is an electricity flow meter installed in the woodchip storage site. The parameters each meter measures and information of the monitoring equipments are as follows:

Monitoring parameter	Serial number	Type of equipment	Description	Remarks
$Q_{woodchip,i,y}$ $Q_{ash,y}$	WIT2301	Weigh bridge	Weighing Woodchip / Ash	*Until 09/12/2011, amount of woodchip and ash are weighed by the same weigh bridge *From 09/12/2011 only amount of ash is measured by this equipment. Amount of woodchip is weighed by the weigh bridge installed on the storage site
$Q_{woodchip,i,y}$	WIT9303	Weigh bridge	Weighing Woodchip	*From 09/12/2011, amount of woodchip is weighed by this weigh bridge
EG_y	53086944	Electricity flow meter	Measuring amount of electricity supplied to grid	*Data measured by meter is used for cross check *Data adjusted by KPX exchange system is used for cross check
$EG_{captive,y}$	0802432	Electricity flow meter (replaced)	Measuring amount of electricity for captive use	
$EG_{captive,y}$	06112004568	Electricity flow meter	Measuring amount of electricity for captive use	
$EG_{thermal,y}$	TIT-9612	Thermal indicator	Measuring water temperature before heating service	
	TIT-9611	Thermal indicator	Measuring water temperature after heating service	
	FIT-9611	Ultrasonic flow meter	Measuring water flow for heating	
$FF_{start\text{-}up,y,LNG}$	1080154	Turbine gas meter	Measuring amount of LNG used to start up boiler	
$EG_{storage,y}$	02030005467	Electricity flow meter	Measuring amount of electricity for captive use	

<**Monitoring procedures of equipments**>

Weigh bridge (CHP): Trucks loaded with woodchip/ash come to weigh bridge before transport woodchip/ash to boiler/ash processing facilities to weigh the materials loaded. All the trucks access to CHP site are registered in management system of KDHC.

Truck drivers bring truck ID card issued for each truck. They read the card and enter the type of cargo every time they weigh their cargo loaded on the trucks. When drivers read their card and enter cargo type, information such as car number, belonging organization, weights of cargo, and the type of cargo is recorded in the weighing system management PC. The recorded data is backed up in different PC separated from the weighing system daily. After completion of the storage site (from 09/12/2011), this equipment is only used for measuring amount of ash transported from CHP site.

Weigh bridge (Storage): After the woodchip storage site is built, amount of woodchip used is weighed by the weigh bridge installed on the storage site.
All the information of woodchip transported from various sources is recorded and backed up in different PC separated from the weighing system daily.

Electricity flow meter (CHP): Electricity flow meters are all located in Motor Control Centre Room and collected data is recorded in data log sheet and stored in DCS server daily. The backup data is kept in different PC.

For electricity supplied to national grid, the amount of electricity supplied is measured by the meter installed in the CHP site. The measured data is managed by both KPX and KDHC. Data measured by KDHC is the prior data to be used in calculation of emission reductions and other monitoring processes. KPX data is used for cross check.
The captive use electricity is supplied from national grid. For captive use electricity, data collected from the installed meter is used for measuring electricity used and cross-checked with KEPCO invoices for purchased electricity.

Electricity flow meter (Storage): The captive use electricity used in the storage site is also supplied from national grid. For captive use electricity, data collected from the installed meter is used for measuring electricity used and cross-checked with KEPCO invoices for purchased electricity.

Thermal indicator / Ultrasonic flow meter: Two thermal meters and an ultrasonic flow meter are installed for measuring heat generation. The thermal meters are located on the front and rear of a heat exchanger. The ultrasonic flow meter is installed at rear point of a heat exchanger.
The temperature and water flow data is used for calculating heat generation. Minutely, the water temperature gap between temperatures measured by each temperature indicator is used for calculating calorie value of heat generated. The calorie generated is calculated by multiplying the temperature gap and amount of water flow.
A calorimeter installed performs the calculating process and displays calories generated. The temperature data, water flow data and calculated calorie data is recorded to Centre Control Room's Distributed control system and daily log sheet.

