CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-SSC-PDD)
Version 03 - in effect as of: 22 December 2006

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Revision history of this document

Version Number	Date	Description and reason of revision
01	21 January 2003	Initial adoption
02	8 July 2005	• The Board agreed to revise the CDM SSC PDD to reflect guidance and clarifications provided by the Board since version 01 of this document. • As a consequence, the guidelines for completing CDM SSC PDD have been revised accordingly to version 2. The latest version can be found at <http://cdm.unfccc.int/Reference/Documents>.
03	22 December 2006	• The Board agreed to revise the CDM project design document for small-scale activities (CDM-SSC-PDD), taking into account CDM-PDD and CDM-NM.

SECTION A. General description of small-scale project activity

A.1. Title of the small-scale project activity:

(1) The title of the project activity:
Jinju Landfill Gas Recovery and Power Generation CDM Project

(2) The version number of the document:
Version number 04

(3) The date of the document:
2 July 2012

A.2. Description of the small-scale project activity:

"Jinju Landfill Gas Recovery and Power Generation CDM Project" is a landfill gas collection and utilization as a renewable energy project, developed by Nurieconet Co., Ltd. in collaboration with Jinju City.

Jinju Landfill (The Project site) is located in San 287, Yusu-Ri, Naedong-Myeon, Jinju-Si, Gyeongsangnam-Do, Republic of Korea. The Jinju Landfill began operation in January 1995 with a total volume of 5,855,000m^3 dumping zone, designed to treat the municipal solid waste (MSW).

Prior to this proposed project, Jinju Landfill has emitted landfill gas (LFG) into the atmosphere directly without recovery and/or utilization. The baseline scenario[1] is the same as the scenario existing prior to the start of the implementation of the proposed project. The proposed project activity involves the installation of a highly efficient collecting system, a pre-treatment system, and a landfill gas power generation plant.

The implementation of the Project activity will reduce the emission of methane into the air from the landfill, leading to a reduction in greenhouse gas emissions (GHG).

In addition, Landfill waste will be used for generating electricity (Waste to Energy) by utilizing landfill gas. From this project, generated electricity over the project lifetime will be 5,892 MWh[2] by an annual average. After electricity consumption on the project boundary, net electricity will be delivered to Korea Electric Power Corporation (KEPCO) grid. This project has substitution effect on alternative energy from fossil fuels power generation to bio-gas power generation. Considering these effects of emission reductions, the annual average emission reductions are estimated to be 37,376 tCO_{2e} [3] over the crediting period (the fixed 10-year).

[1] Refer to the following section B.4.

[2] The net electricity delivered to the grid is calculated by concerning the self-use electricity rate is assumed as 4%, and electricity imported from the grid is assumed as 0.

Apart from this, the proposed project activity will contribute to local and global sustainable development in the following ways:

- Reducing air pollution to the surrounding area, decreasing odour nuisance and minimising health risks of local residents from hazardous landfill gas.
- Increasing the safety on the landfill by minimizing the potential for explosion risks of landfill gas.
- Increasing long term and/or short term employment opportunities in the local area.
- Promoting sustainable and socio-economic development through optimization technology transfer.

A.3. Project participants:

Name of Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant(Yes/No)
Republic of Korea(host)	Jinju City	**No**
	Nurieconet Co., Ltd.	**No**

Further contact information of Project participants is provided in Annex 1.

A.4. Technical description of the small-scale project activity:

A.4.1. Location of the small-scale project activity:

A.4.1.1. Host Party(ies):

Republic of Korea

A.4.1.2. Region/State/Province etc.:

Naedong-Myeon, Jinju-Si,

A.4.1.3. City/Town/Community etc:

Gyeongsangnam-Do

[3] Refer to the following section B.6.3

A.4.1.4. Details of physical location, including information allowing the unique identification of this small-scale project activity :

The proposed project is located in San 287, Yusu-Ri, Naedong-Myeon, Jinju-Si, Gyeongsangnam-Do, Republic of Korea, which is the province located in south-east part of Korea; latitude North 35.119074° and longitude East 128.014091° and Jinju landfill is located around mountain area at where is 1 ~ 1.3km away from the local village.

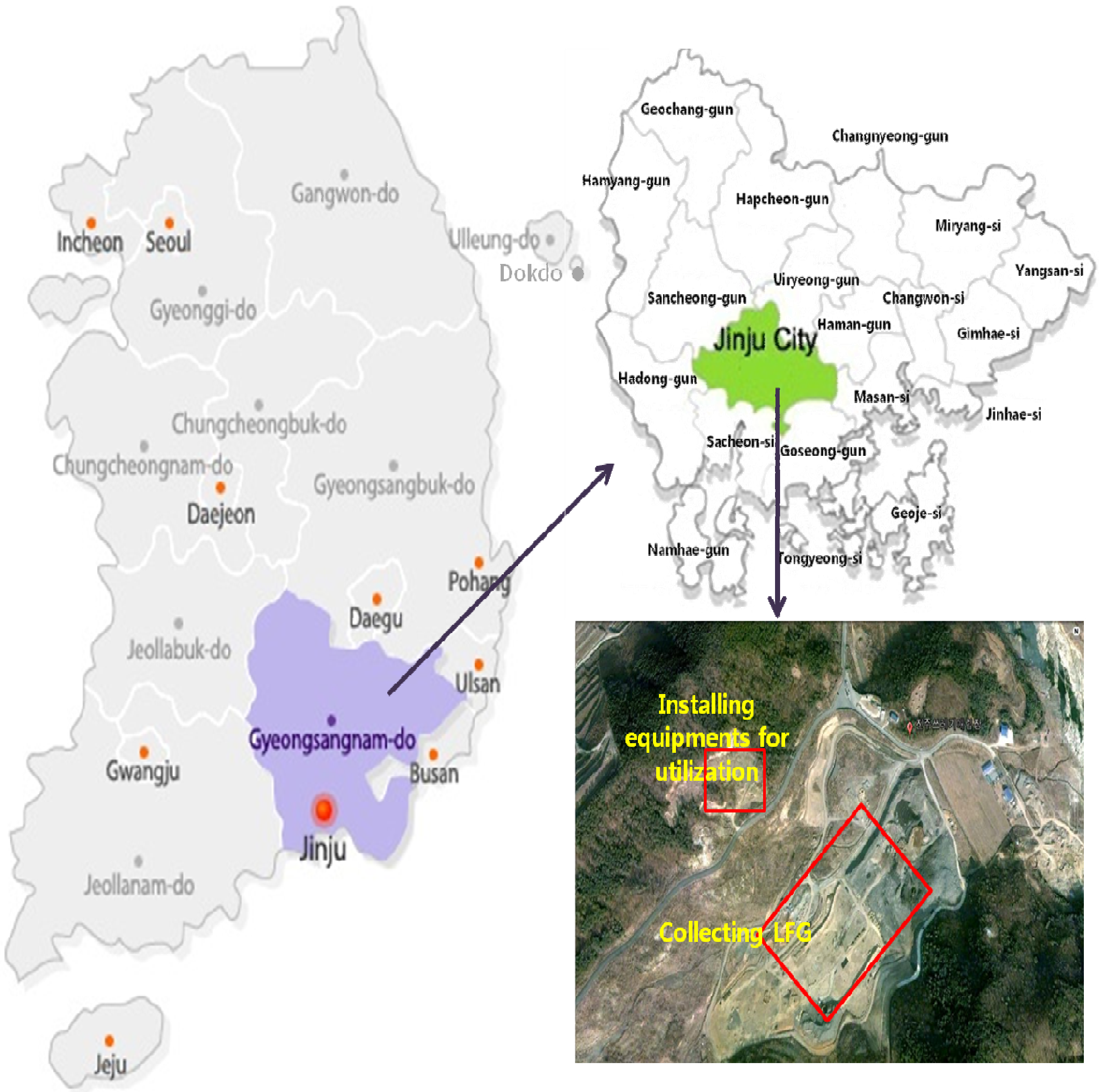

Figure A-1 Geographic location of the proposed project

A.4.2. Type and category(ies) and technology/measure of the small-scale project activity:

According to Annex A of the Kyoto Protocol, this project is involved in the following sectoral scopes:
01-Energy industry (renewable and non-renewable sources)
13-Waste handling and disposal

Project activity: Landfill gas collecting and generating electricity
Appendix B of the simplified modalities and procedures for small scale CDM project activities, the project falls into:

Type III – Other project activities and category G – Landfill Methane Recovery; and
Type I – Renewable energy projects and category D – Grid connected renewable electricity generation.

The description of the technology in the proposed project is provided below
The main components of the proposed project are a landfill gas collecting system, a pre-treatment system, an electricity generation system and a monitoring system. This Project activity involves the best available installation of:

Landfill gas collecting system
The landfill gas extraction system is a gas transportation network, consisting of vertical and horizontal gas wells, well head station, J-Trap and B-Trap, a main pipeline to extract and convey the landfill gas from the landfill to the gas pre-treatment system. For operation efficiency increase and continuous power production, collecting landfill gas will be controlled by gas valves to be continuously collected from the gas wells.

Gas pre-treatment system
Prior to electricity generation, the landfill gas must be pre-treated to remove its impurities and moisture to prevent corrosion which could cause generator shutdown. The pre-treatment consists of 1) CSV (Condensate Separation Vessel), 2) separator, 3) heat exchange and chiller, 4) H_2S remover, 5) gas filter, 6) receiver tank, and 7) gas boosting air blower.

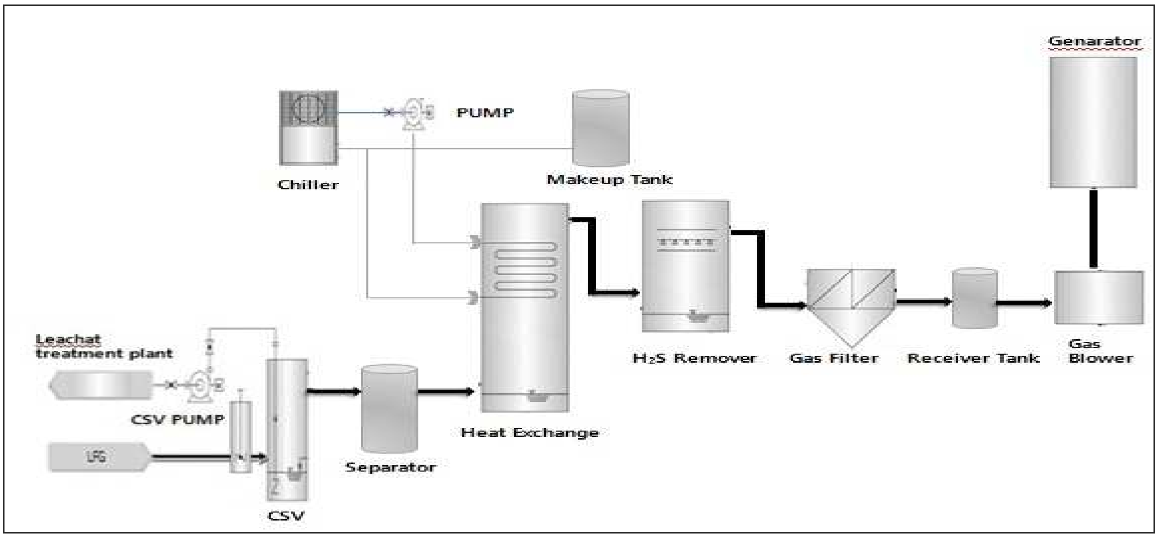

Figure A-2 The LFG pre-treatment process

H_2S is one of toxic components of landfill gas. If H_2S is not refined, it could create negative effects on the generator, and when it is supplied directly to the generator and emits air pollutants such as sulfur oxide with exhaust fumes during operation. So H_2S remover is installed.

Power generation technology

The proposed project is designed to install one generator with capacity of 925 kW in the Jinju landfill. The collected landfill gas will be sent to the generators and the electricity generated is exported to the grid-connected system of the Korea Electric Power Corporation (KEPCO) supply system. The technical specification of the power generation system is shown in the table.

Table A-1 The technical data of engine and power generator

<table>
<tr><td rowspan="10">LANDFILL GAS ENGINE GENERATOR (925 kW*1 SET)</td><td rowspan="4">Gas engine technical specification</td><td>Manufacturer</td><td>CATERPILLAR INC. (U.S.A)</td></tr>
<tr><td>Model</td><td>G3516 LE SITA</td></tr>
<tr><td>Engine power</td><td>974 kW</td></tr>
<tr><td>Fuel consumption</td><td>546 Nm^3/h
(100% load)</td></tr>
<tr><td rowspan="6">Generator technical specification</td><td>Manufacturer</td><td>CATERPILLAR INC. (U.S.A)</td></tr>
<tr><td>Type</td><td>BRUSHLESS, REVOLVING FIELD EXCITATION</td></tr>
<tr><td>Generator power</td><td>925 kW</td></tr>
<tr><td>Frequency</td><td>60 Hz</td></tr>
<tr><td>Voltage</td><td>480 V</td></tr>
<tr><td>Speed</td><td>1200 rpm</td></tr>
</table>

Monitoring system

The monitoring instruments to be installed in the project activity include LFG flow meters, a methane analyzer and electricity meters. All the monitoring instruments meet the relevant accuracy requirements and monitoring equipment and lay-out is shown in Section B.7.1.

