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

CONTENTS

Annexes

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:
Mokpo Landfill Gas Recovery Project for Electricity Generation

(2) The version number of the document:
Version number 05

(3) The date of the document:
29 November 2013

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

Mokpo Landfill Gas Recovery Project for Electricity Generation is developed by Hanwha Corporation in the Republic of Korea. The purpose of this project is to collect the CH_4 in landfill gas at the landfill site as renewable energy and to utilize CH_4 for generating electricity.

Mokpo Landfill, located in Daeyang-dong, Mokpo City, Jeollanam-do and constructed at the end of 1995 as a municipal solid waste (MSW) landfill, has disposed of 275 tons on average waste per day over the past eleven years. The total land area is 290,490 m^2, waste disposal area is 180,000 m^2 and the amount of available landfill capacity is 2,897,000 m^3. About 1,774,000 m^3 of landfill capacity has been used to dispose of household waste and non-hazardous commercial and industrial wastes at the Mokpo Landfill since 1996.

Prior to this proposed project, Mokpo Landfill emits landfill gas (LFG) into the atmosphere directly without recovery and utilization of LFG; this baseline scenario will be presented in the following section B.4. The proposed project involves the installation of a highly efficient collecting system, transmitting system, pre-treatment system and two electricity generators. The two generators will be installed with a total capacity of 2.123 MW (2 1.065 MW and 1.058 MW). The generated electricity from this project is exported to a grid. In terms of CO_2 emission reductions, the estimated annual average reductions are 25,795 tons CO_2 over the crediting period.

In the absence of the proposed project, MSW landfill is the most significant source of landfill gas emissions into the atmosphere, because approximately 50% - 60% of the waste in a typical MSW landfill is organic with the rest being mainly carbon dioxide, with some hydrogen sulphide and other unwanted components. In the proposed project, LFG (also known as biogas) is perfectly acceptable for running a gas motor to produce electricity.

The objectives of the project are as follows:
- helping to dispose of the flammable constituents, particularly methane, safely and to control odour nuisance, health risk, and adverse environmental impacts.
- replacing electricity from Fossil fuel power plants to LFG power plants.

Moreover, the project improves the Host Country’s goal of promoting sustainable development and brings about positive social and environmental impacts:

- To prevent a potentially explosive situation and to support an environmentally sound policy associated with subsurface gas migration.
- To minimize environmental damage through reducing methane emissions (global warming), odour nuisance and significant risk to human health from hazardous LFGs.
- To increase job opportunities related to the management, operation and maintenance of collecting LFG system and generating electricity.
- To optimize the use of biogas (renewable energy) in substitution of fossil fuel and the clean technology demonstration project, thus promoting sustainable and socio-economic development through significant technology transfer.

Date	Project Schedule
March 2008	Hanwha Corporation decided to invest in the proposed project (1.123 MW)
April 2008	Starting date of the project activity (the date of the start of construction work: gas collecting system)
September 2008	Date of completion for the installation of the 1.065 MW generator
	Starting date of commercial operation (electricity sales to KEPCO)
June 2009	Date of additional 1.058 MW generator installation
	Starting date of commercial operation (electricity sales to KEPCO)

Source: Hanwha official report (April 2008, June 2009)

A.3. Project participants:

Table 1: 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)	Hanwha Corporation	No

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.:

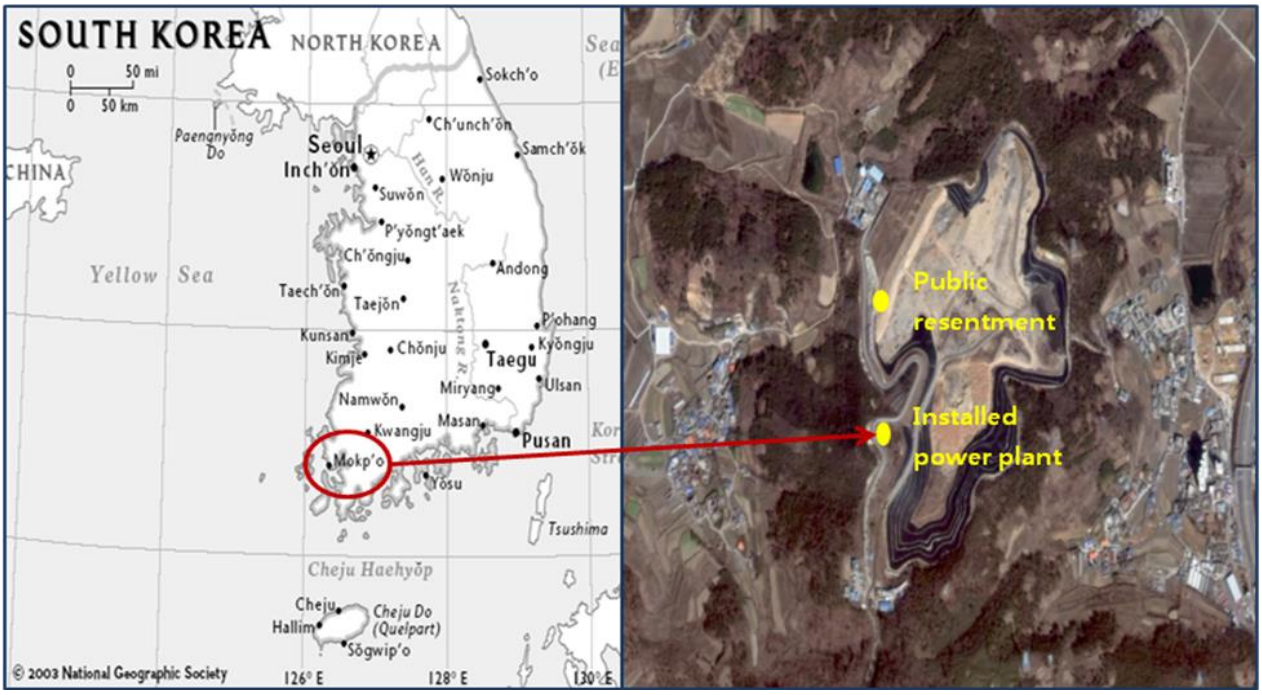
Jeollanam-do

A.4.1.3. City/Town/Community etc:

Mokpo City

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

The site of the “Mokpo Landfill Gas Recovery Project for Electricity Generation” is located in Daeyang-dong, Mokpo City, Jeollanam-do, Republic of Korea. The facilities and equipment will be installed inside the Mokpo landfill. The coordinates are latitude of 34.8328 and longitude of 126.4096. The coordinates are based on the power plant.



<Fig. A-1> The location of landfill site and the whole site view of the 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

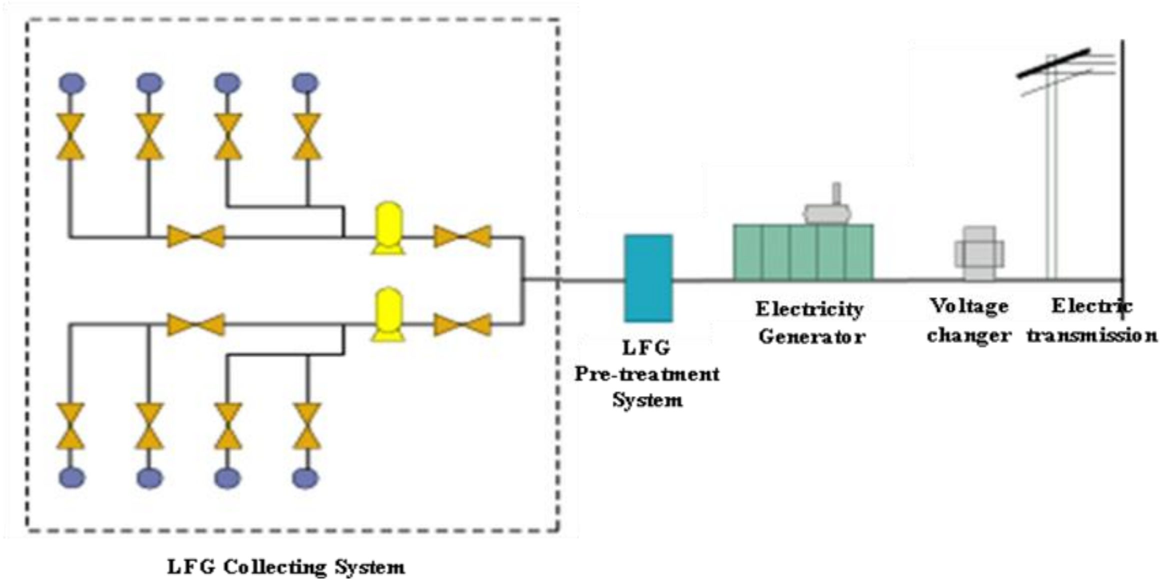
Project activity: Landfill gas collecting and generating electricity

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 process of the project is a landfill gas collecting system, a landfill gas pre-treatment system and an electricity generation system. The best available technology for each process of collecting and recycling LFG effectively is adopted into the proposed project.



<Fig. A-2> The main process of the proposed project

- ***Landfill Gas Collecting System***

The landfill gas collecting system is a gas transportation network, consisting of gas collecting wells, lateral gas collecting sub-pipes and a main pipe to cover all the landfill. The landfill gas collected from the gas wells is delivered to the main-heater pipe through sub-pipes, and the gas from the landfill gas collecting system is delivered into the CSV (Condensate Separation Vessel). High-density polyethylene (HDPE) collecting system is installed to convey the landfill gas from the wells to the blower.