Turbine gas meter: For starting up the woodchip boiler, LNG is used. The LNG consumption is measured by the turbine gas meter installed in Gas Control Room. Although KDHC is using LNG for multiple purposes, KDHC manages the amount of LNG use for each purpose. The turbine gas meter 1080154 is only measuring the amount of LNG for starting up the woodchip boiler. LNG consumption data is recorded in data log sheet and can be cross-checked with City Gas Supplier invoices for purchased LNG.

<**Quality Assurance and Quality Control of monitoring equipments**>
All of monitoring equipments will be regularly calibrated by certified institution. Calibrating frequency of monitoring equipments is as follows:

Serial number	Type of equipment	Description	Frequency
WIT2301	Weighing system	Weighing Woodchip / Ash	3 yrs
WIT9303	Weighing system	Weighing Woodchip	3 yrs
53086944	Watt-hour meter	Measuring amount of electricity supplied to grid	7 yrs
0802432	Watt-hour meter (replaced)	Measuring amount of electricity supplied from grid	Replaced
06112004568	Watt-hour meter	Measuring amount of electricity for captive use(CHP)	7 yrs
02030005467	Watt-hour meter	Measuring amount of electricity for captive use(Storage site)	7 yrs
TIT-9612	Thermal indicator (Calorimeter)	Measuring water temperature before heating service	3 yrs
TIT-9611	Thermal indicator	Measuring water temperature after heating service	3 yrs

	(Calorimeter)		
FIT-9611	Water flow meter (Calorimeter)	Measuring water flow for heating	3 yrs
1080154	Gas flow meter	Measuring amount of LNG used to start up boiler	8 yrs

All the equipments above are to be regularly calibrated. Currently, all the equipments are under calibration validity period. However, some equipments were under calibration invalid period in past. Calibration and maintenance history of all equipments is as follow:

Serial number	Type of equipment	Calibration and Maintenance History	Calibration Status
WIT2301	Weighing system	**2011.11.03** – Regular accuracy test passed **2012.03.15** – Regular accuracy test passed	Valid
WIT9303	Weighing system	**2011.11.10** – initial accuracy test passed	Valid
53086944	Watt-hour meter	**2010.12.20** – Initial accuracy test	Valid
0802432	Watt-hour meter (replaced)	**2011.08.16** – Regular accuracy test passed	Valid
06112004568	Watt-hour meter	**2011.08** – equipment produced (initial accuracy test performed) **2012.02.23** – Equipment installed	Valid
06112004568	Watt-hour meter	**2010.08** – equipment produced (initial accuracy test performed)	Valid
TIT-9612	Thermal indicator (Calorimeter)	**2008.02.06** – Calibration performed **2009.02.09** – Boiler installation completed (accuracy test performed) **2012.09.04** – Calibration performed	Invalid btw **2012.02.09 ~2012.09.03**
TIT-9611	Thermal indicator (Calorimeter)	**2008.02.06** – Calibration performed **2009.02.09** – Boiler installation completed (accuracy test performed) **2012.09.04** – Calibration performed	Invalid btw **2012.02.09 ~2012.09.03**
FIT-9611	Water flow meter (Calorimeter)	**2009.02.09** – Boiler installation completed (accuracy test performed) **2012.09.06** – Calibration performed	Invalid btw **2012.02.09 ~2012.09.06**
1080154	Gas flow meter	**2009.01.14** – Calibration performed **2009.02.09** – Boiler installation completed (accuracy test performed) **2012.09.03** – Calibration performed	Valid

As described above, the watt-hour meters and the weighing system are under calibration validity since first calibration. However, the thermal indicator, water flow meter, and gas flow meter were under calibration invalid period since 2012.02.09. For the period, parameters measured by the 4 equipments are adjusted in conservative way in emission reduction calculation.

In addition to the regular calibration of the meters, KDHC is planning yearly internal auditing. The evaluation includes all the monitoring issues such as accuracy of data management, performance of regular education, and so on.

<Monitoring organization>

As described in PDD, the monitoring process is managed by operation division of Daegu district office and Climate Change and Environment of Headquarter. Details of monitoring roles for each sub department of operation division are as follows:

- Operation Department: in charge data monitoring related to daily operation of facility such as electricity generation, heat generation and resources used for facility operation
- Operational Management Department: in charge of data monitoring related to woodchip supply and

woodchip consumption. Operation Management Department is also in charge of primary data management which is collected by Operation Department.

