



## Monitoring report form (Version 03.1)

### Monitoring report

<b>Title of the project activity</b>	Mokpo Landfill Gas Recovery Project for Electricity Generation
<b>Reference number of the project activity</b>	2834
<b>Version number of the monitoring report</b>	Version 6.0
<b>Completion date of the monitoring report</b>	29/11/2013
<b>Registration date of the project activity</b>	18/02/2010
<b>Monitoring period number and duration of this monitoring period</b>	4 <sup>th</sup> monitoring period: 19/08/2012~18/08/2013
<b>Project participant(s)</b>	Hanwha Corporation
<b>Host Party(ies)</b>	Republic of KOREA
<b>Sectoral scope(s) and applied methodology(ies)</b>	Scope 1. Energy industry Scope 13. Waste handling and disposal
	Applied methodologies: - AMS I. D: Grid connected renewable electricity generation_V13 - AMS III. G: Landfill methane recovery_V06
<b>Estimated amount of GHG emission reductions or net anthropogenic GHG removals by sinks for this monitoring period in the registered PDD</b>	25,623 tCO <sub>2</sub> -eq
<b>Actual GHG emission reductions or net anthropogenic GHG removals by sinks achieved in this monitoring period</b>	41,686 tCO <sub>2</sub> -eq

**SECTION A. Description of project activity****A.1. Purpose and general description of project activity**

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Mokpo Landfill Gas Recovery Project for Electricity Generation is developed by Hanwha Corporation in the Republic of Korea. 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<sup>2</sup> and waste disposal area is 180,000 m<sup>2</sup>.

***The purpose of the project and the measures taken to reduce greenhouse gas emission:***

The purpose of this project is to collect and utilize CH<sub>4</sub> (as a renewable energy) for electricity generation at the landfill site.

Prior to this proposed project, Mokpo Landfill was emitting landfill gas (hereinafter referred to as the LFG) into the atmosphere directly without recovery and utilization of LFG. The Project captures the land fill gas that would have been released to the atmosphere without the project activity and generates electricity with the landfill gas. The generated electricity will be transmitted to the grid of Korea Electric Power Corporation (hereinafter referred to as the KEPCO grid) which is a company in charge of exclusively managing the grid of Republic of Korea.

***The installed technology and equipments:***

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).

***Total emission reduction achieved in this monitoring period:***

In terms of CO<sub>2</sub> emission reductions, the reductions were 41,686 tons CO<sub>2</sub> over the 12 month (365days, 19/08/2012~18/08/2013) of crediting period.

***The relevant dates for the project activity:***

The relevant dates of the project activity are given below:

&lt;Table A-1&gt; 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)
June 2009	Date of additional 1.058 MW generator installation
	Starting date of commercial operation (electricity sales to KEPCO)
18, February 2010	Registered as a CDM project

**A.2. Location of project activity**

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<b>Host Party(ies)</b>	Republic of Korea
<b>Region/State/Province, etc.;</b>	Jeollanam-do
<b>City/Town/Community, etc.;</b>	Mokpo city

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 latitude of 34.8328 and longitude of 126.4096. 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.3. Parties and project participant(s)

Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of KOREA (host)	Hanwha Corporation	No
Switzerland	Hanwha Corporation	No

### A.4. Reference of applied methodology

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#### ***The approved small-scale CDM baseline methodologies;***

- AMS I. D: Grid connected renewable electricity generation\_V13
- AMS III. G: Landfill methane recovery\_V06

#### ***The referred tools on 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.5. Crediting period of project activity

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Start date: 18/02/2010

Length of crediting period: 10years

Crediting period: 18/02/2010 ~ 17/02/2020

## SECTION B. Implementation of project activity

### B.1. Description of implemented registered project activity

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#### *The Implementation status of the project activity*

Hanwha Corporation decided to invest in the proposed 2.123MW landfill gas generation project in March, 2008. Gas collecting system construction started in April, 2008.

Installation of 1.065MW generator was completed and started commercial operation in September, 2008. A generator with capacity of 1.058MW was added in Mokpo landfill site in June, 2009. Therefore, the total installed generator capacity is 2.123MW. The CDM project monitoring activity has been started since 18/02/2010. It is registered date for CDM project.

The landfill gas collecting equipment installed on site is 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

There was no significant event affecting on the amount of reduction during the monitoring period. And also, any regulation or policy has not changed that could affect the normal operation of the project or the applicability of the methodology.

There was no monitoring equipment malfunction and the monitoring was carried out in accordance with the registered PDD. And the monitoring is compliant with the monitoring plan as described in "Operating Manual-Mokpo LFG Power Plant".

Based on "Operating Manual-Mokpo LFG Power Plant", if there is system error or any difficulties due to natural disasters, a daily work log has been temporarily applied during the error period. The details of errors of the monitoring system are as follows:

<Table B-1> Operation events history

Date	Duration	Operation events	Note
20/08/2012	13.5 hours (05:31~18:58)	Maintenance of power plant. • Activated carbon replacement. • Calibration of watt-hour meter. (Exported electricity) Maintenance of 1 <sup>st</sup> generator. → Generator shift (Alternator replacement). • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
21/08/2012	0.2 hours (09:01~09:11)	Maintenance of 2 <sup>nd</sup> generator. → Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
28/08/2012	0.5 hours (03:26~03:54)	The entire project boundary was blacked out by typhoon. Power transmission (Import/Export) stopped.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.7 hours (06:00~06:39)	The entire project boundary was blacked out. Power transmission (Import/Export) stopped. → Generator shift (Generator trip occurred). • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	17 hours (07:11~24:00)	Error of electric power transmission. Power transmission (Import/Export) stopped.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
29/08/2012	10.7 hours (00:00~10:41)	Error of electric power transmission. → Generator shift (Blower purge). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
30/08/2012	9 hours (00:00~09:00)	Maintenance of monitoring system. • Replacement parts.	Keep an hourly work log on the CH <sub>4</sub> concentration.

	4 hours (10:24~14:27)	The entire project boundary was blacked out. Power transmission (Import/Export) stopped.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
07/09/2012	0.4 hours (12:58~13:17)	Maintenance of 1 <sup>st</sup> generator. • Replacement parts (change the oil). → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.6 hours (22:06~22:42)	The entire project boundary was blacked out. Power transmission (Import/Export) stopped.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
08/09/2012	1 hours (01:46~02:41)	The entire project boundary was blacked out. Power transmission (Import/Export) stopped.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
10/09/2012	0.5 hours (07:57~08:06)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
17/09/2012	7 hours (07:55~14:59)	The entire project boundary was blacked out by typhoon. Power transmission (Import/Export) stopped.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
05/10/2012	7.5 hours (10:11~17:37)	Maintenance of 1 <sup>st</sup> generator. • Perforated pipe for 1 <sup>st</sup> generator. → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
06/10/2012	3 hours (10:21~13:24)	Landfill maintenance. • The generator is stopped by construction of condensate traps, collection systems.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
10/10/2012	0.2 hours (10:45~10:59)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
16/10/2012	0.1 hours (14:40~14:47)	Maintenance of 1 <sup>st</sup> generator. • Replacement parts (change the oil). → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.1 hours (17:20~17:31)	Maintenance of 2 <sup>nd</sup> generator. • Conduct a safety check of cylinder. → Generator shift. • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
18/10/2012	0.1 hours (13:32~13:41)	Generator shift (Alternator replacement). • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.