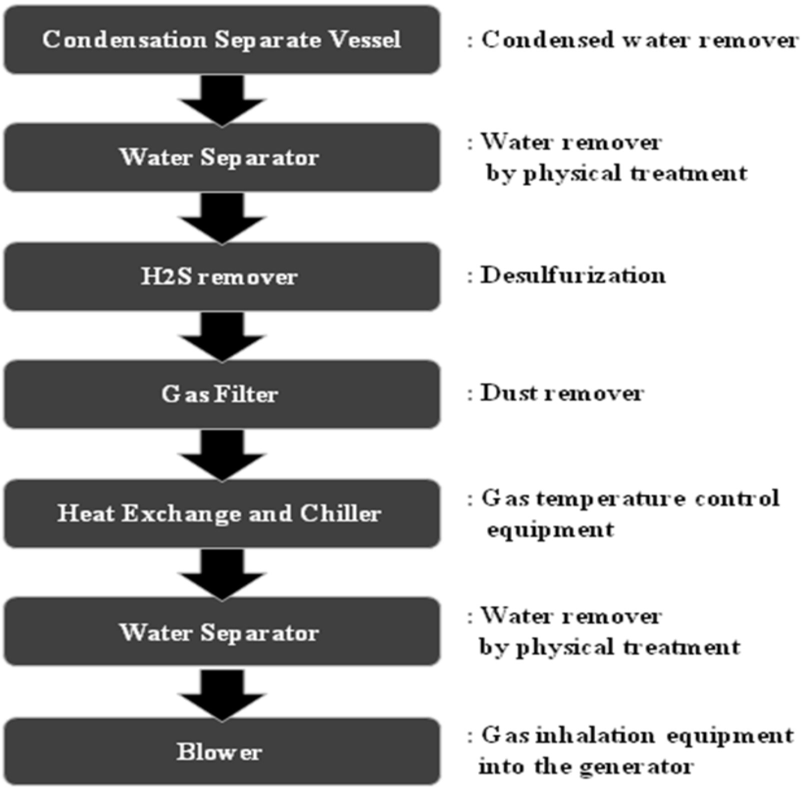
<Table A-1> The facilities of landfill gas collecting system

Facility	Function	Quantity
Vertical well	LFG capture (75mm HDPE)	121
Wellhead	Collecting LFG from vertical gas wells	11

Barrel trap	Trapping the condensate from the main pipeline	15
J-Trap	Trapping the condensate from the vertical wells	117
Main Pipeline	LFG supply to the gas engine (250mm)	1

- ***Landfill 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. Two water separators are installed to remove H_2S and to protect the generators for this project. The pre-treatment consists of 1) CSV (Condensate Separation Vessel), 2) water separator, 3) H_2S remover, 4) gas filter, 5) heat exchange and chiller, 6) water separator, and 7) blower.



<Fig. A-3> The process of pre-treatment system

- ***Electricity Generation System***

The proposed project is designed to install the two generators with capacity of 2.123 MW (1.065 MW and 1.058 MW) inside the Mokpo landfill. One generator was already installed in the landfill site with capacity of 1.065 MW in September 2008 and one additional generator with capacity of 1.058 MW was added in June 2009. The collected LFGs are sent to the generators and the electricity thereby generated is exported to the grid-connected system of the Korea Electric Power Corporation (KEPCO) supply system.

<Table A-2> The technical data of engine and power generator based on full load

Engine	Capacity of 1.065 MW	Manufacturer	GE Jenbacher
		Engine type	J 320 GS-C81
		Gas volume	522 Nm^3/h
	Capacity of 1.058 MW	Manufacturer	GE Jenbacher
		Engine type	JGC 320 GS-L.L
		Gas volume	450 Nm^3/h
Generator	Capacity of 1.065 MW	Manufacturer	STAMFORD
		Type	PE 734 B2
		Electrical output	1065 kW el.
		Frequency	60 Hz
		Voltage	380 V
		Speed	1800 rpm
		Efficiency	97.3 %
	Capacity of 1.058 MW	Manufacturer	STAMFORD
		Type	HCI 734 E2
		Electrical output	1058 kW el.
		Frequency	60 Hz
		Voltage	380 V
		Speed	1800 rpm
		Efficiency	96.6 %

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

The crediting period is 10 years (from 01/06/2009 to 31/05/2019). The total expected emission reductions are 257,949 tonnes of CO_2e and annual average emission reductions are 25,795 tonnes of CO_2e. The following table shows the estimated emission reductions of the proposed project over the crediting period.

<Table A-3> Annual estimation of emission reductions

Years	Annual estimation of emission Reductions tonnes of CO_2e
2009 (June to December)	13,712
2010	24,220
2011	24,831
2012	25,350
2013	25,783
2014	26,137
2015	26,417
2016	26,630
2017	26,780
2018	26,874
2019 (January to May)	11,214
Total estimated reductions (tonnes of CO_2e)	257,949
Total Number of crediting years	10
Annual average over the credit period of estimated reductions (tonnes of CO_2e)	25,795

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

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

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

According to Appendix C of the simplified modalities and procedures for the small-scale CDM project activities, the project is not a part of any large scale project and/or program, and not a de-bundled component of a large project activity. The proposed project is not included in the following definition of Appendix C of the simplified modalities and procedures for the small-scale CDM project activities:

- With the same project participants;
- In the same project category and technology/measure;
- Registered within the previous 2 years; and

- Whose project boundary is within 1 km of the project boundary of the proposed small scale activity at the closest point.

The project participants further confirm that they have not registered any small scale CDM activity or applied to register another small CDM project activity within the same project boundary.

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_V13
- AMS III. G: Landfill methane recovery_V06

And the tools referred by the approved methodology;
- Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site_V04
- Tool to calculate the emission factor for an electricity system_V01.1

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

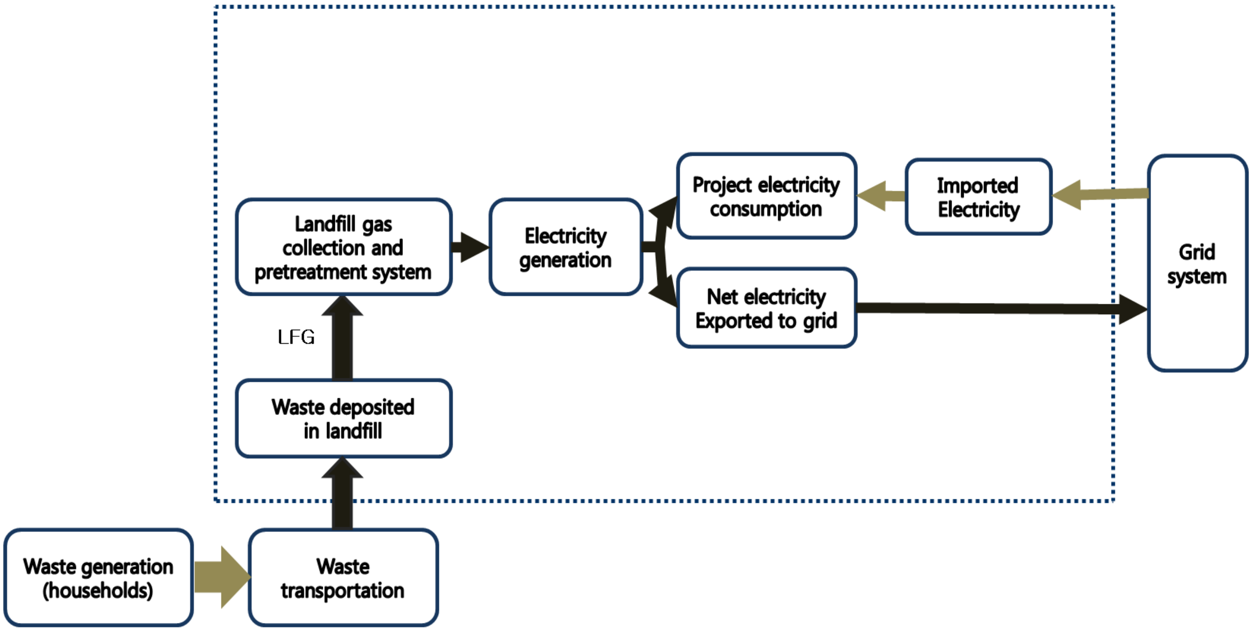
The project activity is based on collecting LFGs (reducing greenhouse gases effect), utilizing LFGs to create electricity (replacing electricity from the fossil fuel power plants to LFG power plants) and supplying electricity to local power purchaser. Thus the proposed project is satisfied with the conditions 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, as follows:
- For grid connected renewable electricity generation (AMS-I.D), the capacity is less than 15MW
- 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	2.123 MW (1.065 MW and 1.058 MW) 3,389 ton CO_2e/ annual average	15MW
AMS-III.G	22,406 ton CO_2e/ annual average	60,000 ton CO_2e

B.3. Description of the project boundary:

According to AMS-III.G methodology and AMS-I.D methodology, the project boundary should encompass the physical/geographical site of the landfill where the gas should be captured, destroyed and used as renewable generation source. Net electricity generated from the proposed project is exported to the 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 the grid-connected system, maintained by the Korea Electric Power Corporation (KEPCO).



<Fig. 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 Mokpo landfill.

Source		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 generation	CO_2	CO_2 would be otherwise emitted by grid connected power plants (using fossil fuel) without this project utilizing LFG.
Project	Emissions from electricity generation	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:

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.

Consistency of laws and regulations
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 LFGs from organic waste have not only to install pipelines (landfill gas venting system) in compliance with its Enforcement Regulation, but also to burn and/or utilize landfill gas in line with the Article 7 of its Enforcement Ordinance for local environment and resident's protection from odour/hazard materials and potential explosion.

Gas venting systems have been installed in Mokpo landfill. However, burning systems and/or utilizing systems have not been installed because when Mokpo landfill -located in a mountainous area (refer to Fig. A-1)**-** burned landfill gas in the past, a fire broke out that burned through the pipeline as well as surrounding mountains. As a result, Jeollanam-do provincial government (http://english. jeonnam.go.kr) permitted the Mokpo local government to allow venting landfill gas into atmosphere, since venting LFGs is more desirable than burning them. Thus, Jeollanam-do officials certificated Mokpo City to operate Mokpo landfill without burning systems.