- Environment Department: in charge of managing CDM project and monitoring data collected by operation department and operational management department.

Climate Change and Environment Team of Headquarter is not directly engaged in the monitoring processes. The team develops monitoring guideline and has final authority and responsibility of whole monitoring processes. Headquarter operation manager is also related to the project indirectly. The manager has responsibility of facility operation and management education.

Managers of each organization entities have their responsibilities as follows:

- Manager of Operation Division: in charge of overall control of CHP facility operation, monitoring data management, and education.
- Manager of Operation Department: in charge of calibration and maintenance of meters used in monitoring.
- Manager of Operational Management Department: in charge of daily monitoring data gathering (including woodchip related data and energy consumption data from a storage) and general facility operation especially in emergence situation.
- Manager of Environment Department: in charge of daily monitoring data management and handling

SECTION D. Data and parameters

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

Data / Parameter:	$EF_{grid,CM,y}$
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
Purpose of data:	Calculation of Baseline Emission, Calculation of Project Emission, Calculation of Leakage Emission
Additional comment:	

Data / Parameter:	$\eta_{BL,thermal}$
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)

Purpose of data:	Calculation of Baseline Emission
Additional comment:	

Data / Parameter:	TDL_y
Unit:	%
Description:	Average technical transmission and distribution losses in the year y
Source of data:	UNFCCC
Value(s) applied):	20
Purpose of data:	Calculation of Project Emission
Additional comment:	

Data / Parameter:	$FE_{woodchip,truck}$
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
Purpose of data:	Calculation of Leakage
Additional comment:	

Data / Parameter:	$FE_{ash,truck}$
Unit:	km/ℓ
Description:	Fuel(Diesel) efficiency of truck for transportation of ash
Source of data:	Truck Manufacture Company
Value(s) applied):	3.5
Purpose of data:	Calculation of Leakage
Additional comment:	

Data / Parameter:	$FC_{woodchip,facility}$
Unit:	ℓ/ton
Description:	Fuel(Diesel) consumption per unit production of woodchip
Source of data:	Manufacture Company
Value(s) applied):	14.5
Purpose of data:	Calculation of Leakage
Additional comment:	

D.2. Data and parameters monitored

Data / Parameter:	EG_y
Unit:	MWh/year
Description:	Electricity generated by the project activity and supplied to the grid in the year y
Measured/ Calculated / Default:	Measured

Source of data:	Watt-hour meter (Korea Power Exchange, hereinafter KPX)
Value(s) of monitored parameter:	Measured values and applied values for EG_y are as follows:

	Measured		Applied	
Months	**2011**	**2012**	**2011**	**2012**
1		1,221.971		1,221.971
2		1,269.619		1,269.619
3		1,282.858		1,282.858
4		1,475.164		1,475.164
5		1,257.854		1,257.854
6		180.064		180.064
7		7.855		7.855
8		465.682		465.682
9	433.454	252.136	433.454	252.136
10	1,075.880	801.859	1,075.880	801.859
11	335.278	1,525.955	335.278	1,525.955
12	1,085.889	1,100.938	1,085.889	1,100.938
Sum	**2,930.501**	**10,841.956**	**2,930.501**	**10,841.956**

Since watt-hour meter has been under calibration validity period, all the measured data are directly applied to emission reduction calculation

Monitoring equipment:	Watt-hour meter (SN: 53086944)
Measuring/ Reading/ Recording frequency:	It is continuously monitored, integrated hourly and at least monthly recorded by the watt-hour meter and managed by KDHC power management system.
Calculation method (if applicable):	-
QA/QC procedures:	The watt-hour meter will be calibrated once every 7 years by the authorized institution. The result of measurement will be cross checked with the confirmation of KPX who is the electricity buyer.
Purpose of data:	Calculation of Baseline Emission
Additional comment:	Accuracy ± 0.5%

Data / Parameter:	$EG_{captive,y}$
Unit:	MWh/year
Description:	Electricity used by the project cogeneration facility from the national grid
Measured/ Calculated / Default:	Measured
Source of data:	Watt-hour meter (Korea Electric Power Corporation, hereinafter KEPCO)

