



Monitoring report form for CDM project activity
(Version 06.0)

Complete this form in accordance with the instructions attached 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 PDD applicable to this monitoring report	Version 6.0	
Version number of this monitoring report	Version 2.2	
Completion date of this monitoring report	11/10/2018	
Monitoring period number	8 th monitoring period	
Duration of this monitoring period	01/01/2017 ~ 31/12/2017	
Monitoring report number for this monitoring report	1	
Project participants	Hanwha Corporation(Republic of Korea) Hanwha Corporation(Switzerland)	
Host Party	Republic of Korea	
Sectoral scopes	Scope 1. Energy industry Scope 13. Waste handling and disposal	
Applied methodologies and standardized baselines	Applied methodologies: - AMS I.D: Grid connected renewable electricity generation_V13 -AMS III. G: Landfill methane recovery_V06	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by the project activity in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 tCO ₂ -eq	46,241 tCO ₂ -eq
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the PDD	26,780 tCO ₂ -eq	

SECTION A. Description of project activity

A.1. General description of project activity

>>

Mokpo Landfill Gas Recovery Project for Electricity Generation is developed by Hanwha Corporation (hereinafter referred to as HWC) 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 LFG that would have been released to the atmosphere without the project activity and generates electricity with the LFG. 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 equipment:

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 46,241 tons CO₂ over the 12 months (365 days, 01/01/2017~31/12/2017) 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	HWC decides to invest in 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

>>

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 participants**

Parties involved	Project participants	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 to applied methodologies and standardized baselines

>>

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 type and duration

>>

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 project activity**

>>

The Implementation status of the project activity

HWC decided to invest in the proposed 2.123MW LFG 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 LFG 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-2> 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 or the lowest CH₄ concentration data of the day 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
1/1/2017	19:36-21:35	119 min	Error of equipment • Error of coolant pressure. →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.
	23:54-23:59	5 min		
	2.07 hours			
2/1/2017	0:00-0:13	13 min	Generator shift 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
	0:23-0:26	3 min		
	10:42-10:55	12 min	Monitoring system error →CH ₄ concentration data was unstable.	CH ₄ concentration data is not available due to measurement error. →Only when the flow data is normal, the lowest CH ₄ concentration date of the day is applied.
	0.47 hours			
3/1/2017	13:00-13:18	18 min	Error of equipment • Error of 2 nd generator flow meter. →Generator shift 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.
	0.28 hours			

Date	Duration		Operation events	Note
12/1/2017	13:04-00:00	656 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	10.93 hours			
13/1/2017	01:00-09:10	490 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration
	8.17 hours			
18/1/2017	09:06-12:52	225 min	Maintenance of facilities - Restart 1 st generator after 1 st generator maintenance	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	3.75 hours			
4/2/2017	06:13-00:00	1,067 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	17.78 hours			
5/2/2017	00:00-23:59	1,439 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	23.98 hours			
6/2/2017	01:00-08:32	452 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	7.53 hours			
13/2/2017	10:43-10:59	16 min	Error of equipment • Error of gas pressure	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.27 hours			
17/2/2017	08:33-13:12	278 min	Maintenance of facilities - Generator Shift from 1 st generator to 2 nd generator after maintenance.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	13:22-14:24	61 min		
	14:25-14:37	11 min		
	5.83 hours			
20/2/2017	09:22-09:28	6 min	Generator shift 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.
	0.10 hours			
2/3/2017	09:09-09:15	5 min	Generator shift 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.
	10:56-11:42	45 min	Maintenance of facilities • Temperature rising of exhaust gas by 1 st generator shut-down →Error of 2 nd generator flow meter	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction
	11:48-11:50	2 min		
	11:52-11:54	1 min		
	12:04-13:12	67 min	Error of equipment • Error of PLC card	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction
	2 hours			
6/3/2017	10:00-23:59	892 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	14.87 hours			
7/3/2017	00:00-14:00	840 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	14 hours			
13/3/2017	18:00-23:59	421 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	7.02 hours			
14/3/2017 ~ 20/3/2017	00:00-23:59	10,073 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
160.86 hours				

Date	Duration		Operation events	Note
21/3/2017	00:00-16:19	979 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	16.32 hours			
23/3/2017	08:40-10:00	79 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.32 hours			
24/3/2017	12:30-13:27	57 min	Maintenance of facilities • Maintenance of 1 st generator	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	13:28-13:40	11 min		
	14:02-14:07	5 min	Generator shift 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.
	14:20-14:59	38 min		
	15:19-15:20	1 min		
	15:31-15:45	14 min		
	16:11-16:37	26 min		
	2.53 hours			
1/4/2017	12:19-12:54	35 min	Error of equipment • Error of ignition system.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	0.58 hours			
6/4/2017	09:40-11:24	103 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.72 hours			
12/4/2017	13:46-15:14	87 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.45 hours			
13/4/2017	09:46-10:58	72 min	Error of equipment • Error of ignition system	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	1.20 hours			
18/4/2017	06:54-08:05	70 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.17 hours			
20/4/2017	08:29-11:20	171 min	Error of equipment. • Cooling water leakage occurred by Intercooler line crackingblocked.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	2.85 hours			
25/4/2017	09:48-10:46	58 min	Maintenance of facilities. • Replace engine oil.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	10:52-13:21	149 min		
	13:25-13:27	1 min		
	3.47 hours			
26/4/2017	22:37-23:59	82 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.37 hours			
4/5/2017	16:18-18:10	112 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.88 hours			
5/5/2017	11:50-13:48	109 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.82 hours			
18/5/2017	10:32-11:23	51 min	Error of equipment • Error of ignition system.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	20:37-22:31	113 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	2.73 hours			

