MONITORING REPORT
Version 01 and 20-08-2011

Mokpo Landfill Gas Project for Electricity Generation
CDM Registration Reference Number: 2834
2nd monitoring period: 18th August, 2010 ~ 17th July, 2011

SECTION A. General description of the project activity

A.1. Brief description of the project activity: >>

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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 and utilize CH_4 (as a renewable energy) for electricity generation at the landfill site.

Mokpo Landfill which is located in Daeyang-dong Mokpo-city Jeollanam-do, was constructed at the end of 1995 as a municipal solid waste (MSW) landfill. The total land area is 290,490 m^2 and waste disposal area is 180,000 m^2.

Prior to this proposed project, Mokpo Landfill was emitting landfill gas (LFG) into the atmosphere directly without recovery and utilization of LFG. The proposed project involves the installation of a highly efficient collecting, transmitting and pre-treatment system and two electricity generators. The two generators installed with total capacity of 2.123 MW (1.065 MW and 1.058 MW). In terms of CO_2 emission reductions, the reductions were 33,607 tons CO_2 over the 11 month (335days, 18/08/2010~17/07/2011) of crediting period.

<Table A-1> Project Schedule

Date	Project Schedule
March 2008	Hanwha Corporation decides to invest in the proposed project (2.123 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)
April 2009	date of additional 1.058 MW generator
18, February 2010	Registered as a CDM project

A.2. Project Participants

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<Table A-2> 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.3. Location of the project activity:

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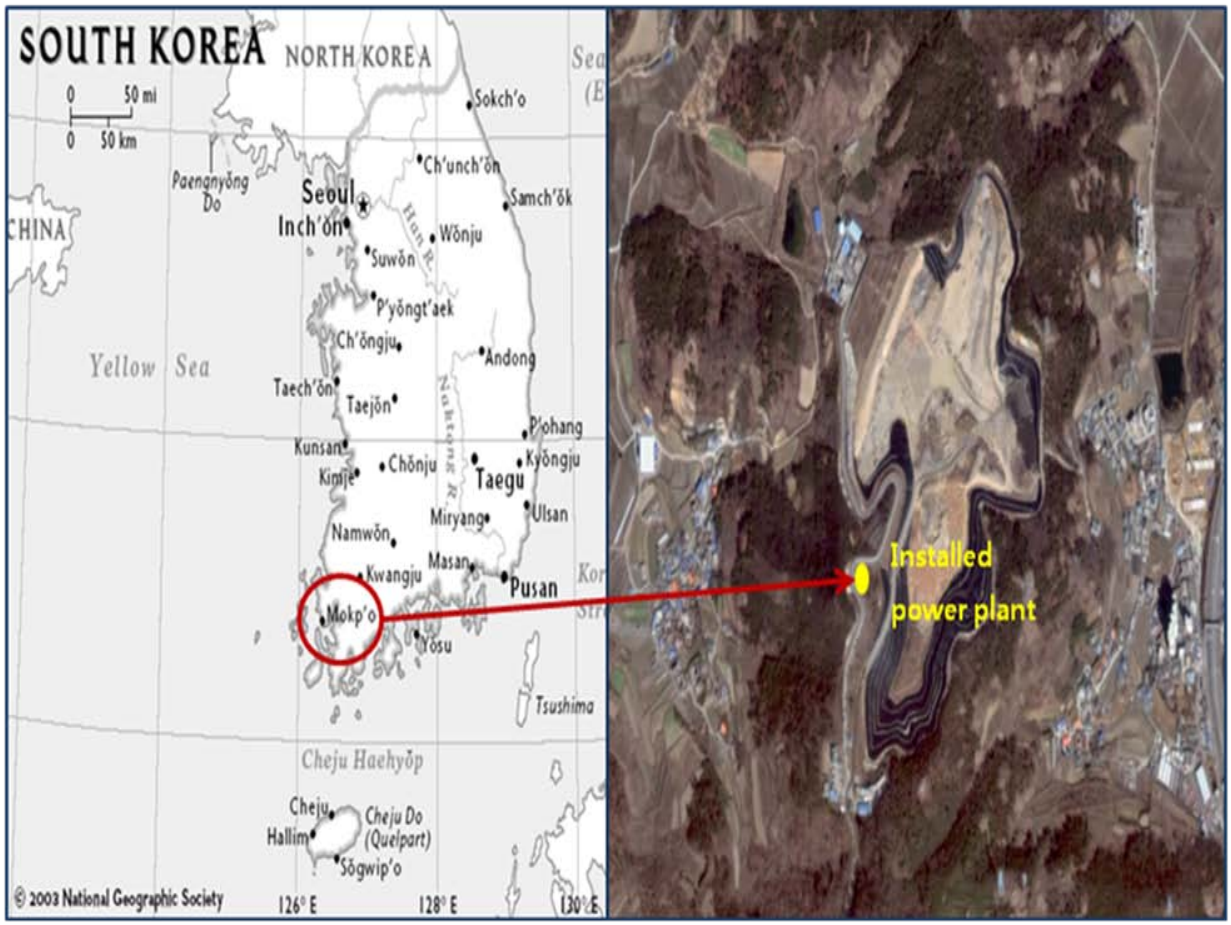
The site of the “Mokpo Landfill Gas Recovery Project for Electricity Generation” is located in Daeyang-dong, Mokpo City, Jeollanam-do, Republic of Korea. The facilities and equipment were installed inside the Mokpo landfill. The coordinates are longitude of 34:48 N and latitude of 126:22 E. The coordinates are based on the power plant.