Value(s) of monitored parameter:	Measured values and applied values for $EG_{captive,y}$ are as follows: Since watt-hour meter has been under calibration validity period, all the measured data are directly applied to emission reduction calculation
Monitoring equipment:	Watt-hour meter (SN: 06112004568)
Measuring/ Reading/ Recording frequency:	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.
Calculation method (if applicable):	-
QA/QC procedures:	The watt-hour meter will be calibrated once every 7 years by the authorized institution or the watt-hour meter manufacturer. The result of measurement will be cross-checked with invoices for sale.
Purpose of data:	Calculation of Project Emission
Additional comment:	

	Measured		Applied	
Months	**2011**	**2012**	**2011**	**2012**
1		14.256		14.256
2		13.451		13.451
3		13.734		13.734
4		12.096		12.096
5		20.448		20.448
6		56.970		56.970
7		40.140		40.140
8		34.956		34.956
9	24.192	43.074	24.192	43.074
10	12.168	42.624	12.168	42.624
11	50.814	11.448	50.814	11.448
12	23.256	12.042	23.256	12.042
Sum	**110.430**	**315.239**	**110.430**	**315.239**

Data / Parameter:	$EG_{thermal,y}$
Unit:	TJ/year (Gcal/year)
Description:	Total quantity of heat generated by the project activity
Measured/ Calculated / Default:	Measured
Source of data:	Calorimeter (KDHC)

Value(s) of monitored parameter:	Measured values and applied values for $EG_{thermal,y}$ are as follows: Since the components of calorimeter, temperature meters and flow meter, were under equipment calibration invalidity period from 2012.02.09 to 2012.09.06, measured data is adjusted in conservative way.
Monitoring equipment:	Temperature meter (TIT9611) front of heat exchanger Temperature meter (TIT9612) rear of heat exchanger Flow meter(FIT-9611))
Measuring/ Reading/ Recording frequency:	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.
Calculation method (if applicable):	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.
QA/QC procedures:	The flow meter and temperature meter will be calibrated once every 3 years by the authorized institution. The result of measurement is recorded to Centre control Room′s Distributed control system and log sheet.
Purpose of data:	Calculation of Baseline Emission
Additional comment:	

	Measured		Applied	
Month	**2011**	**2012**	**2011**	**2012**
1		8,231		8,231
2		8,477		8,426
3		8,156		8,095
4		7,834		7,775
5		7,776		7,718
6		1,221		1,212
7		73		72
8		3,127		3,104
9	3,103	2,135	3,103	2,135
10	7,187	5,275	7,187	5,275
11	2,843	8,399	2,843	8,399
12	7,263	8,232	7,263	8,232
Sum	**20,396**	**68,936**	**20,396**	**68,673**

Data / Parameter:	$EG_{storage,y}$
Unit:	MWh/year
Description:	Electricity imported from the national grid used in woodchip storage site

Measured/ Calculated / Default:	Measured
Source of data:	Watt-hour meter (Korea Electric Power Corporation, hereinafter KEPCO)
Value(s) of monitored parameter:	Measured values and applied values for $EG_{storage,y}$ are as follows:

	Measured		Applied	
Months	**2011**	**2012**	**2011**	**2012**
1		28.906		28.906
2		23.119		23.119
3		18.084		18.084
4		21.247		21.247
5		19.025		19.025
6		13.506		13.506
7		7.768		7.768
8		14.814		14.814
9		15.222		15.222
10		17.555		17.555
11		20.077		20.077
12	14.502	23.549	14.502	23.549
Sum	**14.502**	**222.872**	**14.502**	**222.872**

Since watt-hour meter has been under calibration validity period, all the measured data are directly applied to emission reduction calculation

Monitoring equipment:	Watt-hour meter (SN: 02030005467)
Measuring/ Reading/ Recording frequency:	The electricity used in the storage site 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.
Calculation method (if applicable):	
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:	Calculation of Leakage Emission
Additional comment:	Accuracy ± 1%

Data / Parameter:	EF_{LNG}
Unit:	tCO_2/TJ
Description:	The CO_2 emission factor per unit of energy of the fuel LNG
Measured/ Calculated / Default:	Default
Source of data:	IPCC
Value(s) of monitored parameter:	56.1

Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	-
QA/QC procedures:	When the IPCC value is revised, the modified value should be applied
Purpose of data:	Calculation of Project Emission
Additional comment:	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"

Data / Parameter:	NCV_{LNG}
Unit:	$Kcal/Nm^3$
Description:	Net calorific value for fossil fuel LNG
Measured/ Calculated / Default:	Default
Source of data:	Ministry of Knowledge Economy
Value(s) of monitored parameter:	9,550
Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	-
QA/QC procedures:	When the value is revised, the modified value should be applied
Purpose of data:	Calculation of Project Emission
Additional comment:	The value is applied by "Energy Statistics Yearbook" and "Energy Policy Act" which published by Korea Ministry of knowledge Economy.

Data / Parameter:	EF_{diesel}
Unit:	tCO_2/TJ
Description:	The CO_2 emission factor per unit of energy of the fuel Diesel
Measured/ Calculated / Default:	Default

Source of data:	IPCC
Value(s) of monitored parameter:	74.1
Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	-
QA/QC procedures:	When the IPCC value is revised, the modified value should be applied
Purpose of data:	Calculation of Leakage Emission
Additional comment:	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"

Data / Parameter:	NCV_{diesel}
Unit:	Kcal/ℓ
Description:	Net calorific value for fossil fuel Diesel
Measured/ Calculated / Default:	Default
Source of data:	Ministry of Knowledge Economy
Value(s) of monitored parameter:	8,450
Monitoring equipment:	.
Measuring/ Reading/ Recording frequency:	
Calculation method (if applicable):	
QA/QC procedures:	When the IPCC value is revised, the modified value should be applied
Purpose of data:	Calculation of Leakage Emission
Additional comment:	The value is applied by "Energy Statistics Yearbook" and "Energy Policy Act" which published by Korea Ministry of knowledge Economy

Data / Parameter:	HL_y
Unit:	%

Description:	Technical transmission and distribution heat losses for providing heat to users in the year y
Measured/ Calculated / Default:	Calculated
Source of data:	KDHC balance sheet
Value(s) of monitored parameter:	4.26
Monitoring equipment:	Calorimeter installed at KDHC / end-user
Measuring/ Reading/ Recording frequency:	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.
Calculation method (if applicable):	Heat lose is calculated by { (heat supplied to end-users) – (sum of heat use of end-users)}
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:	Calculation of Baseline emission
Additional comment:	

Data / Parameter:	$FF_{start-up,y,LNG}$
Unit:	Nm^3/year
Description:	Quantity of start-up fossil fuel, LNG used
Measured/ Calculated / Default:	Measured
Source of data:	Gas flow meter (KDHC)

Value(s) of monitored parameter:	Measured values and applied values for $FF_{start\text{-}ip,y,LNG}$ are as follows:

	Measured		Applied	
Month	**2011**	**2012**	**2011**	**2012**
1		3,869		3,869
2		6,009		6,026
3		5,389		5,452
4		5,117		5,177
5		8,297		8,394
6		3,453		3,493
7		3,553		3,595
8		7,697		7,787
9	6,445	8,830	6,445	8,830
10	19,006	23,081	19,006	23,081
11	63,876	11,030	63,876	11,030
12	34,460	15,535	34,460	15,535
Sum	**123,787**	**101,860**	**123,787**	**102,269**

Since the gas flow meter was under equipment calibration invalidity period from 2012.02.09 to 2012.09.02, measured data is adjusted in conservative way.

Monitoring equipment:	Gas flow meter (SN: 1080154)
Measuring/ Reading/ Recording frequency:	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.
Calculation method (if applicable):	-
QA/QC procedures:	The Gas flow meter will be calibrated once every 8 years by the authorized institution.
Purpose of data:	Calculation of Project Emission
Additional comment:	

Data / Parameter:	$Q_{woodchip,i,y}$
Unit:	ton/year
Description:	Total woodchip/biomass i quantity consumed
Measured/ Calculated / Default:	Measured
Source of data:	Weighing system (KDHC)
Value(s) of monitored parameter:	69,491
Monitoring equipment:	Weighing system (SN: WIT2301)

