



Monitoring report form
(Version 05.1)

Complete this form in accordance with the Attachment "Instructions for filling out the monitoring report form" at the end of this form.

MONITORING REPORT

Title of the project activity	Mokpo Landfill Gas Recovery Project for Electricity Generation	
UNFCCC reference number of the project activity	2834	
Version number of the monitoring report	Version 2.0	
Completion date of the monitoring report	20/04/2016	
Monitoring period number and duration of this monitoring period	6 th monitoring period: 19/12/2014~31/12/2015 (378 days)	
Project participant(s)	Hanwha Corporation	
Host Party	Republic of KOREA	
Sectoral scope(s)	Scope 1. Energy industry Scope 13. Waste handling and disposal	
Selected methodology(ies)	Applied methodologies: - AMS I. D: Grid connected renewable electricity generation_V13 - AMS III. G: Landfill methane recovery_V06	
Selected standardized baseline(s)	N/A	
Estimated amount of GHG emission reductions or net GHG removals by sinks for this monitoring period in the registered PDD	27,348 tCO ₂ -eq	
Total amount of GHG emission reductions or net GHG removals by sinks achieved in this monitoring period	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	0 tCO ₂ -eq	52,030 tCO ₂ -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 m² and waste disposal area is 180,000 m².

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

The purpose of this project is to collect and utilize CH₄ (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 landfill 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 CO₂ emission reductions, the reductions were 52,030tons CO₂ over the 13 month (378days, 19/12/2014~31/12/2015) of crediting period.

The relevant dates for the project activity:

The relevant dates of the project activity are given below:

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

**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 whether 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 and standardized baseline

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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

A.6. Contact information of responsible persons/entities

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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 were several monitoring equipment maintenances but no significant malfunction 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 operation events during this monitoring period are as follows:

<Table B-1> Operation events history

Date	Duration		Operation events	Note
27/12/2014	06:23~6:32	9 min	Maintenance of 1 st generator. • Water leak of Cylinder. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate data is not available due to measurement error. → Excluded for estimation of emission reduction.
	06:44~06:47	3 min	2 nd generator's trip occurred.	
	0.2 hours			

31/12/2014	13:42~14:18	36min	Generator shift after maintenance for 1 st generator. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	15:19~16:09 16:23~17:19	50min 56min	Maintenance of 1 st generator. • Mark error of pressure. → Generator trip occurred due to an error of pressure.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	2.37 hours			
13/01/2015	09:51~15:18	327min	Maintenance of 1 st generator. • Replace engine oil.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	5.45 hours			
28/01/2015	04:38~09:00	262 min	Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to monitoring system recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	4.37 hours			
13/02/2015	09:33~10:30	57 min	Maintenance of 1 st generator. • Replace engine oil. → Generator shift due to maintenance.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.95 hours		• From 1 st generator to 2 nd generator.	
16/02/2015	09:34~11:10	96 min	Generator shift after maintenance for 1 st generator. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	1.6 hours			
28/02/2015	11:02~11:11	9 min	Landfill maintenance. • Wellhead damage caused by construction of collection system. → Generator stopped by inflow of oxygen. → Generator shift due to maintenance.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.15 hours		• From 1 st generator to 2 nd generator.	
02/03/2015	10:33~10:45	12 min	Generator shift after maintenance of 1 st generator. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.2 hours			
03/03/2015	13:37~15:40	123 min	Landfill maintenance. • Wellhead damage caused by construction of collection system. → Generator stopped by inflow of oxygen.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	2.05 hours			
07/03/2015	14:34~24:00	566 min	Maintenance of monitoring system. • Error of monitoring system.	1 st generator's flow rate and CH ₄ concentration data is not available due to monitoring system recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	9.43 hours			
08/03/2015	00:00~24:00	1440 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to monitoring system recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	24 hours			
09/03/2015	00:00~08:54	534 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to monitoring system recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	8.9 hours			

23/03/2015	09:02~11:23	141 min	Maintenance of 1 st generator. • Replace engine oil. → Generator shift due to maintenance.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	2.35 hours			
25/03/2015	14:02~14:09 14:09~24:00	7 min 591 min	Maintenance of monitoring equipment. • Calibration of gas analyzer. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to monitoring system recording error. → Excluded for estimation of emission reduction.
	9.97 hours			
26/03/2015	00:00~24:00	1440 min	Maintenance of monitoring equipment. • Calibration of gas analyzer. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to monitoring system recording error. → Excluded for estimation of emission reduction.
	24 hours			
27/03/2015	00:00~15:30	930 min	Maintenance of monitoring equipment. • Calibration of gas analyzer. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to monitoring system recording error. → Excluded for estimation of emission reduction..
	15.5 hours			
31/03/2015	07:43~24:00	976 min	Landfill maintenance. • Wellhead damage caused by construction of collection system. Maintenance of monitoring equipment. • Calibration of gas flow meter.	Flow rate data is not available due to measurement error. → Excluded for estimation of emission reduction.
	16.27 hours			
01/04/2015	00:00~16:32	992 min	Maintenance of monitoring equipment. • Calibration of gas flow meter.	Flow rate data is not available due to measurement error. → Excluded for estimation of emission reduction.
	16.53 hours			
20/04/2015	08:58~09:34	36min	Maintenance of 1 st generator. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	09:46~09:52	6min	2 nd generator's trip occurred.	
	0.7 hours			
	24 hours		Exceeds allowable tolerance. • Flow meter's daily effectively measure flows is up to 1728 Nm ³ . • Measured daily error between main flowmeter and total of 1 st and 2 nd generator is 1817.9 Nm ³ .	To correct the error, a conservative data (main flow's flow data) has been applied.
24/04/2015	18:50~19:41	51 min	Generator shift after maintenance for 1 st generator. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	19:46~22:02 22:48~23:20	136 min 32 min	1 st generator's trip occurred. → Test operation of 1 st generator. • Normal operation test after maintenance of 1 st generator.	
	3.65 hours			
28/04/2015	08:26~10:25	119 min	Maintenance of 1 st generator. → Engine knocking repair.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	1.99 hours			