In the absence of the proposed project, the current situation will continue to emit LFGs through landfill gas venting systems, instead of burning and/or utilizing the LFGs to cope with climate change.

There are four alternative baseline scenarios considered

Alternative 1: Maintain the status quo.
The landfill will continue to emit LFGs into atmosphere.

Alternative 2: Production and sale of electricity, without CDM revenue.
Install LFG collecting and utilizing system to capture and generate electricity, implemented without considering CDM revenue. This alternative would face investment barrier caused by no revenue without the sale of CERs. Investment barrier is outlined in section B.5 (refer to ***Investment barrier***).

Alternative 3: Flaring the LFGs
Install collecting and flaring system to burn the LFGs. As mentioned above, this alternative is not applicable in Mokpo landfill by reason of the location near mountains, which could lead to forest fire.

Alternative 4: Sale of raw gas to consumer
Install LFG collecting and treatment systems to permit the sale of the gas. However, as there is no consumer to purchase raw gas close to the landfill site, this project will not be implemented.

As a result of baseline scenarios, *Alternative 1* is the only remaining plausible alternative. Therefore, the participants do not require investment and would not face the investment barrier.

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: LFG recovery and utilization projects require high investment cost. Due to this reason, the capital return is expected to be low. It can be identified by calculating the internal rate of return (IRR); 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 revenues 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 revenues. 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_V05.2"* 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 could be supplied; the project IRR of total investment is compared to benchmark.

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 government bond yield rate (3 year-term) in 2006. As a result of this comparison, the IRR of the proposed project is lower than the benchmark for 15 years. 5.24% (3 year-term government bond yield rate) is applied as a discount rate to compare the project's IRR. For the feasibility study of power project investments, this project is obviously not commercially feasible since the IRR is much lower than the benchmark without CDM revenues. Economic analysis shows that the project's IRR returns a negative value, indicating an unattractive investment for the project.

<Table B-3> Basic parameters for calculation of financial indicators

<table>
<tr><td colspan="4">Used values for economic analysis</td></tr>
<tr><td>Content</td><td>Value</td><td colspan="2">Data sources</td></tr>
<tr><td>Analysis period (year)</td><td>15</td><td colspan="2">Feasibility study report
(selected upon equipment life time)</td></tr>
<tr><td>Discount rate (%)</td><td>5.24</td><td colspan="2">Korean Central Bank, Korean Economic Statistics System
(3 years-term government bond yield rate in 2007)
(http://ecos.bok.or.kr)</td></tr>
<tr><td>Unit cost of electricity purchase</td><td>81.5</td><td colspan="2">Actual average data in 2007
Source: Electricity exchange statistics system
(http://epsis.kpx.or.kr/)</td></tr>
<tr><td colspan="4">Details of economic analysis implementation</td></tr>
<tr><td>Parameters</td><td colspan="2">Value</td><td>Data sources</td></tr>
<tr><td>Total investment
(thousand won)</td><td colspan="2">3,017,000</td><td>Feasibility study report</td></tr>
<tr><td>Annual operational/maintenance cost
(thousand won/year)</td><td colspan="2">572,100</td><td>Feasibility study report</td></tr>
<tr><td>Capacity Generator
(MW)</td><td colspan="2">2.123
(1.065 MW and 1.058 MW)</td><td>Feasibility study report</td></tr>
<tr><td>Net power export to grid
(MWh)</td><td colspan="2">About 5,000</td><td>Feasibility study report</td></tr>
<tr><td>Depreciation cost of generators
(thousand won/year)</td><td colspan="2">201,133 (for 15 years)</td><td>Feasibility study report</td></tr>
<tr><td>Income tax
(%)</td><td colspan="2">income tax below 100 millions : 13% and
income tax over 100 millions : 25%</td><td>Feasibility study report</td></tr>
<tr><td colspan="4">Outcome</td></tr>
<tr><td>Scenario</td><td colspan="2">IRR</td><td>Benchmark</td></tr>
<tr><td>Without the CDM revenues</td><td colspan="2">-</td><td rowspan="2">5.24%</td></tr>
<tr><td>With the CDM revenues</td><td colspan="2">12.40%</td></tr>
</table>

The table above clearly shows that the proposed project is not attractive without CDM revenues and therefore, investors will not be interested; on the other hand, the project's IRR with CER revenues is 12.40% and this will prove very interesting to investors.

With the CDM revenues, assuming a CER price of € 15 per tCO_{2e}, the IRR is 12.40%. 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 operation 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 sold to KEPCO
- Investment Cost
- Operation Cost

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

<Table B-4> The result of sensitivity analysis

Scenario	IRR (%)	NPV (thousand won)
Standard	-	- 3,287,271
Increase of electricity sale price by 5%	-	- 3,042,656
Increase of electricity sale price by 10%	-	- 2,810,109
Decrease of investment cost by 5%	-	- 3,131,864
Decrease of investment cost by 10%	-	- 2,988,525
Decrease of operation cost by 5%	-	- 3,020,640
Decrease of operation cost by 10%	-	- 2,766,077

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

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

CDM Consideration

Mokpo landfill CDM project was considered by another investor in 2007 after Mokpo City announced this project to the public. That investor waived to invest money for the following reasons: growth in price of operation, Korean currency devaluation and incidental expenses over recent years in the consideration of the investment against revenues. 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).

Hanwha Corporation reviewed "Mokpo Landfill Gas Recovery Project for Electricity Generation" and took part in this project afterwards. Construction of facilities and/or equipment was initiated in accordance with pre-conditions of the Contract ("LFG Utilization and Power Generation Project of Mokpo City sanitary landfill") in which their construction should be started in advance.

Thereafter, Hanwha Corporation started writing the PDD of the CDM project, along with consulting company made a Contact. The schedule arrangement with DOE for validating the CDM project was suspended in a while because of Hanwha's making of selection of DOE.

For the above mentioned reasons, the collecting system and 1.065 MW generator was installed at Mokpo landfill site before registration of a CDM project.

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 6”.

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.

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

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:

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

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})

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."

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

ø	Model correction factor to account for model uncertainties (0.9)
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 (<15MW).

$MD_{reg,y}$ 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 13, 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 CO2equ/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 (2005-2007) from KEPCO'.

"Tool to calculate the emission factor for an electricity system (version 01)". The calculation is as follows:

STEP 1. Identify the relevant electric power system
For the purpose of determining the electricity emission factors, a project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (e.g. the renewable power plant location or the consumers where electricity is being saved) and that can be dispatched without significant transmission constraints.

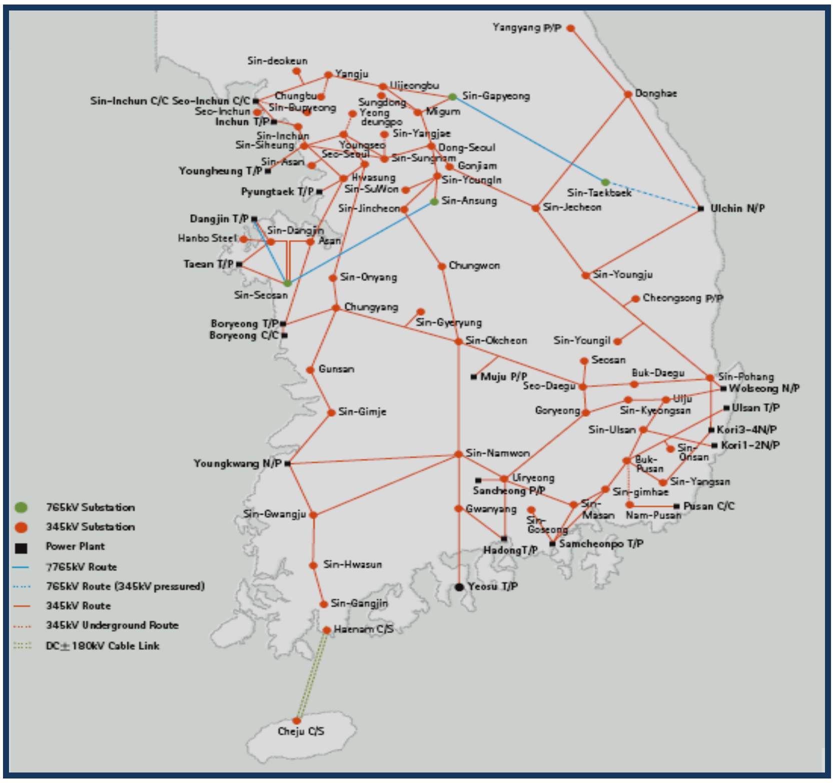
Similarly, a connected electricity system, e.g. national or international, is defined as an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched without significant transmission constraints but transmission to the project electricity system has significant transmission constraint.

If the DNA of the host country has published a delineation of the project electricity system and connected electricity systems, these delineations should be used. If such delineations are not available, project participants should define the project electricity system and any connected electricity system and justify and document their assumptions in the CDM-PDD. In doing so, the following criteria can be used to determine the existence of significant transmission constraints:

• In case of electricity systems with spot markets for electricity: there are differences in electricity prices (without transmission and distribution costs) of more than 5 percent between the systems during 60 percent or more of the hours of the year.

• The transmission line is operated at 90% or more of its rated capacity during 90% percent or more of the hours of the year.

In this sense, the electricity of the proposed project is connected to the KEPCO grid through transmission and distribution lines, which covers the national grid. Therefore the Korean national grid is chosen as relevant electricity power system to determine electricity emission factors.



<Fig. B-2> Electricity power grid in Korea
Source: 2008 Annual Report, Korea Electric Power Corporation

STEP 2. Select an operating margin (OM) method

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 (2003-2007) shows that the rate of low cost/must run is **41.49%** (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).