19/10/2012	0.5 hours (07:21~07:57)	The entire project boundary was blacked out by grounding. Power transmission (Import/Export) stopped.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.1 hours (09:58~10:07)	Maintenance of 1 <sup>st</sup> generator. • Changes in CH <sub>4</sub> concentration. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.5 hours (10:59~11:22)	Maintenance of 1 <sup>st</sup> generator. • Changes in CH <sub>4</sub> concentration. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
27/10/2012	4.6 hours (14:56~17:37)	The entire project boundary was blacked out. Power transmission (Import/Export) stopped. → Generator shift (Emergency stop). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
29/10/2012	0.1 hours (09:44~09:48)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
30/10/2012	0.3 hours (17:48~18:05)	Maintenance of monitoring system.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
31/10/2012	0.4 hours (01:59~02:19)	Maintenance of 1 <sup>st</sup> generator. • Fuel system problems. → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.4 hours (11:02~11:19)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
06/11/2012	0.4 hours (09:49~10:11)	Maintenance of 1 <sup>st</sup> generator. • Coolant leaks. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
12/11/2012	0.2 hours (15:30~15:45)	Maintenance of 1 <sup>st</sup> generator. • Fuel system problems. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
20/11/2012	0.1 hours (13:08~13:11)	Maintenance of 1 <sup>st</sup> generator. • 1 <sup>st</sup> generator runs 30,000 hours.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
23/11/2012	1.4 hours (14:06~15:29)	Maintenance of 2 <sup>nd</sup> generator. • Replacement parts (change the oil). → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
24/11/2012~ 25/11/2012	14.5 hours (18:42~09:00)	Maintenance of 2 <sup>nd</sup> generator. • Repaired generator actuator. → Generator shift. • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.

25/11/2012	0.1 hours (09:17~09:22)	Maintenance of 2 <sup>nd</sup> generator. • Recovery repair actuator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
28/11/2012	0.1 hours (15:06~15:13)	Maintenance of 1 <sup>st</sup> generator. • Power-off of generator. → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
29/11/2012	7.4 hours (09:41~17:03)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
04/12/2012	0.1 hours (10:05~10:08)	Maintenance of 1 <sup>st</sup> generator. • Control head-bolt and valve. → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.1 hours (15:22~15:31)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
05/12/2012	0.1 hours (09:18~09:21)	Maintenance of 1 <sup>st</sup> generator. • Control the oil coolers for Engine. → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.1 hours (17:49~17:51)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
30/12/2012	3 hours (03:29~06:23)	The entire project boundary was blacked out by grounding. Power transmission (Import/Export) stopped. • Emergency stop of 1 <sup>st</sup> generator. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
31/12/2012	6 hours (09:53~15:43)	Maintenance of 1 <sup>st</sup> generator. • Replacement parts (change the oil). • Emergency stop of 1 <sup>st</sup> generator. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
04/01/2013	3 hours (04:00~07:00)	Maintenance of monitoring system.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.
27/01/2013~ 28/01/2013	15 hours (08:22~1:26)	The installation of the watt-hour meter. • Additional watt-hour meter for 2 <sup>nd</sup> generator. • Emergency stop of generators. → Restart 2 <sup>nd</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
29/01/2013	3 hours (11:35~14:28)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.



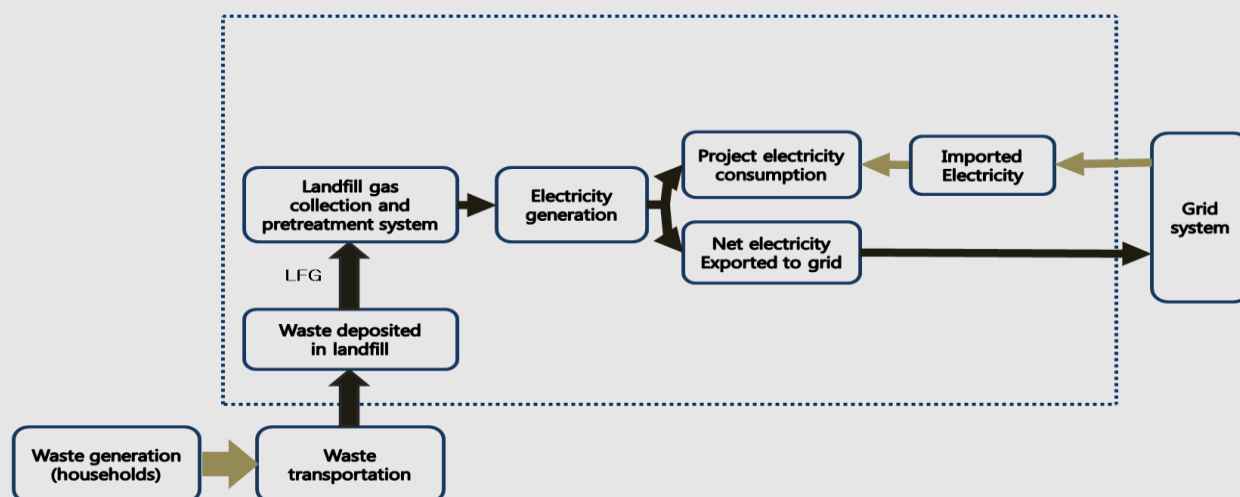
28/02/2013	1 hours (09:07~10:05)	Maintenance of 1 <sup>st</sup> generator. • Replacement parts (change the oil). → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
04/03/2013	2 hours (12:01~14:01)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
11/03/2013	2 hour (08:40~10:30)	Maintenance of 1 <sup>st</sup> generator. • Intercooler leaks. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	3 hours (15:34~18:40)	Remaintenance of 1 <sup>st</sup> generator. • Intercooler leaks. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
13/03/2013	1.5 hours (02:55~04:14)	The entire project boundary was blacked out. Power transmission (Import/Export) stopped.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.7 hours (18:35~19:13)	The entire project boundary was blacked out. Power transmission (Import/Export) stopped.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
05/04/2013	0.7 hours (10:30~11:15)	Maintenance of 1 <sup>st</sup> generator. • Replacement parts (change the oil). → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
08/04/2013	3 hours (11:04~14:00)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
19/04/2013~ 25/04/2013	143 hours (05:00~14:00)	Maintenance of monitoring system.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.
10/05/2013	1 hours (08:31~09:35)	Maintenance of 1 <sup>st</sup> generator. • Replacement parts (change the oil). → Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
13/05/2013	2.6 hours (08:30~11:11)	Generator shift (Alternator replacement). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
16/05/2013	6.6 hours (01:37~08:17)	Maintenance of monitoring system. • Updating software with windows.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.
17/05/2013	5 hours (04:00~09:00)	Maintenance of monitoring system. • Updating software with windows.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.

13/06/2013	0.3 hours (09:40~09:56)	Maintenance of 1 <sup>st</sup> generator. • Replacement parts (change the oil). Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
13/06/2013	1.1 hours (13:40~14:49)	Generator shift (Maintenance complete). • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
27/06/2013	5 hours (19:00~24:00)	Maintenance of monitoring system. • Check the program.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.
28/06/2013	7 hours (01:00~08:00)	Maintenance of monitoring system. • Check the program.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.
05/07/2013	0.5 hours (03:12~03:44)	The entire project boundary was blacked out. • Power-off of generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
06/07/2013	2 hours (08:00~10:00)	Maintenance of monitoring system. • Line to ground fault.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.
11/07/2013	2 hours (12:48~14:46)	Maintenance of 1 <sup>st</sup> generator. • Power-off of generator. → Restart 1 <sup>st</sup> generator after maintenance.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
14/07/2013	10 hours (14:00~24:00)	Maintenance of monitoring system. • Check the program.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.
15/07/2013	8 hours (01:00~09:00)	Maintenance of monitoring system. • Check the program.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.
17/07/2013	0.2 hours (09:59~10:09)	Maintenance of 1 <sup>st</sup> generator. • Replacement parts (change the oil). Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
18/07/2013	0.3 hours (13:35~13:51)	Generator shift (Maintenance complete). • From 2 <sup>nd</sup> generator to 1 <sup>st</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
26/07/2013	6 hours (10:00~16:00)	Maintenance of monitoring system. • Check the program.	Keep an hourly work log on the flow rate and CH <sub>4</sub> concentration.
29/07/2013	9.3 hours (09:04~18:24)	Maintenance of flow meter.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.