04/05/2015	17:01~17:50	49 min	1 st generator's trip occurred due to the grounding. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
04/05/2015 ~ 22/05/2015	04/05/2015 17:00 ~ 22/05/2015 17:18	24,498 min	Maintenance of monitoring system. • Error of monitoring system. → Scanned the monitoring system by system services vendor.	CH ₄ concentration data is not available due to monitoring system recording error. → Keep an hourly work log on the CH ₄ concentration.
	1020.75 hours			
	15:31~16:42 16:53~17:06	71 min 13 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.4 hours			
27/05/2015	08:57~10:34	97 min	Maintenance of 1 st generator. • Replace engine oil. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	11:17~13:27	130 min	Maintenance of 2 nd generator. • Cooling water leak. → Generator shift due to maintenance. • From 2 nd generator to 1 st generator.	
	3.78 hours			
30/06/2015	09:04~12:51	227 min	Maintenance of 1 st generator. • Replace engine oil.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	3.78 hours			
03/07/2015	03:10~07:55	285 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	4.75 hours			
04/07/2015	07:10~13:15	365 min	The entire project boundary was blacked out. Power transmission (Import/Export) stopped. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	13:17~13:21 13:24~13:39 13:42~13:54 14:18~14:33	4 min 15 min 12 min 15 min	2 nd generator's trip occurred.	
	6.85 hours			
07/07/2015	11:52~13:08	76 min	Generator shift after maintenance of 1 st generator. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	1.27 hours			
08/07/2015	21:37~22:25	48 min	Maintenance of 1 st generator. • Mark error of pressure. → Generator trip occurred due to an error of pressure.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.8 hours			
27/07/2015	09:06~09:16	10 min	Test operation of 2 nd generator. • Normal operation test after maintenance of 2 nd generator. (Replace parts: the bellows for exhaust). → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.17 hours			

28/07/2015	09:06~10:27	81 min	Generator shift after test operation. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	1.35 hours			
07/08/2015	08:16~8:27	11 min	Maintenance of 1 st generator. • Replace engine oil. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	08:32~08:34	2 min	2 nd generator's trip occurred.	
	09:06~13:00	236 min	Maintenance of 2 nd generator. • Error of monitoring system. → Communication port of error of 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	13:00~13:54	54 min	Maintenance of 2 nd generator. • Mark error of pressure. → Generator trip occurred due to an error of pressure.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	5.05 hours			
08/08/2015	07:06~9:55	169 min	Maintenance of 2 nd generator. • Mark error of pressure. → Replace parts: spark plug socket for #20 cylinder.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	2.81 hours			
10/08/2015	13:29~13:55	26 min	Generator shift after maintenance. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	13:56~13:59	3 min	1 st generator's trip occurred.	
	15:41~16:48	67 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.6 hours			
02/09/2015	09:31~11:43	132 min	Maintenance of 1 st generator. • The water pump cavitation occurred.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	2.2 hours			
04/09/2015	08:56~09:54	58 min	Test operation of 2 nd generator. • Normal operation test after maintenance of 2 nd generator. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	14:13~24:00	587 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	10.75 hours			
05/09/2015	00:00~12:29	538 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	12.48 hours			
08/09/2015	08:51~09:28	37 min	Generator shift after maintenance of 1 st generator. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.

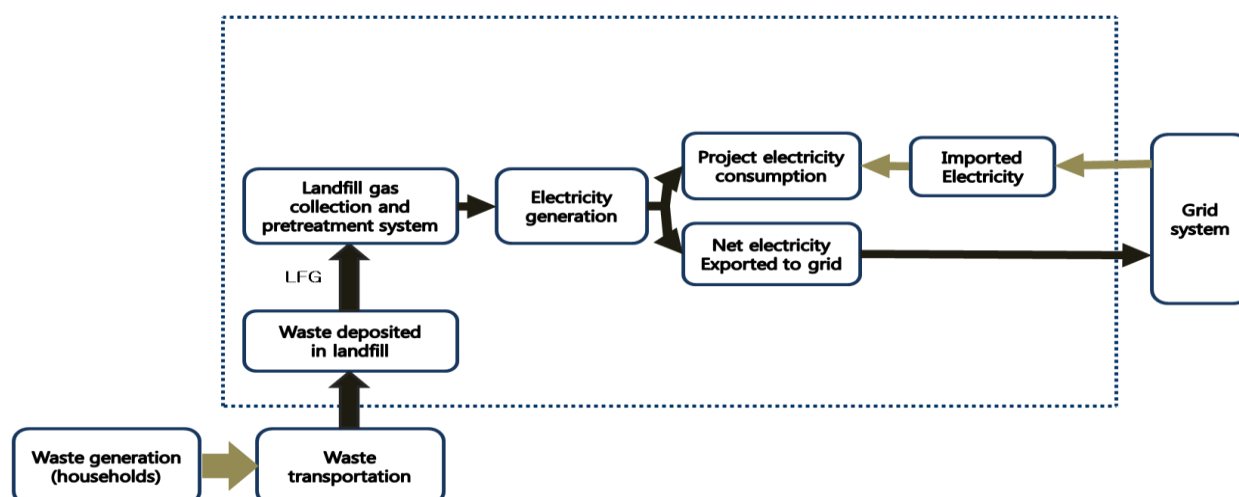
	11:24~11:39	15 min	Momentary power interruptions occurred in the entire project boundary due to the grounding. → Power transmission (Import/Export) stopped.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.87 hours			
15/09/2015	04:16~24:00	1184 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	19.73 hours			
16/09/2015	00:00~08:19	499 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	8.31 hours			
21/09/2015	15:11~16:05	54 min	Landfill maintenance. • Wellhead damage caused by construction of collection system. → 1 st generator's trip occurred.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.9 hours			
24/09/2015	00:33~07:47	387 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	6.45 hours			
01/10/2015	21:23~24:00	157 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	2.62 hours			
02/10/2015	00:00~07:32	452 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	7.53 hours			
07/10/2015	15:08~16:31	83 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.38 hours			
08/10/2015	13:11~13:55	44 min	Maintenance of 1 st generator. • Replace engine oil. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	21:00~24:00	180 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	3.73 hours			
09/10/2015	00:00~24:00	1440 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	24 hours			
10/10/2015	00:00~24:00	1440 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	24 hours			