<Table B-5> Gross generation by energy sources (Unit: million kWh)

Source	2003	2004	2005	2006	2007	Total
Hydro*	6,887	5,861	5,189	5,219	5,042	28,198
Domestic Coal*1	5,398	4,603	4,484	4,312	4,470	23,267
Bituminous Coal1	114,878	122,556	129,174	134,894	150,204	651,706
Heavy Oil1	23,656	21,591	20,079	18,596	20,769	104,691
Diesel Oil1	2,870	474	412	599	446	4,801
Gas	39,091	55,999	58,118	68,302	78,427	299,937
Nuclear*	129,672	130,715	146,779	148,749	142,937	698,852
Alternative*	-	350	404	511	829	2,094
Total	322,452	342,148	364,638	381,181	403,124	1,813,543
The rate of low cost/must run power generation (%)	41.49%					

Source: Electricity statistics on Electricity quantity from Korea Electric Power Corporation
* : low-operating cost and must-run power plants
1 : Thermal

The Simple OM emission factor can be calculated using either of the two following data vintages for years(s) y:

• 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. On this PDD, ex-ante data were applied. The simple OM emission factor is calculated, as follows, in step 3.

STEP 3. Calculate the Operating Margin emission factor (EFgrid,OM,y)

The simple OM emission factor is calculated as the generation-weighed emissions per electricity unit of all generating units serving the system, excluding low-operating cost and must-run power plants. Low operating cost and must run power plants include hydro, nuclear, low cost biomass, geothermal and domestic coal. It is calculated based on data on fuel consumption and net electricity generation of each power plant /unit (Option A) as follows:

$$EF_{grid,\,OMsimple,\,y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO2,i,y}}{\sum_{m} EG_{m,y}} \qquad \textbf{(1)}$$

Where:

$EF_{grid,OMsimple,y}$ is Simple operating margin CO_2 emission factor in year y (tCO_2/MWh)
$FC_{i,m,y}$ is Amount of fossil fuel type ***i*** consumed by power plant / 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 CO_2 emission factor of fossil fuel type ***i*** in year y (tCO_2/GJ)
$EG_{m,y}$ is Net electricity generated and delivered to the grid by power plant / unit m in year y (MWh)
m is All power plants / units serving the grid in year y except low-cost / must-run power plants / units
i is All fossil fuel types combusted in power plant / unit m in year y
y is Either the three most recent years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (ex ante option) or the applicable year during monitoring (ex post option), following the guidance on data vintage in ***step 2***

In the case of this project, the applied parameters are presented for estimation of Operating Margin emission factor ($EF_{grid,OM,y}$) in Annex 3. As a result, the OM emission factor ($\mathbf{EF_{grid,OM,y}}$) is 0.6817 (tCO_2/MWh).

STEP 4. Identify the cohort of power units to be included in the Build Margin emission factor ($EF_{grid,BM,y}$)

The sample group of power unit m used to calculate the build margin consists of either:

(a) The set of five power units that have been built most recently, or
(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

Project participants should use the set of power units that comprises the larger annual generation.

As a general guidance, a power unit is considered to have been built at the date when it started to supply electricity to the grid.

Power plant registered as CDM project activities should be excluded from the sample group m. However, if the group of power units, not registered as CDM project activity, identified for estimating the build margin emission factor includes power unit(s) that is(are) built more than 10 years ago, then:

(i) Exclude power unit(s) that is (are) built more than 10 years ago from the group; and
(ii) Include grid connected power projects registered as CDM project activities, which are dispatched by dispatching authority to the electricity system.

Capacity additions from retrofits of power plants should not be included in the calculation of the build margin emission factor.

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, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2. For the first crediting period, the build margin emission factor shall be updated annually, ex-post, including those 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.

For this project, Option 1 was taken to calculate the Build Margin emission factor, $EF_{grid,BM,y}$ ex-ante, estimated in the Table below, in line with each regulation to compose proper sample groups(m) that the electricity quantity of candidate sample groups and their ratio to total generation in Korea.

<Table B-6> 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	33 MWh	84,736,759 MWh	Total generation is 385,990,619 MWh in Korea (based on KEPCO's data of the year 2007) CDM registered power plants generation is 376,177 MWh.
Proportion (ratio of total generation in Korea)	0.00001%	21.953%	

The annual generation of "the five power plants that have been built most recently" was 33MWh (0.00001% of total generation of the grid system), and the annual generation of "the power plants capacity additions in the electricity system that comprise 21.953% of the system generation and that have been built most recently" was 84,736,759MWh. Therefore, the latter was chosen for this project as a lager figure. Annex 3 presentes the sample group of plants used in the Build Margin emission factor ($EF_{grid,BM,y}$).

STEP 5. Calculate the build margin emission factor ($EF_{grid,BM,y}$)

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, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} \qquad (2)$$

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

According to the BM calculation formula and variables of above tables, $EF_{BM,y}$ is 0.3933 (tCO_2/MWh).

STEP 6. Calculate the combined margin emissions factor ($EF_{grid,CM,y}$)

The combined margin emissions factor is calculated using the following formula:

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

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 this tool.

Alternative proportions can be proposed, as long as $w_{OM} + w_{BM} = 1$, for consideration by the Executive Board, taking into account the guidance as described below. The values for $w_{OM} + w_{BM}$ applied by project participants should be fixed for a crediting period.

Therefore baseline emission factor ($EF_{grid,CM,y}$) for this project is = 0.5375 (tCO_2/MWh) as follows:

$$EF_{grid,CM,y} = w_{OM} \cdot EF_{grid,OM,y} + w_{BM} \cdot EF_{grid,BM,y}$$
$$= 0.5 \cdot 0.6817\ (tCO_2/MWh) + 0.5 \cdot 0.3933\ (tCO_2/MWh)$$
$$= 0.5375\ (tCO_2/MWh)$$

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

Data / Parameter:	**ø**
Data unit:	NA
Description:	Model correction factor to account for model uncertainties
Source of data used:	Default value "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site"
Value applied:	0.9
Justification of the choice of data or description of measurement methods and procedures actually applied :	Oenk et al.(1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results.
Any comment:	

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. Mokpo 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 to determine methane emissions avoided from dumping waste at a solid waste disposal site," which must be used to estimate methane emission potential in accordance with AMS III.G.
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:	see table below
Justification of the choice of data or description of measurement methods and procedures actually applied :	Using 2006 IPCC default values; conservation factor was chosen for DOC_j.
Any comment:	

Waste type j	DOC_j (% wet waste)
Wood and wood product	43%
Pulp, paper and cardboard (other than sludge)	40%
Food, food waste, beverages and tobacco	15%
Textiles	24%
Garden, yard and park waste	20%
Glass, plastic, metal, other inert waste	0%

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:	

Data / Parameter:	**k_j**
Data unit:	NA
Description:	Decay rate for the waste type j

<table>
<tr><td>Source of data used:</td><td colspan="3">IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 3.3)</td></tr>
<tr><td rowspan="6">Value applied:</td><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>
<tr><td colspan="3"></td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied :</td><td colspan="3">Climate data for the Mokpo landfill: 30 years was chosen as a period long-term average.
Mean annual temperature: 13.8 ℃
Annual precipitation: 1125.1 mm
Potential evaporation: 1164.2 mmr</td></tr>
<tr><td>Any comment:</td><td colspan="3">Based on data observed at meteorological observatory in Mokpo 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:	Mokpo landfill data
Value applied:	Refer to xls sheet named “composition rate” - Estimation of waste composition rate in Mokpo landfill (1996-2006) - The result of re-classification using IPCC(2006) Guideline grouping criteria (1996-2006)
Justification of the choice of data or description of measurement methods and procedures actually applied :	The waste composition in each waste type of the project landfill site is calculated by the two different waste composition rates; for 1996-2004 and for 2005-2006. Caused by the regulation: food waste prohibited from filling in the landfill by 2005. Each year data for 1996-2004 is applied to calculate waste composition rate before the regulation and the average data for 2005-2006 was applied to calculate waste composition rate to meet Korean Waste Control Act.
Any comment:	Ministry of Environment, "Status of waste disposal and treatment (1996-2006)”

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	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

and procedures actually applied :	
Any comment:	

Data / Parameter:	**Operation Margin Emission Factor (*EF_{OM}*)**
Data unit:	ton CO_2 e/MWh
Description:	The generation-weighted average of CO_2 emission per electricity unit generated by the existing grid-connected power plants.
Source of data used:	“Statistics of Electric Power in Korea”
Value applied:	0.6817
Justification of the choice of data or description of measurement methods and procedures actually applied :	The simple OM method is used to calculate $\mathbf{EF_{OM}}$ 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. $\mathbf{EF_{OM}}$ is calculated using the data for the most recent 3 years (2005-007) for which data are available at time of this PDD submission, and fixed for the crediting period.
Any comment:	The detail data is described on B.6.1

Data / Parameter:	**Build Margin Emission Factor (*EF_{BM}*)**
Data unit:	ton CO_2 e/MWh
Description:	The generation-weighted average of CO_2 emission per electricity unit generated by additionally constructed power plants.
Source of data used:	“Statistics of Electric Power in Korea”
Value applied:	0.3933
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. the value $\mathbf{EF_{BM}}$ is fixed for the crediting period.
Any comment:	The detail data is described on B.6.1

Data / Parameter:	**CO_2 Emission Intensity of the Electricity displaced (*$CEF_{electricity}$*)**
Data unit:	ton CO_2 e/MWh
Description:	The weighted average of ***EF_{OM}*** and ***EF_{BM}***
Source of data used:	“Statistics of Electric Power in Korea”
Value applied:	0.5375
Justification of the choice of data or description of measurement methods and procedures actually applied :	CO_2 Emission Intensity has to be calculated by combining ***EF_{OM}*** and ***EF_{BM}*** with an appropriate weight, because the quantities of electricity displaced are come from both existing power plant and new plant. The weight is suggested by default in AMS-I.D. 0.5 for both ***EF_{OM}*** and ***EF_{BM}*..** In this project, the default weight is used.