<Figure A-1> The location of landfill site and the whole site view of the project

A.4. Technical description of the project

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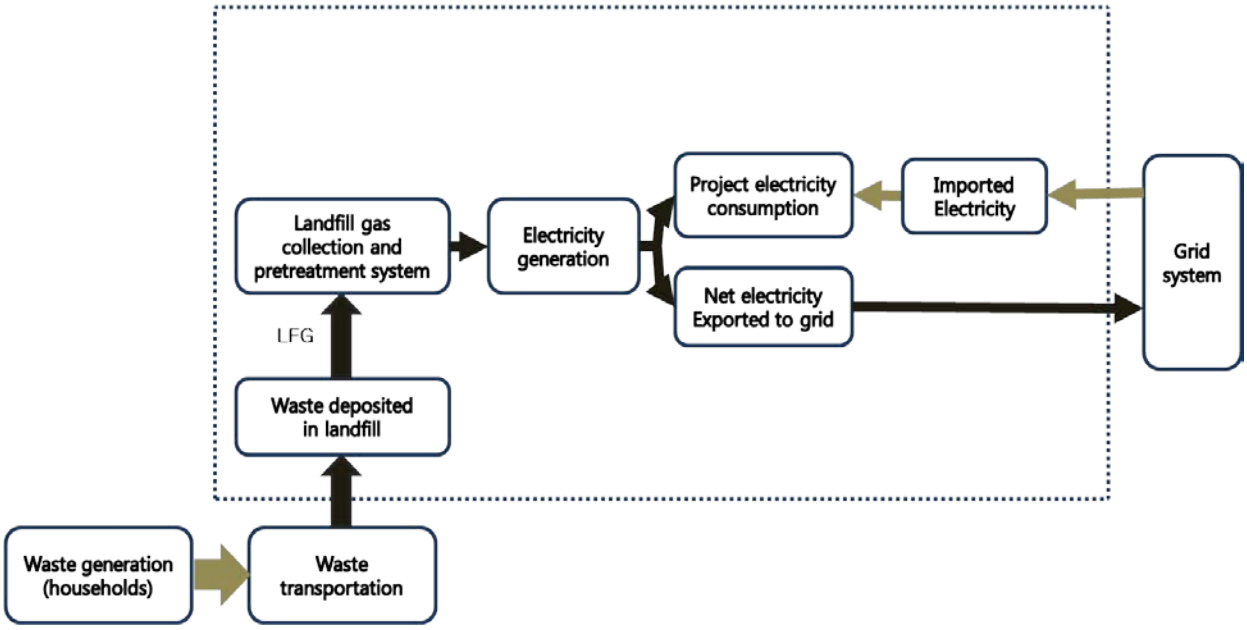
The description of the technology

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.



<Figure 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.

The total number of wellhead was 9. Each wellhead consisted of the 12 vertical well. 108 vertical well were being operated in the initial installation, January 2009.

The total number of wellhead has been 11 since April 2009. Thus, 132 vertical well can be operated. 121 vertical well were being operated in the CDM-PDD.

During monitoring period, 156 vertical well were being operated. The number of vertical well that can be operated will be varied depending on landfill gas status and other factors. J-trap and wellhead has same situation.

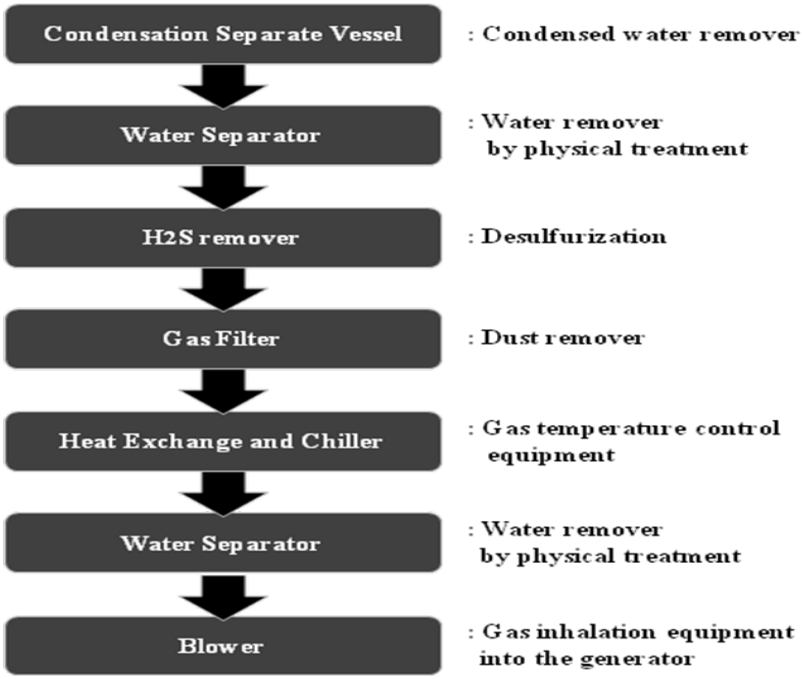
Detail history of wellhead is shown below <Table A-3>. Each drawing was submitted to the DOE.