17/08/2013	0.7 hours (09:58~10:39)	Maintenance of 1 <sup>st</sup> generator. • Replacement parts (change the oil). Generator shift. • From 1 <sup>st</sup> generator to 2 <sup>nd</sup> generator.	Flow rate and CH <sub>4</sub> concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
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### The description of the technology

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



<Figure B-5> The main process of the proposed project

### Landfill Gas Collecting System

The landfill gas collecting system is a gas transportation network which is consisted of gas collecting wells, lateral gas collecting sub-pipes and a main pipe to cover all the landfill. The landfill gas which is collected from the 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 in 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. Existing wellhead were relocated and new wellhead was trapped to activate methane gas capture in February, 2011.

For the efficient management of landfill, repair work has been conducted in October, 2012. In this time, the least efficient LFG collecting system has been removed to maintain optimum operating condition for methane capture.

The number of vertical well that can be operated will be varied depending on landfill gas status and other factors. J-trap and wellhead have same situation. To increase efficiency of landfill gas collection and control, on-going maintenance has been in progress.

Detail history of wellhead is shown below <Table B-2>. Each of drawings has been submitted to the DOE.

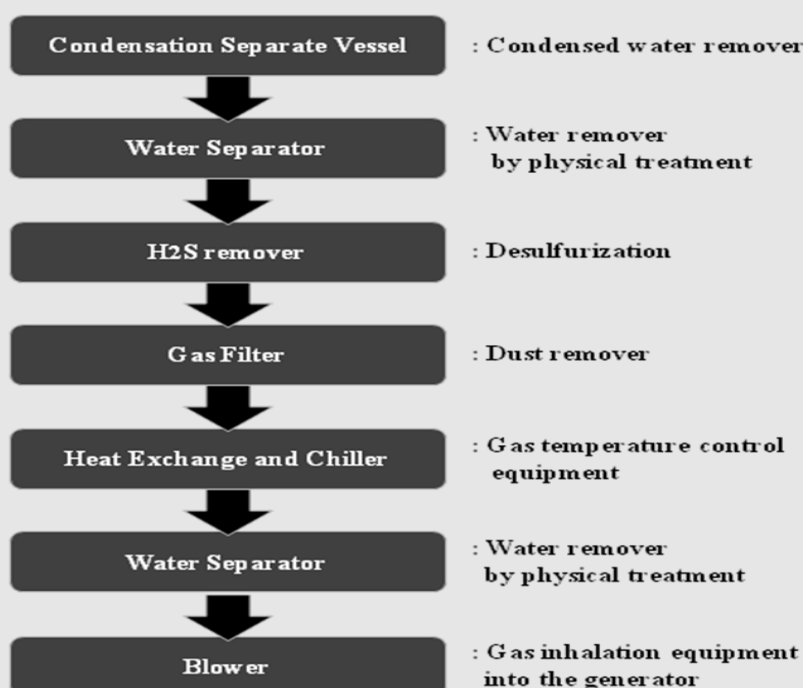
<Table B-2> History of the landfill gas collecting system

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
October 2012	13	149	149	120

### 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<sub>2</sub>S and to protect the generators for this project. The pre-treatment consists of 1) CSV (Condensate Separation Vessel), 2) water separator, 3) H<sub>2</sub>S remover, 4) gas filter, 5) heat exchange and chiller, 6) water separator and 7) blower.



### Electricity Generation System

Two generators with capacity of 2.123 MW (1.065 MW and 1.058 MW) were 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 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 B-3> 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 <sup>3</sup> /h
	Capacity of 1.058 MW	Manufacturer	GE Jenbacher
		Engine type	JGC 320 GS-L.L-B81
		Gas volume	450 Nm <sup>3</sup> /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 %

## B.2. Post registration changes

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

>>

N/A

### B.2.2. Corrections

>>

1. The coordinate information for latitude and longitude was updated up to an exact position on the power plant. These parameters are as follows:

- latitude : 34.8328
- longitude: 126.4096

2. The specification of gas analyzer was corrected.

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

>>

The revision was applied for monitoring plan.

The 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 modified in the revised monitoring plan. These parameters are as below:

- Excluded parameters: T, P, wx, pn,j,x and z parameters
- Modified parameter: LFGelectricity, y parameter

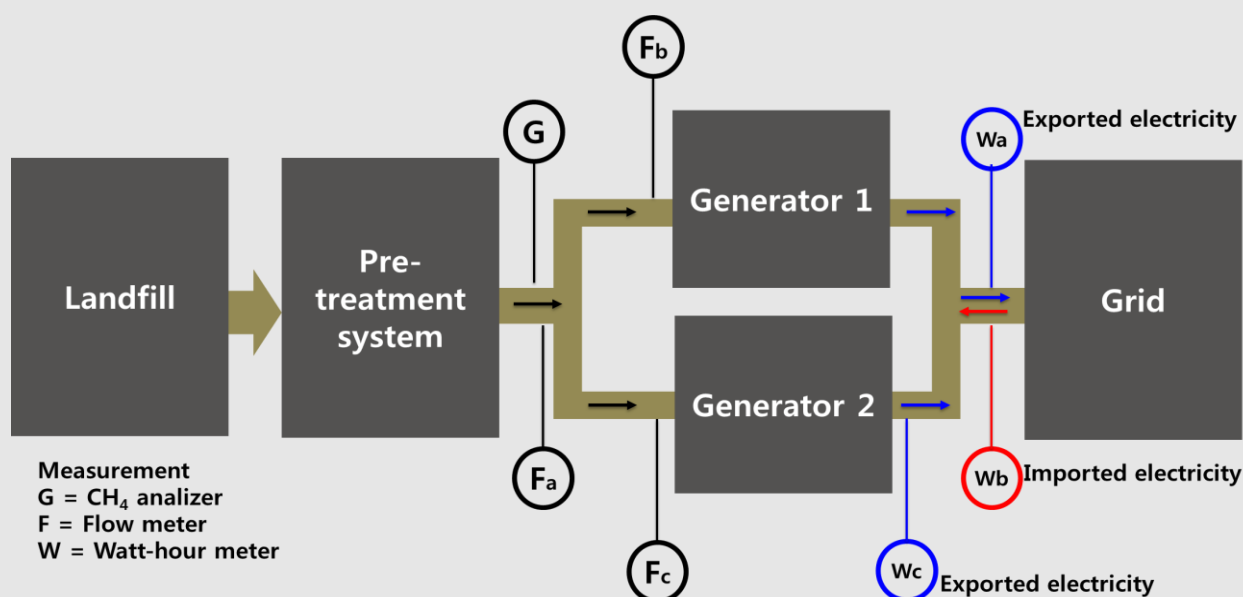
The revision of monitoring plan has been submitted to the DOE in September, 2010. The revision of monitoring plan was approved after the registration on January 19th, 2011.

Additional revision will be applied for monitoring plan.

The 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.

**The location of the monitoring facilities is modified in the revised monitoring plan.**

- During this monitoring period, a watt-hour meter for 2<sup>nd</sup> generator was installed on January 27<sup>th</sup>, 2013. Hanwha Corporation added the watt-hour meter for 2<sup>nd</sup> generator, which requested it under the "Act on the promotion of the development, use and diffusion of new and renewable energy".
- The Revised location of the monitoring facilities is as follows:



Revising monitoring plan has been submitted to DOE on November, 2013. This revision is expected to proceed.