Measuring/ Reading/ Recording frequency:	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.
Calculation method (if applicable):	-
QA/QC procedures:	The weighing system will be calibrated once every 3 years by authorized institution.
Purpose of data:	Calculation of Leakage
Additional comment:	

Data / Parameter:	$FF_{storage,\ diesel}$
Unit:	ℓ
Description:	Quantity of diesel used for operating heavy equipments in a storage site
Measured/ Calculated / Default:	Measured
Source of data:	Diesel purchase receipt
Value(s) of monitored parameter:	

	Measured		Applied	
Month	**2011**	**2012**	**2011**	**2012**
1		5,769		5,769
2		4,632		4,632
3		4,839		4,839
4		5,168		5,168
5		5,360		5,360
6		7,912		7,912
7		2,194		2,194
8		4,420		4,420
9		3,015		3,015
10		4,474		4,474
11		5,145		5,145
12	4,938	5,637	4,938	5,637
Sum	**4,938**	**58,565**	**4,938**	**58,565**

Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	Diesel used for operating heavy equipment in storage site is logged continuously.
QA/QC procedures:	Diesel purchase receipt is double checked by KDHC and outsourced company (equipment owner)
Purpose of data:	Calculation of Leakage Emissions
Additional comment:	

Data / Parameter:	$Q_{ash,y}$
Unit:	ton/year
Description:	Total ash quantity generated
Measured/ Calculated / Default:	Measured
Source of data:	Weighing system (KDHC)
Value(s) of monitored parameter:	7,812
Monitoring equipment:	Weighing System(SN: WIT2301)
Measuring/ Reading/ Recording frequency:	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.
Calculation method (if applicable):	-
QA/QC procedures:	The weighing system will be calibrated once every 3 years by authorized institution.
Purpose of data:	Calculation of Leakage
Additional comment:	

Data / Parameter:	$TL_{woodchip,y}$
Unit:	ton
Description:	Average biomass load of trucks
Measured/ Calculated / Default:	Calculated
Source of data:	On-site measurement
Value(s) of monitored parameter:	23
Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	Determined by averaging the weights of biomass each truck carries to project site Measured continuously and aggregated annually
Calculation method (if applicable):	(Total amount of woodchip supplied) / (number of trucks used for woodchip transportation)
QA/QC procedures:	-
Purpose of data:	Calculation of Leakage
Additional comment:	

Data / Parameter:	$TL_{ash,y}$
Unit:	ton
Description:	Average ash load of trucks
Measured/ Calculated / Default:	Calculated
Source of data:	On-site measurement
Value(s) of monitored parameter:	17
Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	Determined by averaging the weights of ash each truck carries to landfill Measured continuously and aggregated annually
Calculation method (if applicable):	(Total amount of ash transferred) / (number of trucks used for ash transportation)
QA/QC procedures:	-
Purpose of data:	Calculation of Leakage
Additional comment:	

Data / Parameter:	$MAD_{woodchip}$
Unit:	km
Description:	Maximum round-trip distance between project site and biomass supply site
Measured/ Calculated / Default:	Measured
Source of data:	Maps and records by project participants on the origin of the biomass
Value(s) of monitored parameter:	350 Since Geoje is the fathrest from project site, the distance between project site and Geoje (175km) is applied. For data credibility, KDHC checks whether transportation distance of biomass is closer than 175km through maps or GPS or transportation records of biomass. If the average distance between project site and biomass supply site is farther than 175Km, the average distance would be applied.
Monitoring equipment:	-
Measuring/ Reading/ Recording frequency:	Depends on data achieving frequency
Calculation method (if applicable):	-
QA/QC procedures:	The transportation data will be checked with the documents such as waybills or invoices from truckers
Purpose of data:	Calculation of Leakage

Additional comment:	

Data / Parameter:	MAD_{ash}
Unit:	Km
Description:	Maximum round-trip distance between project site and landfill
Measured/ Calculated / Default:	Measured
Source of data:	Map / Records of ash transportation
Value(s) of monitored parameter:	280 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 equipment:	-
Measuring/ Reading/ Recording frequency:	Depends on data achieving frequency
Calculation method (if applicable):	
QA/QC procedures:	The transportation data will be checked with the documents such as waybills or invoices from truckers.
Purpose of data:	Calculation of Leakage
Additional comment:	