11/10/2015	00:00~24:00	1440 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	24 hours			
12/10/2015	00:00~09:52	592 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator. → Generator shift due to maintenance. • From 2 nd generator to 1 st generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	9.87 hours			
13/11/2015	09:02~09:23	21 min	Maintenance of 1 st generator. • Replace engine oil. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	23:00~24:00	60 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	1.35 hours			
14/11/2015	00:00~24:00	1440 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	24 hours			
15/11/2015	00:00~24:00	1440 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	24 hours			
16/11/2015	00:00~12:00	720 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	12:00~15:23	203 min	Generator shift after maintenance for 1 st generator. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	15.38 hours			
19/11/2015	07:49~08:13	24 min	Maintenance of monitoring system. • Error of monitoring system.	Flow rate and CH ₄ concentration data is not available due to monitoring system recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	0.4 hours			
09/12/2015	14:30~14:56	26min	Maintenance of 1 st generator. • Mark error of pressure. → Generator trip occurred due to an error of pressure.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.43 hours			
18/12/2015	12:27~12:51	24 min	Maintenance of 1 st generator. • Replace engine oil. → Generator shift due to maintenance. • From 1 st generator to 2 nd generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	23:00~24:00	60 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	1.4 hours			

19/12/2015	00:00~24:00	1440 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	24 hours			
20/12/2015	00:00~24:00	1440 min	Maintenance of monitoring system. • Error of communication port for 2 nd generator.	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	24 hours			
21/12/2015	00:00~13:00	780 min	Maintenance of monitoring system. • Error of monitoring system. → Scanned the monitoring system by system services vendor	Flow rate data is not available due to recording error. → Keep an hourly work log on the flow rate.
	13:00~13:57	57 min	Generator shift after maintenance for 1 st generator. • From 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	13.95 hours			
22/12/2015	11:32~11:46	14 min	Maintenance of 1 st generator. • Mark error of pressure. → Generator trip occurred due to an error of pressure.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.23 hours			
23/12/2015	10:14~10:54	40 min	Maintenance of 1 st generator. • Mark error of pressure. → Generator trip occurred due to an error of pressure.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.67 hours			
28/12/2015	07:55~08:51	56 min	Maintenance of 1 st generator. • Replace engine oil.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.93 hours			

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

Mokpo Landfill, located in Daeyang-dong, Mokpo City, Jeollanam-do and constructed at the end of 1995 as a municipal solid waste (MSW) landfill. The total land area is 290,490 m², the amount of available landfill capacity is 2,897,000 m³.

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.

The same repair work has been conducted in May 2014. As a result, 150 vertical well were being operated.

As landfill progresses, the management of landfill gas collecting system has been going on. The total amount of available landfill capacity was 2,897,000 m³. And about 80% of the landfill is in progress. The amount of available landfill capacity was 616,000 m³ in December 2015.

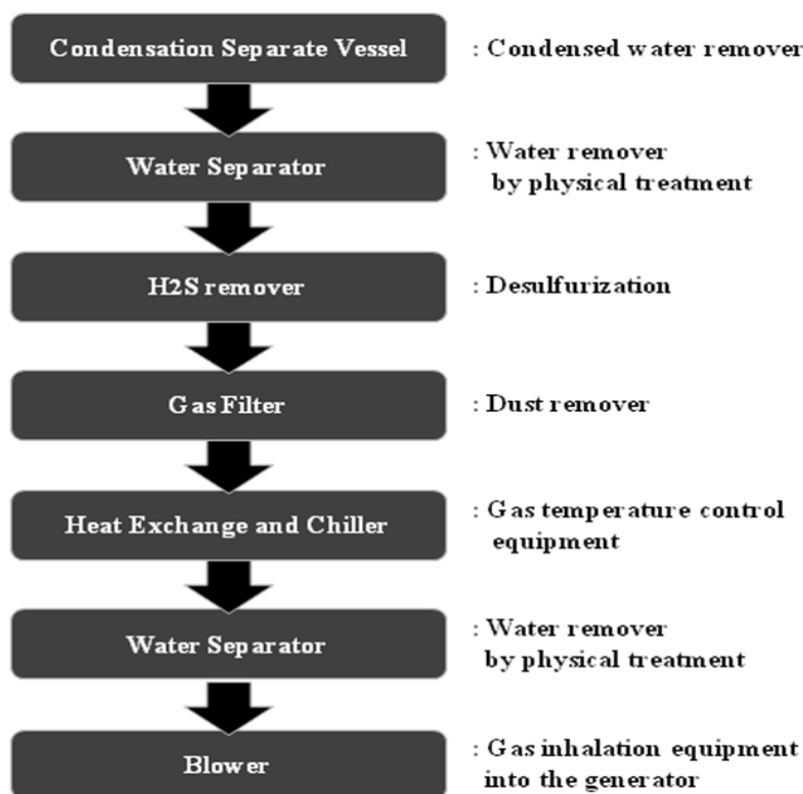
Detail history of wellhead is shown below <Table B-2>. Each of drawings has been submitted to the DOE.