Date	Duration		Operation events	Note
19/5/2017	11:12-12:13	60 min	Error of equipment - Error of PLC card → 1 st generator's trip occurred after recovery operation of PLC card.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	1 hours			
20/5/2017	03:51-04:30	39 min	Error of equipment. • Cooling water pressure error occurred.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	07:57-08:18	20 min	Error of equipment. • Cooling water leakage occurred.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	1.13 hours			
22/5/2017	14:46-15:57	70 min	Generator shift 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.
	21:53-23:00	66 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	2.27 hours			
25/5/2017	15:56-17:09	72 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.20 hours			
27/5/2017	11:00-13:26	161 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	2.68 hours			
28/5/2017	04:51-06:19	87 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.45 hours			
29/5/2017	09:35-13:54	258 min	Maintenance of facilities. • Replace engine oil.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	4.30 hours			
1/6/2017	11:32-13:00	87 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.45 hours			
3/6/2017	15:54-17:49	115 min	There was black out.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	1.92 hours			
6/6/2017	12:06-13:09	63 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.05 hours			
15/6/2017	08:32-10:12	99 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.65 hours			
19/6/2017	14:48-15:45	56 min	Maintenance of facilities. → Error of oil sensor	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.93 min			
23/6/2017	13:50-13:53	2 min	Maintenance of facilities. • Error of breaker for power generation	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	13:59-14:01	2 min		
	14:12-14:17	4 min		
	013 hours			
1/7/2017	21:15-22:55	99 min	There was black out. → After black out recovery, failed 1 st generator restart	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	22:55-23:59	64 min		
	2.72 hours			
2/7/2017	00:00-09:18	558 min	Error of equipment. → Operation of 1 st generator was failed. → Solenoid Valves was broken. - Generator shift from 1st generator to 2nd generator	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	09:24-09:30	6 min		
	9.40 hours			

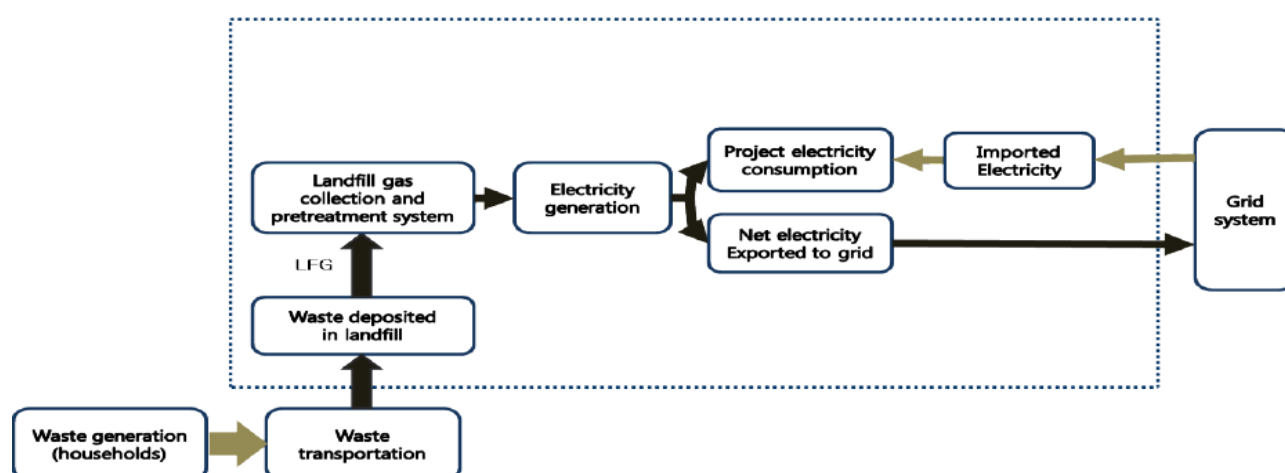
Date	Duration		Operation events	Note
4/7/2017	11:03-14:10	187 min	Generator shift from 2 nd generator to 1 st generator.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	3.12 hours			
6/7/2017	12:58-14:57	118 min	There was black out.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	1.97 hours			
8/7/2017	15:03-18:31	207 min	Error of equipment - 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.
	3.45 hours			
9/7/2017	02:01-10:12	490 min	Error of equipment - 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.
	8.17 hours			
14/7/2017	06:43-09:00	137 min	Error of equipment - 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.
	2.28 hours			
23/7/2017	08:52-09:56	63 min	Error of equipment - 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.
	09:56-11:30	93 min		
	2.60 hours			
31/7/2017	17:30-17:34	3 min	Error of equipment - 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.
	17:36-20:32	175 min		
	2.97 hours			
1/8/2017	05:50-07:08	77 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.28 hours			
4/8/2017	09:05-10:55	110 min	Maintenance of facilities. • Replace engine oil.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	1.83 hours			
9/8/2017	14:29-14:30	0.8 min	Maintenance of facilities. - CH ₄ concentration data was unstable.	CH ₄ concentration data is not available due to CH ₄ analyzer check. →Only when the flow data is normal, the lowest CH ₄ concentration date of the day is applied.
	0.03 hours			
13/8/2017	12:02-12:59	57 min	Error of equipment •Error of oil cooler →Generator shift 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.
	0.95 hours			
14/8/2017	22:51-23:43	51 min	Error of equipment - 2 nd generator's trip occurred.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	0.85 hours			
16/8/2017	14:34-14:36	2 min	Generator shift 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.
	0.03 hours			
6/9/2017	00:13-08:00	467 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	09:39-12:00	141 min		
	10.03 hours			
8/9/2017	8:45-10:51	126 min	Maintenance of facilities. • Replace engine oil.	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	2.10 hours			
19/9/2017	11:00-11:19	18 min	Error of equipment - 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.
	11:24-15:08	224 min		
	15:09-15:12	3 min		
	4.80 hours			