Data / Parameter:	$BU_{woodchip,y}$
Unit:	ton/year
Description:	The quantity of biomass utilized in the region
Measured/ Calculated / Default:	Calculated
Source of data:	On-site measurement / "Statistics on New and Renewable energy" issued by Korea Energy Management Corporation.
Value(s) of monitored parameter:	154,777 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 equipment:	-
Measuring/ Reading/ Recording frequency:	-

Calculation method (if applicable):	-
QA/QC procedures:	-
Purpose of data:	-
Additional comment:	

Data / Parameter:	$BA_{woodchip,y}$
Unit:	ton/year
Description:	The quantity of biomass available in the region
Measured/ Calculated / Default:	Calculated
Source of data:	KDHC
Value(s) of monitored parameter:	361,205 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 equipment:	-
Measuring/ Reading/ Recording frequency:	-
Calculation method (if applicable):	-
QA/QC procedures:	-
Purpose of data:	-
Additional comment:	

D.3. Implementation of sampling plan

>>

No sampling procedure is involved in this project

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

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

>>

Baseline Emissions

Baseline emissions are calculated as sum of emission that would have been occurred for providing the same amount of electricity and heat generated through project activities as per baseline scenario.

$BE_y = BE_{electricity,y} + BE_{thermal,y}$

Calculation formulae for each emission sources and the calculation result are as follows:

Emission from electricity generation

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

Where

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

Emission from heat generation

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

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

Calculation results

Parameter	Value	Unit
EG_y	13,772	MWh/yr
$EF_{grid,CM,y}$	0.5215	tCO2/MWh
$BE_{electricity,y}$	***7,182***	**tCO2/yr**
$EG_{thermal,y}$	89,069	Gcal/yr
	374 (unit conversion)	TJ/yr
HL_y	4.162	%
$\eta_{BL,thermal}$	95	%
EF_k	56.1	tCO2/TJ
$BE_{thermal,y}$	***21,084***	**tCO2/yr**
Baseline Emission	***28,266***	**tCO2/yr**

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

>>

Project Emissions

Since the biomass used for this project is the woody biomass that is carbon neutral, emissions from biomass combustion is not considered as project emission.

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

Woodchip boiler needs initial fuel combustion because of long reaction time for woodchip combustion. In this project, LNG is used for the initial combustion. The emission is calculated using the quantity, net calorific value, and emission factor of LNG,

For the facility operation, electricity consumption is necessary. Corresponding emission shall be included in project emission. The electricity is supplied from national grid. Thus, the amount of electricity imported from national grid, emission factor, and transmission and distribution loss is considered for calculation.

Details of formulae and the result are as follows:

Emission from LNG combustion

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

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

Emission from electricity consumption

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

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

Calculation results

Parameter	Value	Unit
$FF_{start\text{-}up,y,k}$	226,056	Nm3
NCV_k	9,550	Kcal/Nm3
	0.00003998(unit conversion)	TJ/Nm3
EF_k	56.1	tCO2/TJ
$PE_{y,comb}$	***507***	**tCO2/yr**
$EG_{captive,y}$	426	MWh/yr
$EF_{grid,CM,y}$	0.5215	tCO2/MWh
TDL_y	20	%
$PE_{y,power}$	***266***	**tCO2/yr**
Project Emission	***773***	**tCO2/yr**

E.3. Calculation of leakage

>>

Leakage Emissions

AMS I.C suggests that collection/processing/transportation of biomass residues should be considered as a leakage.

Considering that the biomass residues used by this project would have been collected for preventing spreads of pine tree disease (nematode) and for construction site cleaning, biomass collection is not necessarily be included in leakage calculation. Thus leakage is calculated as sum of emissions from processing and transportation of biomass residues 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 ($LE_{PB,y}$)

$$LE_{PB,y} = LE_{chipping,y} + LE_{storage,y}$$

Parameter	Unit	Description
$LE_{PB,y}$	tCO_2/year	Emission from processing of biomass in the year y
$LE_{chipping,y}$	tCO_2/year	Emission from chipping process of biomass in the year y

$LE_{storage,y}$	tCO_2/year	Emission from pretreatment process of biomass performed in storage site in the year y