<Table A-3> History of the landfill gas collecting system

Date	Well			J-Trap
	Wellhead	Well	Usewell	
January 2009	9	108	97	97
April 2009	11	132	121	117
September 2009	11	132	126	117
February 2011	13	156	156	125

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.



<Figure A-3> The process of pre-treatment system

Electricity Generation System

Two generators with capacity of 2.123 MW (1.065 MW and 1.058 MW) installed inside the Mokpo landfill. One generator was 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 April 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-4> The technical data of engine and power generator based on full load

Engine	Capacity of 1.065 MW	Manufacturer	GE Jenbacher
		Engine type	JGC 320 GS-L.L-C81
		Gas volume	522 Nm^3/h
	Capacity of 1.058 MW	Manufacturer	GE Jenbacher
		Engine type	JGC 320 GS-L.L-B81
		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.5. Title, reference and version of the baseline and monitoring methodology applied to the project activity:

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(1) The title of the project activity: Mokpo Landfill Gas Recovery Project for Electricity Generation
(2) Reference of the project activity: 2834
(3) Version of the baseline and monitoring methodology applied to the 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

A.6. Registration date of the project activity:

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The registration date for the project is February 18th, 2010 and the link is as follows:
http://cdm.unfccc.int/Projects/DB/emc1249265030.9/view

A.7. Crediting period of the project activity and related information (start date and choice of crediting period):

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Start date: 18/02/2010
Length of crediting period: 10years
Crediting period: 18/02/2010 ~ 17/02/2020

A.8. Name of responsible person(s)/entity(ies):

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The monitoring report is responsible by Hanwha Corporation, as a LFG CDM project manager.
Ms. Jihyun, Park.
Trade division, Green & Renewable Energy Business Team
renewables@hanwha.co.kr
+82-2-729-3543

The monitoring report is finished by Econetwork Co.,Ltd, as a consultant.
Ms. Seonyoung, Moon.
Climate change business division
seonyoung225@econetwork.com
+82-2-571-6155

SECTION B. Implementation of the project activity

B.1. Implementation status of the project activity

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Hanwha Corporation decided to invest in the proposed 2.123MW landfill gas generation project on March, 2008. Gas collecting system construction started on April, 2008.
September 2008, installation of 1.065MW generator was completed and starts commercial operation.
In April 2009, added 1.058MW generator in Mokpo landfill site. Therefore, total installed generator capacity is 2.123MW. The CDM project monitoring activity has been started since 18/02/2010. It's registered date for CDM project.
The project implementation is not phased.
The landfill gas collecting equipment installed on site is as described in the registered PDD. The main component is the gas collecting system.
The actual implementation of the flaring system was initiated in September 2008 and has continued through this monitoring period.
Gas analyzer's specification was corrected as below.
- Linearity is +/- 1% of F.S
- Zero drift is +/- 2% of F.S

<Figure B-1> The gas flow meter

<Figure B-2> The gas analyzer


<Figure B-3> The monitoring system

<Figure B-4> The watt-hour meter

During the operation of this monitoring period, the project not recorded a significant event affecting on the amount of reduction. Thus, rule or policy changes have taken place that could have affected the normal operation of the project and the applicability of the methodology.
No malfunction occurred to the monitoring equipment, and was implemented in accordance with the validated and registered PDD. And the monitoring is compliant with the monitoring plan as "Operating Manual-Mokpo LFG Power Plant".
"Operating Manual-Mokpo LFG Power Plant" was submitted to DOE.
Based on "Operating Manual-Mokpo LFG Power Plant", if we encounter system error or any difficulties due to natural disasters, a daily work log temporarily have been applied during the error period. Details of a transmission error of the monitoring system are as follows:

<Table B-1> Detail events for the monitoring

Date	Duration	Operation events	Note
2010.09.13	9 hours	Transmission error of the monitoring system. Keep a daily work log on the flow rate and CH_4 concentration.	Lowest CH_4 data applied.
2010.09.15 ~ 2010.09.16	48 hours	Transmission error of the monitoring system. Keep a daily work log on the CH_4 concentration.	Lowest CH_4 data applied.
2010.09.17 ~ 2010.09.20	81 hours	Transmission error of the monitoring system. Keep a daily work log on the flow rate and CH_4 concentration.	Lowest CH_4 data applied.
2010.09.20	15 hours	Transmission error of the monitoring system. Keep a daily work log on the CH_4 concentration.	Lowest CH_4 data applied.
2010.09.21	9 hours	Transmission error of the monitoring system. Keep a daily work log on the flow rate and CH_4 concentration.	Lowest CH_4 data applied.
2010.09.22 ~ 2010.11.05	1080 hours	Transmission error of the monitoring system. Keep a daily work log on the CH_4 concentration.	Lowest CH_4 data applied.
2010.11.06	11 hours	Transmission error of the monitoring system. Keep a daily work log on the flow rate and CH_4 concentration.	Lowest CH_4 data applied.
2010.11.06	13 hours	Transmission error of the monitoring system. Keep a daily work log on the CH_4 concentration.	Lowest CH_4 data applied.
2010.11.07 ~ 2010.11.20	336 hours	Transmission error of the monitoring system. Keep a daily work log on the CH_4 concentration.	Lowest CH_4 data applied.
2010.11.21	22 hours	Transmission error of the monitoring system. Keep a daily work log on the flow rate and CH_4 concentration.	Lowest CH_4 data applied.
2010.11.21	2 hours	Transmission error of the monitoring system. Keep a daily work log on the CH_4 concentration.	Lowest CH_4 data applied.
2010.11.22	20 hours	Transmission error of the monitoring system. Keep a daily work log on the flow rate and CH_4 concentration.	Lowest CH_4 data applied.
2010.11.22	4 hours	Transmission error of the monitoring system. Keep a daily work log on the CH_4 concentration.	Lowest CH_4 data applied.
2010.11.23 ~ 2010.11.24	40 hours	Transmission error of the monitoring system. Keep a daily work log on the flow rate and CH_4 concentration.	Lowest CH_4 data applied.
2010.11.24 ~ 2010.11.25	29 hours	The entire project boundary was blacked out. Keep a daily work log on the flow rate and CH_4 concentration. Power transmission (Import/Export) stopped.	Lowest CH_4 data applied.
2010.11.25	3 hours	Transmission error of the monitoring system. Keep a daily work log on the CH_4 concentration.	Lowest CH_4 data applied.
2010.12.04 ~ 2010.12.08	127 hours	Maintenance monitoring system. Keep a daily work log on the flow rate and CH_4 concentration.	Lowest CH_4 data applied.
2011.03.21	10 hours	Telecommunication lines error of monitoring system. Keep a daily work log on the flow rate and CH_4 concentration.	Lowest CH_4 data applied.

When the flow rate data was transferred to the server, data lag was occurred occasionally. In this case there is no record spot flow rate data but it is possible to measure flow rate during the time that data lag is occurred because flow meter is integration type.
When data lag is occurred, need to data control for calculate ER as a conservative manner. When the CH_4 data was not transferred to the server (centralized monitoring system), selected the lowest CH_4 concentration during this lagging time and calculated CH_4 quantity with this CH_4 concentration as a conservative manner. Almost data lagging time is not associated with the generator shut down.

The calibration of watt-meter of electricity imported has been delayed about two months. In accordance with "Guidelines for assessing compliance with the calibration frequency requirements (Ver. 01)" the calibration has been implemented applying the maximum permissible error ±1.5% during the delayed period.

B.2. Revision of the monitoring plan

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Revision was applied for this monitoring plan.
Revision of monitoring plan was performed on the basis of applied methodology (AMS-III.G version 06 and AMS-I.D version 13) and "Procedures for revising monitoring plans in accordance with paragraph 57 of the modalities and procedures for the CDM (version 02)" in annex 28 of EB49 meeting report.
Some parameters in the registered monitoring plan are excluded and some parameters are modified in the revised monitoring plan. These parameters are as below:

- Excluded parameters: **T** and **P, Wx, pn,j,x** and **z** parameters
- Modified parameter: $\mathbf{LFG_{electricity,\,y}}$ parameter

Revision of monitoring plan was submitted to DOE on September, 2010. A revision of monitoring plan was approved after the registration on 19th January 2011.

B.3. Request for deviation applied to this monitoring period

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The monitoring plan was not deviated and on deviation is pending.

B.4. Notification or request of approval of changes

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No notification or request of approval of changes has been made.