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

>>

N/A

**B.2.5. Changes to start date of crediting period**

>>

N/A

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

>>

N/A

## SECTION C. Description of monitoring system

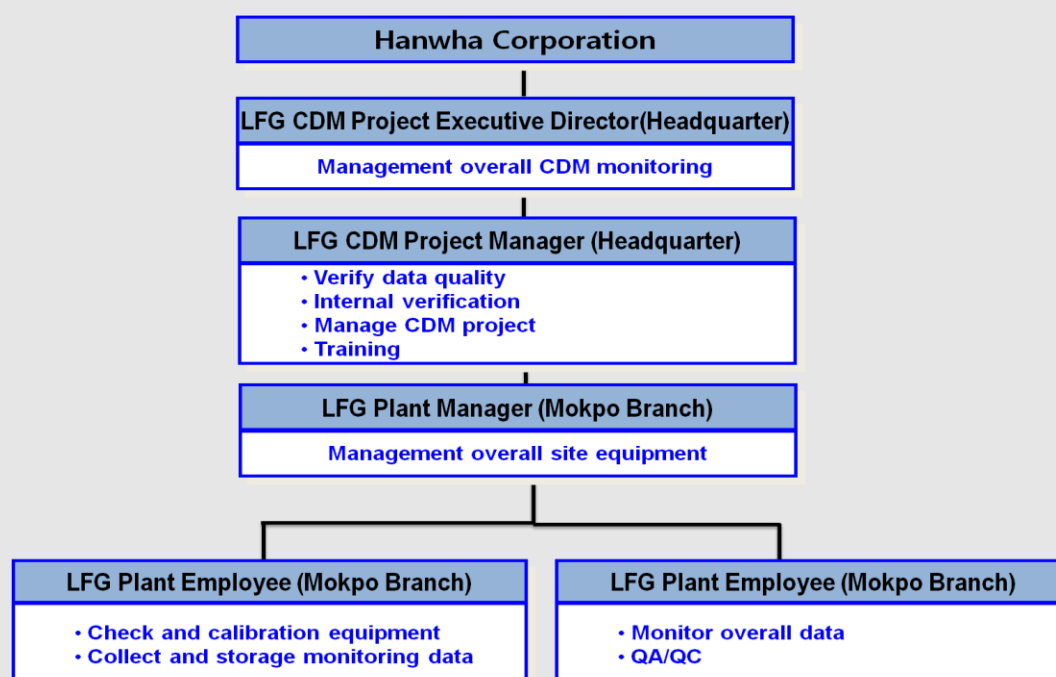
>>

Monitoring data and parameters will be monitored and their measurement method will be referred to “Operating Manual-Mokpo LFG Power Plant”. The relevant document has been submitted to the DOE.

Data and parameters are provided in Section D.

### Monitoring organization and the role of each party

The following figure describes the operation and management structure for monitoring of the project activity. Below table 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 <sub>electricity, y</sub>	Responsible person/department for the project : • LFG plant manager / Mokpo operating Team of HWC Mokpo branch
	W <sub>CH4, y</sub>	
	EL <sub>EXP, PJT, y</sub>	
	EL <sub>IMP, PJT, y</sub>	
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:	Responsible person/department for the project : • LFG plant employee / Mokpo operating team of HWC Mokpo branch Responsible person/department for the project : • Calibration institutions (According to “Act for measurement” and “Regulation for operation of electricity market”)

Establish monitoring plan	Responsible person/department for the project : <ul style="list-style-type: none"> <li>• LFG CDM project executive director / Environment /Renewable team of HWC Headquarter</li> </ul>
Task coordination	<ul style="list-style-type: none"> <li>• LFG plant manage / Mokpo operating team of HWC Mokpo branch</li> <li>• LFG CDM project manager / Environment / Green &amp; Renewable energy business team of HWC Headquarter</li> </ul>
Monitoring report	Responsible person/department for the project : <ul style="list-style-type: none"> <li>• LFG plant manager / Mokpo operating team of HWC Mokpo branch</li> <li>• LFG CDM project manager / Environment / Green &amp; Renewable energy business team of HWC Headquarter</li> </ul>

***The monitoring equipments to measure the amount of methane and electricity***

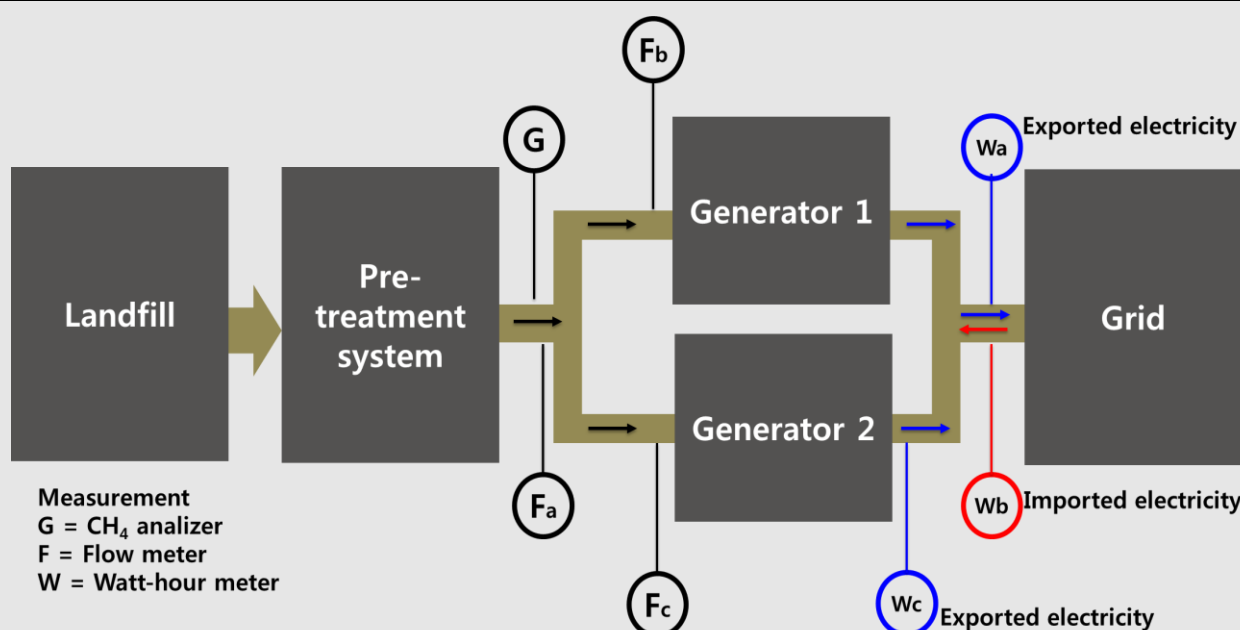
- Gas flow meters are installed between the blower and generating facility to measure LFG flow rate. LFG volumes are expressed in normalized cubic meters.
- A methane analyzer is located in front of the flow meter to measure the concentration of methane in LFG which flows into the gas engine.
- The Watt-hour meters are to be set-up transparently in accordance with “Law regarding measurement” and “Act on operation of electricity market”. Thereafter, the electricity measuring meter will be calibrated when it is installed behind the generator and sealed up after affirmation of Korea Power Exchange. The certified sheet of measurement registration has been submitted to the DOE.
- During this monitoring period, a watt-hour meter for 2<sup>nd</sup> generator was installed on January 27<sup>th</sup>, 2013. Hanwha Corporation added the watt-hour meter for 2<sup>nd</sup> 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 C-2 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 2<sup>nd</sup> generator (Wc) in this monitoring period, the amount of exported electricity is expressed as follows:

- Case 1 (only 1<sup>st</sup> generator operating): The amount of exported electricity = Wa
- Case 2 (only 2<sup>nd</sup> generator operating): The amount of exported electricity = Wc
- Case 3 (Both 1<sup>st</sup> generator and 2<sup>nd</sup> generator operating): The amount of exported electricity = Wa





<Figure C-2> The layout of monitoring equipment

#### **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 storage, equipment calibration and maintenance, corrective action and emergency procedures for unintended emissions.

- Three gas flow meters were installed to ensure that if one of the meters has a problem to measure LFG flow rate, the two remaining meters 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<sup>3</sup>/day from theoretical calculation with each flow meter's accuracy. To be conservative, if the measured value between two flow meters is out of the range, the smaller value was applied. In this monitoring period, no out of the range of meters unique error has 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<sub>2</sub> gas is used. Span calibration is for span point adjustment. For this calibration, the standard gas (CH<sub>4</sub>, CO<sub>2</sub>, and O<sub>2</sub>) was used with a concentration of each specification in accordance with manufacturer's specification.