Date	Duration		Operation events	Note
25/9/2017	10:48-12:15	86 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.43 hours			
29/9/2017	18:33-20:08	94 min	Monitoring system error occurred.	Flow rate is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.57 hours			
10/10/2017	09:36-11:30	114 min	Maintenance of facilities. •Replace engine oil. →Generator shift from 1 st generator to 2 nd generator due to maintenance.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	11:40-13:57	137 min		
	4.18 hours			
13/10/2017	08:03-11:27	204 min	Generator shift 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.
	11:35-12:44	69 min		
	13:14-13:42	28 min		
	5.02 hours			
15/10/2017	14:04-16:03	119 min	Error of equipment - 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.
	16:04-16:48	44 min		
	2.72 hours			
17/10/2017	10:57-13:09	131 min	Monitoring system error occurred.	Flow rate is not available due to recording error. → Keep an hourly work log on the flow rate and CH ₄ concentration.
	2.18 hours			
13/11/2017	08:54-11:08	133 min	Maintenance of facilities. • Replace engine oil. →Generator shift from 1 st generator to 2 nd generator due to maintenance.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	11:26-13:22	116 min	Error of equipment - 2 nd generator's trip occurred.	
	4.15 hours			
15/11/2017	06:57-06:59	2 min	Error of equipment - Operation of 1 st generator due to failure of operation of 2 nd generator	Flow rate and CH ₄ concentration data is not available due to measurement error. →Excluded for estimation of emission reduction.
	07:00-07:52	52 min		
	0.90 hours			
16/11/2017	14:00-14:34	83 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.38 hours			
17/11/2017	11:31-11:40	9 min	Error of equipment - 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.
	11:45-13:24	98 min		
	13:31-13:34	3 min		
	1.83 hours			
21/11/2017	17:35-19:37	122 min7	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	2.03 hours			
23/11/2017	19:06-21:26	140 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	2.33 hours			
27/11/2017	13:45-15:03	78 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.30 hours			
5/12/2017	15:31-17:11	100 min	Monitoring system error occurred.	Flow rate is not available due to recording error. →Keep an hourly work log on the flow rate and CH ₄ concentration.
	1.67 hours			
18/12/2017	09:13-15:09	355 min	Maintenance of facilities. • Replace engine oil. →Generator shift from 1 st generator to 2 nd generator due to maintenance.	Flow rate and CH ₄ concentration data is not available due to measurement error. → Excluded for estimation of emission reduction.
	17:23-17:30	6 min	Error of equipment • Error of PLC card →Generator shift from 2 nd generator to 1 st generator	
	6.02 hours			
	6.42 hours			

Date	Duration		Operation events	Note
22/12/2017	05:38-12:04	385 min	Error of equipment - 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.
	6.42 hours			
26/12/2017	04:02-10:55	413 min	Error of equipment - 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.
	10:57-11:01	4 min		
	6.95 hours			

The description of the technology

The main process of the project is comprised of a LFG collecting system, a LFG 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

LFG 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 LFG 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 LFG 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 LFG 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 LFG status and other factors. J-trap and wellhead have same situation. To increase efficiency of LFG 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 LFG collecting system has been going on. The total amount of available landfill capacity was 2,897,000 m³. And about 87% of the landfill is in progress. in December 2017.

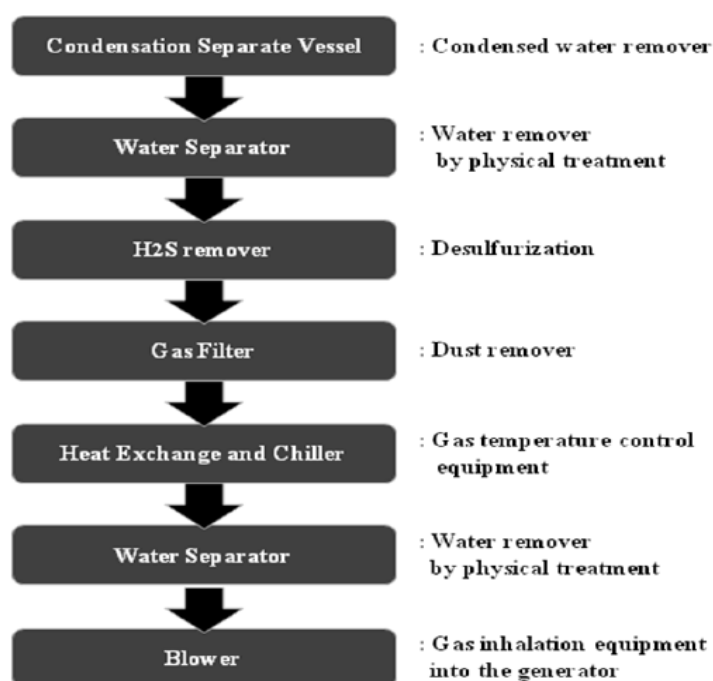
Detail history of wellhead is shown below <Table B-2>. Each of drawings has been submitted to the DOE.