Any comment:	The detail data is described on B.6.1

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 CH4 recovery and combustion in year, y

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

<Table B-7> Emission reduction by this project (unit: ton CO_2e)

Year	$ER_{y,estimated}$	=	$ER_{y,\,CH4}$	+	$ER_{y,\,electricity}$
2009	13,712	=	11,911	+	1,801
2010	24,220	=	21,038	+	3,182
2011	24,831	=	21,569	+	3,262
2012	25,350	=	22,020	+	3,331
2013	25,783	=	22,396	+	3,387
2014	26,137	=	22,703	+	3,434
2015	26,417	=	22,946	+	3,471
2016	26,630	=	23,131	+	3,499
2017	26,780	=	23,262	+	3,519
2018	26,874	=	23,343	+	3,531
2019	11,214	=	9,741	+	1,473

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

$ER_{y,\,,estimated}$ 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 CH4 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-8> Emission reduction by capture and combustion of CH_4

Year	$ER_{y,\ CH4}$	=	$BE_{y,\ CH4}$	-	$PE_{y,\ CH4}$	-	Leakage
2009	11,911	=	11,911	-	0	-	0
2010	21,038	=	21,038	-	0	-	0
2011	21,569	=	21,569	-	0	-	0
2012	22,020	=	22,020	-	0	-	0
2013	22,396	=	22,396	-	0	-	0
2014	22,703	=	22,703	-	0	-	0
2015	22,946	=	22,946	-	0	-	0
2016	23,131	=	23,131	-	0	-	0
2017	23,262	=	23,262	-	0	-	0
2018	23,343	=	23,343	-	0	-	0
2019	9,741	=	9,741	-	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-9> Baseline emission of CH_4

Year	$BE_{y,CH4}$	=	$BE_{CH4,SWDS,y}$	-	$MD_{reg,y}$
2009	11,911	=	11,911	-	0
2010	21,038	=	21,038	-	0
2011	21,569	=	21,569	-	0
2012	22,020	=	22,020	-	0
2013	22,396	=	22,396	-	0
2014	22,703	=	22,703	-	0
2015	22,946	=	22,946	-	0
2016	23,131	=	23,131	-	0

2017	23,262	=	23,262	-	0
2018	23,343	=	23,343	-	0
2019	9,741		9,741		0

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

<Table B-10> the emission reduction claimed for the displaced electricity

Year	$ER_{y, electricity}$	=	$BE_{y, electricity}$	-	$PE_{y, electricity}$	-	Leakage
2009	1,801	=	1,802	-	1	-	0
2010	3,182	=	3,183	-	1	-	0
2011	3,262	=	3,263	-	1	-	0
2012	3,331	=	3,332	-	1	-	0
2013	3,387	=	3,389	-	1	-	0
2014	3,434	=	3,435	-	1	-	0
2015	3,471	=	3,472	-	1	-	0
2016	3,499	=	3,500	-	1	-	0
2017	3,519	=	3,520	-	1	-	0
2018	3,531	=	3,532	-	1	-	0
2019	1,473	=	1,474	-	1	-	0

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

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 (0.03)

CEF Combined emission factor in electricity generation by grid system; weighed average of EF_{OM} and EF_{BM}. (0.5375 ton CO_2e/MWh)

<Table B-11> Baseline emissions from electricity by the project

Year	$BE_{y, electricity}$	=	**EG_y**	*	**$(1-p_{IC, y})$**	*	**CEF**
2009	1,802	=	3,457	*	(1-0.03)	*	0.5375
2010	3,183	=	6,105	*	(1-0.03)	*	0.5375
2011	3,263	=	6,259	*	(1-0.03)	*	0.5375
2012	3,332	=	6,390	*	(1-0.03)	*	0.5375
2013	3,389	=	6,499	*	(1-0.03)	*	0.5375
2014	3,435	=	6,588	*	(1-0.03)	*	0.5375
2015	3,472	=	6,659	*	(1-0.03)	*	0.5375

2016	3,500	=	6,713	*	(1-0.03)	*	0.5375
2017	3,520	=	6,751	*	(1-0.03)	*	0.5375
2018	3,532	=	6,774	*	(1-0.03)	*	0.5375
2019	1,474	=	2,827	*	(1-0.03)	*	0.5375

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

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) (16.20)

GC Generation capacity (MW) (2.123)

h_{year} Hours per year (8,000)

<Table B-12> Gross quantity of electricity generated by the project activity in year, y

Year	EG_y	=	(LFG_y	/	LFG_{max})	*	GC * h_{year}
2009	3,457	=	3.30	/	16.20	*	2.123*8,000
2010	6,105	=	5.82	/	16.20	*	2.123*8,000
2011	6,259	=	5.97	/	16.20	*	2.123*8,000
2012	6,390	=	6.10	/	16.20	*	2.123*8,000
2013	6,499	=	6.20	/	16.20	*	2.123*8,000
2014	6,588	=	6.28	/	16.20	*	2.123*8,000
2015	6,659	=	6.35	/	16.20	*	2.123*8,000
2016	6,713	=	6.40	/	16.20	*	2.123*8,000
2017	6,751	=	6.44	/	16.20	*	2.123*8,000
2018	6,774	=	6.46	/	16.20	*	2.123*8,000
2019	2,827	=	2.70	/	16.20	*	2.123*8,000

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

GWP Global warming potential (21)

D_{CH4} Density of CH4 (m^3 CH_4/m^3 LFG) (0.0007168)

$w_{CH4,y}$ Methane fraction in landfill gas (%) (0.5)

Min_{year} Minutes per year (min) (480,000)

<Table B-13> 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}
2009	3.30	=	11,911	/	21	/	0.0007168	/	0.5	/	480,000

2010	5.82	=	21,038	/	21	/	0.0007168	/	0.5	/	480,000
2011	5.97	=	21,569	/	21	/	0.0007168	/	0.5	/	480,000
2012	6.10	=	22,020	/	21	/	0.0007168	/	0.5	/	480,000
2013	6.20	=	22,396	/	21	/	0.0007168	/	0.5	/	480,000
2014	6.28	=	22,703	/	21	/	0.0007168	/	0.5	/	480,000
2015	6.35	=	22,946	/	21	/	0.0007168	/	0.5	/	480,000
2016	6.40	=	23,131	/	21	/	0.0007168	/	0.5	/	480,000
2017	6.44	=	23,262	/	21	/	0.0007168	/	0.5	/	480,000
2018	6.46	=	23,343	/	21	/	0.0007168	/	0.5	/	480,000
2019	2.70	=	9,741	/	21	/	0.0007168	/	0.5	/	480,000

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

$EL_{IMP,\ PJT,\ y}$ 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-14> Project emission to operate LFG utilizing facilities

Year	$PE_{y,\ electricity}$	=	$(EL_{IMP,PJT,y}$	-	$EL_{IMP,BASE,y})$	*	**CEF**
2009	1	=	2.016	-	0	*	0.5375
2010	1	=	2.016	-	0	*	0.5375
2011	1	=	2.016	-	0	*	0.5375
2012	1	=	2.016	-	0	*	0.5375
2013	1	=	2.016	-	0	*	0.5375
2014	1	=	2.016	-	0	*	0.5375
2015	1	=	2.016	-	0	*	0.5375
2016	1	=	2.016	-	0	*	0.5375
2017	1	=	2.016	-	0	*	0.5375
2018	1	=	2.016	-	0	*	0.5375
2019	1	=	2.016	-	0	*	0.5375

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

<Table B-15> Emission Reductions from methane destruction

Year	Estimation of project activity emissions (ton CO_2e)	Estimation of baseline emissions (ton CO_2e)	Estimation of leakage (ton CO_2e)	Estimation of emission reductions (ton CO_2e)
2009	0	11,911	0	11,911
2010	0	21,038	0	21,038
2011	0	21,569	0	21,569

2012	0	22,020	0	22,020
2013	0	22,396	0	22,396
2014	0	22,703	0	22,703
2015	0	22,946	0	22,946
2016	0	23,131	0	23,131
2017	0	23,262	0	23,262
2018	0	23,343	0	23,343
2019	0	9,741	0	9,741
Total (ton CO2e)	0	224,060	0	224,060

<Table B-16> Emission Reductions from grid displacement

Year	Estimation of project activity emissions (ton CO2e)	Estimation of baseline emissions (ton CO2e)	Estimation of leakage (ton CO2e)	Estimation of emission reductions (ton CO2e)
2009	1	1,802	0	1,801
2010	1	3,183	0	3,182
2011	1	3,263	0	3,262
2012	1	3,332	0	3,331
2013	1	3,389	0	3,387
2014	1	3,435	0	3,434
2015	1	3,472	0	3,471
2016	1	3,500	0	3,499
2017	1	3,520	0	3,519
2018	1	3,532	0	3,531
2019	1	1,474	0	1,473
Total (ton CO2e)	12	33,901	0	33,889

<Table B-17> Estimation of emission reductions from the project

Year	Estimation of emission reductions from LFG destruction (ton CO2e)	Estimation of emission reductions from gird displacement (ton CO2e)	Estimation of emission reductions (ton CO2e)
2009	11,911	1,801	13,712
2010	21,038	3,182	24,220
2011	21,569	3,262	24,831
2012	22,020	3,331	25,350

2013	22,396	3,387	25,783
2014	22,703	3,434	26,137
2015	22,946	3,471	26,417
2016	23,131	3,499	26,630
2017	23,262	3,519	26,780
2018	23,343	3,531	26,874
2019	9,741	1,473	11,214
Total (ton CO2e)	224,060	33,889	257,949

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

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

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)
CEF	tCO_2e	Combined emission factor in electricity generation by grid-connected system; weighted average of EF_{OM} and EF_{BM}.