<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
May 2014	13	150	150	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 H₂S and to protect the generators for this project. The pre-treatment consists of 1) CSV (Condensate Separation Vessel), 2) water separator, 3) H₂S remover, 4) gas filter, 5) heat exchange and chiller, 6) water separator and 7) blower.



<Figure B-6> Pre-treatment system

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 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 %

B.2. Post-registration changes

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

>>

N/A

B.2.2. Corrections

>>

No corrections to project information or parameter fixed at validation have been approved during the current monitoring period. During the previous monitoring period, post-registration changes request was approved on March 6th, 2014. PRC ref is PRC-2834-001.

B.2.3. Changes to start date of crediting period

>>

N/A

B.2.4. Inclusion of a monitoring plan to the registered PDD that was not included at registration

>>

N/A

B.2.5. Permanent changes from registered monitoring plan, applied methodology or applied standardized baseline

>>

No permanent changes from the registered monitoring plan or applied methodology have been

approved during this monitoring period. During the previous monitoring period, post-registration changes request was approved on March 6th, 2014. PRC ref is PRC-2834-001.

B.2.6. Changes to project design of registered project activity

>>

N/A

B.2.7. Types of changes specific to afforestation or reforestation project activity

>>

N/A

SECTION C. Description of monitoring system

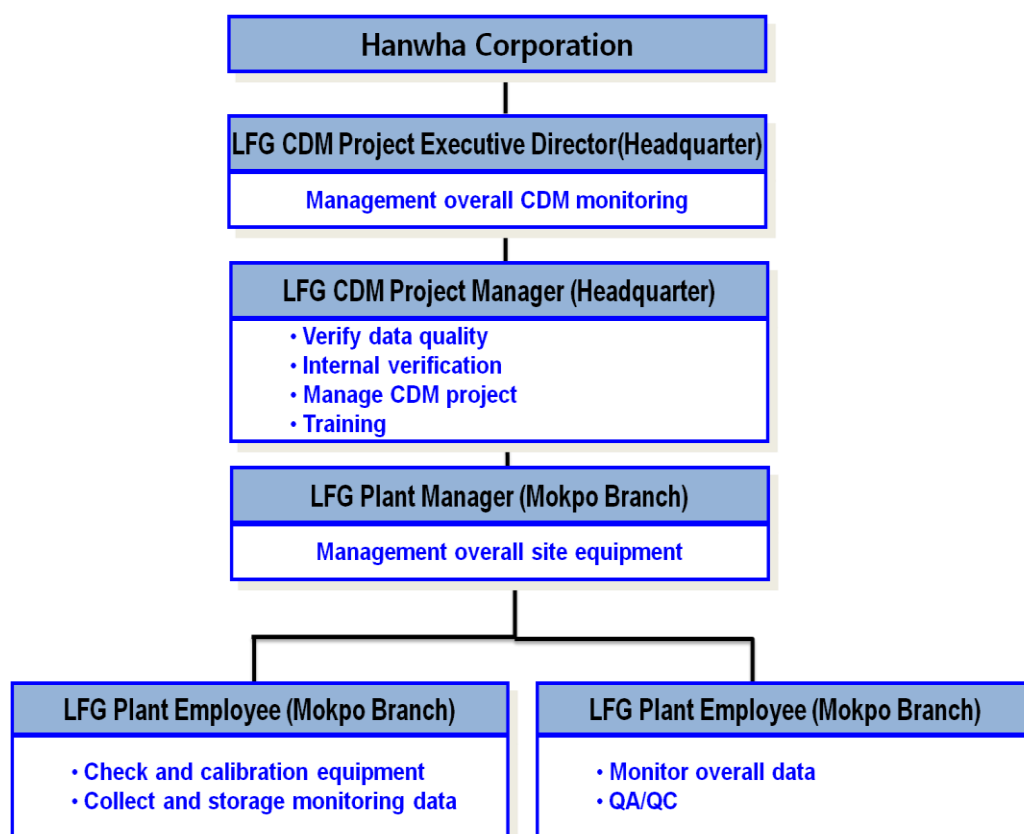
>>

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 _{electricity, y}	Responsible person/department for the project : • LFG plant manager / Mokpo operating Team of HWC Mokpo branch
	WCH _{4,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	Responsible person/department for the project : • LFG plant employee / Mokpo operating team of HWC Mokpo branch
	Gas analyzer	
	Watt-hour meter Responsible person/department for the project:	
Establish monitoring plan		Responsible person/department for the project : • LFG CDM project executive director / Green & Renewable energy business team of HWC Headquarter • LFG plant manage / Mokpo operating team of HWC Mokpo branch • LFG CDM project manager / 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 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.