When data lag is occurred, the lower CH<sub>4</sub> concentration value was selected between before and after of this lagging time and the CH<sub>4</sub> quantity was calculated with this CH<sub>4</sub> concentration as a conservative manner.

- Two watt-hour meters were installed to measure the amount of exported electricity. The amount of exported electricity was recorded electronically by watt-hour meters which are connected to Korea Power Exchange (KPX) and collected data shall be compared with those of sales receipt of KPX (<http://epsis.kpx.or.kr>).

Before installation the watt-hour meter for 2<sup>nd</sup> 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 2<sup>nd</sup> generator was operated. When 1<sup>st</sup> generator or both 1<sup>st</sup> and 2<sup>nd</sup> 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).

## Related watt-hour meters

Tag	Serial No	Accuracy level	Description	Remarks
W <sub>a</sub>	95246742	0.5s	Exported electricity (1 <sup>st</sup> generator)	
W <sub>c</sub>	50339836	0.5s	Exported electricity (2 <sup>nd</sup> generator)	A watt-hour meter for 2 <sup>nd</sup> generator (W <sub>c</sub> ) was installed on January 27th, 2013. W <sub>c</sub> added requested it under the "Act on the promotion of the development, use and diffusion of new and renewable energy".
W <sub>b</sub>	0190662	1s	Imported electricity	

**Data records and storage:**

The measured data is monitored by a computer and Mokpo operation team should check it 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. If necessary, LFG plant manager could calibrate the CDM project related equipment.
- 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 in electricity market" of South Korea. Under this regulation, the calibration period is every two years.
- The calibration of watt-hour meter for imported electricity will be certified by authorized organization.

**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 for the knowledge of operating equipment and monitoring by skilled technician from the generator manufacturer. The employees should attain a comprehensive knowledge with regard to the general and technical aspects of the CDM project.

Employees involved in the monitoring were trained internally on the overall CDM project activity.

External training for risk assessment education was done by experts (from Korea Occupational Safety & Health Agency) on June 20, 2013.

External training for emissions trading scheme was done by experts (from consulting company) on May 16, 2013.

Internal training for the monitoring was done by LFG CDM project manager of headquarter on May 16, 2013.

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

<b>Data / Parameter:</b>	<b>Operation Margin Emission Factor (EF<sub>OM</sub>)</b>
Unit:	ton CO <sub>2</sub> e/MWh
Description:	The generation-weighted average of CO <sub>2</sub> emission per electricity unit generated by the existing grid-connected power plants
Source of data:	"Statistics of Electric Power in Korea"
Value(s) applied:	0.6817
Purpose of data:	Calculation of Baseline/ Project emission
Additional comment:	This data is available at time of this PDD submission, and fixed for the crediting period.

<b>Data / Parameter:</b>	<b>Build Margin Emission Factor (EF<sub>BM</sub>)</b>
Unit:	ton CO <sub>2</sub> e/MWh
Description:	The generation-weighted average of CO <sub>2</sub> emission per electricity unit generated by additionally constructed power plants.
Source of data:	"Statistics of Electric Power in Korea"
Value(s) applied:	0.3933
Purpose of data:	Calculation of Baseline/ Project emission
Additional comment:	This data is available at time of this PDD submission, and fixed for the crediting period.

<b>Data / Parameter:</b>	<b>CO<sub>2</sub> Emission Intensity of the Electricity displaced (CEF<sub>electricity</sub>)</b>
Unit:	ton CO <sub>2</sub> e/MWh
Description:	The weighted average of EF <sub>OM</sub> and EF <sub>BM</sub>
Source of data:	"Statistics of Electric Power in Korea"
Value(s) applied:	0.5375
Purpose of data:	Calculation of Baseline/ Project emission
Additional comment:	This data is available at time of this PDD submission, and fixed for the crediting period

**D.2. Data and parameters monitored**

<b>Data / Parameter:</b>	<b>F</b>
Unit:	Not applied.
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Measured/ Calculated / Default:	Not applied.

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(s) of monitored parameter:	0
Monitoring equipment:	Not applied.
Measuring/ Reading/ Recording frequency:	Monitored annually
Calculation method (if applicable):	Not applied.
QA/QC procedures:	Not applied.
Purpose of data:	Calculation of Baseline emission
Additional comment:	Not applied.

<b>Data / Parameter:</b>	<b>GWP<sub>CH4</sub></b>
Unit:	tCO <sub>2</sub> e/tCH <sub>4</sub>
Description:	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
Measured/ Calculated / Default:	Not applied.
Source of data:	Decisions under UNFCCC and the Kyoto Protocol
Value(s) of monitored parameter:	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)
Monitoring equipment:	Not applied.
Measuring/ Reading/ Recording frequency:	Monitored annually
Calculation method (if applicable):	Not applied.
QA/QC procedures:	Not applied.
Purpose of data:	Calculation of Baseline/ Project emission
Additional comment:	Not applied.

<b>Data / Parameter:</b>	<b>LFG<sub>electricity, y</sub></b>
Unit:	Nm <sup>3</sup> /y
Description:	Amount of landfill gas combusted in power plant
Measured/ Calculated / Default:	Measured
Source of data:	Gas flow meters

Value(s) of monitored parameter:	Data	Measured LFG <sub>electricity, y</sub> (Nm <sup>3</sup> )		
		F <sub>b</sub>	F <sub>c</sub>	F <sub>b</sub> + F <sub>c</sub>
	19/08/2012 ~ 18/09/2012	309,729.0	36,081.6	345,810.6
	19/09/2012 ~ 18/10/2012	288,400.0	61,150.1	349,550.1
	19/10/2012 ~ 18/11/2012	329,476.7	19,899.9	349,376.6
	19/11/2012 ~ 18/12/2012	215,141.8	94,417.8	309,559.6
	19/12/2012 ~ 18/01/2013	392,209.0	0.0	392,209.0
	19/01/2013 ~ 18/02/2013	355,765.0	15,630.5	371,395.5
	19/02/2013 ~ 18/03/2013	280,537.1	44,150.0	324,687.1
	19/03/2013 ~ 18/04/2013	347,325.7	31,574.7	378,900.4
	19/04/2013 ~ 18/05/2013	338,330.7	33,483.1	371,813.8
	19/05/2013 ~ 18/06/2013	368,836.2	12,557.7	381,393.9
	19/06/2013 ~ 18/07/2013	369,924.1	12,773.3	382,697.4
	19/07/2013 ~ 18/08/2013	387,842.4	18,439.1	406,281.5
	19/08/2012 ~ 18/08/2013	3,983,517.7	380,157.8	4,363,675.5
	<p>Measured LFG data by the flow meter is accumulated data showing integrating meter. Measured real time data have calculated from automatically recorded data by continuous integrating flow meters.</p> <p>'Measured LFG electricity, y' in above table is calculated by difference between current measuring data and previous measuring data in every recording time</p> <p>All measured data for the crediting period has been submitted to the DOE as a spread sheet named "Mokpo_4<sup>th</sup> MR_R2834_Emission Reduction_ver6".</p>			

Monitoring equipment:	Tag	F <sub>a</sub> (main)	F <sub>b</sub> (1 <sup>st</sup> generator)	F <sub>c</sub> (2 <sup>nd</sup> generator)
	Type	Thermal Mass Flow Meter		
	Serial No	906044B	812003	906044A
	Accuracy level	1%	1%	1%
	<ul style="list-style-type: none"> <li>Measured automatically and continuously by integrating flow meters.</li> <li>The measured data is monitored by a computer and Mokpo operation team should check it continuously. <ul style="list-style-type: none"> <li>- Accuracy is +/- 1.0 of F.S</li> <li>- Sensor response time is one second</li> </ul> </li> <li>To ensure accuracy, the flow meters are subject to regular maintenance and testing. The flow meter is calibrated every three years.</li> <li>The archived data is kept during the crediting period as well as two years after that.</li> <li>Daily data is documented in paper and archived in electronic file.</li> <li>The temperature and pressure in Landfill gas are not monitored separately.</li> </ul>			
Measuring/ Reading/ Recording frequency:	Measured automatically.			
Calculation method (if applicable):	Not applied.			