A.4.3. Estimated amount of emission reductions over the chosen crediting period:

The crediting period is 10-year fixed. The total expected emission reductions are 373,763 tonnes of CO_2e and annual average emission reductions are 37,376 tonnes of CO_2e. The ex-ante estimated amount of emission reductions over the crediting period is listed in the following table.

Table A-2 Annual estimation of emission reductions

Years	Annual estimation of emission Reductions In tonnes of CO_{2e}
2012	38,740
2013	38,703
2014	38,611
2015	38,470
2016	38,282
2017	38,052
2018	37,784
2019	36,376
2020	35,023
2021	33,723
Total estimated reductions (tonnes of CO_2e)	373,763
Total Number of crediting years	10
Annual average over the credit period of estimated reductions (tonnes of CO_2e)	37,376

A.4.4. Public funding of the small-scale project activity:

The Project activity obtains no public funding from Parties included in Annex I of the UNFCCC.

A.4.5. Confirmation that the small-scale project activity is not a debundled component of a large scale project activity:

In accordance with "guideline on assessment of de-bundling for SSC project activities", the project participants confirm the project is not a de-bundled component of a larger scale project activity.

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

The proposed project is neither a part of any larger scale project or program nor a de-bundled component of a larger project activity and there is no registered small-scale CDM project activity or an application to register another small-scale CDM project activity within the same project boundary. The proposed project will be the first landfill recovery and utilizing LFG CDM project in Yeongnam area (south-east part of Korea).

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the small-scale project activity:

According to Annex A of the Kyoto Protocol, this project fits in sectoral categories:
1. Energy Industry; and
13. Waste Handling and Disposal.

The approved small-scale CDM baseline methodologies;
- AMS I. D: Grid connected renewable electricity gerneration_V.17
- AMS III. G: Landfill methane recovery_V.7

The tools referred by the approved methodology;
- Emissions from solid waste disposal sites _V.6.0.1
- Tool to calculate the emission factor for an electricity system _V.2.2.1
- Tool for the demonstration and assessment of additionality_V.6.0.0

B.2 Justification of the choice of the project category:

The project activity is based on collecting landfill gas (reducing greenhouse gases effect), utilizing them to create electricity (replacing electricity from the fossil fuel power plants to LFG power plants) and supplying electricity to KEPCO grid. Thus the proposed project is satisfied with the conditions of AMS-III.G methodology for measures to capture methane from landfill and AMS-I.D methodology for electrical energy generation.

The project is justified with applicability criteria of a small-scale project during every year of crediting period (10-year fixed), as follows:
- For grid connected renewable electricity generation (AMS-I.D), the capacity is less than 15 MW
- For landfill methane recovery (AMS-III.G), emission reduction is less than 60 ktCO_2e.

Table B-1 Justification of methodologies for proposed project

Small-Scale Methodology	Project capacity / Estimated emission reductions of proposed project	Small-Scale criteria
AMS-I.D	925kW rated output 3,752 ton CO_2e/ annual average	15 MW
AMS-III.G	1,601 ton CH_4e 33,624 ton CO_2e/ annual average	60,000 ton CO_2e

Applicability of methodology

	Technology/measure	Project activities
AMS III. G	1. This methodology comprises measures to capture and combust methane from landfills (i.e. solid waste disposal sites) used for disposal of residues from human activities including municipal, industrial, and other solid wastes containing biodegradable organic matter.	The proposed project will recover LFG generated from a municipal solid waste disposal site
	2. Different options to utilize the recovered landfill gas as detailed in paragraph 3 of AMS-III.H. Methane recovery in wastewater treatment. (V.16) are eligible for use under this methodology. The relevant procedures in AMS-III.H shall be followed in this regard.	Not applicable for the proposed project
	3. Measures are limited to those that result in aggregate emission reductions of less than or equal to 60 kt CO_2 equivalent annually from all Type III components of the project activity.	Expected aggregate emission reductions of the proposed project from all type III components is 33,624 tCO2e , which is less than 60kt tCO2e annually. Please refer to B.6.4.
AMS I. D	1. This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass: (a) Supplying electricity to a national or a regional grid; or (b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.	The proposed project will displace electricity from fossil fuel consumption to electricity by utilizing LFG. The proposed project will export power to local power grid which is connected to the KEPCO grid.
	2. Illustration of respective situations under which each of the methodology (i.e. AMS-I.D, AMS-I.F and AMS-I.A[2]) applies is included in Table 2.	The proposed project supplies electricity to KEPCO grid.
	3. This methodology is applicable to project activities that: (a) Install a new power plant at a site where there was no renewable energy power plant operating prior to the implementation of the project activity (Greenfield plant); (b) Involve a capacity addition;[3] (c) Involve a retrofit[4] of (an) existing plant(s); or (d) Involve a replacement[5] of (an) existing plant(s).	The proposed project will install a new power plant so it is a Greenfield plant.
	4. Hydro power plants with reservoirs[6] that satisfy at	Not applicable for this project

	least one of the following conditions are eligible to apply this methodology: • The project activity is implemented in an existing reservoir with no change in the volume of reservoir; • The project activity is implemented in an existing reservoir,[7] where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the project emissions section, is greater than 4 W/m2; • The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the project emissions section, is greater than 4 W/m2.	
	5. If the new unit has both renewable and non-renewable components (e.g. a wind/diesel unit), the eligibility limit of 15 MW for a small-scale CDM project activity applies only to the renewable component. If the new unit co-fires fossil fuel, the capacity of the entire unit shall not exceed the limit of 15 MW.	The installed capacity of the generation set is 925 kW, less than 15MW.
	6. Combined heat and power (co-generation) systems are not eligible under this category.	The proposed project is not a co-generation system and only electrical energy is generated.
	7. In the case of project activities that involve the addition of renewable energy generation units at an existing renewable power generation facility, the added capacity of the units added by the project should be lower than 15 MW and should be physically distinct from the existing units.	The proposed project activity involves no addition of renewable energy generation units at an existing renewable power generation facility.
	8. In the case of retrofit or replacement, to qualify as a small-scale project, the total output of the retrofitted or replacement unit shall not exceed the limit of 15 MW.	The proposed project is a green field project and involves no retrofitting or replacement activity.

B.3. Description of the project boundary:

According to methodologies, project boundary of AMS-III.G is the physical, geographical site of the landfill where the gas is captured and destroyed/used and project boundary of AMS-I.D includes the project power plant and all power plants connected physically to the electricity system that the CDM project power is connected to. Landfill gas collecting system, gas pre-treatment system, power generation system and KEPCO grid will be involved in the proposed project boundary.

Net electricity generated from the proposed project is sent to KEPCO, grid-connected system to replace fossil fuel with alternative energy.

CO_2 emissions for proposed project activity are calculated on the basis of the imported electricity consumption read from KEPCO grid-connected system, maintained by the Korea Electric Power Corporation (KEPCO). Figure B-1 below shows a representation of the project boundary.

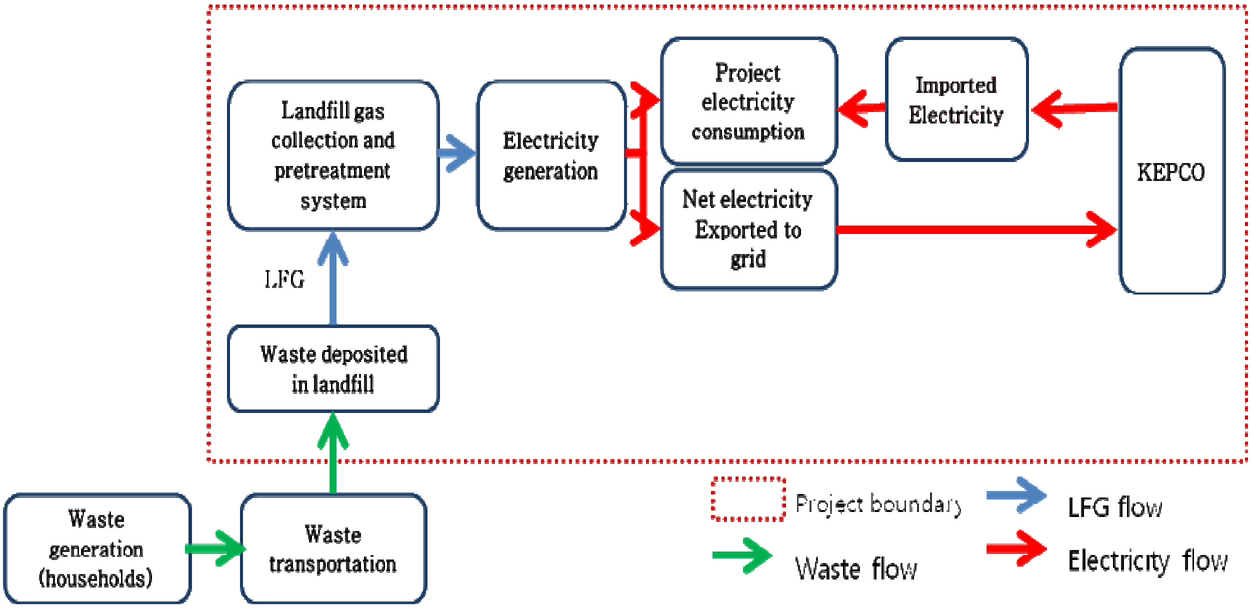

Figure B-1 The proposed project boundary

The following project activity and emission sources are considered within the project boundary and baseline scenario can be identified in the table below.

Table B-2 Emission sources and justification for Jinju landfill.

Sources		Gas	Justification/Explanation
Baseline	Emission from decomposition of waste at the landfill site	CH_4	The major source of emissions in the baseline and methane released to atmosphere due to the decomposition of the organic waste.
	Emissions from electricity consumption	CO_2	CO_2 would be otherwise emitted by grid connected power plants (using fossil fuel) without this project utilizing landfill gas.
Project	Emissions from electricity use due to the project activity	CO_2	CO_2 emitted to generate the quantity of electricity imported from grid by this project.

B.4. Description of baseline and its development:

Baseline scenario for methane recovery

To develop baseline scenario, steps defined in the paragraph 19 of the "General Guidelines to SSC CDM methodologies (EB61 annex21)" has been applied

According to AMS III.G defines the baseline scenario as the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere. To describe baseline scenario in the absence of the project activity, biomass and other organic matter shall exclude methane emissions that would have to be removed to comply with national or local safety requirements or legal regulations.

Step 1:

Identify the various alternatives available to the project proponent that deliver comparable level of service including the proposed project activity undertaken without being registered as a CDM project activity.

Alternative 1: Maintain the status quo.
Methane generated at the landfill site is directly emitted to the atmosphere without any treatment.

Alternative 2: Methane capture and electricity generation, without CDM revenue.
Install landfill gas collecting and utilizing system to capture and generate electricity, implemented without considering CDM revenue.

Alternative 3: Capture and flare, without energy generation
By using the existing simple burning system, methane is partially captured and flared without energy generation such as steam, heat and/or electricity.

Alternative 4: Sale of raw gas to consumer
Install landfill gas collection systems, and export the captured gas outside of the project boundary. However, there is no potential demand for biogas around the project site, so this alternative is not plausible.

Step 2:

List the alternatives identified per Step 1 in compliance with the local regulations (if any of the identified baseline is not in compliance with the local regulations, then exclude the same from further consideration).

To satisfy the regulations of CDM project, the baseline scenario should comply with the Korean laws and regulations.

According to the Waste Control Act, landfill operators of emitting landfill gas from organic waste have not only to install pipelines (landfill gas venting system) in compliance with its Enforcement

Regulation, but also to flare and/or utilize landfill gas in line with the Article 9[4] of its Enforcement Ordinance for local environment and resident's protection from odour/hazard materials and potential explosion. But under the regulations, there is no specific data on how much landfill gas should be treated and how efficient flaring system to be installed.

Under the regulation, landfill gas venting system (vertical pipeline) and simple flaring system had been installed in Jinju landfill and LFG had been flared in the past. On this, Jinju landfill had a fire accident, broking out and burning through the pipeline and embers had spread to mountain. It should cause forest fire as Jinju landfill is located in and around mountainous area (refer to Fig. A-1). For Jinju landfill, landfill gas is vented into atmosphere through venting system to stabilize landfill instead of flaring to prevent worse result.