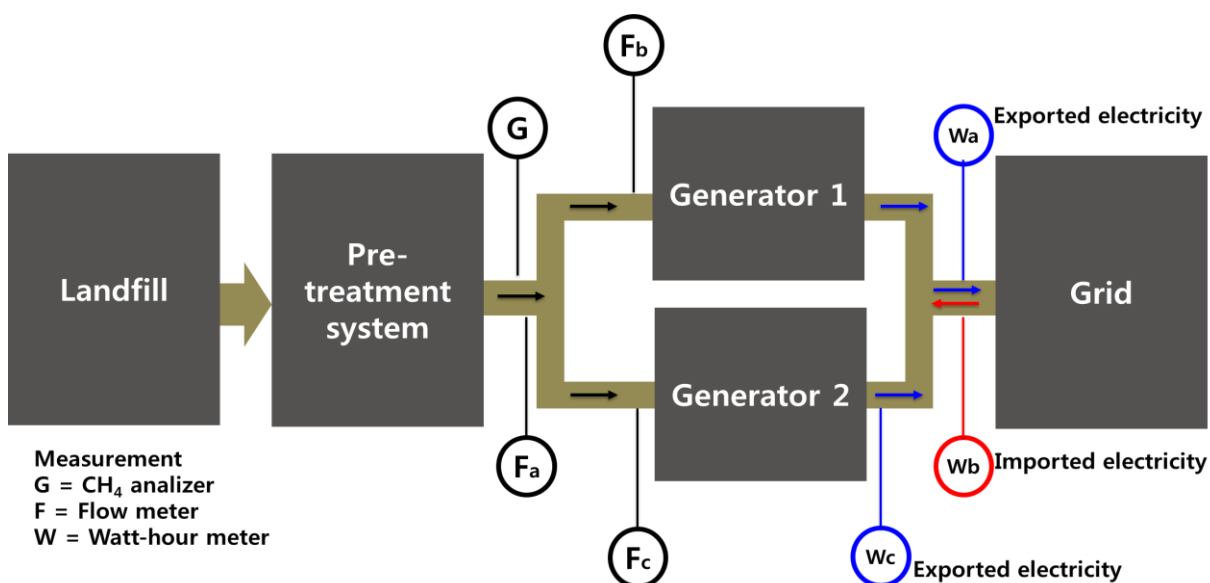
- The Watt-hour meters are to be set-up transparently in accordance with “Law regarding measurement” and “Act on operation of electricity market”. Thereafter, the electricity measuring meter will be calibrated when it is installed behind the generator and sealed up after affirmation of Korea Power Exchange.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

- For last monitoring period, a watt-hour meter for 2nd generator was installed on January 27th, 2013. Hanwha Corporation added the watt-hour meter for 2nd generator, which requested it under the “Act on the promotion of the development, use and diffusion of new and renewable energy”. In previous installation, total amount of exported electricity out of project had been monitored by Wa watt-hour meter, Wa as shown in <Figure 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 2nd generator (Wc) in this monitoring period, the amount of exported electricity is expressed as follows:

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



<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 Nm³/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, Had only one 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 N₂ gas is used. Span calibration is for span point adjustment. For this calibration, the standard gas (CH₄, CO₂, and

O₂) was used with a concentration of each specification in accordance with manufacturer's specification.

When data lag is occurred, the lower CH₄ concentration value was selected between before and after of this lagging time and the CH₄ quantity was calculated with this CH₄ 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 2nd generator(W_c), total amount of exported electricity out of project had been monitored by W_a.

After installation of W_c, W_c is used to measure only if 2nd generator was operated. When 1st generator or both 1st and 2nd generator operates, W_a 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 (W_b) which managed and monthly invoiced by Korea Electric Power Corporation (KEPCO).

<Table C-2> Related watt-hour meters

Tag	Serial No	Accuracy level	Description	Remarks
W _a	95246742	0.5s	Exported electricity (1 st generator)	
W _c	50339836	0.5s	Exported electricity (2 nd generator)	A watt-hour meter for 2 nd generator (W _c) was installed on January 27 th , 2013. W _c added requested it under the "Act on the promotion of the development, use and diffusion of new and renewable energy".
W _b	0190662	1s	Imported electricity	According to the "Measures Act", Watt-hour meter for imported electricity is replaced on April 14, 2015.
	24142000332	0.5s	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 Republic of 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 (Green & Renewable energy business team).

Operation review, internal audit and corrective action are carried out by Green & Renewable energy business 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 Electricity Safety Management was done by experts (from Korea Electric Engineers Association) on May 8, 2015.

External training for emissions trading scheme was done by experts (from consulting company) on May 16, 2015.

Internal training for the monitoring was done by LFG CDM project manager of headquarter on November 20, 2015.

Internal training for the monitoring was done by LFG CDM project manager of headquarter on December 11, 2015.

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

Data/parameter:	Operation Margin Emission Factor (EF_{OM})
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	"Statistics of Electric Power in Korea"
Value(s) applied)	0.6817
Choice of data or measurement methods and procedures	The simple OM method is used to calculate EFOM 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 (2005-007) for which data are available at time of this PDD submission, and fixed for the crediting period.
Purpose of data	Calculation of Baseline/ Project emission
Additional comments	This data is available at time of this PDD submission, and fixed for the crediting period

Data/parameter:	Build Margin Emission Factor (EF_{BM})
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	"Statistics of Electric Power in Korea"
Value(s) applied)	0.3933
Choice of data or measurement methods and procedures	EFBM 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.
Purpose of data	Calculation of Baseline/ Project emission
Additional comments	This data is available at time of this PDD submission, and fixed for the crediting period.

Data/parameter:	CO₂ Emission Intensity of the Electricity displaced (CEF_{electricity})
Unit	ton CO ₂ e/MWh
Description	The weighted average of EF _{OM} and EF _{BM}
Source of data	"Statistics of Electric Power in Korea"
Value(s) applied)	0.5375
Choice of data or measurement methods and procedures	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.

Purpose of data	Calculation of Baseline/ Project emission
Additional comments	This data is available at time of this PDD submission, and fixed for the crediting period

D.2. Data and parameters monitored

Data/parameter:	F
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 comments:	Not applied.

Data/parameter:	GWP_{CH4}
Unit	tCO ₂ e/tCH ₄
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 comments:	Not applied.