QA/QC procedures:

To ensure accuracy, the flow meters are subject to regular maintenance and testing.  
The flow meter is calibrated every three years.

Tag		F <sub>a</sub> (main)	F <sub>b</sub> (1 <sup>st</sup> generator)	F <sub>c</sub> (2 <sup>nd</sup> generator)
Type		Thermal Mass Flow Meter		
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.		
Second Testing	Data of Calibration	02/04/2012 ~ 03/04/2012	02-04-2012 ~ 03-04-2012	02-04-2012 ~ 03-04-2012
	Validity	01/04/2015	01/04/2015	01/04/2015
	Calibration Entity	Flow Technology Co., Ltd.		

This project involves the installation of two electricity generators. One of the generators is operating normally, and the other one is used as a standby unit. During the normal operation period, either one or the other generator has been operated.

Purpose of data: Calculation of Baseline emission

Additional comment: Not applied.

**Data / Parameter:****w<sub>CH<sub>4</sub>,y</sub>**

Unit:

%

Description:

Methane fraction in LFG

Measured/  
Calculated /  
Default:

Measured

Source of data:

Methane analyzer

Value(s) of  
monitored  
parameter:

- Weighted average CH<sub>4</sub> concentration during the monitoring period  
The measured methane fraction data is monitored automatically and continuously by gas analyzer.

Date	Measured CH <sub>4</sub> (%) (Weighted average CH <sub>4</sub> concentration)
19/08/2012 ~ 31/12/2012	54.90
01/01/2013 ~ 18/08/2013	50.59

All measured data for the crediting period has been submitted to the DOE as a spread sheet.

Monitoring equipment:	Tag	G																										
	Serial No	A8M7282T																										
	Accuracy level	Linearity 1%, Repeatability 0.5%																										
	<ul style="list-style-type: none"> <li>Methane fraction is measured with continuous gas analyzer.</li> <li>The measured data is monitored by a computer and Mokpo operation team should check it continuously. <ul style="list-style-type: none"> <li>Linearity is +/- 1% of F.S</li> <li>Zero drift is +/- 2% of F.S</li> <li>Span Drift is +/- 2% of F.S</li> <li>Response time is 15~30 seconds</li> <li>Operating condition's temperature is – 5℃ to 45℃</li> </ul> </li> <li>To ensure accuracy, the gas analyzer is subject to regular maintenance and testing regime in accordance with the manufacturer's specification.</li> <li>The methane analyzer is calibrated every three years.</li> <li>The archived data is kept during the crediting period as well as two years after that.</li> <li>Daily data is documented in paper and archived in electronic file.</li> </ul>																											
Measuring/ Reading/ Recording frequency:	Measured automatically.																											
Calculation method (if applicable):	Not applied.																											
QA/QC procedures:	<p>To ensure accuracy, the gas analyzer is subject to regular maintenance and testing regime in accordance with the manufacturer's specification.</p> <p>The methane analyzer is calibrated every three years.</p> <table> <tr> <td colspan="2">Tag</td><td>G</td></tr> <tr> <td colspan="2">Serial No</td><td>A8M7282T</td></tr> <tr> <td colspan="2">Accuracy level</td><td>Linearity 1%, Repeatability 0.5%</td></tr> <tr> <td colspan="2">Installation Date</td><td>02-06-2009</td></tr> <tr> <td rowspan="3">Initial Testing</td><td>Testing Report No.</td><td>09-04-2009 (K02505)</td></tr> <tr> <td>Validity</td><td>08-04-2012</td></tr> <tr> <td>Calibration Entity</td><td>Fuji Electric Instrumentation Co., Ltd. (Initial)</td></tr> <tr> <td rowspan="3">Second Testing</td><td>Testing Report No.</td><td>02-04-2012 (1201-00302-001)</td></tr> <tr> <td>Validity</td><td>01-04-2015</td></tr> <tr> <td>Calibration Entity</td><td>National Metrology Institute</td></tr> </table>		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)	Second Testing	Testing Report No.	02-04-2012 (1201-00302-001)	Validity	01-04-2015	Calibration Entity	National Metrology Institute
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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)																										
Second Testing	Testing Report No.	02-04-2012 (1201-00302-001)																										
	Validity	01-04-2015																										
	Calibration Entity	National Metrology Institute																										
Purpose of data:	Calculation of Baseline emission																											
Additional comment:	Not applied.																											



<b>Data / Parameter:</b>	<b>EL<sub>EXP</sub>, PJT, y</b>			
Unit:	MWh			
Description:	Total amount of exported electricity out of the project			
Measured/ Calculated / Default:	Measured			
Source of data:	Watt-hour meter			
Value(s) of monitored parameter:	Date	Wa	Wc	Total EL <sub>EXP</sub> (MWh)
	19/08/2012 ~ 18/09/2012	480.752	0.000	480.752
	19/09/2012 ~ 18/10/2012	449.216	0.000	449.216
	19/10/2012 ~ 18/11/2012	524.652	0.000	524.652
	19/11/2012 ~ 18/12/2012	460.767	0.000	460.767
	19/12/2012 ~ 18/01/2013	564.866	0.000	564.866
	19/01/2013 ~ 18/02/2013	546.699	0.000	546.699
	19/02/2013 ~ 18/03/2013	432.365	60.572	492.937
	19/03/2013 ~ 18/04/2013	515.013	44.453	559.466
	19/04/2013 ~ 18/05/2013	483.165	43.905	527.069
	19/05/2013 ~ 18/06/2013	524.030	17.096	541.126
	19/06/2013 ~ 18/07/2013	509.255	16.711	525.966
	19/07/2013 ~ 18/08/2013	518.423	23.004	541.428
	19/08/2012 ~ 18/08/2013	6,009.204	205.740	6,214.945
	The exported electricity data is automatically monitored by certified watt-hour meters which are connected to Korea Power Exchange (KPX) and cross-checked by sales receipts from KPX. All measured data for the crediting period has been submitted to the DOE as a spread sheet.			

Monitoring equipment:	Tag	W <sub>a</sub>	W <sub>c</sub>	
	Serial No	95246742	50339836	
	Accuracy level	0.5s	0.5s	
	<ul style="list-style-type: none"> <li>Two watt-hour meters were installed to measure the amount of exported electricity.</li> <li>The amount of exported electricity is measured automatically by certified watt-hour meters. The measured data is transferred to Korea Power Exchange. It is checked and achieved daily, weekly, monthly in electronic way by the Mokpo operation team.</li> <li>This project involves the installation of two exported electricity watt-hour meters. W<sub>a</sub> watt-hour meter had been installed as measure of the amount of exported electricity in Mokpo LFG plant. In this monitoring period, additionally a watt-hour meter for 2<sup>nd</sup> generator (W<sub>c</sub>) was installed on January 27<sup>th</sup>, 2013. W<sub>c</sub> added requested it under the “Act on the promotion of the development, use and diffusion of new and renewable energy”.</li> <li>In previous installation the watt-hour meter for 2<sup>nd</sup> generator (W<sub>c</sub>), total amount of exported electricity out of project had been monitored by W<sub>a</sub> watt-hour meter.</li> <li>After installation of W<sub>c</sub>, W<sub>c</sub> is used to measure only if 2<sup>nd</sup> generator was operated. When 1<sup>st</sup> generator or both 1<sup>st</sup> and 2<sup>nd</sup> generator operates, W<sub>a</sub> is used to measure the amount of exported electricity.</li> <li>The archived data is kept during the crediting period as well as two years after that.</li> <li>Daily data is documented in paper and archived in electronic file.</li> </ul>			
Measuring/ Reading/ Recording frequency:	Measured automatically.			
Calculation method (if applicable):	Not applied.			