SECTION C. Description of the monitoring system

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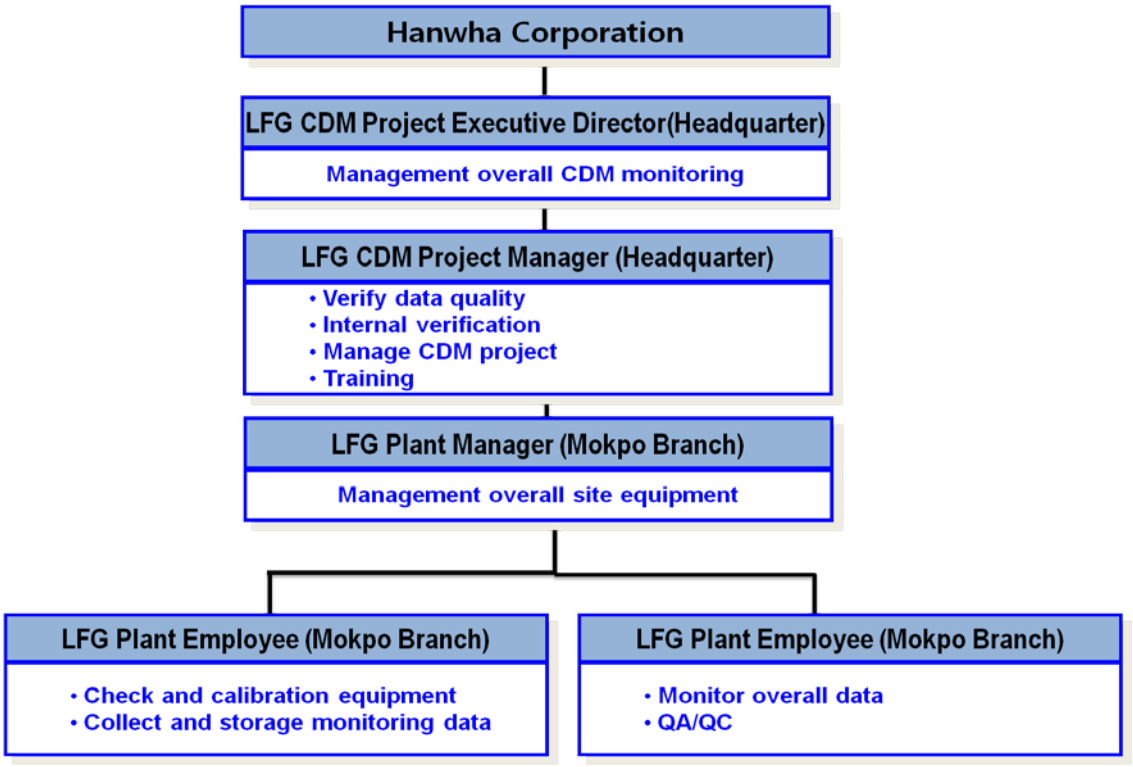
Monitoring data and parameters will be monitored and their measurement method will be referred to "Operating Manual-Mokpo LFG Power Plant". The relevant document is submitted to DOE.
Data and parameters are provided in Section D.

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 C-1>The structure of monitoring system

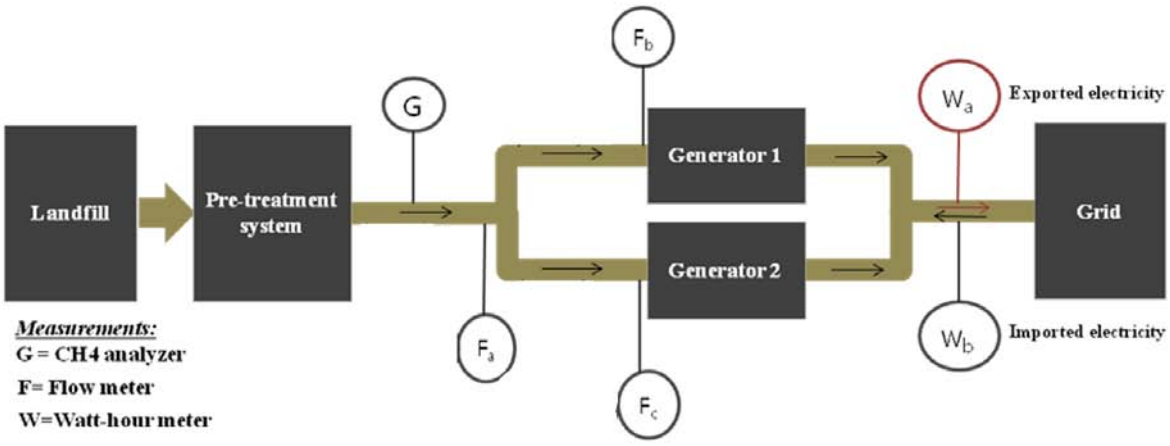
<Table C-1> The responsible party for each task of monitoring.

Item	Sub-item	Responsible person
Measure & Archive	$LFG_{electricity, y}$	Responsible person/department for the project : 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 : LFG Plant Employee / 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 : LFG CDM Project Executive Director / Environment /Renewable Team of HWC Headquarter LFG Plant Manage / Mokpo Operating Team of HWC Mokpo branch LFG CDM Project Manager / Environment / Green & Renewable Energy Business Team of HWC Headquarter
Task coordination		
Monitoring report		Responsible person/department for the project : LFG Plant Manager / Mokpo Operating Team of HWC Mokpo branch LFG CDM Project Manager / Environment / Green & Renewable Energy Business 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 meter is 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.



<Figure C-2> 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 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.
The manufacturer provides the official document for the unique error between two flow meters and it says the maximum error range is 1,728 Nm^3/day from theoretical calculation with each flow meter's accuracy. To be conservative, if the gap which is out of the range of meters unique error occurred between two flow meters, applied smaller LFG flow value at that time.
In this monitoring period, had no out of the range of meters unique error taken place.
When the flow rate data was transferred to the server, data lag was occurred occasionally. In this case there is no record spot for the data but it is possible to measure total flow rate during the time because measuring figure is accumulated data. When data lag is occurred, data correction applied as a conservative manner.