Data/parameter:	LFG_{electricity, y}
Unit	Nm ³ /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 _{electricity, y} (Nm ³)		
		F _b	F _c	F _b + F _c
	19/12/2014 ~ 18/01/2015	354,777.2	46,396.8	401,174.0
	19/01/2015 ~ 18/02/2015	374,885.2	30,772.0	405,657.2
	19/02/2015 ~ 18/03/2015	349,161.5	22,505.3	371,666.8
	19/03/2015 ~ 18/04/2015	365,366.0	0.0	365,366.0
	19/04/2015 ~ 18/05/2015	320,608.0	48,593.5	369,201.5
	19/05/2015 ~ 18/06/2015	418,545.8	293.0	418,838.8
	19/06/2015 ~ 18/07/2015	358,779.0	33,413.1	392,192.1
	19/07/2015 ~ 18/08/2015	358,404.1	48,173.0	406,577.1
	19/08/2015 ~ 18/09/2015	360,298.8	44,375.8	404,674.6
	19/09/2015 ~ 18/10/2015	348,151.0	41,276.6	389,427.6
	19/10/2015 ~ 18/11/2015	370,956.1	33,460.8	404,416.9
	19/11/2015 ~ 18/12/2015	387,564.5	4,975.6	392,540.1
	19/12/2015 ~ 31/12/2015	138,352.6	27,428.0	165,780.6
	19/12/2014 ~ 31/12/2015	4,505,849.8	381,663.5	4,887,513.3
	<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_6th MR_2834_Emission Reduction".</p>			

Monitoring equipment	Tag	F _a (main)	F _b (1 st generator)	F _c (2 nd generator)
	Serial No	906044B	812003	906044A
	Accuracy level	1%	1%	1%
	Type	Thermal Mass Flow Meter		
	Calibration frequency	3years	3years	3years
	Date of last calibration	31/03/2015 ~ 01/04/2015	31/03/2015 ~ 01/04/2015	31/03/2015 ~ 01/04/2015
	Validity	30/03/2018	30/03/2018	30/03/2018
	Calibration Entity	Flow Technology Co., Ltd.		
	<ul style="list-style-type: none">Measured automatically and continuously by integrating flow meters.The measured data is monitored by a computer and Mokpo operation team should check it continuously.To ensure accuracy, the flow meters are subject to regular maintenance and testing. The flow meter is calibrated every three years.The archived data is kept during the crediting period as well as two years after that.Daily data is documented in paper and archived in electronic file. <p>The temperature and pressure in Landfill gas are not monitored separately.</p> <p>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.</p>			
	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.			
Purpose of data:	Calculation of Baseline emission			
Additional comments:	Not applied.			

Data/parameter:	W_{CH₄,y}				
Unit	%				
Description	Methane fraction in LFG				
Measured/calculated/default	Measured				
Source of data	Methane analyzer				
Value(s) of monitored parameter	<p>- Weighted average CH₄ concentration during the monitoring period The measured methane fraction data is monitored automatically and continuously by gas analyzer.</p> <table> <tr> <th>Date</th><th>Measured CH₄ (%) (Weighted average CH₄ concentration)</th></tr> <tr> <td>19/12/2014 ~ 31/12/2015</td><td>55.48</td></tr> </table> <p>All measured data for the crediting period has been submitted to the DOE as a spread sheet.</p>	Date	Measured CH ₄ (%) (Weighted average CH ₄ concentration)	19/12/2014 ~ 31/12/2015	55.48
Date	Measured CH ₄ (%) (Weighted average CH ₄ concentration)				
19/12/2014 ~ 31/12/2015	55.48				

Monitoring equipment	Tag	G
	Serial No	A8M7282T
	Accuracy level	Linearity 1%, Repeatability 0.5%
	Type	Infrared gas analyzer
	Calibration frequency	3 years
	Date of last calibration	26/03/2015
	Validity	25/03/2018
	Calibration Entity	National Metrology Institute
	<ul style="list-style-type: none"> Methane fraction is measured with continuous gas analyzer. The measured data is monitored by a computer and Mokpo operation team should check it continuously. To ensure accuracy, the gas analyzer is subject to regular maintenance and testing regime in accordance with the manufacturer's specification. The methane analyzer is calibrated every three years. The archived data is kept during the crediting period as well as two years after that. Daily data is documented in paper and archived in electronic file. 	
Measuring/reading/recording frequency:	Measured automatically.	
Calculation method (if applicable):	Not applied.	
QA/QC procedures:	To ensure accuracy, the gas analyzer is subject to regular maintenance and testing regime in accordance with the manufacturer's specification. The methane analyzer is calibrated every three years.	
Purpose of data:	Calculation of Baseline emission	
Additional comments:	Not applied.	