<Table B-2> History of the LFG 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
November 2016	13	150	150	120
October 2017	13	150	150	120

LFG Pre-treatment System

Prior to electricity generation, the LFG 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 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	JGS 320 GS-L.L
		Gas volume	522 N m ³ /h
	Capacity of 1.058 MW	Manufacturer	GE Jenbacher
		Engine type	J 320 GS B81
		Gas volume	450 N m 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 the registered monitoring plan, applied methodologies or standardized baselines**

>>N/A

B.2.2. Corrections

>> Approval date and ref. No : 07 Sep 17(ref. No. PRC-2834-002)

The typographical errors of engine type were found during verification period for 7th monitoring.

(a) Modification to maintain consistency of engine type information representation

- 1st generator engine type : JGS 320 GS-L.L
- 2nd generator engine type : J 320 GS B81

B.2.3. Changes to the start date of the crediting period

>>N/A

B.2.4. Inclusion of monitoring plan

>>N/A

B.2.5. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other applied standards or tools

>> Approval date and ref. No : 06 Mar 14(ref. No. PRC-2834-001)

The by watt-hour meter (W_a) was measured 'exported electricity' from both 1st generator and 2nd generator. As per national regulation, "Act on the promotion of the development, use and diffusion of new and renewable energy", the electricity generation from 1st generator and 2nd generator should be measured separately because the commercial operation starting date was different. Accordingly, the PP was requested to measure the electricity generation separately and the PP installed new meter (W_c) to measure electricity from 2nd generator in attendance with KPX, the grid company.

W_a measures generated electricity from 1st and 2nd generators; W_c measures generated electricity from 2nd generator.

For more information, refer to PRC-2834-001.

B.2.6. Changes to project design

>> Approval date and ref. No : 07 Sep 17(ref. No. PRC-2834-002)

- (a) Changes in the number of facilities of collecting system(vertical well, well head and j-trap) due to maintenance

As landfill progresses, the management of LFG collecting system has been going on. The quantity of facility of collecting system changed by maintenance for 7th monitoring period.

The details of changes are as follow :

Facility	Function	Quantity (PDD ver.5)	Quantity (PDD ver.6)
Vertical well	LFG capture (75mm HDPE)	121	150
Wellhead	Collecting LFG from vertical gas wells	11	13
Barrel trap	Trapping the condensate from the main pipeline	15	15
J-Trap	Trapping the condensate from the vertical wells	117	120
Main Pipeline	LFG supply to the gas engine (250mm)	1	1

SECTION C. Description of monitoring system

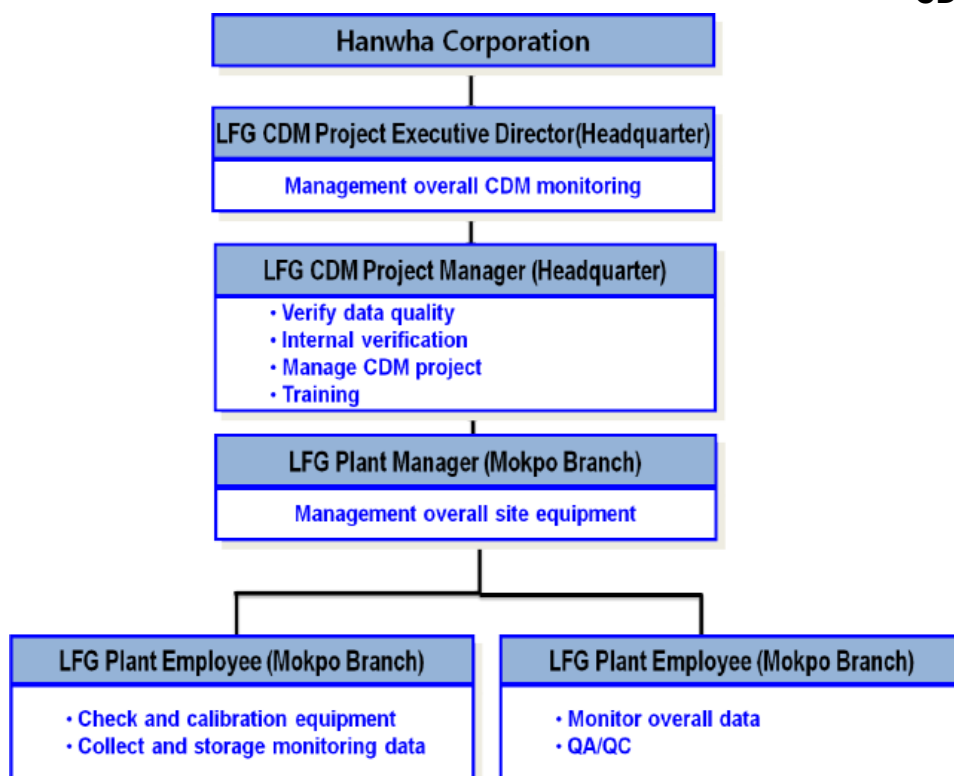
>>

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 & Achieve	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	
	Gas analyzer	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”)
	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