Ministry of Environment certificated Jinju City to operate Jinju landfill in 1995. According to Article 30, Section 2, of the Waste Control Act and Article 41, Section 7, of its Enforcement Ordinance, Jinju City received a letter of certificate, satisfied of landfill condition by Korea Rural Corporation in 2009.

The date of approval of operating Jinju landfill was On 11 May 1991 and the starting date of landfill was in January 1995. At the time there was no any regulation on landfill gas treatment and/or utilization. About those regulations and this article was made in 1999.

So, there is no alternative not in accordance with local regulations. Alternative 1,2 and 3 remain.

Step 3:
Eliminate and rank the alternatives identified in Step 2 taking into account barrier tests specified in attachment A to Appendix B of the simplified modalities and procedures of SSC CDM.

Investment barrier can be demonstrated at this stage

In the current situation, simple burning system exists at the landfill site, but has not been operated for years. If alternative 3 is implemented, it will result in O&M cost, but there is no income. In this reason, alternative 3 is not financially feasible.

For alternative 2, investment analysis has been carried out in section B.5 below. The result of the analysis shows that the alternative 2 is not profitable without CDM revenue.

So, only alternative 1 is most reasonable scenario among the three alternatives.

Step 4:
If only one alternative remains that is:

- *Not the proposed project activity undertaken without being registered as a CDM project activity; and*

[4] The installation standard on disposal facility or recycling facility, the Article 9 of Waste Control Act's Enforcement Regulation

- *It corresponds to one of the baseline scenarios provided in the methodology; then the project activity is eligible under the methodology*

The only remaining alternative is not the proposed project without CDM, and it is corresponds to the baseline scenario defined in the applied methodology.

So, baseline scenario for the methane recovery activity is:

The situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary and methane is emitted to the atmosphere.

Baseline scenario for electricity generation

AMS-I.D. version 17 describes the baseline for electricity generation states that: the baseline scenario is that the electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources into the grid. The baseline emissions are the products of electrical energy baseline $EG_{BL,y}$ expressed in MWh of electricity produced by the renewable generating until multiplied by the grid emission factor

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered small-scale CDM project activity:

The determination of project scenario additionality is explicated in the following Attachment A of Appendix B of the simplified modalities and procedures for small-scale CDM project activities. Additionality can be proved through demonstration of at least one of following barriers:
- Investment barrier
- Technological barrier
- Barrier due to prevailing practice
- Other barriers

Investment barrier

The biggest barrier of the project is the investment barrier: Investment barrier is applied to demonstrate the additionality.

Landfill gas recovery and utilization projects require high investment cost and O&M cost, and therefore to show the definite business potential, the incentive from the CDM project had been seriously taken into account prior to the starting date of the project activity. Because this proposed project is economically unattractive without CDM project. Due to this reason, the capital return is expected to be low. It can be identified by calculating the internal rate of return (IRR[5]).

[5] IRR is a capital budgeting method used by firms to decide whether or not they should make investments. It is an indicator of the efficiency or quality of an investment, as opposed to net present value (NPV), which indicates value or magnitude. IRR for an investment is the discount rate that makes the net present value of the investment's income stream total to zero.

For investment analysis, the proposed project involves the investment costs and the revenue from the sale of electricity as well. In order to demonstrating additionality, financial analysis is provided to determine whether the proposed project activity is financially less attractive without the credit revenue or not. The economic analysis is conducted in the following steps:

Step 1: Determine appropriate analysis method:
The three analysis methods, suggested by *"Tools for the demonstration and assessment of additionality_V. 6.0.0."* are: 1) simple cost analysis (option I), 2) investment comparison analysis (option II) and 3) benchmark analysis (option III). For this proposed project, Option III-Benchmark analysis is applied; the project IRR of total investment is compared to benchmark and NPV is calculated for evaluating the economical value.

Step 2: Option III-Apply benchmark analysis:
IRR (Internal Rate of Return) is selected for the financial analysis indicator and in order to examine the financial feasibility, the project's IRR should be compared with discount rate of renewable energy, published by Ministry of Knowledge economy, 2006. As a result of this comparison, the IRR of the proposed project is lower than the benchmark for 15 years. 7% is applied as a discount rate to compare the project's IRR. Landfill gas utilization power project is economically infeasible since the IRR is much lower than the benchmark without CDM revenue. Economic analysis shows that the project's IRR returns a negative value, indicating an unattractive investment as a power project.

Table B-3 Basic parameters for calculation of financial indicators

Used values for economic analysis		
Content	Value	Data sources
Analysis period (year)	15	Engineering work report (selected upon equipment life time)
Discount rate (%)	7	Discount rate of renewable energy, published by Ministry of Knowledge economy, 2006
Unit price of electricity sales(SMP)	101.41	Actual average price during 2006 to 2010 Source: Electricity exchange statistics system (http://epsis.kpx.or.kr/)
Details of economic analysis implementation		
Parameters	Value	Data sources
Total investment (thousand won)	2,745,194	Engineering work report
Annual operational/maintenance cost (thousand won)	4,814,652	Engineering work report
Capacity Generator (kW)	925kW (About 1MW)	Engineering work report

<table>
<tr><td>Average net power export to grid (MWh/year)</td><td>5,892 MWh</td><td>Jinju landfill CER_Investment analysis file</td></tr>
<tr><td colspan="3">Outcome</td></tr>
<tr><td>Scenario</td><td>IRR</td><td>Benchmark</td></tr>
<tr><td>Without the CDM revenue</td><td>1.87%</td><td rowspan="2">7%</td></tr>
<tr><td>With the CDM revenue</td><td>17.49%[6]</td></tr>
</table>

The table above clearly shows that the proposed project is not attractive without CDM revenue therefore investors will not be interested in; on the other hand, the project's IRR with CER revenue is 17.49% and this will prove very interesting to investors. It is extremely difficult for the participants to make a decision to construct the proposed project without the income from CERs sales. So this proposed project, installing equipments to utilize landfill gas, has additonality compared to existing simple flaring system.

With the CDM revenue, assuming a CER price of € 11 per tCO_{2e}, the IRR is 17.49%. The project is profitable.

Step 3: Sensitive analysis:

Sensitivity analysis is used to determine how "sensitive" economic analysis is to changes in the value of the parameters with regard to the key assumptions: price of electricity sold to KEPCO, investment cost and O&M cost in each scenario considering values + or - 5% to 10%. Over the range, IRR remains below the benchmark discount rate: Sensitivity analysis was conducted by altering the following parameters:
- Price of electricity sales: increase of electricity sale to KEPCO
- Investment Cost: decrease of investment cost
- O&M cost: decrease of operation cost

Sensitivity analysis shows that the project's IRR has a negative value in the each scenario, which means it is still lower than the benchmark.

[6] 11.95 Euro/ ton CO2e (Average price for three months during January to March in 2010) is applied to analysis IRR.

Table B-4 The result of sensitive analysis

1. The result of increase of electricity sale to KEPCO

Increase of electricity sale price rate(%)	SMP(won/kW)	IRR(%)	NPV(1,000won)
-	101.41	1.87%	-687,231
5	106.48	2.19%	-649,460
10	111.55	3.64%	-465,907

2. The result of decrease of investment cost

Decrease of investment cost rate(%)	Investment cost (1,000won)	IRR(%)	NPV(1,000won)
-	2,745,194	1.87%	-687,231
5	2,607,934	1.41%	-704,733
10	2,470,675	2.23%	-576,453

3. The result of decrease of O&M cost

Decrease of operation cost rate(%)	Operation cost (1,000won)	IRR(%)	NPV(1,000won)
-	4,814,652	1.87%	-687,231
5	4,573,919	1.47%	-739,069
10	4,333,187	2.33%	-636,612

In conclusion, the project's IRR remains much lower than the benchmark, even with an increase in price of electricity sales and a decrease in of investment cost and O&M cost. The sensitivity analysis shows that the proposed project is not substantial enough to warrant investment.

Without CDM revenue, the proposed project is not attractive to investors and not implemented.

CDM Consideration

Jinju landfill CDM project was considered since 2009 and Jinju City gave public notice of a bid in September 2009 but any other investors didn't bid at all because of the following reasons: growth in price of operation and LFG utilization fee, Korean currency devaluation and incidental expenses over recent years in the consideration of the investment against revenue. According to that research paper, "a small scale project of the renewable energy market is hard to bring up benefits" (the research paper was submitted to DOE).

Nurieconet reviewed "Jinju Landfill Gas Recovery and Power Generation CDM Project" and took part in this project afterwards with CDM project consideration. Thereafter, Nurieconet started writing the PDD of the CDM project, along with consulting company made a Contact. The definite project schedules are listed in the table below.

Table B-5 The procedure of CDM consideration

Date	Project Schedule
May 2010	Draft Engineering work report on "Jinju Landfill Gas Recovery and Power Generation CDM Project"
May to December 2010	Project deliberation date (composed of local experts)
April 2011	Final Engineering work report on "Jinju Landfill Gas Recovery and Power Generation CDM Project"
10th June 2011	Conclusion of a contract among Jinju City Hall, Korea Environment Corporation and Nurieconet Co., Ltd
14th October 2011	Starting date of construction (civil engineering work)
26th October 2011	Approval of construction business
14th November 2011	"Prior consideration of CDM[7]" was submitted to UNFCCC and DNA of Republic of Korea
5th December 2011	Approval of electricity generation business
12th January 2012 (expected date)	The installation of 925 kW generator, but it could be just to change in case of an unexpected delay
9th March 2012 (expected date)	The completion date of the construction, but it could be just to change in case of process
16th March 2012(expected date)	End of Self-testing date for 10days from 9th March, but it could be just to change in case of The completion date of the construction
9th April 2012(expected date)	End of trial operation date for one month from 9th March, but it could be just to change in case of The completion date of the construction

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

The baseline scenario of the project is total atmospheric release of the LFG from the landfill site and the emission reduction is claimed for displacing electricity generation. According to this condition, the emission reduction corresponds to the applicability condition in the approved small-scale baseline methodology AMS-Ⅲ.G; "Landfill Methane Recovery---Version 7".

7 GUIDANCE ON THE DEMONSTRATION AND ASSESSMENT OF PRIOR CONSIDERATION OF THE CDM, EB41_Annex 46

The project activity applies AMS I.D, because this project transmits electricity to a grid-connected system. Appendix B of the simplified modalities and procedures for small-scale CDM project activities for projects under category I.D "Grid connected renewable electricity generation" comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal, and renewable biomass, that supply electricity to and/or displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generating unit.

Formula for ER ex-ant in the PDD:
According to the AMS-III.G Landfill methane recovery, the emission reductions achieved by the project activities can be estimated ex-ante by:

Project emissions:
Project activity emissions consist of CO_2 emissions related to the power used by the project activity facilities. Emission factors for electricity shall be calculated from AMS-I.D. When the proposed project is in operation, the electricity consumed by the proposed project will be supplied by the project.

Leakage:
Methane destruction component: Not applicable as the methane recovery technology is not transferred from another activity.
Grid displacement component: Not applicable as the energy generating equipment is not transferred from another activity.

Emission Reductions:
The emission reduction achieved by the project activity is constituted by both the methane destruction and grid displacement components.

$$ER_{y\text{, estimated}} = BE_y - PE_y - Leakage$$

Parameter	Unit	Description
$ER_{y,estimated}$	tCO_{2e}	Estimated emission reduction from both methane destruction and grid displacement
BE_y	tCO_{2e}	Baseline emissions from both methane destruction and grid displacement
PE_y	tCO_{2e}	Project emissions from electricity or fossil fuel use (only applicable to methane destruction component)
Leakage	tCO_{2e}	Leakage emissions from both methane destruction and grid displacement

Baseline emissions:
Based on both AMS III.G and AMS.I.D, the baseline scenario for the proposed project activity is:

$$BE_y = BE_{CH4,SWDS,y} - MD_{reg,y} * GWP_{CH4}$$

Where:
BE_y the baseline emissions in year y (tCO_{2e})

$BE_{CH4,SWDS,y}$ the methane generation from the landfill in the absence of the project activity at year y (tCO_{2e})

$MD_{reg,y}$ methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year y (tCO_{2e})

GWP_{CH4} Global Warming Potential for methane (value of 21)

The methane emission potential of a solid waste disposal site, $\mathbf{BE_{CH4,SWDS,y}}$ in $\mathbf{tCO_{2e}}$**,** is undertaken using the followed equation in the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site."

$$\mathbf{BE_{CH4,SWDS,y} = ø*(1-f)*GWPCH_4*(1-OX)*16/12*F*DOC_f*MCF*\Sigma\Sigma W_{j,x}*DOC_j*exp(-k_j*(y-x))*(1-exp(-k_j))}$$

ø	Default value for the model correction factor to account for model uncertainties (0.75)
f	Fraction of methane captured at SWDS and flared, combusted or used in another manner
GWP_{CH4}	Global warming potential of methane (21)
OX	Oxidation factor - reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste (0.0)
F	Fraction of methane in the landfill gas (volume fraction) (0.5)
DOC_f	Fraction of degradable organic carbon (DOC) that can decompose (0.5)
MCF	Methane correction factor (1.0)

$W_{j,x}$	Amount of organic waste type j filled in the year, x
DOC_j	Fraction of degradable organic carbon (by weight) in the waste type j
k_j	Decay rate for the waste type j (refer to B.6.2 for the value applied)
j	Waste type category
x	x runs from the first year of landfill site operation to the year y for which avoided emission is calculated (x = y)
y	Year for which avoided emissions are calculated

The captured gas will be used for electricity generation where emission reductions will be claimed, and the excess gas will be flared (not related to the proposed project). The generation component of the project will use Methodology for Small Scale Activities Type I.D Grid connected to renewable electricity generation (<15 MW).