CEF is 0.5375 tCO_2e/MWh and this is fixed factor during crediting period.

As described above B.4, Mokpo 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:	**f**
Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data:	Written information from the operator of the solid waste disposal site and/or site visits at the solid waste disposal site
Value of data:	0
Brief description of measurement methods and procedures to be applied:	Monitored annually
QA/QC procedures:	Not applied.
Any comment:	Not applied.

Data / Parameter:	**GWP_{CH4}**
Data unit:	tCO_2e / t CH_4
Description:	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
Source of data:	Decisions under UNFCCC and the Kyoto Protocol
Value of data:	21(to be applied for the first commitment period of the Kyoto Protocol) 25(to be applied for the secondary commitment period of the Kyoto Protocol)
Brief description of measurement methods and procedures to be applied:	Monitored annually
QA/QC procedures:	Not applied.
Any comment:	Not applied.

Data / Parameter:	**$LFG_{electricity, y}$**
Data unit:	Nm^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 Mokpo Operation team should check the measured data continuously. - Accuracy is +/- 1.0 of F.S - Sensor response time is one second - Flow rate is 1,400 Nm3/h - Temperature is 50 ℃ - Pressure is 200 mmbar
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. No separate monitoring of temperature and pressure when expressing LFG volumes in normalized cubic meters

Data / Parameter:	$\mathbf{w_{CH4,y}}$
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 Mokpo Operation team should check the measured data continuously. - Linearity is +/- 1% of F.S - Zero drift is +/- 2% of F.S - Span Drift is +/- 2% of F.S - Response time is 15~30 seconds - Operating condition’s temperature is – 5 ℃ to 45 ℃
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:	$\mathbf{EL_{EXP,\,PJT,\,y}}$
Data unit:	MWh
Description:	Total amount of electricity exported out of the project
Source of data:	Read from watt-hour meter
Value of data :	The estimation result is presented in B.6.3

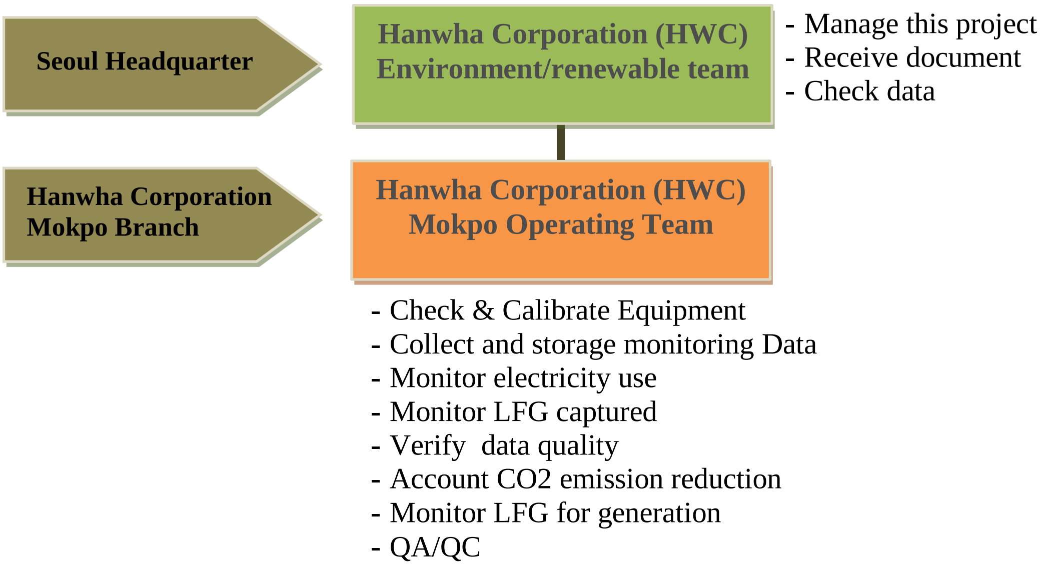
Brief description of measurement methods and procedures to be applied:	Two watt-hour meters were installed to measure the amount of exported electricity. The amount of exported electricity is measured automatically by certified watt-hour meters which are connected to Korea Power Exchange (KPX) and cross-checked by sales receipts from KPX. The measured data are transferred to KPX and collected data shall be compared with those of sales receipt of KPX (http://epsis.kpx.or.kr).. Measured by watt-hour meter
QA/QC procedures to be applied:	The watt-hour meters are subject to a regular maintenance and testing regime to ensure accuracy. Comply with "Act for measurement", "Regulation for operation of electricity market" of South Korea. Calibrate the meter every two 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:	**$EL_{IMP, PJT, y}$**
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
QA/QC procedures to be applied:	The watt-hour meter is subject to a regular maintenance and testing regime to ensure accuracy. Comply with "Act for measurement", "Regulation for operation of electricity market" of South Korea. Calibrate the meter every two 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.

B.7.2 Description of the monitoring plan:

Data and parameters provided in Section B.7.1 will be monitored and their measurement method will be referred to Section B.7.1l. "Operating Manure-Mokpo LFG Power Plant" 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-3> The structure of monitoring system

<Table B-18> The responsible party for each task of monitoring.

Item	Sub-item	Responsible person
Measure & Archive	**$LFG_{electricity,y}$**	Responsible person/department for the project : Kunhong, Lee (LFG Plant Manager) / Mokpo Operating Team of HWC Mokpo branch
	$w_{CH4,y}$	
	$EL_{EXP,PJT,y}$	
	$EL_{IMP,PJT,y}$	
Measuring instrument check & Calibration	**Centralized monitoring system**	Responsible person/department for the project : Kunhong, Lee (LFG Plant Manager) / Mokpo Operating Team of HWC Mokpo branch
	Flow meter	
	Gas analyzer	
	Watt-hour meter	Responsible person/department for the project: Korea Power Exchange (According to “Law regarding measurement” and : act on operation of electricity market”)
Establish monitoring plan		Responsible person/department for the project : Kunhong, Lee (LFG Plant Manager) / Mokpo Operating Team of HWC Mokpo branch Jihyun, Park (LFG CDM Project Manager) / Environment /Renewable Team of HWC Headquarter
Task coordination		

Monitoring report	Responsible person/department for the project : Kunhong, Lee (LFG Plant Manager) / Mokpo Operating Team of HWC Mokpo branch Jihyun, Park (LFG CDM Project Manager) / Environment /Renewable Team of HWC Headquarter

The monitoring equipments to measure amount of methane and electricity

- Gas flow meters are installed between the blower and generating facility to measure LFG flow rate, LFG volumes expressing in normalized cubic meters.

- 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 measuring meters are to be set-up transparently in accordance with "Law regarding measurement" and "Act on operation of electricity market". Thereafter, the meters are calibrated when installed behind the generator and sealed up after affirmation of Korea Power Exchange. The certified sheet of measurement registration is submitted to DOE.

- A watt-hour meter for 2nd generator was installed on January 27th, 2013. Hanwha Corporation added the watt-hour meter for 2nd generator, which requested it under the "Act on the promotion of the development, use and diffusion of new and renewable energy". In previous installation, total amount of exported electricity out of project had been monitored by Wa watt-hour meter, Wa as shown in figure B-4 below.

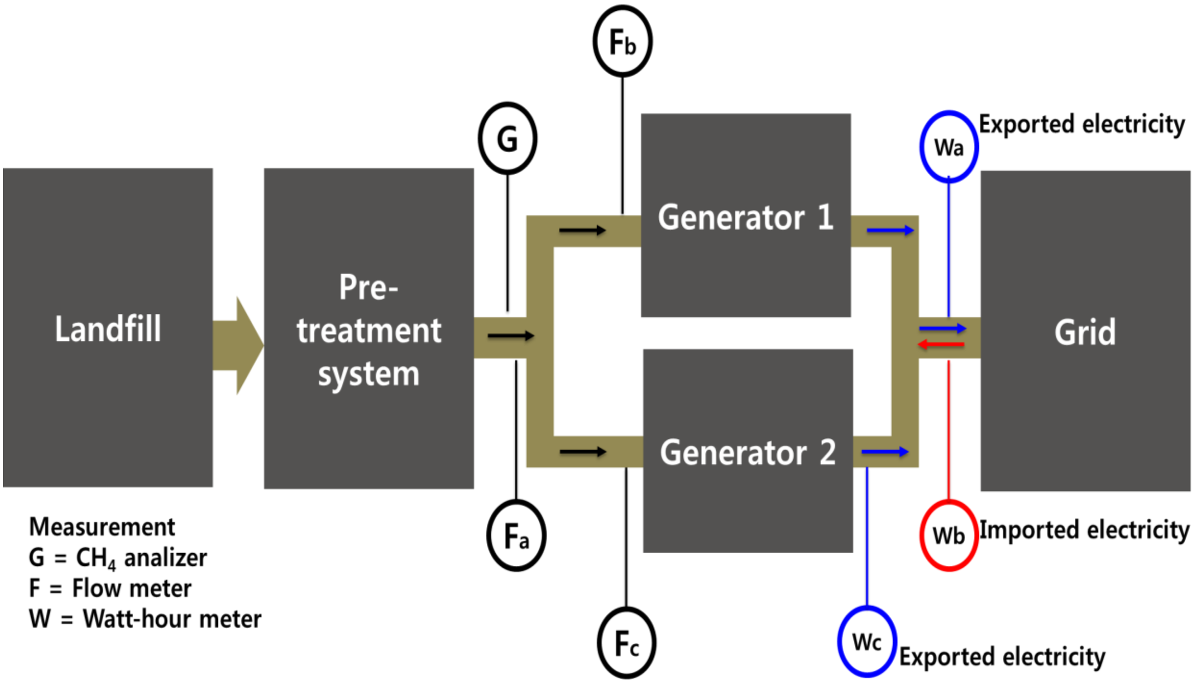
Wa watt-hour meter had been installed as measure of the amount of exported electricity in Mokpo LFG plant.