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

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
$LE_{chipping,y}$	tCO_2/year	Emission from chipping process of biomass in the year y

$$LE_{storage,y} = EG_{storage,y} \times EF_{grid,CM,y} \times (1 + TDL_y) + FF_{storage,diesel} \times NCV_{diesel} \times EF_{diesel} \times CF_{thermal}$$

Parameter	Unit	Description
$EG_{storage,y}$	MWh/year	The electricity imported from grid to storage sites
$EF_{grid,CM,y}$	tCO2/MWh	CO_2 emission factor for electricity from public supply
TDL_y	%	Average technical transmission and distribution losses in the year y
$FF_{storage,diesel}$	ℓ	Quantity of diesel used for operating heavy equipments in a storage site
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
$LE_{storage,y}$	tCO_2/year	Emission from pretreatment process of biomass performed in storage site 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/year	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
EF_{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

Calculation Results

Parameter	Value	Unit
$Q_{woodchip,y}$	*69,491*	ton/yr
$FC_{woodchip,facility}$	*14.5*	ℓ/ton
NCV_{diesel}	8,450	Kcal/liter
	4.1868*10^(-9)(unit conversion)	TJ/Kcal
EF_{diesel}	*74.1*	tCO_2/TJ
$LE_{chipping,y}$	***2,642***	**tCO_2/yr**
$EG_{storage,y}$	237	MWh/yr
$EF_{grid,CM,y}$	0.5215	tCO2/MWh
TDL_y	20	%
$FF_{storage,diesel}$	63,503	ℓ
NCV_{diesel}	8,450	Kcal/liter
	4.1868*10^(-9) (unit conversion)	TJ/Kcal
EF_{diesel}	*74.1*	tCO_2/TJ
$LE_{storage,y}$	**290**	**tCO_2/yr**
$LE_{PB,y}$	***2,932***	**tCO2/yr**
$Q_{woodchip,y}$	74,008	ton/yr
$TL_{woodchip,y}$	23	Ton
$MAD_{woodchip}$	350	Km
$FE_{woodchip,truck}$	3.5	km/liter
NCV_{diesel}	8,450	Kcal/liter
	4.1868*10^(-9) (unit conversion)	TJ/Kcal
EF_{diesel}	*74.1*	tCO2/TJ
$LE_{TB,y}$	***745***	**tCO2/yr**
$Q_{ash,y}$	7,812	ton/yr
$TL_{ash,y}$	17	ton
MAD_{ash}	280	km
$FE_{ash,truck}$	3.5	km/liter

NCV_{diesel}	8,450	Kcal/liter
	4.1868*10^(-9) (unit conversion)	TJ/Kcal
EF_{diesel}	74.1	tCO2/TJ
$LE_{TA,y}$	***94***	tCO2/yr
Leakage	***3,771***	**tCO2/yr**

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

Item	Baseline emissions or baseline net GHG removals by sinks (t CO_2e)	Project emissions or actual net GHG removals by sinks (t CO_2e)	Leakage (t CO_2e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO_2e)
Total	**28,266**	**773**	**3,771**	**23,722**

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

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO_2e)	**20,606 (365days) 26,816(475days)**	**23,722(475days)**

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

>>

Compare to the ex-ante calculation result, the CHP facility reduced 3,000tCO_2 of emissions less than it is expected to reduce (comparing based on the same daily period). It seems the difference comes from increased project and leakage emissions. Monitoring results shows that the amount of project emissions and leakage emissions are much larger than those are expected.

	Ex-ante estimation (converted from original 365 day base estimation to 475 day base)	Ex-post calculation
Baseline emission	29,359	28,266
Project emissions	13	773
Leakage emissions	2,205	3,771

There has been no structural change related to the project emissions. It means, increased project emissions simply comes from massive use of non-renewable fuel(LNG in this case)

Unlike the case project emissions, there is a structural change of project related to the leakage emissions calculation. Since the Storage site is constructed, physical distance of woodchip transportation is expanded, and extra equipments for woodchip processing are applied. Hence, the leakage emissions from woodchip transportation and processing are increased.

E.7. Actual emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO_2e)	23,722	-

Monitoring period is from Sep.14, 2011 to Dec.31, 2012.

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Document information

Version	*Date*	*Description*
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
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