$MD_{reg,y}$ methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year "y" (tCO_{2e}).

As mentioned above B.4, ***$MD_{reg,y}$*** = 0

$ER_{y,\ electricity}$ = $BE_{y,\ electricity}$ - $PE_{y,\ electricity\ y}$ – Leakage

$BE_{y,\ electricity}$	GHG that the grid-connected system would be emitted to produce electricity as much as the same quantity displaced by this project in the absence of this project (tCO_{2e})
$PE_{y,\ electricity}$	Emission to generate electricity imported from grid system (tCO_{2e})
Leakage	Emission caused by transportation in case power generation equipment is transferred from another activity, or existing equipment is transferred to another activity (tCO_{2e})

Calculation of GHG reduction by electricity generation and transmission to the grid:
According to the methodology AMS I.D. Version 17, baseline of the project activity is the kWh produced by the renewable generating unit multiplied by an emission coefficient (measured in kg CO_{2e}/kWh) calculated in a transparent and conservative manner as:

(a) 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.;

OR

(b) The weighted average emissions (in kg CO_2equ/kWh) of the current generation mix. The data of the year in which project generation occurs must be used. Therefore the baseline for this project was calculated according to "Tool to calculate the emission factor for an electricity system". Calculations are based on data from an official source and made available to the public in the website of the Korea power exchange.

A combined margin (CM) was calculated as the baseline emission factor (EF_y), consisting of the combination of operating margin (OM) and build margin (BM) factors in line with the following six steps of 'Tool to calculate the emission factor for an electricity system'. A combined margin (CM) applied the originated (original) data from existing power plants that provide electricity to the current grid-connected electricity generation. They were collected from the 'Statistics of Electric Power in KOREA published in the most recent 3 years (2008-2010) from KEPCO'.

The ex-ante calculation of the emission reductions takes following steps:

STEP 1. Identify the relevant electric power system
OM (Operating Margin) and BM (Build Margin) are calculated by using the data from existing power plants that provide electricity with the current grid-connected electricity generation, and with this result, the $EF_{grid,CM,y}$ (Baseline Emission Factor). The steps for the Baseline calculation methodology are as follows; The electricity from the project activities is connected to KEPCO grid, which is the only one in Korea and so relevant electric power system is KEPCO grid.

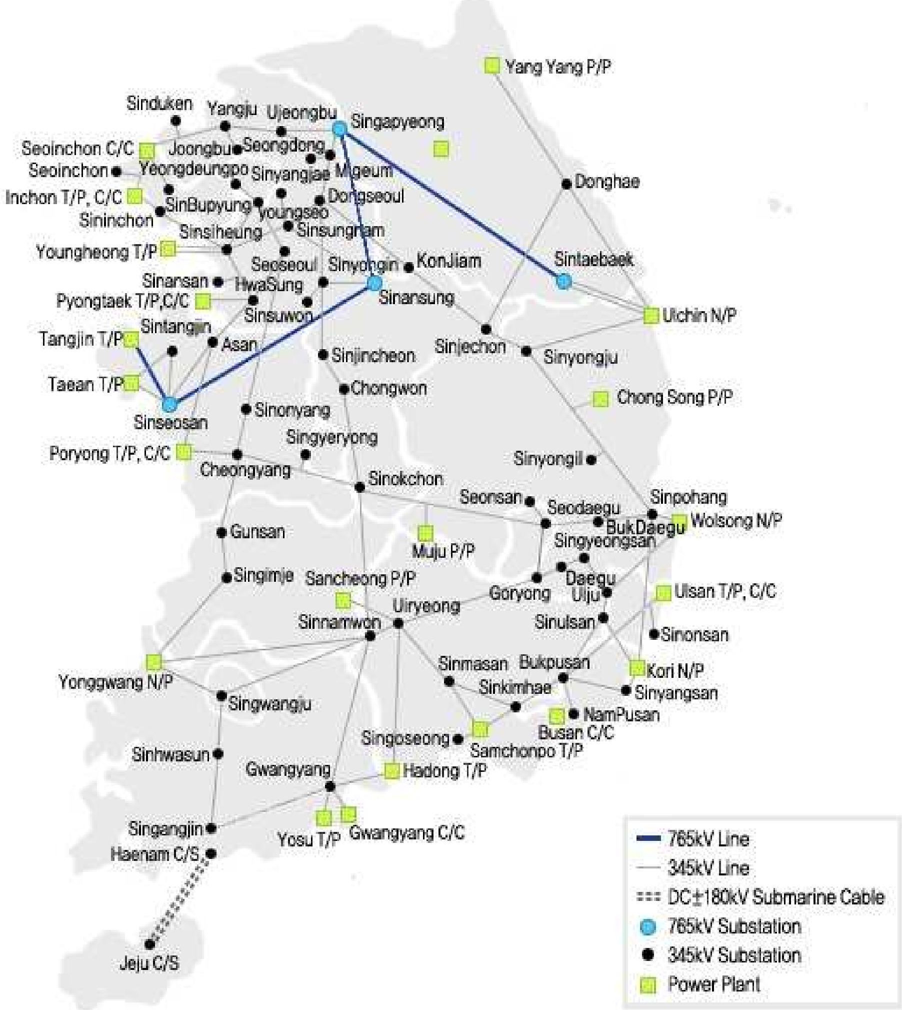

Figure B-2 Electricity power grid in South Korea
Source: 2011 Annual Report, Korea Electric Power Corporation

STEP 2. Choose whether to include off-grid power plants in the project electricity system
According to "Tool to calculate the emission factor for an electricity system", there are two options to calculate the operating margin and build margin emission factor:

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

For the proposed project, Option I is chosen; there are no off-grid power plants included in the calculation.

STEP 3. Select a method to determine the operating margin (OM)
The calculation of the Operating Margin emission factor ($EF_{grid,OM,y}$) shall be calculated based on one of the four following methods:

Option (a) Simple OM, or
Option (b) Simple adjusted OM, or
Option (c) Dispatch Data Analysis OM, or
Option (d) Average OM

If low-cost/must-run resources constitute less than 50% of total grid generation in average of the five most recent years, simple OM can be chosen. Referring to the gross electricity generation rate by energy sources of the host country (Republic of Korea), the rate of low cost/must run power generation will not exceed 50% of the total grid. In fact, the average data of most recent 5 years (2006-2010) shows that the rate of low cost/must run is **37.78%** (Source: KEPCO).

Therefore, Option (a) Simple OM is available and the following Table shows the yearly proportion of the generation of electricity based on the source of energy (Source: KEPCO).

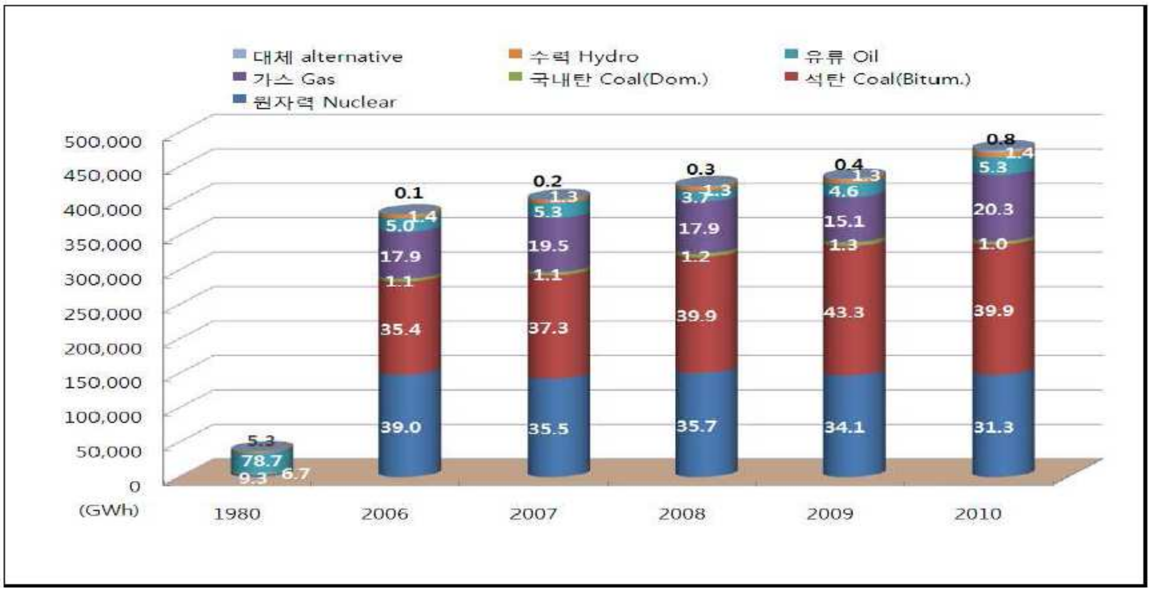

Figure B-3 Yearly gross generation graph by energy sources
Source: Electricity statistics on Electricity quantity from Korea Electric Power Corporation

Table B-6 Yearly Gross generation by energy sources (Unit: million kWh)

Source	2006	2007	2008	2009	2010
Hydro	5,219	5,042	5,563	5,641	6,472
Domestic Coal	4,312	4,470	5,010	5,559	4,613
Bituminous Coal	134,894	150,204	168,498	187,657	189,156
Oil	19,195	21,215	15,425	19,912	25,356
Gas	68,302	78,427	75,809	65,273	96,483
Nuclear	148,749	142,937	150,958	147,771	148,596
Alternative	511	829	1,092	1,791	3,984

Total	381,181	403,124	422,355	433,604	474,660
The rate of low cost/must run power generation (%)	37.78%				

Source: Electricity statistics on Electricity quantity from Korea Electric Power Corporation

For the sample OM, the simple adjusted OM and the average OM, the emissions factor can be calculated using either of the following data vintages:

• Ex ante option: A 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emissions factor during the crediting period,

OR

• Ex post option: The year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required for calculating the emission factor for year y is only available later than six months after the end of year y, alternatively, the emission factor of the previous year (y-1) may be used. If the data is only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.

Ex ante option is applied. The average data of 5 years (2006-2010) is available from KEPCO's Statistics of Electric Power.

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

The simple OM emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units. Low-cost/must-run power plants/units include hydro, geothermal, wind, low cost biomass, nuclear and solar generation and domestic coal and they are calculated based on fuel consumption data.

The simple OM may be calculated using one of the following options:
Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit;

OR

Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system.
For this project, Option A is used to calculate the simple OM. Under this option, the simple OM emission factor is calculated on the net electricity generation of each power unit and emission factor for each power unit, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,OMsimple,y}$ is Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EG_{m,y}$ is Net quantity of electricity generated and delivered to the grid by power plant/unit *m* in year y (MWh)

$EF_{EL,m,y}$ is CO_2 emission factor of power unit *m* in year y (tCO_2/MWh)
m is All power plants / units serving the grid in year y except low-cost / must-run power plants / units
y is The relevant year as per the data vintage chosen in **Step 3**

And for determination of ***$EF_{EL,m,y}$***, Option A1 is used.

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

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

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

The OM emission factor (***$EF_{EL,m,y}$***) is 0.6933 (tCO_2/MWh). The applied parameters are presented for the estimation of Operating Margin emission factor (***$EF_{EL,m,y}$***).

STEP 5. Calculate the build margin (BM) emission factor
According to “Tool to calculate the emission factor for an electricity system”, in terms of vintage of data, project participants can choose between one of the following two options:

Option 1. For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, he build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2. For the first crediting period, the build margin emission factor shall be updated annually, *ex post*, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated *ex ante*, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.
And here, Option 1 is selected between the two options proposed by the methodology.

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

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$, in MWh);

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

(c) From $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

Identify the date when the power units in SET_{sample} started to supply electricity to the grid.

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

Otherwise:

(d) Exclude from SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activity, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample\text{-}CDM}$) the annual electricity generation ($AEG_{SET\text{-}sample\text{-}CDM}$, in MWh);

If the annual electricity generation of that set is comprises at least 20% of the annual electricity generation of the project electricity system (i.e. $AEG_{SET\text{-}sample\text{-}CDM} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample\text{-}CDM}$ to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

(e) Include in the sample group $SET_{sample\text{-}CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);

(f) The sample group of power units m used to calculate the build margin is the resulting set ($SET_{sample\text{-}CDM\text{-}>10yrs}$).