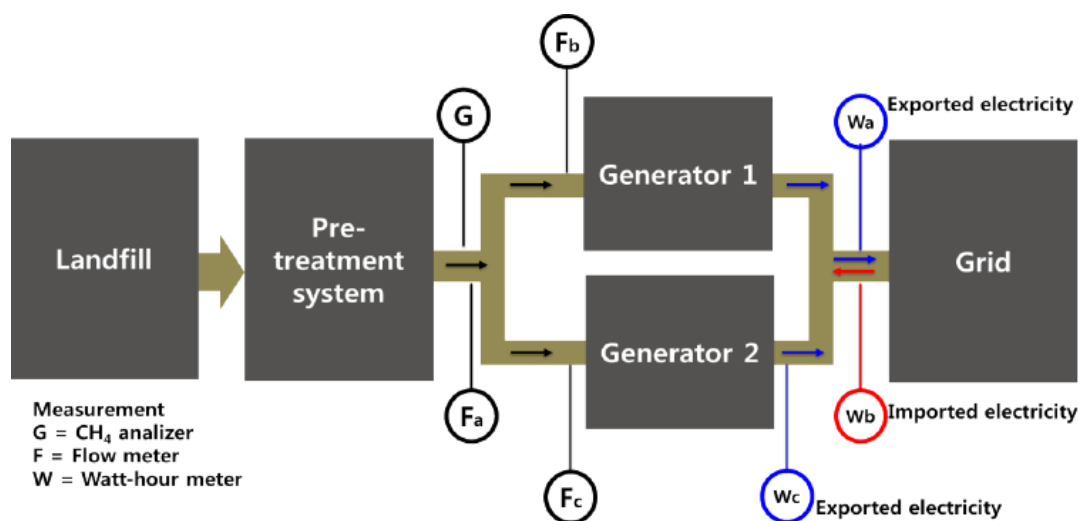
The monitoring equipment to measure the amount of methane and electricity

- 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 (hereinafter referred to as KPX). The certified sheet of measurement registration has been submitted to the DOE.
- A watt-hour meter for 2nd generator was installed on January 27th, 2013. HWC 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 W_a watt-hour meter, W_a as shown in <Figure C-2> below.

W_a 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 (W_c) in this monitoring period, the amount of exported electricity is expressed as follows:

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



<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 LFG. 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, it happened 3 times and was conservatively treated.

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.

In this monitoring period, there were replacements of 2nd generator flow meter on March 21st, 2017.

<Table C-2> Related flow meters

Tag	Fc (2 nd generator)	
	Before the replacement	After the replacement
Serial No	906044A	GR-170320
Accuracy level	1%	0.5%
Type	Thermal Mass Flow Meter	

- Gas analyzer records the density of methane gas in the LFG. 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 KPX and collected data shall be compared with those of sales receipt of KPX (<http://epsis.kpx.or.kr>).
- Before installation of 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 KEPCO.

<Table C-3> 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", Watthour 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 emissions trading scheme was done by experts (from consulting company) on November 27, 2017.

Internal training for the monitoring was done by LFG CDM project manager of headquarter on November 27, 2017.

SECTION D. Data and parameters**D.1. Data and parameters fixed ex ante**

Data/Parameter	Operation Margin Emission Factor (EF _{OM})
Unit	tCO 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 EF _{OM} in accordance with the guidance of AMS-I.D. which allows the above method where low-cost/must-run resources constitute less than 50% of total grid generation. The generating sources do not include low-cost and must-run plant in conformity with the direction of AMS-I.D. EF _{OM} is calculated using the data for the most recent 3 years (2005-2007) for which data are available at time of the PDD submission, and fixed for the crediting period.
Purpose of data/parameter	Calculation of Baseline/Project emission
Additional comments	This data is available at time of the PDD submission, and fixed for the crediting period

Data/Parameter	Build Margin Emission Factor (EF _{BM})
Unit	tCO ₂ e/MWh
Description	The generation-weighted average of CO ₂ emission per electricity unit generated 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	EF _{BM} is calculated ex-ante based on the most recent information available on plants already built for sample group at this PDD submission. According to AMS-I.D., the sample group consists of either the five power plants that have been built most recently or the power plant capacity additions in the electricity system that comprise 20% of the system generation and that have been built most recently. In this project, the latter is selected because project participant has to select the sample group that comprise the larger annual generation in guidance with the direction of AMS-I.D. the value EF _{BM} is fixed for the crediting period.
Purpose of data/parameter	Calculation of Baseline/Project emission
Additional comments	This data is available at time of the PDD submission, and fixed for the crediting period

Data/Parameter	CO ₂ Emission Intensity of the Electricity displaced (CEF _{electricity})
Unit	tCO 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/parameter	Calculation of Baseline/Project emission
Additional comments	This data is available at time of the 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/parameter	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/parameter	Calculation of Baseline emission
Additional comments	Not applied.