- Gas analyzer records the density of methane gas in the landfill gas.
Regular maintenance and testing for gas analyzer was done once a month in two ways, zero calibration and span calibration. Zero calibration is to set zero for analyzer and N_2 gas is used. Span calibration is for span point adjustment. For this calibration, the standard gas (CH_4, CO_2, and O_2) was used with a concentration of each specification in accordance with manufacturer's specification.
When data lag is occurred, selected the lowest CH_4 concentration during the lagging time and calculated CH_4 quantity with this CH_4 concentration.

- The amount of electricity exported (W_a) to the grid-connected system is measured by watt-hour meter. The measured data is simultaneously transferred to Korea Power Exchange and the amount of imported electricity (W_b) is measured by a meter, as well. They are collected daily, weekly and monthly.

Data records and storage:

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 meter is 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 are 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 on 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.
Employees involved in the monitoring were trained externally and internally on the overall CDM project activity.
12/07/2011, internal training has been done by headquarters' LFG CDM project manager on the monitoring.
23/11/2010, external training for electric system operation has been done by experts (KPX).
13/01/2011~14/01/2011, external training for monitoring system has been done by experts (BB system).

SECTION D. Data and parameters

D.1. Data and parameters determined at registration and not monitored during the monitoring period, including default values and factors

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(s) :	0.6817
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline/ Project emission calculations
Brief description of measurement methods and procedures to be applied:	The simple OM method is used to calculate EF_{OM} in accordance with the guidance of AMS-I.D. which allows the above method where low-cost/must-run resources constitute less than 50% of total grid generation. The generating sources do not include low-cost and must-run plant in conformity with the direction of AMS-I.D. EF_{OM} is calculated using the data for the most recent 3 years (2005-2007) for which data are available at time of this PDD submission, and fixed for the crediting period.
QA/QC procedures:	Not applied.
Any comment:	Not applied.

Data / Parameter:	**Build Margin Emission Factor (EFBM)**
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(s) :	0.3933
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline/ Project emission calculations
Brief description of measurement methods and procedures to be applied:	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 EF_{BM} is fixed for the crediting period.
QA/QC procedures:	Not applied.
Any comment:	Not applied.

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(s) :	0.5375
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline/ Project emission calculations
Brief description of measurement methods and procedures to be 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. The value $CEF_{electricity}$ is fixed for the crediting period.
QA/QC procedures:	Not applied.
Any comment:	Not applied.

Data / Parameter:	**F**
Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data used:	Written information from the operator of the solid waste disposal site and/or site visits at the solid waste disposal site
Value(s) :	0
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations
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 used:	Decisions under UNFCCC and the Kyoto Protocol
Value(s) :	21(to be applied for the first commitment period of the Kyoto Protocol)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations
Brief description of measurement methods and procedures to be applied:	Monitored annually
QA/QC procedures:	Not applied.
Any comment:	Not applied.

D.2. Data and parameters monitored

Data / Parameter:	**$LFG_{electricity, y}$**
Data unit:	Nm^3/y
Description:	Amount of landfill gas combusted in power plant
Source of data used:	Measured by using gas flow meters
Value(s) :	Not applied.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations
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. The flow meter is calibrated every three years.

Tag	F_a (main)	F_b (1^{st} generator)	F_c (2^{nd} generator)
Type"	Thermal Mass flowmeter		
Serial No	906044B	812003	906044A
Accuracy level	1%	1%	1%
Installation Date	27-07-2009	27-07-2009	20-05-2009
Initial testing (Testing Report No.)	24-07-2009 (2009-06-31)	18-03-2009 (2008-12-03)	24-07-2009 (2009-06-31)
Validity	23-07-2012	17-03-2012	23-07-2012

	Calibration Entity: Flow Technology Co., Ltd.
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:	$w_{CH4,y}$
Data unit:	%
Description:	Methane fraction in LFG
Source of data used:	Measured by using a methane analyzer
Value(s) :	50% (IPCC default value)
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations
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 The methane analyzer is calibrated every three years.
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.

Tag	G
Serial No	A8M7282T
Accuracy level	Linearity 1%, Repeatability 0.5%
Installation Date	02-06-2009
Initial testing (Testing Report No.)	09-04-2009 (K02505)
Validity	08-04-2012
Calibration Entity	Fuji Electric Instrumentation Co., Ltd. (Initial)

Data / Parameter:	$EL_{EXP, PJT, y}$
Data unit:	MWh
Description:	Total amount of electricity exported out of the project
Source of data used:	Read from watt-hour meter
Value(s) :	The estimation result is presented in B.6.3
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Baseline emission calculations