The build margin emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year y for which power generation data is available, calculate as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EF_{grid,BM,y}$ is Build margin CO_2 emission factor in year y (tCO_2/MWh)

$EG_{m,y}$ is Net quantity of electricity generated and delivered to the grid by power unit m in year ***y (MWh)***

$EF_{EL,m,y}$ is CO_2 emission factor of power unit m in year y (tCO_2/MWh)

m is Power units included in the build margin

y is Most recent historical year for which power generation data is available

For BM emission factor, $EF_{EL,m,y}$ was calculated by multiplying $F_{Ci,\,m,y}$ by $NCV_{i,y} \times EF_{CO2\,,\,i,y}$ and divide it by power generation of each plant. In the project, as the annual generation of "the power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently" was 92,308,943 MWh and the annual generation of "the five power plants that have been built most recently" was 5,345,801 MWh. BM emission factor is 0.6357tCO_2/MWh and the detailed data used in the calculation are submitted to DOE.

Therefore the "The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently." is chosen as a sample group.

Table B-7 Sample Plant group (m) for determining Build margin Emission factor

Sample group(m) Classification	The five power plants that have been built most recently	The power plants capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently	Comments
Electricity quantity	5,345,801 MWh	92,308,943 MWh	Total generation in Korea is 455,785,943 MWh (based on KEPCO's data of the year 2010)
Proportion (ratio of total generation in Korea)	1.1755%	20.297%	CDM registered power plants generation is 144,703 MWh. (based on UNFCCC)

STEP 6. Calculate the combined margin (CM) emissions factor

According to the tool to calculate the emission factor for electricity system, the calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

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

The weighted average CM method (option A) should be used as the preferred option.
The simplified CM method (option b) can only be used if:

- The project activity is located in a Least Developed Country (LDC) or in a country with lessthan 10 registered projects at the starting date of validation; and
- The data requirements for the application of step 5 above cannot be met.

In this project, the weighted average CM method (option A) is chosen for the calculating the emission factor. The combined emissions factor is calculated as follows:

$$EF_{grid,\,CM,y} = w_{OM} \cdot EF_{grid,OM,y} + w_{BM} \cdot EF_{grid,BM,y} \quad (3)$$

Where:

$EF_{grid,BM,y}$ is Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$ is Operating margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM} is Weighting of operating margin emissions factor (%)

W_{BM} is Weighting of build margin emissions factor (%)

• Wind and solar power generation project activities: W_{OM} = 0.75 and W_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods.

• All other projects: W_{OM} = 0.5 and W_{BM} = 0.5 for the first crediting period, and W_{OM} = 0.25 and W_{BM} = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology which refers to the “Tool to calculate the emission factor for an electricity system”.

Therefore baseline emission factor ($EF_{grid,CM,y}$) for this project is = 0.6645 (tCO_2/MWh) as follows:

$$EF_{grid,CM,y} = w_{OM} \cdot EF_{grid,OM,y} + W_{BM} \cdot EF_{grid,BM,y}$$
$$= 0.5 \cdot 0.6933\ (tCO_2/MWh) + 0.5 \cdot 0.6357\ (tCO_2/MWh)$$
$$= 0.6645\ (tCO_2/MWh)$$

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	**D_{CH4}**
Data unit:	kg/m^3
Description:	Methane Density
Source of data used:	Tool to determine project emissions from flaring gases containing methane
Value applied:	0.716kg/m^3
Justification of the choice of data or description of measurement methods and procedures actually applied :	Density of methane at normal conditions
Any comment:	

Data / Parameter:	**ø**
Data unit:	NA
Description:	Default value for the model correction factor to account for model uncertainties
Source of data used:	Default value “Tool Emissions from solid waste disposal sites_V.6.0.1”
Value applied:	0.75
Justification of the choice of data or description of measurement methods and procedures actually applied :	For baseline emissions: refer to Table 3 to identify the appropriate factor based on the application of the tool (A or B) and the climate where the SWDS is located **Table 3: Default values for the model correction factor**

	Humid/wet conditions	Dry conditions
Application A	0.75	0.75

	Application B	0.85	0.80
Any comment:	Table 3 is applicable to Option 1 in the procedure .Determining the model correction factor (ϕ_y).		

Data / Parameter:	**OX**
Data unit:	NA
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
Source of data used:	Use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories for the choice of the value to be applied.
Value applied:	0.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	For managed solid waste disposal sites which are covered with oxidizing material such as soil or compost. Jinju landfill has daily soil cover, thus OX is 0.1
Any comment:	

Data / Parameter:	**DOC_f**
Data unit:	%
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5
Justification of the choice of data or description of measurement methods and procedures actually applied :	The above default value is suggested in "Tool Emissions from solid waste disposal sites_V.6.0.1"
Any comment:	

Data / Parameter:	**DOC_j**
Data unit:	%
Description:	Fraction of degradable organic carbon (by weight) in the waste type j
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4, and 2.5)

Value applied:	<table><tr><td>Waste type j</td><td>DOC_j (% wet waste)</td></tr><tr><td>Wood and wood product</td><td>43%</td></tr><tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40%</td></tr><tr><td>Food, food waste, beverages and tobacco</td><td>15%</td></tr><tr><td>Textiles</td><td>24%</td></tr><tr><td>Garden, yard and park waste</td><td>20%</td></tr><tr><td>Glass, plastic, metal, other inert waste</td><td>0%</td></tr></table>
Justification of the choice of data or description of measurement methods and procedures actually applied :	The above default value is suggested in “Tool Emissions from solid waste disposal sites_V.6.0.1”
Any comment:	

Data / Parameter:	**f**
Data unit:	
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data used:	AMS III.G_V.7
Value applied:	0%
Justification of the choice of data or description of measurement methods and procedures actually applied :	0.0 may be used in accordance with AMS III.G_V.7
Any comment:	Jinju landfill only has controlled LFG to diffuse into the atmosphere through pipes.

Data / Parameter:	**MCF**
Data unit:	NA
Description:	Methane correction factor
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	1.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	For anaerobic managed solid waste disposal sites.
Any comment:	

<table>
<tr><td>Data / Parameter:</td><td>k_j</td></tr>
<tr><td>Data unit:</td><td>NA</td></tr>
<tr><td>Description:</td><td>Decay rate for the waste type j</td></tr>
<tr><td>Source of data used:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 3.3)</td></tr>
<tr><td>Value applied:</td><td>
<table>
<tr><td colspan="2">Waste type j</td><td>$k_{j\ Dry}$
(MAP/PET <1)</td></tr>
<tr><td rowspan="2">Slowly Degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>0.06</td></tr>
</table>
</td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied :</td><td>Data : during 1981 to 2010 (long-term average)
Mean annual temperature: 13.1 ℃
It is not available to find PET data so conservative data, MAP/PET<1 is applied.</td></tr>
<tr><td>Any comment:</td><td>Based on data observed at meteorological observatory in Jinju data source: Korea Meteorological Administration</td></tr>
</table>

Data / Parameter:	**$W_{j,x}$**
Data unit:	%
Description:	Amount of organic waste type j prevented from disposal in the SWDS in the year x (tons)
Source of data used:	Jinju landfill data
Value applied:	Refer to xls sheet named “amount of waste”
Justification of the choice of data or description of measurement methods and procedures actually applied :	Amount of waste data (1995 – 2010) is recorded on the basis of daily receipt and aggregated annually by the landfill site.
Any comment:	Ministry of Environment, "Status of waste disposal and treatment (1995-2010)”

Data / Parameter:	**F**
Data unit:	NA
Description:	Fraction of methane in the SWDS gas (volume faction)
Source of data used:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value applied:	0.5

Justification of the choice of data or description of measurement methods and procedures actually applied :	This factor reflects the fact that some degradable organic carbon doesn't degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC
Any comment:	

Data / Parameter:	$\boldsymbol{EF_{OM}}$
Data unit:	ton CO_2 e/MWh
Description:	Operating Margin Emission Factor of the grid
Source of data used:	"Statistics of Electric Power in Korea"
Value applied:	0.6933
Justification of the choice of data or description of measurement methods and procedures actually applied :	The simple OM method is used to calculate EF_{OM} in accordance with the guidance of AMS-I.D. which allows the above method where low-cost/must-run resources constitute less than 50% of total grid generation. The generating sources do not include low-cost and must-run plant in conformity with the direction of AMS-I.D. EF_{OM} is calculated using the data for the most recent 3 years (2008-2010) available data
Any comment:	This Operating Margin Emission Factor is fixed for the crediting period

Data / Parameter:	$\boldsymbol{EF_{BM}}$
Data unit:	ton CO_2 e/MWh
Description:	Build Margin Emission Factor of the grid
Source of data used:	"Statistics of Electric Power in Korea"
Value applied:	0.6357
Justification of the choice of data or description of measurement methods and procedures actually applied :	$\mathbf{EF_{BM}}$ is calculated ***ex-ante*** based on the most recent information available on plants already built for sample group at this PDD submission. According to AMS-I.D., the sample group 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 and that have been built most recently. In this project, the latter is selected because project participant has to select the sample group that comprise the larger annual generation in guidance with the direction of AMS-I.D.
Any comment:	This Operating Margin Emission Factor is fixed for the crediting period

Data / Parameter:	$\boldsymbol{EF_y}$
Data unit:	ton CO_2 e/MWh
Description:	CO_2 emissions intensity of the electricity displaced
Source of data used:	"Statistics of Electric Power in Korea"
Value applied:	0.6645

Justification of the choice of data or description of measurement methods and procedures actually applied :	This value was calculated according to “Tool for calculation of emission factor for electricity system”.
Any comment:	This Operating Margin Emission Factor is fixed for the crediting period

B.6.3 Ex-ante calculation of emission reductions:

In accordance with AMS III.G and AMS I.D, the GHG emission reduction by this project can be calculated to add the emission reduction by CH_4 destruction and electricity displacement.

$$\mathbf{ER_{y,\ estimated} = ER_{y,\ CH4} + ER_{y,\ electricity}}$$

$ER_{y,\ estimated}$ Emission reduction achieved by the project activity in year, y

$ER_{y,\ CH4}$ Emission reduction achieved by CH_4 recovery and combustion in year, y

$ER_{y,\ electricity}$ Emission reduction achieved by displacing electricity in year, y

Table B-8 Emission reductions by this project (unit: ton CO_{2e})

Year	$ER_{y,estimated}$	=	$ER_{y,\ CH4}$	+	$ER_{y,\ electricity}$
2012	38,740	=	34,851	+	3,889
2013	38,703	=	34,818	+	3,885
2014	38,611	=	34,735	+	3,876
2015	38,470	=	34,608	+	3,862
2016	38,282	=	34,439	+	3,843
2017	38,052	=	34,232	+	3,820
2018	37,784	=	33,991	+	3,793
2019	36,376	=	32,724	+	3,652
2020	35,023	=	31,507	+	3,516
2021	33,723	=	30,337	+	3,385

$$\mathbf{ER_{y,\,CH4} = BE_{y,\,CH4} - PE_{y,\,CH4} - Leakage}$$

$ER_{y,\,CH4}$ Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site during the period from the start of the project activity to the end of the year (tCO_{2e})

$BE_{y,CH4}$ Baseline CH_4 emission (tCO_{2e})

$PE_{y,\,CH4}$ Emission related to the power used to operate the LFG capture and utilization facility (tCO_{2e})

Leakage Emission caused by transportation in case methane recovery equipment is transferred from another activity, or existing equipment is transferred to another activity (tCO_{2e})

Project emission is considered in the calculation of $ER_{y,\,electricity}$. There is no leakage effect in this project, because this project employs new facilities to utilize landfill gas.

Table B-9 Emission reduction by capture and combustion of CH_4

Year	$ER_{y,\,CH4}$	=	$BE_{y,\,CH4}$	-	$PE_{y,\,CH4}$	-	Leakage
2012	34,851	=	34,851	-	0	-	0
2013	34,818	=	34,818	-	0	-	0
2014	34,735	=	34,735	-	0	-	0
2015	34,608	=	34,608	-	0	-	0
2016	34,439	=	34,439	-	0	-	0
2017	34,232	=	34,232	-	0	-	0
2018	33,991	=	33,991	-	0	-	0
2019	32,724	=	32,724	-	0	-	0
2020	31,507	=	31,507	-	0	-	0
2021	30,337	=	30,337	-	0	-	0

$$\mathbf{BE_{y,CH4} = BE_{CH4,SWDS,y} - MD_{reg,y}}$$

$BE_{CH4,SWDS,y}$ Methane emissions avoided during the year y from preventing waste disposal at the solid waste disposal site during the period from the start of landfill to the end of the year, y (tCO_{2e})

$MD_{reg,y}$ Methane emission that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year, y

Table B-10 Baseline emission of CH_4

Year	$BE_{y,CH4}$	=	$BE_{CH4,SWDS,y}$	-	$MD_{reg,y}$
2012	34,851	=	34,851	-	0
2013	34,818	=	34,818	-	0
2014	34,735	=	34,735	-	0
2015	34,608	=	34,608	-	0
2016	34,439	=	34,439	-	0
2017	34,232	=	34,232	-	0
2018	33,991	=	33,991	-	0
2019	32,724	=	32,724	-	0
2020	31,507	=	31,507	-	0
2021	30,337	=	30,337	-	0

There is no leakage effect in this project, because this project employs new facilities to utilize landfill gas.