QA/QC procedures:

- To ensure accuracy, the watt-hour meters are subject to regular maintenance and testing regime complying with the “Regulation for operation of electricity market” in South Korea.
- The calibration of watt-hour meters will be carried out before the installation initially and periodically performed at least once in 2 years.

Tag		W <sub>a</sub>
Serial No		95246742
Accuracy level		0.5s
Installation Date		06/09/2008
Initial Testing	Testing Report No.	28/08/2008 (2008-074-6)
	Validity	27-08-2010
	Calibration Entity	Meter and Petrochemical testing and research Institute.
Second Testing	Testing Report No.	25-08-2010 (DC2010-318)
	Validity	24-08-2012
	Calibration Entity	Korea Testing Certification.
Third Testing	Testing Report No.	23-08-2012 (DC2012-339)
	Validity	22-08-2014
	Calibration Entity	Korea Testing Certification.
Tag		W <sub>c</sub>
Serial No		50339836
Accuracy level		0.5s
Installation Date		27/01/2013
Initial Testing	Testing Report No.	04/01/2013 (2013-008-4)
	Validity	03-01-2015
	Calibration Entity	Korea Testing Certification.

Purpose of data: Calculation of Baseline emission

Additional comment: Not applied.

<b>Data / Parameter:</b>	<b>EL<sub>IMP, PJT, y</sub></b>
Unit:	MWh
Description:	Total amount of imported electricity to meet project requirement
Measured/ Calculated / Default:	Measured
Source of data:	Watt-hour meter

Value(s) of monitored parameter:	Date		Measured EL <sub>IMP</sub> (MWh)
	19/08/2012 ~ 18/09/2012		0.312
	19/09/2012 ~ 18/10/2012		0.312
	19/10/2012 ~ 18/11/2012		0.144
	19/11/2012 ~ 18/12/2012		0.696
	19/12/2012 ~ 18/01/2013		0.672*
	19/01/2013 ~ 18/02/2013		0.504
	19/02/2013 ~ 18/03/2013		0.240
	19/03/2013 ~ 18/04/2013		0.096
	19/04/2013 ~ 18/05/2013		0.144
	19/05/2013 ~ 18/06/2013		0.048
	19/06/2013 ~ 18/07/2013		0.096
	19/07/2013 ~ 18/08/2013		0.024
	19/08/2012 ~ 18/08/2013		3.288
	<p>* The imported electricity for 19/12/2012 ~ 18/01/2013 is 0.336 MWh and the imported electricity cannot be allocated daily basis because there is no daily imported electricity record. Thus, 0.336 MWh is applied for 19/12/2012 ~ 31/12/2013 and 01/01/2013 ~ 18/01/2013 respectively to conservatively calculate emission reductions achieved up to 31/12/2012 and from 01/01/2013.</p> <p>The imported electricity data is automatically monitored by a certified meter. All measured data for the crediting period has been submitted to the DOE as a spread sheet.</p>		
Monitoring equipment:	Tag	W <sub>b</sub>	
	Serial No	0190662	
	Accuracy level	1s	
<ul style="list-style-type: none"><li>• 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 (<a href="http://cyber.kepco.co.kr">http://cyber.kepco.co.kr</a>) and get the paper bill from KEPCO monthly.</li><li>• The archived data is kept during the crediting period as well as two years after that.</li><li>• The monthly data is archived in paper bill from KEPCO.</li></ul>			
Measuring/ Reading/ Recording frequency:	Measured automatically.		
Calculation method (if applicable):	Not applied.		

QA/QC procedures:

- To ensure accuracy, the watt-hour meter is subject to regular maintenance and testing regime complying with the "Measures Act" in South Korea.
- The calibration of watt-hour meter will be carried out before the installation initially and periodically performed at least once in 2 years.

Tag		W <sub>b</sub>
Serial No		0190662
Accuracy level		1s
Installation Date		01-06-2009
Initial Testing	Testing Report No.	22-08-2008
	Validity	21-08-2010
	Calibration Entity	LS industrial systems Co., Ltd
Second Testing	Testing Report No.	27-09-2011 (DC2011-398)
	Validity	26-09-2013
	Calibration Entity	Korea Testing Certification (KTC)

Purpose of data: Calculation of Project emission

Additional comment: Not applied.

**D.3. Implementation of sampling plan**

&gt;&gt;

N/A

**SECTION E. Calculation of emission reductions or GHG removals by sinks****E.1. Calculation of baseline emissions or baseline net GHG removals by sinks**

&gt;&gt;

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

Parameter	Unit	Description
MD <sub>y</sub>	tCO <sub>2</sub> e	CO <sub>2</sub> equivalent of the methane captured and destroyed/ gainfully used by the project activity in year y;
MD <sub>reg,y</sub>	tCO <sub>2</sub> e	Methane emissions that would be captured and destroyed to comply with national or local safety requirements or legal regulations in the year 'y'
EL <sub>EXP, PJT, y</sub>	MWh	The quantity of electricity exported to the grid-connected system by this project activity during the year, y
CEF	tCO <sub>2</sub> e/MWh	Combined emission factor in electricity generation by grid-connected system; weighted average of EF <sub>OM</sub> and EF <sub>BM</sub> .

CEF is 0.5375 tCO<sub>2</sub>e/MWh and this is fixed factor during the crediting period.

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

Parameter	Unit	Description
$LFG_{electricity,y}$	Nm <sup>3</sup>	Landfill gas flared or used as fuel in the year 'y'
$wCH_{4,y}$	%	Methane content in landfill gas in the year 'y' (mass fraction)
$DCH_{4,y}$	kg/ Nm <sup>3</sup>	Density of methane at normal conditions in the year 'y' (Source: ACM0001 ver.11)
$GWP_{CH4}$	tCO <sub>2</sub> /tCH <sub>4</sub>	Global warming potential of methane

Density of methane in landfill gas is determined at the temperature and pressure of the landfill gas as described in AMS-III.G. However,  $LFG_{electricity,y}$  is automatically measured at normal condition by a flow meter, and the temperature and pressure are not monitored separately. Thus, density of methane at normal conditions in the year 'y' is measured in kg/ Nm<sup>3</sup>.  
Methane content is measured by gas analyzer.

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

>>

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

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

CEF is 0.5375 tCO<sub>2</sub>e/MWh and this is fixed factor during the crediting period.

## E.3. Calculation of leakage

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

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

Date	ER <sub>y</sub>	$LFG_{electricity,y}$	$wCH_{4,y}$	$DCH_{4,y}$	$GWP_{CH4}$	$MD_{reg,y}$	$EL_{EXP, PJT, y}$	$EL_{IMP, PJT, y}$	CEF	Leakage
19/08/2012 ~ 18/09/2012	3,262.037	345,810.6	57.705	0.0007168	21	0	480.752	0.312	0.5375	0
19/09/2012 ~ 18/10/2012	3,125.527	349,550.1	54.816	0.0007168	21	0	449.216	0.312	0.5375	0
19/10/2012 ~ 18/11/2012	3,150.589	349,376.6	54.547	0.0007168	21	0	524.652	0.144	0.5375	0
19/11/2012 ~ 18/12/2012	2,795.995	309,559.6	54.696	0.0007168	21	0	460.767	0.696	0.5375	0
19/12/2012 ~ 31/12/2012	1,334.208	160,071.9	50.198	0.0007168	21	0	232.282	0.336	0.5375	0
<b>19/08/2012 ~ 31/12/2012</b>	<b>13,668.356</b>	<b>1,514,368.8</b>	<b>54.901</b>	0.0007168	21	0	<b>2,147.670</b>	<b>1.800</b>	0.5375	0
01/01/2013~	2,206.173	232,137.1	48.741	0.0007168	25	0	332.584	0.336	0.5375	0