<table>
<tr><td>Brief description of measurement methods and procedures to be applied:</td><td>The amount of exported electricity is measured automatically by certified meter. The measured data are transferred to Korea Power Exchange and are checked and achieved daily, weekly, monthly in electronic way by Mokpo Operation team.
Measured by watt-hour meter.</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>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.
The watt-hour meter is calibrated every two years.
<table>
<tr><th colspan="2">Tag</th><th>W_a</th></tr>
<tr><td colspan="2">Serial No</td><td>95246742</td></tr>
<tr><td colspan="2">Accuracy level</td><td>0.5s</td></tr>
<tr><td colspan="2">Installation Date</td><td>06-09-2008</td></tr>
<tr><td rowspan="3">Initial Testing</td><td>Testing Report No.</td><td>28-08-2008
(2008-074-6)</td></tr>
<tr><td>Validity</td><td>27-08-2010</td></tr>
<tr><td>Calibration Entity</td><td>Meter and Petrochemical testing and research Institute.</td></tr>
<tr><td rowspan="3">Second Testing</td><td>Testing Report No.</td><td>25-08-2010~30-08-2010
(DC2010-318)</td></tr>
<tr><td>Validity</td><td>29-08-2012</td></tr>
<tr><td>Calibration Entity</td><td>Korea Testing Certification.</td></tr>
</table></td></tr>
<tr><td>Any comment:</td><td>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.</td></tr>
</table>

Data / Parameter:	**$EL_{IMP, PJT, y}$**
Data unit:	MWh
Description:	Total amount of electricity imported to meet project requirement
Measured /Calculated /Default:	Measured
Source of data:	Measurement by watt-hour meter
Value(s) of monitored parameter:	The estimation result is presented in E.4.
Indicate what the data are used for (Baseline/ Project/ Leakage emission calculations)	Project emission calculations
Monitoring equipment (type, accuracy class, serial number, calibration frequency, date of last calibration, validity)	<table><tr><th colspan="2">Tag</th><th>W_b</th></tr><tr><td colspan="2">Serial No</td><td>0190662</td></tr><tr><td colspan="2">Accuracy level</td><td>1s</td></tr><tr><td colspan="2">Installation Date</td><td>01-06-2009</td></tr><tr><td rowspan="2">Initial Testing</td><td>Testing Report No.</td><td>22-08-2008</td></tr><tr><td>Validity</td><td>21-08-2010</td></tr></table>

			Calibration Entity	LS industrial systems Co., Ltd
		Second Testing	Testing Report No.	18-10-2010 (DC2010-318)
			Validity	17-10-2012
			Calibration Entity	Korea Electric Power Corporation (KEPCO)
Measuring/ Reading/ Recording frequency:	The amount of imported electricity will be measured automatically by certified watt-hour 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.			
Calculation method (if applicable):	Not applied.			
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.			

SECTION E. Emission reductions calculation

E.1. Baseline emissions calculation

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$$BE_y = (MD_y - MD_{reg,y}) + EL_{EXP,\,PJT,\,y} * CEF$$

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'
$EL_{EXP,\,PJT,\,y}$	MWh	The quantity of electricity exported to the grid-connected system by this project activity during the year, y
CEF	tCO_2e/MWh	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.

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

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 no separate monitoring of temperature and pressure when expressing LFG volumes in normalized cubic meters. Methane content is measured by gas analyzer.

E.2. Project emissions calculation

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$$PE_y = EL_{IMP, PJT, y} * CEF$$

Parameter	Unit	Description
$EL_{IMP, PJT, y}$	MWh	The quantity of electricity imported from gird-connected system by project activity during the year, y

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

E.3. Leakage calculation

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Mokpo landfill gas has not been destructed by flaring and/or taken utilisation before developing the proposed project. For this project, there is no leakage effect.

E.4. Emission reductions calculation / table

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

Date	ER_y	$LFG_{elecricity, y}$	$wCH_{4, y}$	$DCH_{4, y}$	GWP_{CH4}	$MD_{reg, y}$	$EL_{EXP, PJT, y}$	$EL_{IMP, PJT, y y}$	CEF	Leakage
18/08/2010 ~ 17/09/2010	3,380.834	371,544.400	0.557	0.0007168	21	0	498.184	0.414	0.5375	0
18/09/2010 ~ 17/10/2010	3,227.488	369,137.500	0.532	0.0007168	21	0	509.567	0.049	0.5375	0
18/10/2010 ~ 17/11/2010	3,178.958	391,494.200	0.493	0.0007168	21	0	512.492	0.216	0.5375	0
18/11/2010 ~ 17/12/2010	2,521.408	320,483.700	0.477	0.0007168	21	0	409.597	0.384	0.5375	0
18/12/2010 ~ 17/01/2011	2,622.354	327,712.700	0.485	0.0007168	21	0	424.258	0.144	0.5375	0
18/01/2011 ~ 17/02/2011	2,494.430	298,365.700	0.510	0.0007168	21	0	379.467	0.096	0.5375	0
18/02/2011 ~ 17/03/2011	3,119.524	357,530.700	0.531	0.0007168	21	0	483.597	0.144	0.5375	0
18/03/2011 ~ 17/04/2011	3,335.890	397,558.100	0.510	0.0007168	21	0	524.436	0.240	0.5375	0