Table B-11 The emission reduction claimed for the displaced electricity

Year	$ER_{y, electricity}$	=	$BE_{y, electricity}$	-	$PE_{y, electricity}$	-	Leakage
2012	3,889	=	4,058	-	169	-	0
2013	3,885	=	4,054	-	169	-	0
2014	3,876	=	4,045	-	169	-	0
2015	3,862	=	4,030	-	168	-	0
2016	3,843	=	4,010	-	167	-	0
2017	3,820	=	3,986	-	166	-	0
2018	3,793	=	3,958	-	165	-	0
2019	3,652	=	3,810	-	159	-	0
2020	3,516	=	3,669	-	153	-	0
2021	3,385	=	3,532	-	147	-	0

$BE_{y,\ electricity} = EG_y * (1 - p_{IC,\ y}) * EF$

EG_y Gross quantity of electricity generated by the project activity in year, y (MWh)

$p_{IC,\ y}$ The proportion of the quantity consumed to operate and maintain the project facilities to the gross quantity of electricity generated by the project activity (4%)

EF Combined emission factor in electricity generation by grid system; weighed average of EF_{OM} and EF_{BM}.

Table B-12 Baseline emissions from electricity by the project

Year	$BE_{y,\ electricity}$	=	EG_y	*	$(1-p_{IC,\ y})$	*	EF
2012	4,058	=	6,107	*	(1-0.04)	*	0.6645
2013	4,054	=	6,101	*	(1-0.04)	*	0.6645
2014	4,045	=	6,087	*	(1-0.04)	*	0.6645
2015	4,030	=	6,064	*	(1-0.04)	*	0.6645
2016	4,010	=	6,035	*	(1-0.04)	*	0.6645
2017	3,986	=	5,998	*	(1-0.04)	*	0.6645
2018	3,958	=	5,956	*	(1-0.04)	*	0.6645
2019	3,810	=	5,734	*	(1-0.04)	*	0.6645
2020	3,669	=	5,521	*	(1-0.04)	*	0.6645
2021	3,532	=	5,316	*	(1-0.04)	*	0.6645

$EG_y = (LFG_y / LFG_{max}) * GC * h_{year}$

LFG_y Quantity of LFG generated from the project landfill site (m^3/min)

LFG_{max} Maximum limit of LFG input to the project generator (m^3/min) (9.10)

GC Operating hour(kW) (749) 81% from Output operating (kW) (925)

h_{year} Hours per year (8,760)

Table B-13 Gross quantity of electricity generated by the project activity in year, y

Year	EG_y	=	$(LFG_y$	/	$LFG_{max})$	*	$GC * h_{year}$
2012	6,107	=	8.82	/	9.10	*	0.7493*8,760
2013	6,101	=	8.81	/	9.10	*	0.7493*8,760
2014	6,087	=	8.79	/	9.10	*	0.7493*8,760
2015	6,064	=	8.76	/	9.10	*	0.7493*8,760
2016	6,035	=	8.72	/	9.10	*	0.7493*8,760
2017	5,998	=	8.66	/	9.10	*	0.7493*8,760
2018	5,956	=	8.60	/	9.10	*	0.7493*8,760
2019	5,734	=	8.28	/	9.10	*	0.7493*8,760
2020	5,521	=	7.97	/	9.10	*	0.7493*8,760
2021	5,316	=	7.68	/	9.10	*	0.7493*8,760

$LFG_y = BE_{CH4,SWDS,y}$ /GWP / D_{CH4} / $w_{CH4,y}$ / Min_{year}

GWP	Global warming potential (21)
D_{CH4}	Density of CH_4 (kg CH_4/m^3 LFG) (0.716)
$w_{CH4,y}$	Methane fraction in landfill gas (%) (0.5)
Min_{year}	Minutes per year (min) (525,600)

Table B-14 The Quantity of LFG generated from the project landfill site

Year	LFG_y	=	$BE_{CH4,SWDS,y}$	/	GWP	/	D_{CH4}	/	$w_{CH4,y}$	/	Min_{year}
2012	8.82	=	1,660	/	21	/	0.000716	/	0.5	/	525,600
2013	8.81	=	1,658	/	21	/	0.000716	/	0.5	/	525,600
2014	8.79	=	1,654	/	21	/	0.000716	/	0.5	/	525,600
2015	8.76	=	1,648	/	21	/	0.000716	/	0.5	/	525,600
2016	8.72	=	1,640	/	21	/	0.000716	/	0.5	/	525,600
2017	8.66	=	1,630	/	21	/	0.000716	/	0.5	/	525,600
2018	8.60	=	1,619	/	21	/	0.000716	/	0.5	/	525,600
2019	8.28	=	1,558	/	21	/	0.000716	/	0.5	/	525,600
2020	7.97	=	1,500	/	21	/	0.000716	/	0.5	/	525,600
2021	7.68	=	1,445	/	21	/	0.000716	/	0.5	/	525,600

$$PE_{y,\ electricity} = (EL_{IMP,\ PJT,\ y} - EL_{IMP,\ BASE,\ y})*EF$$

$EL_{IMP,\ PJT,\ y}$ The quantity of electricity imported from grid-connected system by project activity during the year, y (MWh)

$EL_{IMP,\ BASE,\ y}$ The quantity of electricity imported from grid system in baseline scenario during the year, y (MWh) (0)

Table B-15 Project emission to operate LFG utilizing facilities

Year	$PE_{y,\ electricity}$	=	$(EL_{IMP,PJT,y}$	-	$EL_{IMP,BASE,y})$	*	**EF**
2012	169	=	254	-	0	*	0.6645
2013	169	=	254	-	0	*	0.6645
2014	169	=	254	-	0	*	0.6645
2015	168	=	253	-	0	*	0.6645
2016	167	=	251	-	0	*	0.6645
2017	166	=	250	-	0	*	0.6645
2018	165	=	248	-	0	*	0.6645
2019	159	=	239	-	0	*	0.6645
2020	153	=	230	-	0	*	0.6645
2021	147	=	221	-	0	*	0.6645

* PEy,electricity will be monitoring by KEPCO meter and the amount of consumption will not be same as estimated. It depends on how much electricity is used for project activity.

B.6.4 Summary of the ex-ante estimation of emission reductions:

Table B-16 Estimation of emission reductions from the project

Year	Estimation of emission reductions from LFG destruction (ton CO_2e)	Estimation of emission reductions from gird displacement (ton CO_2e)	**Estimation of emission reductions (ton CO_2e)**
2012	34,851	3,889	38,740
2013	34,818	3,885	38,703
2014	34,735	3,876	38,611
2015	34,608	3,862	38,470
2016	34,439	3,843	38,282
2017	34,232	3,820	38,052
2018	33,991	3,793	37,784
2019	32,724	3,652	36,376

2020	31,507	3,516	35,023
2021	30,337	3,385	33,723
Total (ton CO2e)	**336,243**	**37,520**	**373,763**

B.7 Application of a monitoring methodology and description of the monitoring plan:

ER_y = (MD_y - $MD_{reg,y}$)+(** $EL_{EXP, PJT, y}$ - $EL_{IMP, PJT, y}$ **) *EF - Leakage

Parameter	Unit	Description
MD_y	tCO_{2e}	CO_2 equivalent of the methane captured and destroyed/ gainfully used by the project activity in year y;
$MD_{reg,y}$	tCO_{2e}	Methane emissions that would be captured and destroyed to comply with national or local safety requirements or legal regulations in the year 'y'
$EL_{EXP, PJT, y}$	tCO_{2e}	The quantity of electricity exported to the grid-connected system by this project activity during the year, y(MWh)
$EL_{IMP, PJT, y}$	tCO_{2e}	The quantity of electricity imported from gird-connected system by project activity during the year, y(MWh)
EF	tCO_{2e}	Combined emission factor in electricity generation by grid-connected system; weighted average of EF_{OM} and EF_{BM}.

EF is 0.6645 tCO_{2e}/MWh and this is fixed factor during crediting period.

As described above B.4, Jinju landfill gas has not been destructed by flaring and/or taken utilisation before developing the proposed project. So Adjustment Factor (AF) is zero. For this project, there is no leakage effect.

$MD_y = LFG_{electricity,y} * wCH_{4,y} * DCH_{4,y} * GWP_{CH4}$

Parameter	Unit	Description
$LFG_{electricity,y}$	Nm^3	Landfill gas flared or used as fuel in the year 'y'
$w_{CH4,y}$	%	Methane content in landfill gas in the year 'y'(mass fraction)
$D_{CH4,y}$	ton/ m^3	Density of methane at the temperature and pressure of the landfill gas in the year 'y'
GWP_{CH4}	tCO_2/tCH_4	Global warming potential of methane

Density of methane is measured by flower meter continuously and flower meter automatically measures temperature and pressure of the landfill gas fed into gas engine. Methane content is measured by gas analyzer.

B.7.1 Data and parameters monitored:

Data / Parameter:	$LFG_{electricity, y}$
Data unit:	m^3/y
Description:	Amount of landfill gas combusted in power plant
Source of data:	Measured by using gas flow meters
Value of data :	Not applied.
Brief description of measurement methods and procedures to be applied:	Measured automatically by continuous flow meters. The measured data is monitored in a computer and Jinju Landfill Operation team should check the measured data continuously.
QA/QC procedures to be applied:	The flow meters are subject to a regular maintenance and testing, to ensure accuracy. Calibrate the meter every three year
Any comment:	Archived data is kept during the crediting period and two years after. Daily data is documented in paper an archived in electronic file.

Data / Parameter:	$w_{CH4,y}$
Data unit:	%
Description:	Methane fraction in LFG
Source of data:	Measured by using a methane analyzer
Value of data :	50% (IPCC default value)
Brief description of measurement methods and procedures to be applied:	Methane fraction is measured with continuous gas analysers. The measured data is monitored in a computer and Jinju Landfill Operation team should check the measured data continuously.
QA/QC procedures to be applied:	The gas analyzer is subject to a regular maintenance and testing regime in accordance with the manufacturer’s specification at once, to ensure accuracy. Calibrate the meter every three year
Any comment:	Archived data are to be kept during the crediting period and two years after. Daily data is documented in paper and archived in electronic file.

Data / Parameter:	T
Data unit:	℃
Description:	Temperature of the landfill gas fed into gas engine
Source of data:	Reading from flow-meter
Value of data :	Not applied.
Brief description of measurement methods and procedures to be applied:	Measured continuously to determine the density of methane. No separate monitoring of temperature is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.
QA/QC procedures to be applied:	The flow meter is subject to a regular maintenance and testing regime, to ensure accuracy. Calibrate the meter every three year.

Any comment:	Archived data are to be kept during the crediting period and two years after.

Data / Parameter:	P
Data unit:	Bar
Description:	Pressure of the landfill gas fed into gas engine
Source of data:	Reading from flow-meter
Value of data :	Not applied.
Brief description of measurement methods and procedures to be applied:	Measured continuously to determine the density of methane. No separate monitoring of pressure is necessary when using flow meters that automatically measure temperature and pressure, expressing LFG volumes in normalized cubic meters.
QA/QC procedures to be applied:	The flow meter is subject to a regular maintenance and testing, to ensure accuracy. Calibrate the meter every three year.
Any comment:	Archived data are to be kept during the crediting period and two years after.

Data / Parameter:	$EL_{EXP, PJT, y}$
Data unit:	MWh
Description:	Total amount of electricity exported to KEPCO
Source of data:	Read from watt-hour meter
Value of data :	The estimation result is presented in B.6.3
Brief description of measurement methods and procedures to be applied:	The amount of exported electricity is measured automatically by certified meter. The measured data are transferred to Korea Power Exchange and are checked and achieved daily, weekly, monthly in electronic way by Jinju Landfill Operation team Measured by watt-hour meter
QA/QC procedures to be applied:	Project operator will calibrate electricity meter in accordance “General Guidelines to SSC CDM methodologies”, and update version of CDM regulation.
Any comment:	Archived data are to be kept during the crediting period and two years after. Daily data is documented in paper and archived in electronic file.