Data/parameter:	EL_{EXP}, PJT, y
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 _{EXP} (MWh)
	19/12/2014 ~ 18/01/2015	486.739	58.538	545.277
	19/01/2015 ~ 18/02/2015	515.435	40.526	537.486
	19/02/2015 ~ 18/03/2015	478.535	26.615	505.150
	19/03/2015 ~ 18/04/2015	563.677	0.000	563.677
	19/04/2015 ~ 18/05/2015	431.186	59.973	491.159
	19/05/2015 ~ 18/06/2015	569.887	0.281	570.169
	19/06/2015 ~ 18/07/2015	490.240	39.683	493.084
	19/07/2015 ~ 18/08/2015	486.921	54.536	541.456
	19/08/2015 ~ 18/09/2015	495.705	54.002	531.280
	19/09/2015 ~ 18/10/2015	475.531	52.318	527.850
	19/10/2015 ~ 18/11/2015	507.281	42.531	532.585
	19/11/2015 ~ 18/12/2015	507.133	6.272	513.404
	19/12/2015 ~ 31/12/2015	177.497	35.064	212.561
	19/12/2014 ~ 31/12/2015	6,185.767	470.339	6,656.105
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 _a	W _c
	Serial No	95246742	50339836
	Accuracy level	0.5s	0.5s
	Type	watt-hour meters	
	Calibration frequency	performed at least once in 2 years	
	Date of last calibration	20/08/2014~26/08/2014	20/08/2014~26/08/2014
	Validity	19-08-2016	19-08-2016
	Calibration Entity	KTC(Korea Testing Certification)	
	<ul style="list-style-type: none"> Two watt-hour meters were installed to measure the amount of exported electricity. The amount of exported electricity is measured automatically by certified watt-hour meters. 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. This project involves the installation of two exported electricity watt-hour meters. W_a watt-hour meter had been installed as measure of the amount of exported electricity in Mokpo LFG plant. Additionally a watt-hour meter for 2nd generator (W_c) was installed on January 27th, 2013. W_c added requested it under the "Act on the promotion of the development, use and diffusion of new and renewable energy". In previous installation the watt-hour meter for 2nd generator (W_c), total amount of exported electricity out of project had been monitored by W_a watt-hour meter. After installation of W_c, W_c is used to measure only if 2nd generator was operated. When 1st generator or both 1st and 2nd generator operates, W_a is used to measure the amount of exported electricity. The archived data is kept during the crediting period as well as two years after that. Daily data is documented in paper and archived in electronic file. 		
Measuring/reading/recording frequency:	Measured automatically.		
Calculation method (if applicable):	Not applied.		
QA/QC procedures:	<ul style="list-style-type: none"> 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 Republic of Korea. The calibration of watt-hour meters will be carried out before the installation initially and periodically performed at least once in 2 years. 		
Purpose of data:	Calculation of Baseline emission		
Additional comments:	Not applied.		

Data/parameter:	EL_{IMP}, PJT, y	
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_{IMP} (MWh)
	19/12/2014 ~ 18/01/2015	0.336
	19/01/2015 ~ 18/02/2015	0.096
	19/02/2015 ~ 18/03/2015	0.096
	19/03/2015 ~ 18/04/2015	0.144
	19/04/2015 ~ 18/05/2015	0.216
	19/05/2015 ~ 18/06/2015	0.096
	19/06/2015 ~ 18/07/2015	0.408
	19/07/2015 ~ 18/08/2015	0.264
	19/08/2015 ~ 18/09/2015	0.144
	19/09/2015 ~ 18/10/2015	0.048
	19/10/2015 ~ 18/11/2015	0.120
	19/11/2015 ~ 18/12/2015	0.024
	19/12/2015 ~ 31/12/2015	0.096
	19/12/2014 ~ 31/12/2015	2.088
	<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> <p>19/12/2014 to 18/01/2015, 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.</p> <p>For conservative estimation, we calculated the total amount of imported electricity including last whole month without divide into a daily basis.</p>	

Monitoring equipment	Tag	W _b	
	Serial No	0190662	24142000332
	Accuracy level	1s	0.5s
	Type	watt-hour meter	watt-hour meter
	Calibration frequency	once in 2 years	once in 2 years
	Measuring Period	Until 14/04/2015	From 14/04/2015
	Date of last calibration	26-09-2011~27-09-2011 24-09-2013~25-09-2013	17-06-2014
	Validity	23-09-2015	16-06-2016
	Calibration Entity	Korea Testing Certification (KTC)	Korea Testing Certification (KTC)
		<ul style="list-style-type: none"> Aside CDM project, according to the article 22 of “enforcement decree of the measures act”, domestic raw, watt-hour meter for imported electricity must be calibrated and/or replaced again every 7 years by KEPCO. Thus existing installed watt-hour meter (serial number: 0190662) has been replaced by KEPCO in this monitoring period. 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.kepcoco.kr) and get the paper bill from KEPCO monthly. The archived data is kept during the crediting period as well as two years after that. The monthly data is archived in paper bill from KEPCO. 	
Measuring/reading/recording frequency:	Measured automatically.		
Calculation method (if applicable):	Not applied.		
QA/QC procedures:	<ul style="list-style-type: none"> To ensure accuracy, the watt-hour meter is subject to regular maintenance and testing regime complying with the “Measures Act” in Republic of Korea. The calibration of watt-hour meter will be carried out before the installation initially and periodically performed at least once in 2 years. 		
Purpose of data:	Calculation of Project emission		
Additional comments:	Not applied.		

D.3. Implementation of sampling plan

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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

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

Parameter	Unit	Description
MD _y	tCO ₂ e	CO ₂ equivalent of the methane captured and destroyed/ gainfully used by the project activity in year y;

MD _{reg,y}	tCO ₂ 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 _{EXP, PJT, y}	MWh	The quantity of electricity exported to the grid-connected system by this project activity during the year, y
CEF	tCO ₂ e/MWh	Combined emission factor in electricity generation by grid-connected system; weighted average of EF _{OM} and EF _{BM} .

CEF is 0.5375 tCO₂e/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 ³	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 ³	Density of methane at normal conditions in the year 'y' (Source: ACM0001 ver.11)
GWP _{CH4}	tCO ₂ /tCH ₄	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/ Nm³.

Methane content is measured by gas analyzer.