19/01/2013										
19/01/2013 ~ 18/02/2013	3,467.253	371,395.5	47.686	0.0007168	25	0	546.699	0.504	0.5375	0
19/02/2013 ~ 18/03/2013	3,070.565	324,687.1	48.222	0.0007168	25	0	492.937	0.240	0.5375	0
19/03/2013 ~ 18/04/2013	3,634.906	378,900.4	49.106	0.0007168	25	0	559.466	0.096	0.5375	0
19/04/2013 ~ 18/05/2013	3,561.217	371,813.8	49.198	0.0007168	25	0	527.069	0.144	0.5375	0
19/05/2013 ~ 18/06/2013	3,863.159	381,393.9	52.268	0.0007168	25	0	541.126	0.048	0.5375	0
19/06/2013 ~ 18/07/2013	4,014.864	382,697.4	54.422	0.0007168	25	0	525.966	0.096	0.5375	0
19/07/2013 ~ 18/08/2013	4,200.386	406,281.5	53.696	0.0007168	25	0	541.428	0.024	0.5375	0
01/01/2013~ 18/08/2013	27,902.938	2,849,306.7	50.386	0.0007168	25	0	4,067.275	1.488	0.5375	0
19/08/2012~ 18/08/2013	41,686.879	4,363,675.5	54.90 / 50.59	0.0007168	21/25	0	6,214.945	3.288	0.5375	0

Item	Baseline emissions or baseline net GHG removals by sinks (t CO <sub>2</sub> e)	Project emissions or actual net GHG removals by sinks (t CO <sub>2</sub> e)	Leakage (t CO <sub>2</sub> e)	Emission reductions or net anthropogenic GHG removals by sinks (t CO <sub>2</sub> e)
19/08/2012 ~ 31/12/2012	13,669.323	0.968	0	13,668.356
01/01/2013 ~ 18/08/2013	28,019.323	0.800	0	28,018.523
<b>Total</b>	<b>41,688.646</b>	<b>1.767</b>	<b>0</b>	<b>41,686.879</b>

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

Item	Values estimated in ex-ante calculation of registered PDD	Actual values achieved during this monitoring period
Emission reductions or GHG removals by sinks (t CO <sub>2</sub> e)	25,623 tCO <sub>2</sub> e	41,686 tCO <sub>2</sub> e*

Detail Values estimated in ex-ante calculation of registered PDD (only 4<sup>th</sup> Monitoring period) are shown as below.

Year	ER <sub>y,estimated</sub> , PDD	=	ER <sub>y,CH4</sub> , PDD	+	ER <sub>y,electricity</sub> , PDD
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

Year	ER <sub>y</sub>	ER <sub>CH4</sub>	BE <sub>y,CH4</sub>	PE <sub>y,CH4</sub>	Leakage	ER <sub>electricity</sub>	BE <sub>y,electricity</sub>	PE <sub>y,electricity</sub>	Leakage
2012 (135days)	9,376	8,144	8,144	0	0	1,232	1,232	0.401	0
2013 (230days)	16,247	14,112	14,112	0	0	2,135	2,135	0.683	0
Total (365days)	25,623	22,257	22,257	0	0	3,366	3,368	1.084	0

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

>>

**Actual values reached during the monitoring period: 41,686 tCO<sub>2</sub>e**

**Values applied in ex-ante calculation of the registered CDM-PDD (2011~2012): 25,623 tCO<sub>2</sub>e**

The emission reductions increased to 62.7% during the monitoring period compared to the expected emission reductions which are on the registered CDM-PDD.

The main causes of the increased emission reductions are as follows.

#### **Updated value of GWP<sub>CH4</sub> to be applied for the secondary commitment period of the Kyoto protocol.**

On the use of new global warming potential (GWP) factors agreed to be applied at the Durban Climate Change Conference (COP 17). Thus updated value of GWP<sub>CH4</sub> applied after first commitment period.

- 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)

After the updated value of GWP<sub>CH4</sub>, the emission reductions increased from 46.6% to 62.7%.

#### **Expected data in registered PDD calculated using conservative data.**

In PDD, BE<sub>y</sub> = BE<sub>CH4,SWDS,y</sub> - MD<sub>req,y</sub>. The methane emission potential of a solid waste disposal site, BE<sub>CH4,SWDS,y</sub> in tCO<sub>2e</sub>, 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 6.16 m<sup>3</sup>/min (on the registered CDM-PDD: 135days in 2012, 230days in 2013) but the actual average flow was 8.30 m<sup>3</sup>/min during the monitoring period. In other words, there was 35% of the difference between the theoretical and the actual values.

#### **Quantity of waste for LFG**

The starting year of Mokpo landfill is in 1996, and the ending year is expected in 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	64,676	66,686
2012	64,197	59,712
2013(~18/08/2013)	40,154	39,187
<b>Total</b>	<b>432,590</b>	<b>463,383</b>

The amount of waste quantity (91,099ton, up 37%) was a lot more than the expected quantity (66,627 ton) in 2007 due to the waste brought from other landfill. The actual quantity of waste was increased compared to the expected quantity of waste which is on the registered CDM-PDD until 2011. Thus quantity of waste was increased methane content in landfill gas by its 1<sup>st</sup> order decay model.

The emission reduction was calculated using actual amount of landfill considering the registered PDD.

The difference between the emission reduction in the monitoring period and on the registered PDD can be explained by the difference of quantity of waste in landfill. This factor can serve as a main cause. The increase in quantity of waste causes the increase in actual LFG generation. So, conservative assumption for the expected amount of waste in landfill is the reason for the difference. And Starting in 2005, it is forbidden to bury food waste in landfill. Although food wastes were forbidden to bury, quantity of waste has been more than expectation. This tendency of increase can affect LFG generation.

#### **CH<sub>4</sub> concentration**

The PDD estimate was based on 50% CH<sub>4</sub> concentration but the actual concentration exceeds 54.9% in 2012.

#### **Seasonal effect**

Rain interrupts landfill gas emitting to atmosphere through cover soil layer. There were lots of torrential rain and abnormally high temperatures with humidity in the monitoring period especially in summer.

As the pressure of the cover soil layer was decreased, the extraction rate of landfill gas was increased.

#### **Maintenance of Landfill gas collecting system**

Another reason for increase in emission reduction is the overall optimization of landfill operation. Emission reduction can be increased depending on the amount of LFG. In addition, the conservative assumptions for the landfill operating conditions including operating hour and the optimization of the LFG power generation can also be the reasons for the difference. The overall and comprehensive environment was optimized for the landfill, although the theoretical model considered less methane fraction in the landfill gas.

Therefore, the emission reduction is not increased proportionally in accordance with only one factor. And the biggest cause is the difference of the prediction of landfill gas.

#### **Amount of exported electricity**

The amount of exported electricity was estimated to be 6,459 MWh (on the registered CDM-PDD: 135days in 2012, 230days in 2013) but the actual amount of exported electricity was 6,215 MWh during the monitoring period. In other words, there was 3.8% of the difference between the theoretical and the actual values. For this project activity, amount of exported electricity is the only factor for revenue. In a point of additionality of this project activity, increasing of treated methane gas is not directly related to income of this project activity. Thus regarding to this change, this change was not occurred intentionally as it does not have influence on revenue and this increasing also does not effect to the additionality of this project activity.

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

Item	Actual values achieved up to 31 December 2012	Actual values achieved from 1 January 2013 onwards
Emission reductions or GHG removals by sinks (t CO <sub>2</sub> e)	13,668	28,018

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**Document information**

<i>Version</i>	<i>Date</i>	<i>Description</i>
03.1	2 January 2013	Editorial revision to correct table in section E.5.
03.0	3 December 2012	Revision required to introduce a provision on reporting actual emission reductions or net anthropogenic GHG removals by sinks for the period up to 31 December 2012 and the period from 1 January 2013 onwards (EB70, Annex 11).
02.0	13 March 2012	Revision required to ensure consistency with the "Guidelines for completing the monitoring report form" (EB 66, Annex 20).
01	28 May 2010	EB 54, Annex 34. Initial adoption.
Decision Class: Regulatory		
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