Data / Parameter:	$EL_{IMP, PJT, y}$
Data unit:	MWh
Description:	Total amount of electricity imported to meet project requirement
Source of data:	Measurement by watt-hour meter
Value of data :	The estimation result is presented in B.6.3
Brief description of measurement methods and procedures to be applied:	The amount of imported electricity will be measured automatically by certified meter. The project participant will check the amount of the imported electricity at the web site (http://cyber.kepco.co.kr) and get the paper bill from KEPCO monthly. Measured by watt-hour meter and the amount of imported electricity will be not same amount it depends on how much electricity will be used for proposed project.

QA/QC procedures to be applied:	To comply within article 21, section 1 of enforcement regulation of "Measures Act". Project operator should calibrate electricity meter every seven year.
Any comment:	Archived data are to be kept during the crediting period and two years after. The monthly data is archived in paper bill from KEPCO. * in case, a problem arises KEPCO will note down and check every month.

B.7.2 Description of the monitoring plan:

Monitoring system

The monitoring instruments to be installed in the project activity include LFG flow meter and methane content analyzer, as well as electricity meter. All the monitoring instruments meet the relevant accuracy requirements.

The installation of monitoring equipments will be maintained and checked under the regular maintenance and testing regime. These data and parameters will be monitored continuously by following monitoring plan. About the details of monitoring plan, "Operating Manual-Jinju Landfill Gas Recovery and Power Generation CDM Project" is submitted to DOE.

Monitoring organization and the role of each party

The following figure describes the operational and management structure that monitor the project activity and the table below shows the responsible party for each task of monitoring.

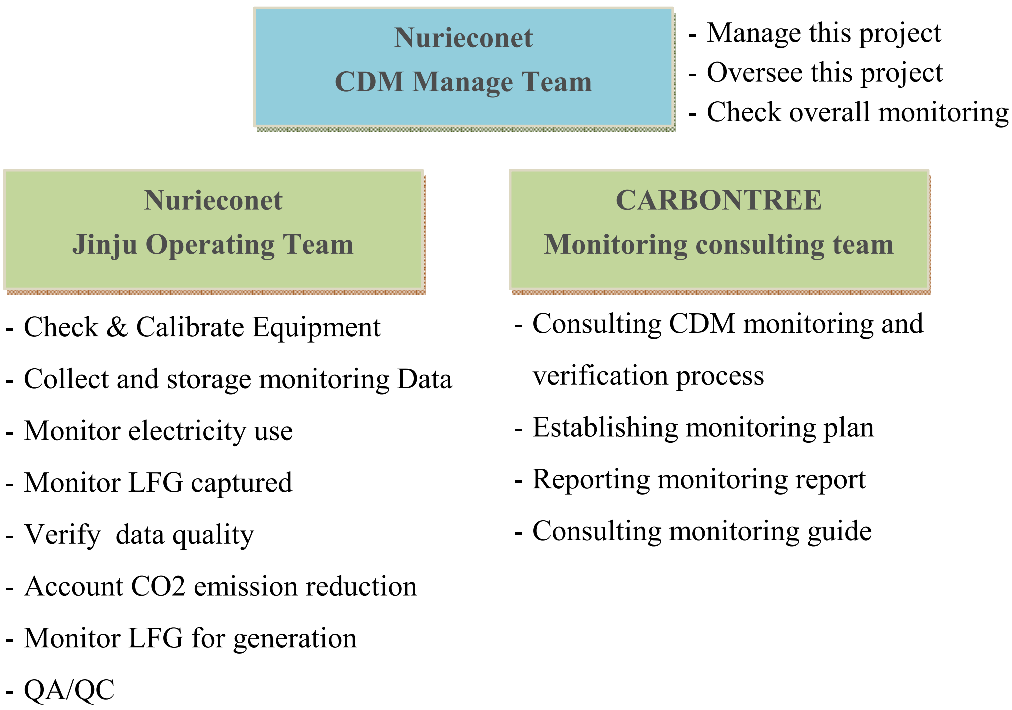

Figure B-4 The structure of monitoring organization

Table B-17 The responsible party for each task of monitoring.

Item	Sub-item	Responsible person
Measure & Archive	LFG electricity, y	Responsible company and/or team for the project : Jinju Operating Team, Nurieconet
	wCH4,y	
	ELEXP, PJT, y	
	ELIMP, PJT, y	
Measuring instrument check & Calibration	Centralized monitoring system	Responsible company and/or team for the project : Jinju Operating Team, Nurieconet
	Flow meter	
	Gas analyzer	
	Watt-hour meter	Responsible company and/or team for the project: Korea Power Exchange (According to "Measures Act" and : act on operation of electricity market")
Establish monitoring plan		Responsible company and/or team for the project : Jinju Operating Team, Nurieconet Monitoring consulting team, CARBONTREE
Task coordination		
Monitoring report		

The monitoring equipments to measure amount of methane and electricity

- A Gas flow meter is installed between blower and generating facility to measure LFG flow rate; temperature and pressure are automatically measured.

Gas flow meter		
Model	**CS Instruments**	VA 450 thermal mass flow meter
Spec	**Measuring range**	0.4 ~ 92.7 sm/s (standard range calibration) 0.8 ~ 185 sm/s (max range calibration)
	Accuracy	±1.5% of reading + 0.3% full scale
	Measuring medium	Any gas where the components and the mixing ration are constant and known.
	Operating temperature	-40 ~ +150 ℃ (medium temperature) -40 ~ +65 ℃ (ambient temperature)
	Operating pressure	1.6 Mpa (16 bar)
Calibration	Calibrate the meter every three year	

- A methane analyzer is located before the above flow meter to measure the fraction of methane in LFG volume fed into the gas engine.

Methane analyzer		
Model	**Geotechnical Instruments (UK) Ltd**	GA3000 Range Gas Analyser
Spec	**Calibration gas**	CH4, CO2, O2
	Measuring range	CH4: 0-70% specification, 0-100% reading CO2: 0-60% specification, 0-100% reading O2: 0-25%
	Accuracy	CH4: 0~5%: ±0.5%(vol), 5~15%: ±1.0%(vol), 15%-FS: ±3.0%(vol) CO2: 0~5%: ±0.5%(vol), 5~15%: ±1.0%(vol), 15%-FS: ±3.0%(vol) O2: 0~5%: ±1.0%(vol), 5~15%: ±1.0%(vol), 15%-FS: ±1.0%(vol)
	Measuring medium	Continuous for CH_4, CO_2, O_2
	Operating temperature	-5 ~ 40℃
Calibration	Calibrate the meter every three year	

- Electricity measuring meter is to be set-up transparently in accordance with "Measures Act" and "Act on operation of electricity market". Thereafter, the meter is calibrated when installed behind the generator and sealed up under the authority of KEPCO after affirmation of Korea Power Exchange. Exported electricity will be measured by watt-hour meter and the amount of exported electricity will be monitored continuously. Imported electricity will be measured by watt-hour meter and monitored continuously. The amount of imported electricity will be not same amount as it depends on how much electricity will be used for proposed project.

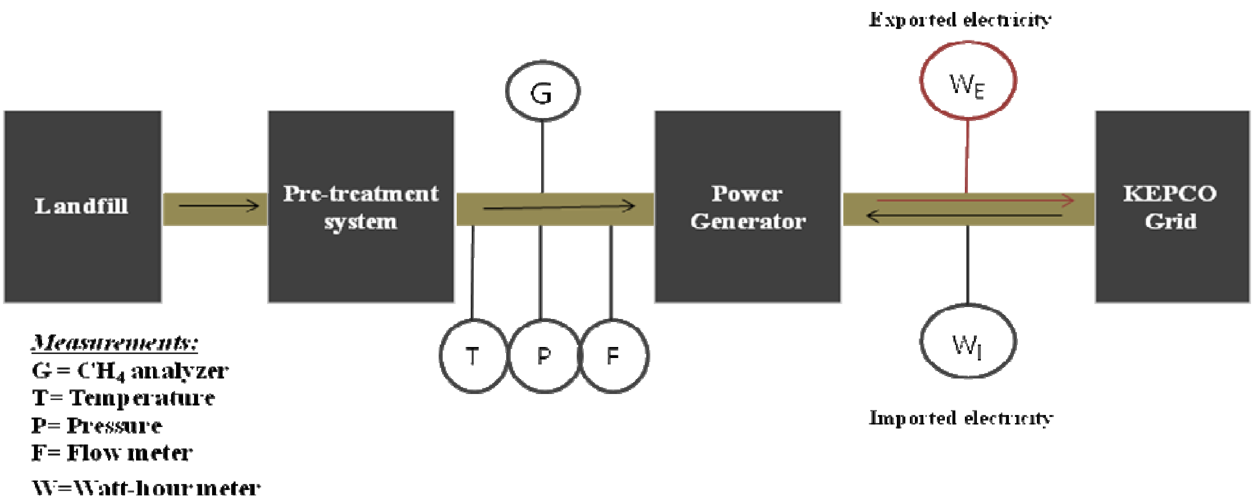

Figure B-5 The Location of the Monitoring facilities

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

Jinju Operating Team is the responsible team for quality management, which ensures the quality and accuracy of the measured data. For quality management, the following items are included: data records and data storage, equipment calibration and maintenance, corrective action, and Emergency procedures for unintended emissions.

- A gas flow meter will be installed between blower and generating facility; automatically calibrated meter of temperature and pressure, and operated in accordance with AMS III.G. When it has a problem to measure LFG flow rate, the IPCC default factor will be used for methane content in the LFG.
- A methane analyzer is located before the above flow meter to measure the fraction of methane in LFG volume fed into the gas engine.

- Electricity will be set-up transparently in accordance with “Measures Act” and “Act on operation of electricity market”. Thereafter, the meter is calibrated when installed behind the generator and sealed up after affirmation of Korea Power Exchange.

- The amount of electricity exported (W_E) to the grid-connected system is measured by watt-hour meter. The measured data is simultaneously transferred to Korea Power Exchange and the amount of imported electricity (W_I) is measured by a meter, as well. The measured data is also checked by central control system of Korea Power Exchange and they are collected daily, weekly and monthly in electronic way. If the landfill site data differs from that of the Korea Power Exchange, each data should be inspected. The collected data should be kept during the crediting period and 2 years after.

If any monitoring equipments are considered to perform abnormally, appropriate actions will be taken immediately.

Data records and storage:

All the daily data related to CDM project are documented on paper and archived in electronic files and kept during the crediting period and two years after. The measured data is monitored on a computer and Jinju Operating Team should check them continuously.

Equipment calibration and maintenance:

- Jinju Operating Team should check monitoring plan and/or schedules, and also calibrate generators periodically in line with procedure calibration manual from related manufacturer. The equipment, related to CDM project could be calibrated by Jinju Operating Team if necessary.

- The watt-hour meter is subject to a regular maintenance and testing regime to ensure accuracy. As to calibration of electricity imported meter, it will be calibrated by regulation of “Measures Act”. The calibration period is every seven years. As to exported electricity, electricity meter will be calibrated in accordance with “General Guidelines to SSC CDM methodologies”, and update version of CDM regulation.

Corrective action:

Jinju Operating Team will report all issues and data related to plant operation to Jinju Operating Team. Operation review, internal audit and corrective action are carried out by Jinju Operating Team, according to the , “Operating Manual-Jinju Landfill Gas Recovery and Power Generation CDM Project”.

Emergency procedure:
In case of emergency situation, proper action is carried out to minimize damage in accordance with "Operating Manual-Jinju Landfill Gas Recovery and Power Generation CDM Project".

Training
All employees involved in this project should be trained in knowledge/information of operating equipment and monitoring by skilled technician from the Generator manufacturer, and/or participate in training programs. The employees should attain a comprehensive knowledge, regard to the general and technical aspects of CDM project.

B.8 Date of completion of the application of the baseline and monitoring methodology and the name of the responsible person(s)/entity(ies)

The date of completion of the baseline and monitoring methodology: 30 November 2011
Responsible person / entity is as follows:

CEO Jungju J Park
CARBONTREE Co., Ltd.
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SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

10/6/2011 (Contract date of Jinju landfill Gas Recovery and Power Generation CDM Project)

C.1.2. Expected operational lifetime of the project activity:

15 years

C.2 Choice of the crediting period and related information:

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/09/2012, or the date of registration; Starting date of crediting period will be on the date of registration as a CDM project.

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

D.1. If required by the host Party, documentation on the analysis of the environmental impacts of the project activity:

According to the Impact Assessment Law related to Environment/Traffic/ Disaster and its Enforcement Ordinance, the operators take an environment impact assessment (EIA) when total capacity of electricity generator is equal to or more than 10 MW[8]. Therefore Jinju landfill does not need to take an EIA for generating electricity as total capacity of electricity generator is 925 kW.

But according to the Waste Control Act[9], the landfill which is equal to or more than 150,000m^2 has to be taken ex-EIA surrounding landfill area. Under this regulation, Jinju landfill operator has to take ex-EIA as Landfill area is 261,500m^2 and has to submit the result of ex-EIA report to the Minister of Environment triennially[10]. Jinju landfill ex-EIA report is submitted to DOE.