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

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

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 tCO₂e/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 destructured 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 GHG removals by sinks

Date	ER _y	LFG _{electricity, y}	wCH _{4, y}	DCH _{4, y}	GWP _{CH₄}	MD _{reg, y}	EL _{EXP, PJT, y}	EL _{IMP, PJT, y}	CEF	Leakage
19/12/2014 ~ 18/01/2015	4,583.298	404,667.100	59.680	0.0007168	25	0	545.277	0.336	0.5375	0
19/01/2015 ~ 18/02/2015	4,484.371	408,842.100	57.578	0.0007168	25	0	555.961	0.096	0.5375	0
19/02/2015 ~ 18/03/2015	3,909.367	373,290.600	54.621	0.0007168	25	0	505.150	0.096	0.5375	0
19/03/2015 ~ 18/04/2015	3,643.002	366,885.800	51.015	0.0007168	25	0	563.677	0.144	0.5375	0
19/04/2015 ~ 18/05/2015	3,744.619	366,233.400	52.862	0.0007168	25	0	491.159	0.216	0.5375	0
19/05/2015 ~ 18/06/2015	4,134.042	418,327.300	50.997	0.0007168	25	0	570.169	0.096	0.5375	0
19/06/2015 ~ 18/07/2015	3,893.284	386,813.700	51.346	0.0007168	25	0	529.922	0.408	0.5375	0
19/07/2015 ~ 18/08/2015	4,217.042	404,026.600	53.887	0.0007168	25	0	541.456	0.264	0.5375	0
19/08/2015 ~ 18/09/2015	4,459.097	399,747.200	57.416	0.0007168	25	0	549.707	0.144	0.5375	0
19/09/2015 ~ 18/10/2015	4,358.250	392,475.800	58.387	0.0007168	25	0	527.850	0.048	0.5375	0
19/10/2015 ~ 18/11/2015	4,410.509	401,644.400	56.782	0.0007168	25	0	549.812	0.120	0.5375	0
19/11/2015 ~ 18/12/2015	4,382.063	396,160.000	58.373	0.0007168	25	0	513.404	0.024	0.5375	0
19/12/2015 ~ 31/12/2015	1,811.322	161,434.300	57.127	0.0007168	25	0	212.561	0.096	0.5375	0
19/12/2014 ~ 31/12/2015	52,030.264	4,880,548.300	55.484	0.0007168	25	0	6,656.105	2.088	0.5375	0

Item	Baseline emissions or baseline net GHG removals by sinks (t CO ₂ e)	Project emissions or actual net GHG removals by sinks (t CO ₂ e)	Leakage (t CO ₂ e)	GHG emission reductions or net GHG removals by sinks (t CO ₂ e) achieved in the monitoring period		
				Up to 31/12/2012	From 01/01/2013	Total amount
Total (19/12/2014 ~ 31/12/2015)	52,031.387	1.122	0	0	52,030.264	52,030

E.5. Comparison of actual emission reductions or net 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 ₂ e)	27,348 tCO₂e	52,030 tCO₂e

Year	ER _{y,estimated, PDD}	=	ER _{y,CH₄, PDD}	+	ER _{y, electricity, 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

Detail Values estimated in ex-ante calculation of registered PDD over this 6th monitoring period are shown in the below table.

Year	ER _y	ER _{CH4}				ER _{electricity}			
			BE _{y,CH4}	PE _{y,CH4}	Leakage		BE _{y,electricity}	PE _{y,electricity}	Leakage
2014 (13days)	931	809	809	0	0	122	122	0	0
2015 (365days)	26,417	22,946	22,946	0	0	3,417	3,472	1	0
Total (378days)	27,348	23,755	23,755	0	0	3,593	3,594	1.122	0

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

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Actual values reached during the monitoring period: 52,030 tCO₂e

Values applied in ex-ante calculation of the registered CDM-PDD: 27,348 tCO₂e

The emission reductions increased to 90% 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_{CH4} 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_{CH4} 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)

Since the increase in the GWP, emission reduction had about 62% increase in this monitoring period

Expected data in registered PDD calculated using conservative data.

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 6.35 m³/min (on the registered CDM-PDD: 13days in 2014, 365days in 2015) but the actual average flow was 8.82 m³/min during the monitoring period. In other words, there was

39% of the difference between the theoretical and the actual values. Because of such differences, emission reduction had about 38% increase in this monitoring period.

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	63,722	61,292
2014	63,251	58,361
2015	62,783	56,416
Total	582,192	600,495

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 1st 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.

CH₄ concentration

The PDD estimate was based on 50% CH₄ concentration but the actual concentration exceeds 55.48% in this monitoring period.

The increased CH₄ concentration had the greatest effect on increasing the emission reduction followed by the GWP update.

Since the increase in CH₄ concentration, emission reduction had about 74% increase in this monitoring period. The change of waste composition and maintenance for landfill is the biggest contributor for increase in CH₄ concentration.

Compared with PDD, the proportion of non-combustables waste decreased by about 29% to 13% over the last decade. A combustible waste could increase CH₄ generation.

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. The activation of methane gas was affected by the more than 150 usewells.

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 6,685 MWh (on the registered CDM-PDD: 13days in 2014, 365days in 2015) but the actual amount of exported electricity was 6,656 MWh during the monitoring period. In other words, there was 0.4% 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.

And in PDD, the amount of expected electricity is not calculated by assuming an operating rate. To calculate the amount of exported electricity, only expected capacity and operating hours are a factor. Thus, the predicted results and the actual results has been a gap.

Appendix 1. Contact information of project participants and responsible persons/entities

Project participant and/or responsible person/ entity	<input checked="" type="checkbox"/> Project participant <input checked="" type="checkbox"/> Responsible person/ entity for completing the CDM-MR-FORM
Organization name	Hanhwa Corporation
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Contact person	Jihyun Park
Title	
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Last name	Park
Middle name	
First name	Jihyun
Department	Trade Division, Strategic Business Development Department
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Direct fax	
Direct tel.	
Personal e-mail	