Data/Parameter	LFG _{electricity,y}					
Unit	N m³/ y					
Description	Amount of LFG combusted in power plant					
Measured/calculated/default	Measured					
Source of data	Gas flow meters					
Value(s) of monitored parameter	Data	Measured LFG_{electricity,y}(N m³)			Applied value	
		F_b	F_c	F_a	F_b + F_c	F_a
	01/01/2017 ~ 18/01/2017	201,679.600	15,162.500	214,388.900	216,842.100	0
	19/01/2017 ~ 18/02/2017	382,815.900	14,974.400	391,116.200	397,790.300	0
	19/02/2017 ~ 18/03/2017	115,299.600	195,056.200	309,627.600	283,431.100	20,876.200
	19/03/2017 ~ 18/04/2017	308,248.200	55,638.900	370,165.200	363,887.100	0
	19/04/2017 ~ 18/05/2017	394,449.000	1.700	395,808.800	394,450.700	0
	19/05/2017 ~ 18/06/2017	388,776.500	26,891.000	408,535.000	415,667.500	0
	19/06/2017 ~ 18/07/2017	306,302.200	58,984.000	365,454.200	365,286.200	0
	19/07/2017 ~ 18/08/2017	360,106.200	30,831.800	394,834.700	390,938.000	0
	19/08/2017 ~ 18/09/2017	406,115.400	0.000	410,093.600	406,115.400	0
	19/09/2017 ~ 18/10/2017	364,207.500	29,036.600	393,837.700	393,244.100	0
	19/10/2017 ~ 18/11/2017	393,488.200	15,480.700	404,773.900	408,968.900	0
	19/11/2017 ~ 18/12/2017	392,025.400	303.300	386,974.900	392,328.700	0
	19/12/2017 ~ 31/12/2017	140,341.900	0.000	143,848.700	140,341.900	0
	01/01/2017 ~ 31/12/2017	4,153,855.600	442,361.100	4,589,459.400	4,590,168.200	
	<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. '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>The manufacturer provides the official document for the unique error between two flow meters and it says the maximum error range is 1,728 N m³/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, it happened 3 times(22/02/2017, 09/03/2017, 10/03/2017) and was conservatively treated.</p> <p>All measured data for the crediting period has been submitted to the DOE as a spread sheet named "Mokpo 8th MR 2834 Emission Reduction".</p>					