After installation watt-hour meter for 2nd generator (Wc) in this monitoring period, the amount of exported electricity is expressed as follows:

· Case 1 (only 1st generator operating): The amount of exported electricity = Wa

· Case 2 (only 2nd generator operating): The amount of exported electricity = Wc

· Case 3 (Both 1st generator and 2nd generator operating): The amount of exported electricity = Wa



<Fig. B-4> The Location of the Monitoring facilities

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

LFG Plant manager is the responsible person 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.

- Three gas flow meters will be installed to ensure that if one of the meters has a problem to measure LFG flow rate, the two remainings are measured to calculate the amount of landfill gas. Otherwise, the IPCC default factor will be used for methane content in the LFG, if a methane analyzer has a problem.

Before installation the watt-hour meter for 2nd generator (Wc), total amount of exported electricity out of project had been monitored by Wa.

After installation of Wc, Wc is used to measure only if 2nd generator was operated. When 1st generator or both 1st and 2nd generator operates, Wa is used to measure the amount of exported electricity

- A watt-hour meter was installed to measure the amount of imported electricity. Imported electricity for Mokpo LFG power plant was monitored by watt-hour meter (Wb) which managed and monthly invoiced by Korea Electric Power Corporation (KEPCO).
- They are collected daily, weekly and monthly. If the landfill site data were to differ 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.

Related watt-hour meters

Tag	Description	Accuracy level	Remarks
W_a	Exported electricity (1st generator)	0.5s	
W_c	Exported electricity (2nd generator)	0.5s	A watt-hour meter for 2nd generator (Wc) was installed on January 27th, 2013. Wc added requested it under the "Act on the promotion of the development, use and diffusion of new and renewable energy".
W_b	Imported electricity	1s	

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 Mokpo Operation team should check them continuously.

Equipment calibration and maintenance:

- LFG Plant Manager 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 LFG Plant Manager if necessary.

The watt-hour meters are subject to a regular maintenance and testing regime to ensure accuracy. This is in compliance with the "Act for measurement" and "Regulation for operation of electricity market" of South Korea; under this regulation, the calibration period is every two years.

Corrective action:

LFG Plant manager will report all issues and data related to plant operation to LFG CDM Project manager (Environment/renewable team).
Operation review, internal audit and corrective action is carried out by Environment/renewable team, according to the "Mokpo LFG Power Plant Operation Manual".

Emergency procedure:

In case of emergency situation, proper action is carried out to minimize damage in accordance with "Mokpo LFG Power Plant Operation Manual".

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 with 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: 16 January 2009
Responsible person / entity is as follows

Ji hyun, Park
Hanwha Corporation
100-797 # 1 Janggyodong, Junggu 22F. Hanwha Bldg. Seoul, Republic of Korea
Phone: 82-2-729-3543
Email: jihyunpark@hanwha.co.kr

Jung ju, Park
EcoNetwork Co., Ltd. (Climate Change Consulting)
137-888 # 502, 13-10, Sukbong B/D., Yangjae-dong, Seocho-gu, Seoul, Republic of Korea
Phone: 82-2-723-3913
Email: greenjaypark@gmail.com

The detailed information is attached to Annex 1.

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:

10/04/2008 (the date is real action for the project activity)

C.1. 2. Expected operational lifetime of the project activity:

15years

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

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

C.2.1.2. Length of the first crediting period:

C.2. 2. Fixed crediting period:

C.2.2.1. Starting date:

The date of registration

C.2.2.2. Length:

10years

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 10 MW and/or more. Therefore Mokpo landfill does not need to take an EIA as total capacity of electricity generator is 2.130 MW. But the EIA of Mokpo landfill is carried out in compliance with Clean Air Conservation Act to measure even small environmental impact.

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 contributes to climate change, 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 of landfill

Although environmental impact assessment is not enforced for the project, project participants should assess possible environmental impacts caused by the project activity or landfill operations.

EIA should be assessed for the protection of the populations and landfill surroundings at periodic intervals and should gain public confidence by publishing the results of EIA to the general public while operating the Mokpo landfill under the EIA regulation.

The EIA's result of Mokpo landfill is satisfied under Korean regulations and the project had no significant environmental impacts. The project not only reduces the uncontrolled release of landfill gas, but also the pollutants caused by the landfill to the air, water and soil quality in the local area.

From environmental protection perspectives, the 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

<table>
<tr><td>Study period</td><td colspan="2">From February 2007 to February 2008</td></tr>
<tr><td rowspan="2">Subject of study</td><td>Air</td><td rowspan="2">Each season
(spring, summer, autumn, winter)</td></tr>
<tr><td>Noise</td></tr>
</table>

	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 14 pollutants. Four points (watercourse, lake, underground water, and leachate) were tested and analyzed to show water quality did meet the environmental policy regulation.

-Noise and Vibration
The level of noise around the landfill site is below the Korean regulation level and the landfill site is far from the residential area and subsequently not influenced directly. Considering this study, the problems from noise or vibration do not occur in the landfill site.

-Soil
Under the fundamental law of environmental policy, soil quality was measured including 13 pollutants. According to the measurements, the topsoil of Mokpo landfill was not influenced by the landfill.

Environmental impacts of CDM project
Considering environmental impacts from the proposed project activities and relevant landfill operations, Hanwha Corporation carries out environmental impacts of the matters to be considered, even though Mokpo landfill does not need to do so. The result of the measurements are implemented and addressed below:

-Generator's operating noise and vibration
According to Korean Noise and Vibration Regulation, the landfill where the generator is located must obey regulations within a 300-meter radius. Mokpo landfill is outside the purview of this regulation, as the residential area is outside the 300-meter radius limit. The permissible level of noise and vibration emission is expressed in the following table.
Nevertheless to recognize the environmental impacts from noise and vibration of an operating generator, 14 points around the generator are selected to measure the quantity of noise and vibration for 5 minutes during daytime and evening. Except in front of the power plant, Mokpo landfill has satisfactory noise and vibration levels and the average measured value is expressed in the table <Table D-2>. Mokpo landfill is in the "Agriculture/forestry and natural environmental conservation area".

<Table D-2>The permissible emission level of noise and vibration

Area	Day time (06:00-18:00)	Evening (18:00-24:00)	Night time (24:00-06:00)
City	Below 50 dB	Below 45 dB	Below 40 dB

Residential area	Below 55 dB	Below 50 dB	Below 45 dB
Agriculture/forestry and natural environmental conservation area	Below 60 dB	Below 55 dB	Below 50 dB
Business and heavy industry area	Below 65 dB	Below 60 dB	Below 55 dB
Industry area	Below 70 dB	Below 65 dB	Below 60 dB

<Table D-3>The measured value of Mokpo landfill's noise and vibration

Area	Far from generator (m)	Day time (dB)	Evening (dB)
In front of power plant	2	68.8	69.1
Landfill site	About 230	42.8	40.8
The end of landfill	About 500	41.2	40.1
In front of environmental management office	About 150	47.6	39.4
Residential area around landfill ①~⑤	Average 400~500	Average 39.8	No detection due to roadway noise

Villages are located far from landfill and the roadway noise remains as one of the back noises which cannot be eliminated. Roadway noise is approximately 42dB, so exact generator noise levels cannot be established. Therefore, the generator would have no impact on the residents.

-Emission concentration of exhaust fumes from generator

Nitrogen Oxide
In accordance with The Air Environment Conservation Act and its Enforcement Regulation, any landfill installed with a 120 kW capacity generator, or more, has to control NO_2 emissions. According to permitted emission levels of exhaust fumes of this regulation, NO_2 must be 125 ppm or under in landfills utilizing LFG. To meet this regulation, the materials of table below were measured twice and the result of Mokpo landfill satisfies the permissible emission levels. Furthermore, NO_2 should be simultaneously measured during crediting period by calibration of flow meter and gas analyzer. If necessary, pollution control facilities should be installed to meet "Environmental Regulations".

<Table D-4> The permissible emission level and measured value of target materials

Material	Average Value (measured twice)	Permissible Emission Level (set by the air environment conservation act)
CO	959.5 mg/m^3	No permissible emission level under the environment regulation
NO	374.5 mg/m^3	No permissible emission level under the environment regulation
NO_2	96.6 mg/m^3	256.7 mg/m^3
NOx	471.5 mg/m^3	No permissible emission level under the environment regulation

Sulfur Oxide

This material, H_2S, this 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 Hanwha Corporation installed H_2S remover, and Efficiency test for H_2S remover was carried out and the concentration of sulfur oxide was measured by Korea Testing and Research institute (KTR). Sulfur oxide was not detected in landfill gas through the H_2S remover.

All measured data for environmental impacts of CDM project is submitted to DOE.

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 Mokpo City stakeholder's website (www.mokpo.go.kr/home).

<Fig. E-1> Project announcement of Mokpo landfill project

Mokpo City held a meeting to describe the proposed project and visited the project site with 42 participants and stakeholders on November 2006. Presentations were given to allow 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 "Mokpo landfill LFG Recovery to

Electricity project". Furthermore the comments from local experts have been advised and incorporated into the proposed project activities.