The Project does actively collect and utilize Landfill gas, thereby improving overall landfill management and reducing greenhouse gases and local adverse environmental effects. Thus the project activity has environmental additionality, copes with climate change, and contributes to environmental health and safety. The project activity brings about the following positive environmental impacts:

- Reduces risk of explosions and/or fires either within the landfill or outside its project boundary,
- Significantly less harmful toxic effects to humans from concentrated emissions of landfill gas,
- And reduces odour/other pollutants and greenhouse gas emissions.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Environmental impacts by operating landfill

Although environmental impact assessment is not enforced for the proposed project, landfill operators should assess possible environmental impacts caused by the landfill operation.

Before operating landfill, EIA should be assessed for the protection of the populations and landfill surroundings at periodic intervals and the operator should gain public confidence by publishing the results of EIA to the general public under the Waste Control Act.

The EIA result of Jinju landfill was satisfied to operate landfill under the Korean regulations and there have been no significant environmental impacts during landfill operation. As long as the operating landfill not only stabilizes landfill gas might possibly bring an explosion, but also reduces the pollutants that could bring odour and hazard to ambient environment and resident.

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[8] The Impact Assessment Law related to Environment/Traffic/ Disaster and its Enforcement Ordinance ("executive orders" 24th December 2008)

[9] The Waste Control Act and it's enforcement decree ("executive orders" 7th September 2011)

[10] The Waste Control Act ("executive orders" 25 July 2011)

From environmental protection perspectives, this proposed project is in compliance with national industry policy, promoting sustainable development and utilization of waste. During the phase of project design and construction, all the mitigation measures proposed by EIA report are implemented and the results of these measures are addressed in the table below.

Table D-1 The recent EIA report was performed for waste treatment systems on landfill in 2008.

Study period	From January 2010 to December 2010	
Check items (Measurement of pollutions)	Air	Each season (spring, summer, autumn, winter)
	Water (Underground water, stream water, leathat, treated water)	
	Soil	

- Air

Under the fundamental law of environmental policy, 6 air pollutants have been measured for the condition of air quality. The result of the measurements satisfied the regulations of the environmental policy.

- Water

Under the fundamental law of environmental policy, water quality was measured including 19 pollutants. Four points (watercourse, lake, underground water, and leachate) were tested and analyzed to show water quality did meet the environmental policy regulation.

- Soil

Under the fundamental law of environmental policy, four points were chosen on the landfill to measure degree of soil contamination twice a year (first half and second-half)

Since operating landfill, Jinju landfill has taken ex-EIA surrounding landfill area triennially under the regulation and submitted the report to the Minister of Environment. Ex-EIA report in 2008 and 2011 mentioned LFG utilization to improve better condition and environment in and around landfill by reducing GHG and bad smell, and landfill stabilized by encouraging bacteria.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

Prior to announcement of the proposed project, the project activities were announced in the local newsletter and Jinju City (http://www.jinju.go.kr) and Korean Environment Corporation (http://www.keco.or.kr). Korean Environment Corporation gave public notice of a bid and guide for biding in September, 2009.

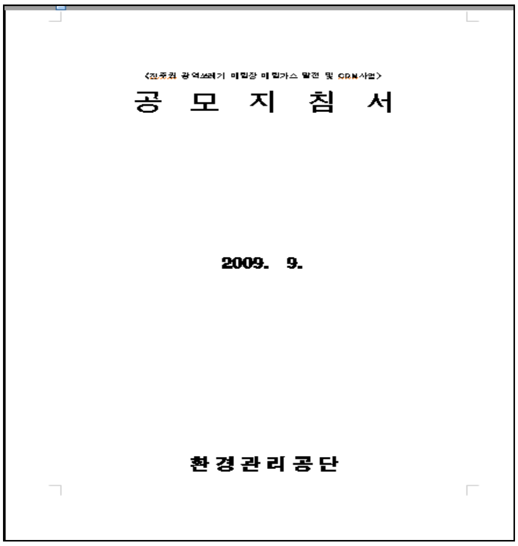


Figure E-1 Public notice of a bid of Jinju landfill project

The first article talks about hazardous gases from Jinju landfill will be used to utilize as a renewable energy and CDM project to register to UNFCCC. Jinju City is on the plan of environment-friendly landfill by installing high-tech eco-generator to landfill and by reducing greenhouse gases (www.hkbs.co.kr).

The second article is local news and talks about Jinju landfill gas recovery and power generation for environment-friendly landfill and reducing greenhouse gases. Participants; Jinju City and Nurieconet will operate for 15years and CDM project (www.idomin.com).

Figure E-2 Project announcement of Jinju landfill project

The meeting was composed of the following contents

- General explanation of proposed project
- The necessity of utilizing LFG to generate electricity
- Explanation of CDM project

Nurieconet and Jinju City had held several meetings to describe the proposed project and visited the project site with experts, participants and stakeholders. Presentations were given to allow ten stakeholders to understand the proposed project, its relation to climate change, its consequences and the aims of the Kyoto Protocol, as well as the most important features of the "Jinju Landfill Gas Recovery and Power Generation CDM Project".

Furthermore Nurieconet had sent to Draft Engineering work report to eight local experts to get their comments. Nurieconet had collected their advice and incorporated in proposed project activities for final Engineering work report.

May 2010	Draft Engineering work report on "Jinju Landfill Gas Recovery and Power Generation CDM Project"
May to December 2010	Project deliberation date (composed of local experts)
April 2011	Final Engineering work report on "Jinju Landfill Gas Recovery and Power Generation CDM Project"

E.2. Summary of the comments received:

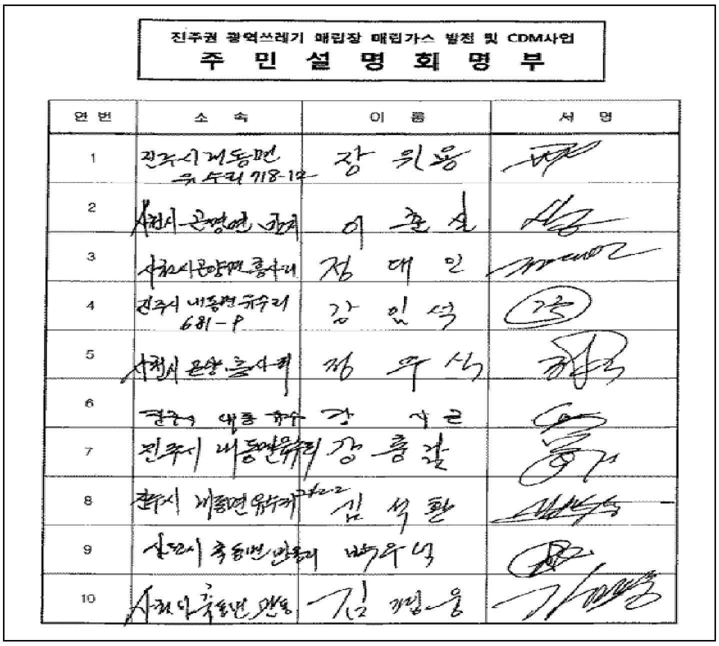
Ten stakeholders, invited to discussion on project activity, agreed to the proposed project plan which has many benefits for environment and stakeholders; by collecting and using landfill gas emitted from the landfill, it fosters sanitary treatment and stabilization of landfill as well as resolving stakeholders' comments about odours and pollutants. For those reasons, the project activities create no adverse effects. Even without any adverse effects, stakeholders can discuss and raise the question about project activities anytime at Jinju City stakeholder's website (http://www.jinju.go.kr/01appeal/01.php).

No other comments have been received from stakeholders except the below "local experts' suggestions and comments": stakeholders they understood the benefits of the proposed project. Jinju City delegated authority to Korea Environment Corporation generally to manage and oversee implement of project in considering of stakeholders and local experts. Contents to discuss to stakeholders and report of experts' suggestions and comments are submitted to DOE.

Figure E-3 The photographs to study and discuss the Jinju landfill project
Source: Nurieconet official letter, December 2010

The contents of stakeholders' suggestions and comments

All of ten stakeholders were attended to listen and discus about Jinju landfill project. They understood and checked all matters of this project commented by local experts. Because local experts mentioned already all the matters, stakeholders allowed investor to utilize LFG to generate electricity and CDM project and signed agreement. Figure E-2 shows those present and signatures.



진주권 광역쓰레기 매립장 매립가스 발전 및 CDM사업
주 민 설 명 회 명 부

연 번	소 속	이 름	서 명
1	진주시 내동면 유수리 718-12	장 위 용	
2	사천시 곤명면 [illegible]	이 춘 [illegible]	
3	사천시 곤양면 [illegible]	정 대 인	
4	진주시 내동면 유수리 681-P	강 인 석	
5	사천시 곤양 [illegible]	[illegible]	
6	[illegible]	강 [illegible]	
7	진주시 내동면 유수리	강 흥 [illegible]	
8	진주시 내동면 유수리	김 석 환	
9	[illegible]	[illegible]	
10	[illegible]	김 [illegible]	

Figure E-4 Signatures of stakeholders
Source: Nurieconet official letter, December 2010

The contents of Local experts' suggestions and comments

- Civil engineering work

Consideration of installing vertical and horizontal pipeline to landfill → Nurieconet provide all related document to local experts to make sure about landfill stabilization.

Optimization of gas collecting system to landfill → Nurieconet provide all related document to place optimizing gas collecting system.

- Electric work

Consideration of operating time and capacity of generator → Nurieconet provide all related document to local experts to make sure about electricity generation.

Consideration of P&I layout for Jinju landfill → Nurieconet submitted layout to local experts.

- Waste and LFG generation

Consideration of all factor to assume methane generation → Nurieconet submitted calculating data to local experts.

Consideration on refinement of LFG for generator → Nurieconet will refine LFG for generator in accordance with generator specification.

Consideration on emergency and maintenance of generator → Nurieconet will not monitor while generator doesn't work and doesn't count as credits as landfill is a tanks to hold LFG during maintenance.

- Recovery and utilization systems

Consideration on human traffic of operator → Nurieconet will make extra door for human traffic.

Consideration on rain water for roof → Nurieconet will consider slope roof.

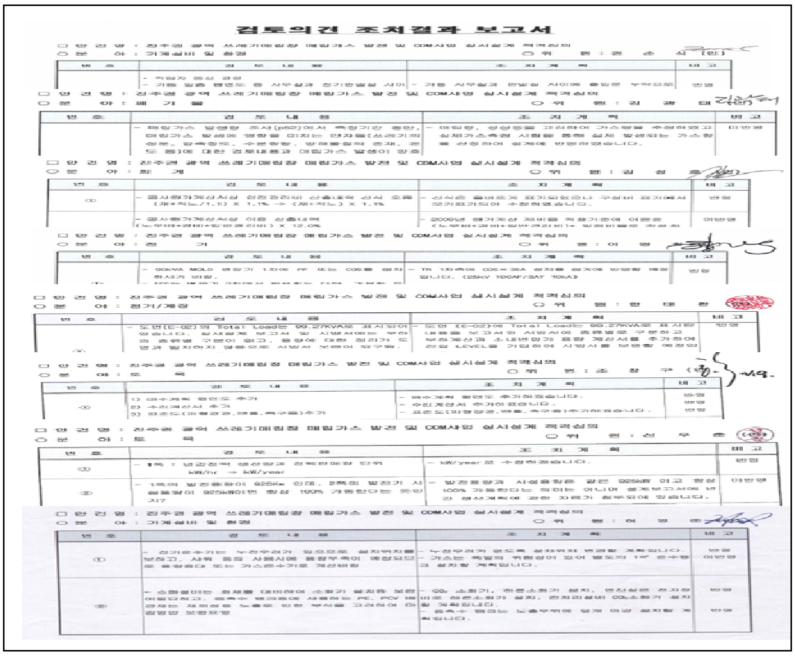

검토의견 조치결과 보고서

Figure E-5 Signatures of local experts

Source: Nurieconet official letter, December 2010

E.3. Report on how due account was taken of any comments received:

Through the meeting, the project was fully explained to stakeholders and there were no significant comments. The stakeholders have understood the project;

- Carries out environmental protection
- Improves social and economical benefits
- Increases job opportunities

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no public funding from Annex I parties for this project.

Annex 3

BASELINE INFORMATION

The total quantity of GHG emission reductions by proposed project is calculated by summing the CO_2 equivalent amount of the methane destroyed in the gas engine and the amount of CO_2 expected to be emitted from the grid connected to power generating system to generate the same amount of power displaced by the project.

For the estimation on amount of the LFG, the data and excel sheet, and EF data and excel sheet is submitted to DOE.

Annex 4

MONITORING INFORMATION

All parameters will be monitored as stated in section B. 7.