Monitoring equipment	Tag	F _a (main)	F _b (1 st generator)	F _c (2 nd generator)	
				Before the replacement	After the replacement
	Serial No	GR-160994	GR-160995	906044A	GR-170320
	Accuracy level	0.5%	0.5%	1%	0.5%
	Type	Thermal Mass Flow Meter			
	Calibration Frequency	3 years			
	Date of installation	09/09/2016	09/09/2016	27/07/2009	20/03/2017
	Date of last calibration	02/09/2016	02/09/2016	31/03/2015 ~ 01/04/2015	20/03/2017
	Validity	01/09/2019	01/09/2019	30/03/2018	19/03/2020
	Calibration Entity	Golden Rules Co., Ltd.	Golden Rules Co., Ltd.	Flow Technology Co., Ltd.	Golden Rules 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. The 2nd generator's flow meter were replaced with new ones on March 21st, 2017. To ensure accuracy, the flow meters are subject to regular maintenance and testing. The flow meter is calibrated every three years. The achieved data is kept during the crediting period as well as two years after that. Daily data is documented in paper and achieved in electronic file. <p>The temperature and pressure in LFG are not monitored separately.</p> <p>This project involves the installation of two electricity generator. One of the generators is operating normally, and the other one is used as a standby unit.</p> <p>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/parameter	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 border="1"> <thead> <tr> <th>Date</th><th>Measured CH₄ (%) (Weighted average CH₄ concentration)</th></tr> </thead> <tbody> <tr> <td>01/01/2017 ~ 31/12/2017</td><td>52.421</td></tr> </tbody> </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)	01/01/2017 ~ 31/12/2017	52.421												
Date	Measured CH ₄ (%) (Weighted average CH ₄ concentration)																
01/01/2017 ~ 31/12/2017	52.421																
Monitoring equipment	<table border="1"> <thead> <tr> <th>Tag</th><th>G</th></tr> </thead> <tbody> <tr> <td>Serial No</td><td>A8M7282T</td></tr> <tr> <td>Accuracy level</td><td>Linearity 1%, Repeatability 0.5%</td></tr> <tr> <td>Type</td><td>Infrared gas analyzer</td></tr> <tr> <td>Calibration frequency</td><td>3 years</td></tr> <tr> <td>Date of last calibration</td><td>26/03/2015</td></tr> <tr> <td>Validity</td><td>25/03/2018</td></tr> <tr> <td>Calibration Entity</td><td>National Metrology Institute</td></tr> </tbody> </table> <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 achieved data is kept during the crediting period as well as two years after that. • Daily data is documented in paper and achieved in electronic file. 	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
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																
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/parameter	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	<table border="1"> <thead> <tr> <th>Date</th><th>W_a</th><th>W_c</th><th>Total EL_{EXP} (MWh)</th></tr> </thead> <tbody> <tr><td>01/01/2017 ~ 18/01/2017</td><td>258.602</td><td>20.860</td><td>279.462</td></tr> <tr><td>19/01/2017 ~ 18/02/2017</td><td>462.749</td><td>18.916</td><td>481.665</td></tr> <tr><td>19/02/2017 ~ 18/03/2017</td><td>142.070</td><td>245.334</td><td>387.403</td></tr> <tr><td>19/03/2017 ~ 18/04/2017</td><td>422.598</td><td>74.035</td><td>496.633</td></tr> <tr><td>19/04/2017 ~ 18/05/2017</td><td>509.065</td><td>0.000</td><td>509.065</td></tr> <tr><td>19/05/2017 ~ 18/06/2017</td><td>479.373</td><td>30.283</td><td>509.656</td></tr> <tr><td>19/06/2017 ~ 18/07/2017</td><td>393.883</td><td>68.183</td><td>462.066</td></tr> <tr><td>19/07/2017 ~ 18/08/2017</td><td>468.731</td><td>39.570</td><td>508.301</td></tr> <tr><td>19/08/2017 ~ 18/09/2017</td><td>530.719</td><td>0.000</td><td>530.719</td></tr> <tr><td>19/09/2017 ~ 18/10/2017</td><td>455.219</td><td>37.501</td><td>492.720</td></tr> <tr><td>19/10/2017 ~ 18/11/2017</td><td>493.308</td><td>18.171</td><td>511.478</td></tr> <tr><td>19/11/2017 ~ 18/12/2017</td><td>461.747</td><td>0.196</td><td>461.942</td></tr> <tr><td>19/12/2017 ~ 31/12/2017</td><td>183.243</td><td>0.000</td><td>183.243</td></tr> <tr><td>01/01/2017 ~ 31/12/2017</td><td>5,261.305</td><td>553.049</td><td>5,814.354</td></tr> </tbody> </table> <p>The exported electricity data is automatically monitored by certified watt-hour meters which are connected to 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.</p>	Date	W _a	W _c	Total EL _{EXP} (MWh)	01/01/2017 ~ 18/01/2017	258.602	20.860	279.462	19/01/2017 ~ 18/02/2017	462.749	18.916	481.665	19/02/2017 ~ 18/03/2017	142.070	245.334	387.403	19/03/2017 ~ 18/04/2017	422.598	74.035	496.633	19/04/2017 ~ 18/05/2017	509.065	0.000	509.065	19/05/2017 ~ 18/06/2017	479.373	30.283	509.656	19/06/2017 ~ 18/07/2017	393.883	68.183	462.066	19/07/2017 ~ 18/08/2017	468.731	39.570	508.301	19/08/2017 ~ 18/09/2017	530.719	0.000	530.719	19/09/2017 ~ 18/10/2017	455.219	37.501	492.720	19/10/2017 ~ 18/11/2017	493.308	18.171	511.478	19/11/2017 ~ 18/12/2017	461.747	0.196	461.942	19/12/2017 ~ 31/12/2017	183.243	0.000	183.243	01/01/2017 ~ 31/12/2017	5,261.305	553.049	5,814.354
Date	W _a	W _c	Total EL _{EXP} (MWh)																																																										
01/01/2017 ~ 18/01/2017	258.602	20.860	279.462																																																										
19/01/2017 ~ 18/02/2017	462.749	18.916	481.665																																																										
19/02/2017 ~ 18/03/2017	142.070	245.334	387.403																																																										
19/03/2017 ~ 18/04/2017	422.598	74.035	496.633																																																										
19/04/2017 ~ 18/05/2017	509.065	0.000	509.065																																																										
19/05/2017 ~ 18/06/2017	479.373	30.283	509.656																																																										
19/06/2017 ~ 18/07/2017	393.883	68.183	462.066																																																										
19/07/2017 ~ 18/08/2017	468.731	39.570	508.301																																																										
19/08/2017 ~ 18/09/2017	530.719	0.000	530.719																																																										
19/09/2017 ~ 18/10/2017	455.219	37.501	492.720																																																										
19/10/2017 ~ 18/11/2017	493.308	18.171	511.478																																																										
19/11/2017 ~ 18/12/2017	461.747	0.196	461.942																																																										
19/12/2017 ~ 31/12/2017	183.243	0.000	183.243																																																										
01/01/2017 ~ 31/12/2017	5,261.305	553.049	5,814.354																																																										
<table border="1"> <thead> <tr> <th>Tag</th><th>W_a</th><th>W_c</th></tr> </thead> <tbody> <tr><td>Serial No</td><td>95246742</td><td>50339836</td></tr> <tr><td>Accuracy level</td><td>0.5s</td><td>0.5s</td></tr> <tr><td>Type</td><td colspan="2">Watt-hour meters</td></tr> <tr><td>Calibration Frequency</td><td colspan="2">Performed at least once in 2 years</td></tr> <tr><td>Date of last calibration</td><td>17/08/2016 ~ 19/08/2016</td><td>17/08/2016 ~ 19/08/2016</td></tr> <tr><td>Validity</td><td>16/08/2018</td><td>16/08/2018</td></tr> <tr><td>Calibration Entity</td><td colspan="2">KTC (Korea Testing Certification)</td></tr> </tbody> </table> <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 KPX. 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 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 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 achieved data is kept during the crediting period as well as two years after that. Daily data is documented in paper and achieved in electronic file. 	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	17/08/2016 ~ 19/08/2016	17/08/2016 ~ 19/08/2016	Validity	16/08/2018	16/08/2018	Calibration Entity	KTC (Korea Testing Certification)																																						
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	17/08/2016 ~ 19/08/2016	17/08/2016 ~ 19/08/2016																																																											
Validity	16/08/2018	16/08/2018																																																											
Calibration Entity	KTC (Korea Testing Certification)																																																												
Monitoring equipment																																																													
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/parameter	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)
	01/01/2017 ~ 18/01/2017	0.240
	19/01/2017 ~ 18/02/2017	0.192
	19/02/2017 ~ 18/03/2017	0.096
	19/03/2017 ~ 18/04/2017	0.264
	19/04/2017 ~ 18/05/2017	0.216
	19/05/2017 ~ 18/06/2017	0.432
	19/06/2017 ~ 18/07/2017	1.032
	19/07/2017 ~ 18/08/2017	0.336
	19/08/2017 ~ 18/09/2017	0.048
	19/09/2017 ~ 18/10/2017	0.456
	19/10/2017 ~ 18/11/2017	0.576
	19/11/2017 ~ 18/12/2017	0.264
	19/12/2017 ~ 31/12/2017	1.104
	01/01/2017 ~ 31/12/2017	5.256
	<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>01/01/2017 to 31/12/2017, 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. 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	24142000332	
	Accuracy level	0.5s	
	Type	Watt-hour meter	
	Calibration Frequency	Once in 2 years	
	Date of installation	14/04/2015	
	Date of last calibration	1 st	2 nd
		17/06/2014	17/08/2016 ~ 19/08/2016
	Validity	1 st	2 nd
		16/06/2016	16/08/2018
Calibration Entity	Korea Testing Certification (KTC)		
	<ul style="list-style-type: none">• The amount of imported electricity will be measured automatically by certified watt-hour meter. The project participant will check the amount of the imported electricity at the web site (http://cyber.kepco.co.kr) and get the paper bill from KEPCO monthly.• The achieved data is kept during the crediting period as well as two years after that.• The monthly data is achieved 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/parameter	Calculation of Project emission		
Additional comments	Not applied.		