The meeting was composed of the following contents
- General explanation of proposed project
- The necessity of utilizing LFG to generate electricity
- The plans of installing collecting system and generators
- The operating plans

E.2 . Summary of the comments received:

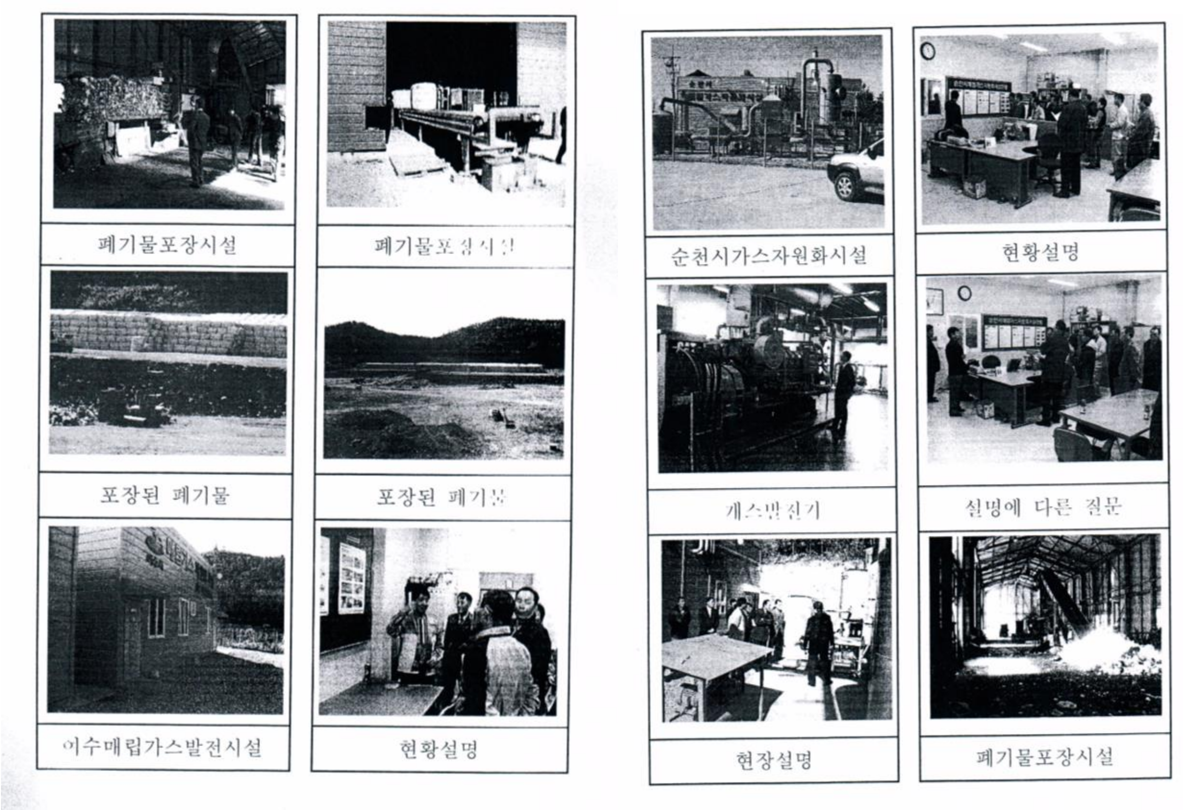
The stakeholders agreed to the project plan which has many benefits for environment and stakeholders; by collecting and using LFGs emitted from the landfill, it fosters sanitary treatment and stabilization of landfill as well as resolving stakeholders' comments about odours and pollutants. For these reasons, the project activities create no adverse effects.

The contents of Mokpo City's suggestions and comments
- Prevention of safety concerns about air pollutants, odour problems and explosion from LFGs
- Resolving public discomfort and saving money through the proposed project

The contents of stakeholders' suggestions and comments
- Prevention of safety concerns about air pollutants, odour problems and explosion from LFGs
- All the stakeholders allowed Investor to utilize LFGs to generate electricity and CDM project
- But, the generators should be dismantled completely after the project

No other comments have been received from stakeholders except the above "contents of stakeholders' suggestions and comments": they understand the benefits of the proposed project of utilizing LFG and CDM project for Mokpo city and stakeholders.

Stakeholders' comments will have been received continuously until the end of the proposed project via Mokpo City's Website (http://www.mokpo.go.kr). The comments should be reported and discussed on the stakeholder meetings.



<Fig. E-2> The photographs to study and discuss the Mokpo landfill project
Source: Mokpo official letter, November 2006

시정조정위원회 심의결과 의견서

□ 위생매립장 매립가스(LFG)발전시설 설치 심의(안)

직 위	직 명	성 명	심의결과			
			가	부	심의의견	서명
위원장	시 장	정종득			없음	정종득
부위원장	부 시 장	이종범	○		없음	이종범
위원	기획관리 국 장	조성평	○		없 음	조성평
〃	주민복지 국 장	박철련	○		없 음	박철련
〃	관광문화 국 장	박병옥	○		없음	박병옥
〃	경제환경 수산국장	추영동	○		〃	추영동
〃	도시건설 국 장	길의식	○		없 음	길의식
〃	보건소장	김일용	○		없 음	김일용
〃	상하수도 사업소장	정은면			출 장	
위원	도시개발 사업소장	서강열	○		없 음	서강열

<Fig. E-3> the signatures of stakeholders
Source: Mokpo official letter, November 2006

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

Organization:	Hanwha Corporation
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URL:	http://english.hanwhacorp.co.kr/
Represented by:	Jihyun Park
Title:	
Salutation:	Ms.
Last Name:	Park
Middle Name:	
First Name:	Jihyun
Department:	Trade Division, Business Development Department
Mobile:	
Direct FAX:	
Direct tel:	
Personal E-Mail:	

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding is involved in the project.

Annex 3

BASELINE INFORMATION

The total quantity of GHG emission reductions by this 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 power generating system to generate the same amount of power displaced by the project. For the first, the procedure to estimate the amount of the LFGs generated from the landfill and the result are presented in Step 1. For the second, the appropriate equations to calculate CO_2 emission intensity (carbon dioxide emitted per unit of electricity) factor of the electricity displaced and the source data are provided in conformity with the approved methodology selected in the section B.

Further waste estimation is calculated by multiplying the population growth of Mokpo city (-0.32%) and increase rate of per capita municipal waste disposal (-0.42%). The result of further estimation waste going to Mokpo landfill is shown below table from 2007 to 2022.

<Table Annex-1> Factor to estimate the future waste disposal in the project landfill site

year	waste disposal and treatment (per capital)	population (Mokpo)
2002	1.03	245,315
2003	1.14	241,460
2004	0.88	242,380
2005	1.02	242,988
annual average growth rate	-0.42%	-0.32%

Source: Master plan for waste disposal and treatment in Jeollanam-do 2007

The actual quantity in 2006 and the next quantity waste estimated in 2007 – 2022 are shown below. Mokpo landfill starting year was in 1996, and expected completion year will be 2022.

<Table Annex -2> Result of further estimation waste going to Mokpo landfill

year	existing waste	Estimation
1996	63,875	63,875
1997	58,400	58,400
1998	66,795	66,795
1999	59,495	59,495
2000	80,300	80,300
2001	73,949	73,949
2002	75,336	75,336
2003	83,476	83,476
2004	57,634	57,634
2005	61,466	61,466
2006	67,124	67,124
2007		66,627
2008		66,134
2009		65,644

2010		65,158
2011		64,676
2012		64,197
2013		63,722
2014		63,251
2015		62,783
2016		62,318
2017		61,857
2018		61,399
2019		60,944
2020		60,493
2021		60,046
2022		59,601

Source: Ministry of Environment, "Status of waste disposal and treatment" 1996-2006

Methane emission potential of landfill site shall be estimated to determine the baseline CH_4 emissions of this project in accordance with AMS III.G_V6. The estimation is to be undertaken using the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal." The table below presents variables, parameters, and data sources needed to determine the baseline emissions for CH_4.

< Table Annex-3>Data used to determine the CH_4 baseline emissions

Variable /Parameter	Unit	Description	Source
ø	0.9	Model correction factor to account for model uncertainties	Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site
f	0	Fraction of methane captured at SWDS and flared, combusted or used in another manner	Project developer-no LFG captured or utilized on site
GWP_{CH4}	21 tCO_2/tCH_4	Global warming potential of methane	Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site
OX	0.1	Oxidation factor	Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site
F	0.5	Fraction of methane in the landfill	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
DOC_f	0.5	Fraction of degradable organic carbon (DOC) that can decompose	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
MCF	1	Methane correction factor	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
$W_{j,x}$	Tonnes	Total amount of organic waste type j filled in the year, x	Ministry of Environment, "Status of waste disposal and treatment" 2002, 2003, 2004, 2005,2006
DOC_j	-	Fraction of degradable organic carbon (by weight) in the waste type j	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
k_j	-	Decay rate for the waste type j	Tool to determine methane emissions

Variable /Parameter	Unit	Description	Source
			avoided from dumping waste at a solid waste disposal site * Korean Metrological Administration

< Table Annex-4>Data used to determine the CO_2 baseline emissions

Variable /Parameter	Unit	description	Source
EG_y	MWh	Electricity generated by the project in year, y	Feasibility study report (expected value according to design of the project)
$F_{i,j,y}$	ton or m^3	The amount of fuel *i*(in a mass or volume unit) consumed by relevant power sources j in year(s) y, *j* refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports to the grid	Statistics of Electric Power in KOREA (2005, 2006, 2007) (KEPCO)
$CV_{i,j,y}$	Kcal	Net Calorific Values of fuel *i* consumed by power source *j* in year, *y*	Statistics of Electric Power in KOREA 2005, 2006, 2007 (KEPCO)
EF_i	TC/TJ	Carbon Emission Factor of fuel *i* (tC/TJ)	IPCC 2006 Revised Guidelines
OXID	-	Fraction of Carbon Oxidised (OXID)	IPCC 2006 Revised Guidelines
EF_{OM}	ton CO_2/MWh	Operating Margin Emissions Factor	Calculated
EF_{BM}	ton CO_2/MWh	Build Margin Emissions Factor	Calculated
CEF	ton CO_2/MWh	Combined Emissions Factor	Calculated

Annex 4

MONITORING INFORMATION

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