18/04/2011 ~ 17/05/2011	3,313.241	399,535.400	0.502	0.0007168	21	0	544.884	0.072	0.5375	0
18/05/2011 ~ 17/06/2011	3,340.320	393,891.900	0.515	0.0007168	21	0	532.281	0.336	0.5375	0
18/06/2011 ~ 17/07/2011	3,072.349	349,847.400	0.533	0.0007168	21	0	491.975	0.312	0.5375	0
18/08/2010 ~ 17/07/2011	33,606.795	3,977,101.700	0.514	0.0007168	21	0	5,310.707	2.407	0.5375	0

In this project, bill of electricity consumption is for the period from 19th of previous month to 18th of present month. And the crediting period start date is 18th Feb.
At the 1st monitoring period, the amount of full electricity consumption during 19th January to 18th February 2010 included for the conservative estimation. Thus, this method results in conservative ER calculation.

Monitoring periods	Emission reductions achieved in each monitoring period (tCO_2e)	The accumulated emission reductions achieved by the project activity (tCO_2e)
18/08/2010~17/07/2011 (335 days)	**33,607**	**33,607**

Total baseline emissions: 33,608.1 tCO_2e
Total project emissions: 1.3 tCO_2e
Total leakage: 0 tCO_2e
Total emission reductions: 33,606.8 tCO_2e

E.5. Comparison of actual emission reductions with estimates in the CDM-PDD

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Item	Values applied in ex-ante calculation of the registered CDM-PDD	Actual values reached during the monitoring period
$BE_{CH4,SWDS,y}$ / MD_y (Nm^3/335days)	2,850,336	3,977,102
EG_y/EL_{exp} (MWh)	2,965	5,311
$EL_{imp,PJT,y}$ (MWh)	1	2
Emission reductions (tCO_2e)	**22,561**	**33,607**

The amount of imported electricity can be checked by the paper bill (from KEPCO) monthly. In the case of Mokpo landfill site, the billing cycle is from 19th of last month to 18th of this month.

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

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Actual values reached during the monitoring period: 33,607 tCO_2e
Values applied in ex-ante calculation of the registered CDM-PDD (2010~2011): 22,561 tCO_2e

The emission reductions increased to 49% during the monitoring period compared to the expected monitoring period which is on the registered CDM-PDD.
The main causes of the increased emission reductions are as follows.

Registered PDD calculated using conservative data expected anti-post.
In PDD, $BE_y=BE_{CH4,SWDS,y}-MD_{reg,y.}$ The methane emission potential of a solid waste disposal site, $BE_{CH4,SWDS,y}$ in tCO_{2e}, is undertaken using the equation in the "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site."
Therefore, the expected LFG by waste composition analysis is differs from actual LFG generation on monitoring system.
The LFG flow was estimated to be 5.42 m^3 / min (on the registered CDM-PDD: 137 days in 2010, 198days in 2011) but the actual average flow was 7.57 m^3 / min during monitoring period. In other words, there was 40% of the difference between the theoretical and the actual values.
The maximum limit of LFG input is 8.10 m^3 / min based on full load by gas volume and the average actual flow was 7.57 m^3 / min in the monitoring period. It can be explained that efficient collection has been made and actual collecting ratio was optimized.

Quantity of waste for LFG
Mokpo landfill starting year was in 1996, and expected completing year will be 2022.
Compared table between the actual quantity and the expected quantity waste are shown below.

Year	Expected waste estimation(ton)	The actual quantity waste(ton)
2007	66,627	91,099
2008	66,134	68,720
2009	65,644	70,032
2010	65,158	70,737
2011(1~7.17, 198 days)	35,085	36,553

The amount of waste quantity was a lot more than expected in 2007 due to the waste brought from other landfill. The actual quantity of waste (during monitoring period) increased compared to the expected quantity of waste which is on the registered CDM-PDD.
"Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" was applied to confirm the difference of emission reduction compared to the registered PDD. The current amount of landfill reflected to calculate the emission reduction by the tool which is considered on the registered PDD. The comparison of difference in amount of waste shows considerable disagreement between theory and practice. It's difficult to make accurate predictions about the amount of waste for landfill.
In conclusion, the difference between the emission reduction in monitoring period and on the registered PDD can be explained in the difference of quantity of waste for landfill. This factor can serve as the main cause. The quantity of waste for LFG causes the increase of actual LFG generation. So, conservative assumptions of the amount of waste for landfill can be the reason for the difference. Another reason for increase is overall optimization of landfill operation. Emission reduction can be increased depending on the amount of LFG. In additions, conservative assumptions of the landfill operating conditions including the operating hour and optimizing the LFG generation can also be the reason for the difference. The theoretical model considered less methane fraction in the landfill gas, which supposes less emission reductions. Overall and comprehensive environment was optimized for the landfill.

Therefore, the emission reduction is not increased proportionally in accordance with only one factor. And the difference of predictions over the LFG is the biggest cause.