D.3. Implementation of sampling plan

>>
N/A

SECTION E. Calculation of emission reductions or net anthropogenic removals

E.1. Calculation of baseline emissions or baseline net removals

>>

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

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.

$$MD_y = LFG_{\text{electricity},y} * w_{CH_4,y} * D_{CH_4,y} * GWP_{CH_4}$$

Parameter	Unit	Description
$LFG_{\text{electricity},y}$	N m ³	LFG flared or used as fuel in the year 'y'.
$w_{CH_4,y}$	%	Methane content in LFG in the year 'y' (mass fraction).
$D_{CH_4,y}$	kg/N m ³	Density of methane at normal conditions in the year 'y'. (Source: ACM0001 ver.11)
GWP_{CH_4}	tCO ₂ /tCH ₄	Global warming potential of methane

Density of methane in LFG is determined at the temperature and pressure of the LFG as described in AMS-III.G. However, $LFG_{\text{electricity},y}$ 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 removals

>>

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

Parameter	Unit	Description
$EL_{\text{IMP,PJT},y}$	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 emissions

>>

Mokpo LFG 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. Calculation of emission reductions or net anthropogenic removals

Date	ER _y	$LFG_{\text{electricity},y}$	w_{CH_4}	$D_{CH_4,y}$	GWP_{CH_4}	$MD_{\text{reg},y}$	$EL_{\text{EXP,PJT},y}$	$EL_{\text{IMP,PJT},y}$	CEF	Leakage
01/01/2017 ~ 31/12/2017	46,241.389	4,590,168.200	52.421	0.0007168	25	0	5,814.354	5.256	0.5375	0

	Baseline GHG emissions or baseline net GHG removals (t CO ₂ e)	Project GHG emissions or actual net GHG removals (t CO ₂ e)	Leakage GHG emissions (t CO ₂ e)	GHG emission reductions or net anthropogenic GHG removals (t CO ₂ e)		
				Before 01/01/2013	From 01/01/2013	Total amount
Total	46,244.214	2.825	0	0	46,241.389	46,241

E.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the registered PDD

Amount achieved during this monitoring period (t CO ₂ e)	Amount estimated ex ante (t CO ₂ e)
46,241	26,780

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 8th monitoring period are shown in the below table.

Year	ER _y	ER _{CH₄}	BE _{y,CH₄}	PE _{y,CH₄}	Leakage	ER _{electricity}	BE _{y,electricity}	PE _{y,electricity}	Leakage
2017 (365days)	26,780	23,262	23,262	0	0	3,5179	3,520	1	0

E.6. Remarks on increase in achieved emission reductions

>>

Actual values reached during the monitoring period: 46,241 tCO₂e

Values applied in ex-ante calculation of the registered CDM-PDD: 26,780 tCO₂e

The emission reductions increased to 73% 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 18% increase in this monitoring period.

Expected data in registered PDD calculated using conservative data.

In PDD, $BE_y = BE_{CH_4,SWDS,y} - MD_{reg,y}$ The methane emission potential of a solid waste disposal site, $BE_{CH_4,SWDS,y}$ in tCO₂e, 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 6.44 m³/min (on the registered CDM-PDD: 365days in 2017) but the actual average flow was 8.73 m³/min during the monitoring period. In other words, there was 36% 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	70,732
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
2016	62,318	53,249
2017	61,857	32,453
Total	706,367	689,457

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 LFG 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. After the waste is landfilled, In the landfill occurs a stable gas production within two years. The assumption for the expected amount of waste in landfill from 2007 to 2016 is 644,510 ton. In same period, the actual quantity of waste is 657,004 ton. This tendency of increase can affect a stable LFG gas production.

CH₄ concentration

The PDD estimate was based on 50% CH₄ concentration but the actual concentration exceeds 52.421% 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 increase in this monitoring period. The change of waste composition and maintenance for landfill is the biggest contributor for increase in CH₄ concentration.

Seasonal effect

Rain interrupts LFG 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 LFG was increased.

Maintenance of LFG 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 LFG.

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 LFG.

Amount of exported electricity

The amount of exported electricity was estimated to be 6,751 MWh (on the registered CDM-PDD: 365days in 2017) but the actual amount of exported electricity was 5,814 MWh during the monitoring period. In other words, there was 16% 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"/> Person/entity responsible for completing the CDM-MR-FORM
Organization name	Hanwha Corporation
Street/P.O. Box	86 Cheonggyecheon-ro, Jung-gu
Building	22F. Hanwha Bldg.
City	Seoul
State/region	
Postcode	04541
Country	Republic of Korea
Telephone	+82-2-729-3543
Fax	+82-2-729-3509
E-mail	jihyunpark@hanwha.com
Website	http://english.hanwhacorp.co.kr/
Contact person	Jihyun Park
Title	
Salutation	Ms.
Last name	Park
Middle name	
First name	Jihyun
Department	Merchandise Business Department
Mobile	
Direct fax	
Direct tel.	
Personal e-mail	